SIEMENS

MULTIGAS and MULTIGAS+ Modules
Service Manual

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ADVISORY

Siemens is liable for the safety of its equipment only if maintenance, repair, and modifications are performed by authorized personnel, and if components affecting the equipment's safety are replaced with Siemens spare parts.

Any modification or repair not done by Siemens personnel must be documented. Such documentation must:

- be signed and dated
- contain the name of the company performing the work
- describe the changes made
- describe any equipment performance changes.

It is the responsibility of the user to contact Siemens to determine warranty status and/or liabilities if other than an authorized Siemens Service Representative repairs or makes modifications to medical devices.

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Chapter 1 Introduction

1 Overview

MULTIGAS™ and MULTIGAS+™ Modules (MGM) are free-standing units that perform sidestream measurements of respiratory and anesthetic gases. The modules automatically identify and measure five common anesthetic agents (Isoflurane, Halothane, Enflurane, Sevoflurane, Desflurane), and report the agent detected and its measurement data to the host device (such as an SC 9000, SC 7000, SC9000XL, or SC 8000 Patient Monitor, or KION). The modules also monitor respiratory gases CO_2, N_2O, and O_2, and report measurements to the host as waveforms (except N_2O) and parameters.

MULTIGAS and MULTIGAS+ Modules differ only in the way that they measure O_2. The basic MULTIGAS Module measures O_2 using a galvanic cell, and calculates average inspiratory values for O_2 (labeled iO2). The MULTIGAS+ Module Incorporates a faster-acting paramagnetic sensor that provides both inspired and expired O_2 measurements (iO2 and etO2). The outward appearance of the modules differs only in the rear view. The O_2 galvanic cell is visible on the rear panel of the MULTIGAS Module. The paramagnetic cell is internal in the MULTIGAS+ Module. See Figure 1-1. In this service manual, the term MULTIGAS is used synonymously with MULTIGAS+ unless specifically stated otherwise.

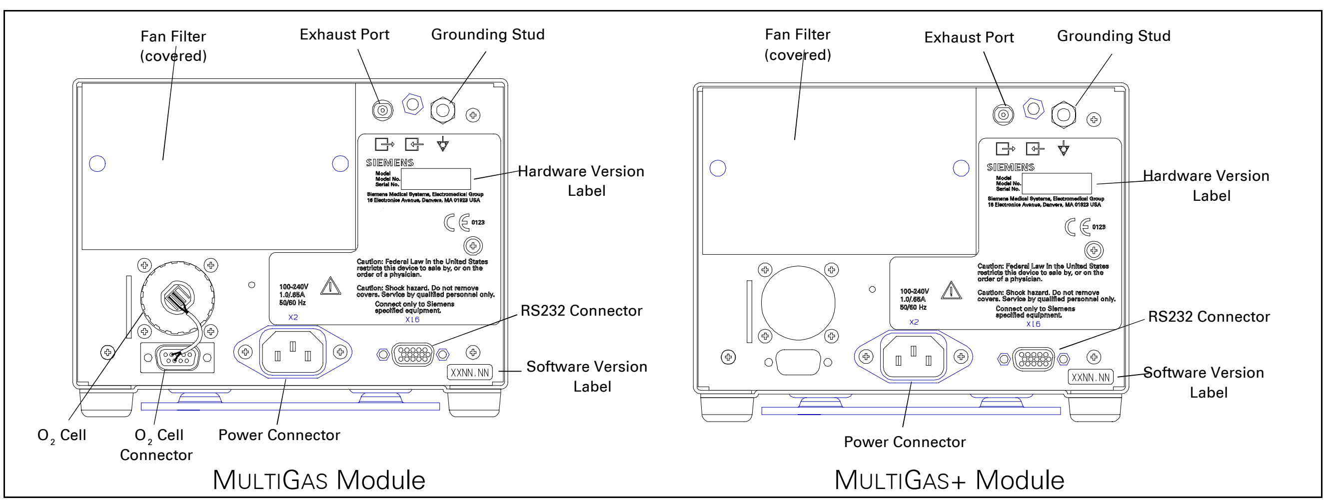
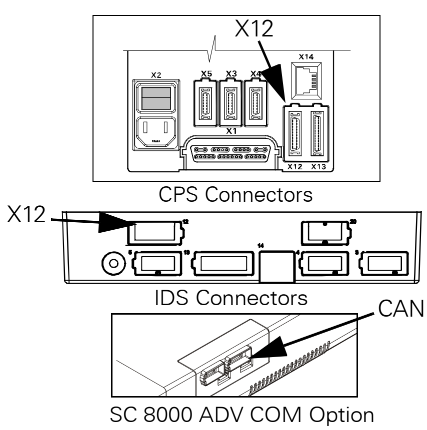


Figure 1-1 MULTIGAS and MULTIGAS+ Modules - Rear Views

2 Hardware Installation



MGM connects to the host (monitor) via an INFINITY Device Communication Power Supply (CPS) or INFINITY Docking Station (IDS) or SC 8000 Patient Monitor. A cable connects the RS232 port on the rear of the MGM to the SC 8000 or to X12 on the CPS/IDS. (The IDS must have a MIB Option installed; SC 8000 requires installed Adv Com Option.) See illustrations at left. The host displays parameter and setup information, only while the module is actually connected. When the module is disconnected, all parameters, waveforms, and setup menus remain on the display until the host is powered off. If host is powered on again without MGM connected, gas parameters and waveforms do not reappear.

Refer to the User Guide for the software version installed in the monitor, for applicable Technical Data, and for procedures to access the MGM menu structure in the monitor.

3 Service Strategy

In light of the state-of-the-art technology used in the manufacture of Siemens' equipment, proprietary nature of the software, and specialized equipment required for replacement of most individual parts, Siemens' policy is for the MGM to be serviced only to the field-replaceable subassembly level, after expiration of the warranty period. While in the warranty period, an MGM found to be malfunctioning should be returned to the factory for repair or replacement. After expiration of the warranty period, replacement of components other than those listed in Spare / Exchange Parts should be performed only at Siemens service depots.

4 Preventative Maintenance

Siemens recommends that the following preventative maintenance procedures be performed annually.

> **Warning**
>
> All parts of a MultiGas/+ module that come in contact with the patient's airway (such as all internal and external tubing, water trap and water trap manifold, and filters) may be contaminated. Handle according to the hospital's procedures and guidelines for handling infectious substances. Also, see Disease Prevention.

Before initiating preventative maintenance procedures, do the following:

- With MGM running with host, verify that the reported revision of the software and hardware is up to date in accordance with the Software Compatibility Chart for the INFININTY NETWORK (or with the installed software in the host if the host is operating in standalone mode). If not, the unit can be updated later in this procedure.
- Verify status that no errors are flagged. If any errors are flagged, troubleshoot and repair the MGM before completing the following procedure.

1. Turn off power to MGM.
2. Unscrew top cover, and gently remove cover.
3. Inspect and replace the following, if necessary (expected replacement rate of these parts is once per year):
   - Internal Nafion® Tubing Assy (qty=2)
   - Room air filter
   - Pump filter
   - Internal Bacterial filter (qty=2)
   - Water trap seals (qty=2)
   - Fan filter
   - Water trap
4. Clean and remove any excess dust, etc.
5. If necessary, update software and/or hardware.
6. Power up MGM.

7. Perform Leakage Check Procedure.
8. Perform Pump Flow Rate Verification Procedure.
9. Perform Span Verification Procedure.
10. Turn unit off and replace top cover.
11. Power up unit and verify status is okay.

5 Recommended Tools & Test Equipment

- SC 9000, SC 7000 / SC 9000XL Patient Monitor with CPS or IDS (with installed MIB Option + CAN), or SC 8000 (with installed Adv Com Option), or KION
- Appropriate communication cables (from host to MGM).
- Siemens Calibration Kit - SVC TOOL MGM/MGM+ CAL KIT, Art. No. 52 07 415 E536U, containing the following:

  Calibration gas - contains 3.00% Isoflurane, 5.00% CO_2, 40.00% N_2O, 52% Oxygen (with a 1% gas concentration accuracy), Siemens Art. No. 57 36 322 E536U.

  Gas Regulator

  Tubing w/ Luer-lock fittings

  T-Piece w/ Luer-lock fittings

  Two-way valve w/ Luer-lock fittings

  Gas collection bag
- Flow meter with a range of minimum 0 - 350 ml/min, accuracy ±5% or better, (Sierra Flow Control Model 822-13-OV1-PV1-V1 calibrated for “standard - l/min” is recommended
- Pressure Gauge

  Recommended: Setra Digital Pressure Gauge, Model 370 or equiv.

Note: Pressure gauge required only if verifying and/or calibrating the pressure channel. The hospital and/or a local weather station or airport may be able to provide a reading.

- Exhaust system (for exhausting calibration gas).
- Digital Voltmeter w/ 3½ digit resolution (minimum)
- Oscilloscope (optional)
- Hand tools:
  - — Medium sized Phillips screwdriver
  - — Medium sized flat head screw driver
  - — Wire cutters
  - — Non - serrated needle nose pliers
- Loctite adhesive or equivalent

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Chapter 2 Functional Description

1 Introduction

Both THE MULTIGAS and MULTIGAS+ Modules provide a non-dispersive infrared measurement of respiratory and anesthetic gases. The O_2 analyzer subsystem of the MULTIGAS module uses an electrochemical fuel cell, and the MULTIGAS+ module uses a paramagnetic cell. Both modules are designed to work with the host monitor through a serial digital interface. The MGM is intended for measuring airway gases of ventilated patients, within the anesthesia workplace, during the induction and maintenance of, and emergence from, general anesthesia.

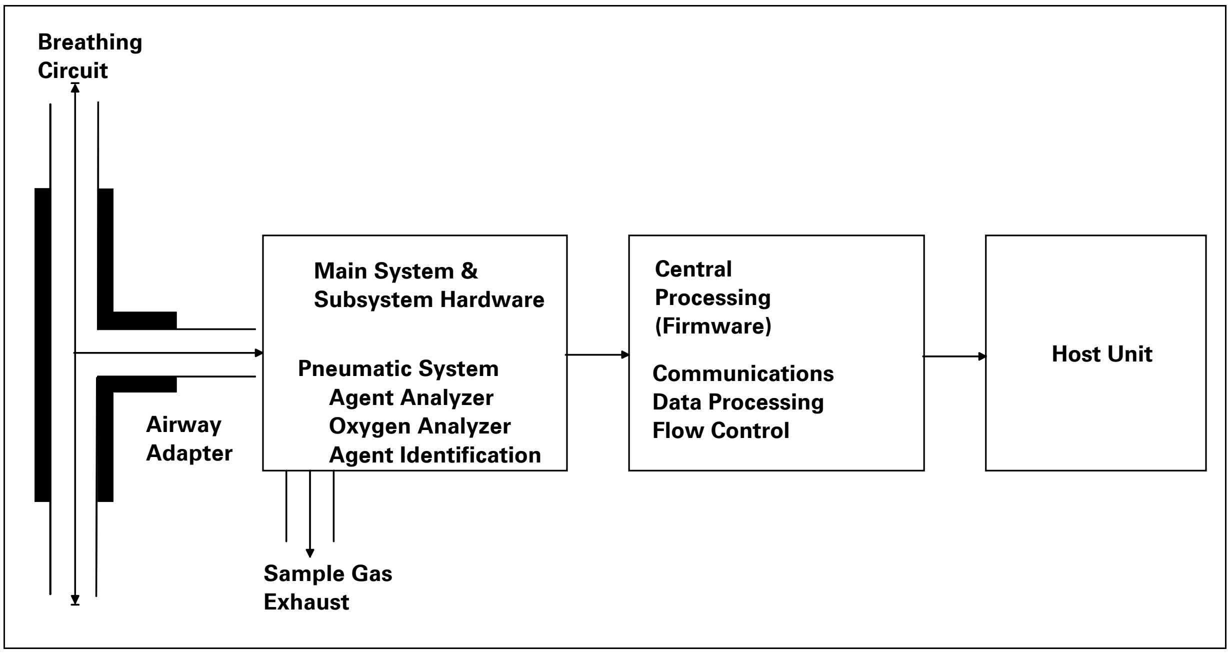


Figure 2-1 Functional MGM Block Diagram

2 Overall Functionality

The MGM pulls the sample gas off the endotracheal tube of a ventilated patient and leads the sample gas through three analyzer subsystems: the Agent Measurement Analyzer (AMA), the Oxygen (O_2) Analyzer, and the Agent Identification Analyzer (AIDA). The computational processing unit in the MGM derives waveform data for CO_2, anesthetic agents (one out of Halothane, Enflurane, Isoflurane, Sevoflurane, and Desflurane), and O_2, together with airway respiration rate and inspired and end-tidal values for the gases, and also including N_2O. The derived data is transmitted to the host system which derives alarms from the received data, displays all the alarms and data, and communicates them to other functional modules in the monitoring system.

3 Method of Operation

The airway gases measurement technique used in the AMA subsystem and the AIDA subsystem are based on the non-dispersive infrared absorption of light by molecular gases.

The airway gases measurement technique used in the oxygen analyzer subsystem of the Anesthetic Gas Subsystem is dependent on the type of O_2 transducer used.

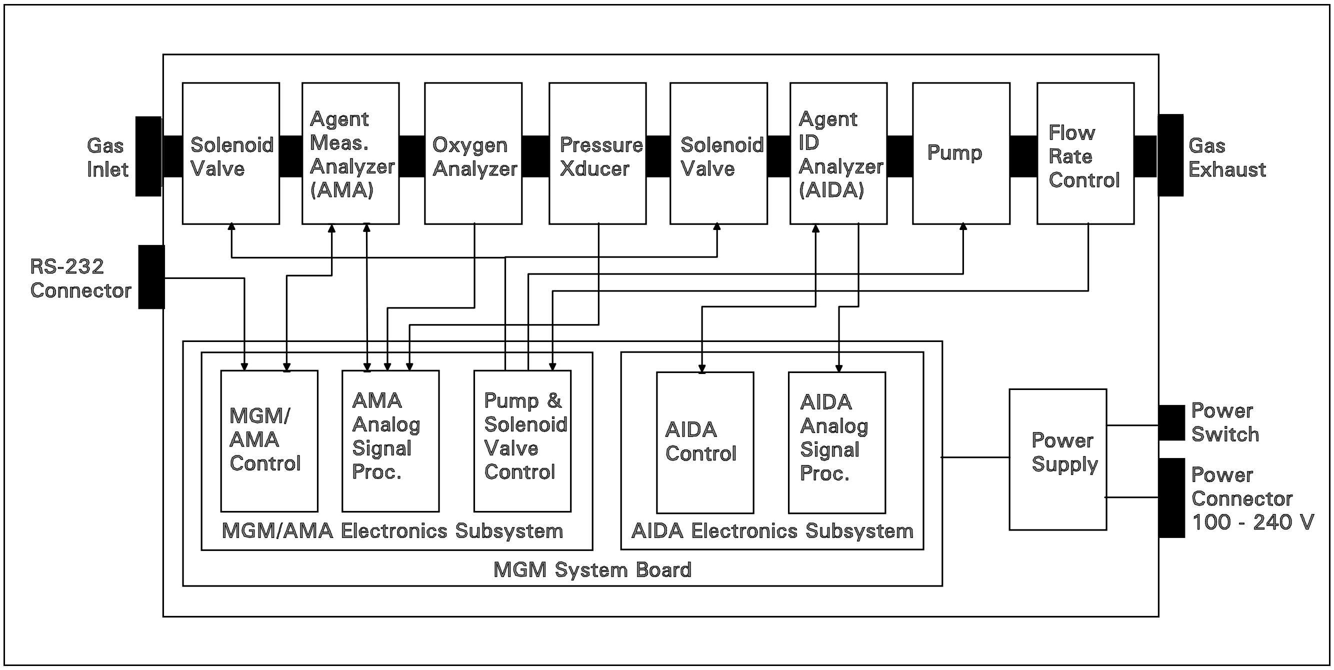


Figure 2-2 Anesthetic Gas Subsystem Functional Block Diagram

4 Subassemblies, Modules and Components

This document describes the subassemblies, modules, and components of the MGM, how they are controlled by the central processing unit, how the CPU processes the data received from the analyzer subsystems, and how communication between the MGM and the host system (SC 9000, SC 7000, SC 9000XL, or SC 8000 Patient Monitor) works.

5 Anesthetic Gas Subsystem

Figure 2-2 shows a functional block diagram of the Anesthetic Gas Subsystem, which houses the system board and the following major components:

- Agent Measurement Analyzer (AMA)
- Agent Identification Analyzer (AIDA)
- Oxygen (O_2) Analyzer
- Pneumatic System
- Power Supply

These components are typically built into a metal box whose dimensions, weight, and additional features meet the unique requirements of the SC9000, SC 7000, SC 9000XL, SC 8000 or similar host. Typically it includes a power switch, a power connector, an RS-232 connector, a gas inlet, and an exhaust tube.

6 Main System

The Pneumatic System (consisting of the pump, tubing system, solenoid valves, and flow control components) pulls the gas from the gas inlet through the analyzer subsystems at a well-defined flow rate. The second solenoid valve is used when both the Oxygen (O_2) Analyzer and the Agent Identification Analyzer are installed.

The Agent Measurement Analyzer determines the concentration of CO_2, N_2O and one anesthetic agent in the gas sample. The AMA is plumbed "first in line," so that CO_2 data is not distorted and capnographic waveforms can accurately be displayed by the host monitoring system.

The O_2 Analyzer determines the oxygen concentration in the gas sample.

The Pressure Transducer measures the differential pressure of the gas contained in the pneumatic system. During a Zero calibration this equals the ambient environmental pressure. This pressure transducer is physically housed in the AMA, but plumbed after the O_2 Analyzer.

The Agent Identification Analyzer determines which anesthetic agents, if any, are contained in the gas sample.

The Power Supply provides the Anesthetic Gas Subsystem and all of its components with the power necessary to keep the system working. It operates at an input voltage range of 100 - 240 V_{ac}, and is certified to be in compliance with the applicable requirements of UL544 (Patient Care Equipment), CSA 22.2 No. 234 (Level 3), IEC 601-1 (1988), EN60601, and VDE 0750/5.82.

The Electronics Subsystem, with memory (ROM and RAM), multiplexers, A-D converter, and power line supervision, is responsible for the following functions:

- Acquisition and processing of data from, and control of, the AMA
- Acquisition and processing of data from the Oxygen Analyzer
- Controlling the Pneumatic System
- Controlling the communications between the Anesthetic Gas Subsystem and the host monitoring system
- Controlling the communications between the Anesthetic Gas Subsystem and the Agent Identification Subsystem.

The MGM/AMA Electronics Subsystem has two communications channels -- one connected to an external RS-232 port and the other connected to the AIDA Electronics Subsystem.

The AIDA Electronics Subsystem, with memory (ROM and RAM), multiplexers, A-D converter, and power line supervision, acquires and processes data from agent identification and controls the AIDA. The only communications channel in the AIDA Electronics Subsystem is the one connected to the MGM/AMA Electronics Subsystem.

Full functionality of the Anesthetic Gas Subsystem is controlled by its firmware.

7 Agent Measurement Analyzer

The proven, known, and widely used technology of non-dispersive infrared gas analysis is used by the AMA in the Anesthetic Gas Subsystem. Figure 2-3 on page 8 is a functional block diagram of this analyzer subsystem.

The infrared light source is constructed of tungsten powder metal which is embedded in an Al_2O_3 ceramic. This source is electrically heated to an operating temperature of 600°C. Infrared emission from this source is distributed as a blackbody radiator.

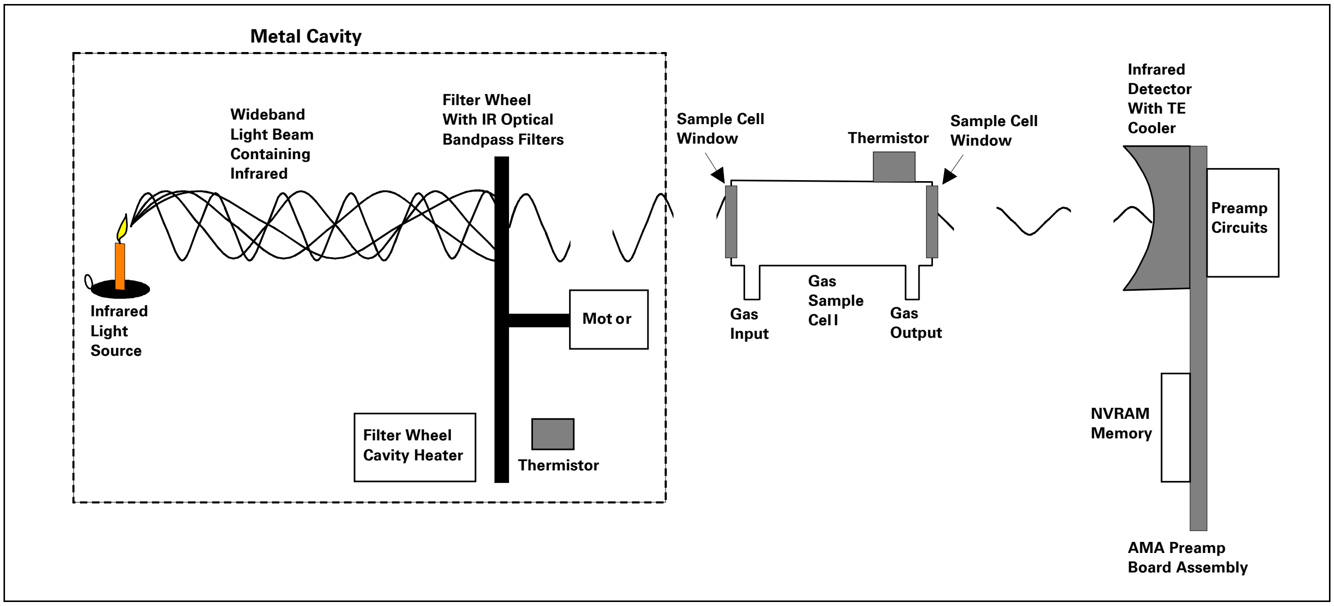
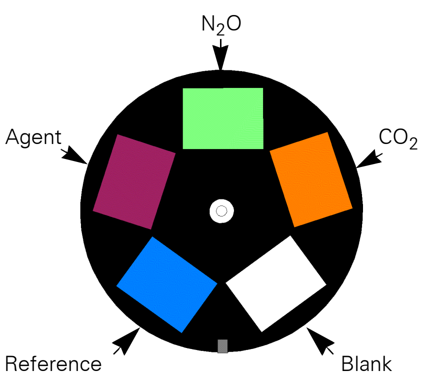


Figure 2-3 Agent Measurement Analyzer Functional Block Diagram



Filter Wheel

The sample cell is constructed of a stainless steel tube with a reflective inside surface which serves as a light pipe. The sample cell length has been designed to provide an adequate absorption length to obtain the desired signal-to-noise ratio for the weakest anticipated absorption. Sapphire serves as the sample cell window material for the two ends of the sample cell.

The gas sample to be analyzed enters the sample cell through the gas inlet and leaves it through the gas outlet. While in the cell, the gas sample is penetrated by light from the infrared light (IR) source. This light is filtered by coated optical bandpass filters mounted on the filter wheel (see illustration at left). The attached brushless DC motor spins the filter wheel so that the appropriate filter for each gas type (CO_2, N_2O, agent) comes into place one after the other. The filter wheel cavity heater maintains the metal cavity at 65°C under control of a thermistor. The wavelengths used are –

- 4.3μ for CO_2
- 3.6μ for N_2O
- 3.3μ for anesthetic agents

The thermistor attached to the sample cell wall provides a measure for the sample cell temperature. Knowledge of sample pressure and sample temperature is vital to accurately determine gas concentrations in the gas sample. Sample pressure is provided by a pressure transducer housed in the AMA but actually plumbed behind the O_2 Analyzer. It is therefore its own gas connection.

The photoresistive lead selenide (PbSe) infrared detector, mounted on the preamplifier board assembly, converts the IR radiation not absorbed by the gas sample to an electrical signal. The transmittance of IR radiation is a measure of the total number of molecules of a given gas in the sample cell. The detector's output signals are preamplified and consist of a pulse stream, one pulse for each IR filter, corresponding to the fraction of this gas type in the sample. The IR detector temperature is kept at 2°C by a thermo-electric cooler to enhance signal-to-noise ratio.

A calibration mechanism guarantees long-term stable measurements and eliminates filter variations.

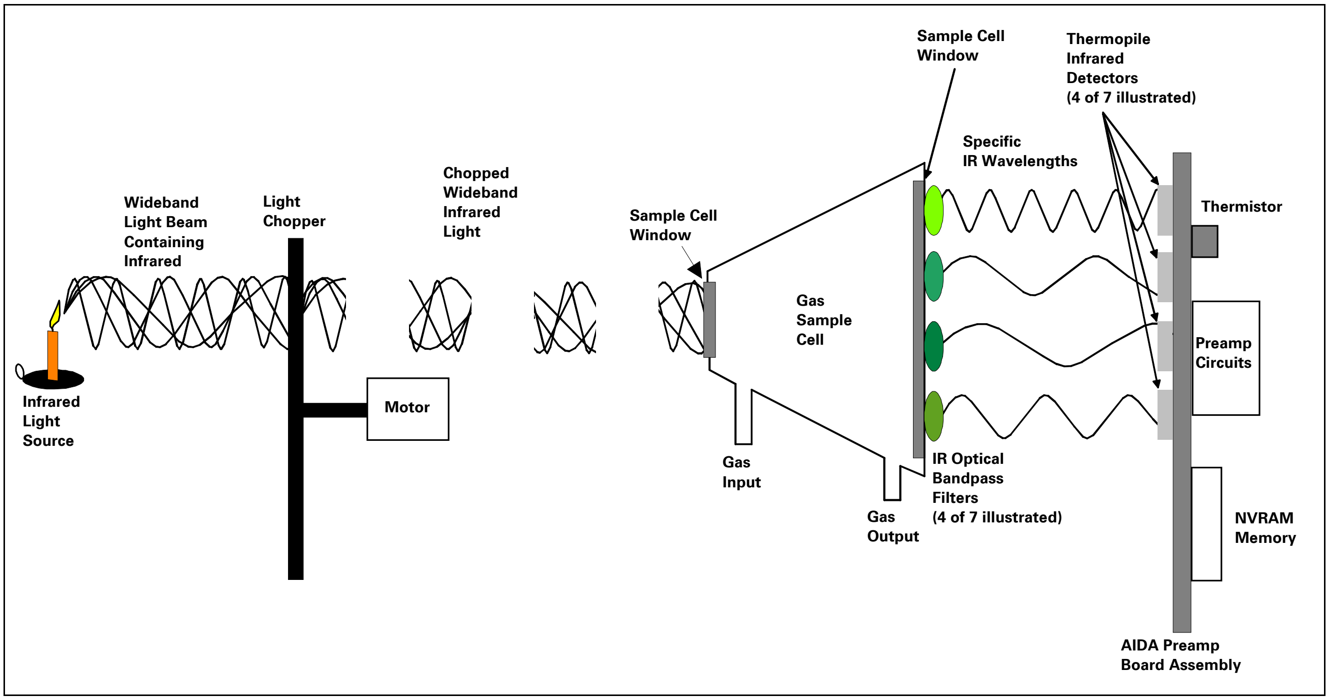


Figure 2-4 Agent Identification Analyzer (AIDA) Functional Block Diagram

8 Agent Identification Analyzer

The agent identification function identifies which of the following anesthetic agents is being used:

- one agent out of Isoflurane, Halothane, Enflurane, or
- one agent out of Isoflurane, Halothane, Sevoflurane, or
- one agent out of Isoflurane, Halothane, Desflurane.

Like the AMA, the AIDA in the Anesthetic Gas Subsystem uses the technology of non-dispersive infrared gas analysis. Figure 2-4 shows a functional block diagram of this analyzer subsystem.

Infrared light from the IR light source (which is identical to the AMA IR light source) is modulated using a rotating chopper wheel driven by a stepping motor which is speed controlled by the Electronics Subsystem.

Narrow band filtering and demodulation techniques greatly enhance the quality of the signal generated in the infrared absorption process.

The sample cell is made of thermoplastic, and has a conical shape and non-reflective walls. The cell window material is silicon.

Seven thermopile IR detectors which do not require cooling, each output an analog signal whose magnitude is inversely proportional to the infrared light absorption at the corresponding frequency. These frequencies are determined by the bandpass filters (4 of 7 illustrated in Figure 2-4) operating in the wavelength region from 10μ to 13μ. The thermistor output is used to compensate for the effect of IR filter temperature changes. The analog signals are directly related to the anesthetic agent gas concentrations in the sample cell.

The IR detector outputs are measured during both chopper wheel phases. Measurements taken when the IR light beam is interrupted provide the dark level reference needed by the signal processing software.

These signals are amplified, filtered, and digitized by the pre-amplifier on the pre-amplifier board assembly. The digitized waveform is then demodulated by the electronics subsystem to obtain a transmission value for each detector.

The following transmission data is used to obtain the gas concentration values used by the agent identification routine.

- The seven preamplified IR detector outputs
- The thermistor output
- The Zero calibration constants
- Factory characterization constants
- Gas concentration algorithms
- Primary agent ID thresholds
- Secondary agent ID thresholds
- Primary to secondary agent ID crosstalk factors

A calibration mechanism guarantees long-term stable measurements and eliminates filter variations.

9 Oxygen Analyzer

In the MULTIGAS+ Module, the Paramagnetic Oxygen Transducer provides "fast" O_2 measurement. In the MULTIGAS Module, the electrochemical type sensor provides O_2 measurement with a slower response time. Both the paramagnetic sensor and the electrochemical cell deliver an analog signal linearly proportional to the oxygen concentration in the sample gas.

9.1 Paramagnetic O_2 Measurement

O_2 is paramagnetic, which means that a magnetic field induced in O_2 will be in the same direction as, and in greater strength than, the magnetizing field. In the paramagnetic oxygen transducer, O_2 is placed in two sealed spheres of a dumb-bell assembly, which is suspended on a spring device in a symmetrical non-uniform magnetic field. The assembly assumes a position away from the most intense part of the field.

Sample gas surrounds the dumb-bell assembly, and when the surrounding gas contains O_2, the dumb-bell spheres are pushed further out of the field by the relatively stronger paramagnetic O_2. The strength of the torque acting on the dumb-bell is proportional to the paramagnetism of the surrounding gas, and is converted into an analog voltage which is likewise proportional to the oxygen concentration.

9.2 Electrochemical O_2 Measurement

The electrochemical O_2 analyzer operates like a battery. O_2 in the gas sample, in contact with an electrolyte, generates a voltage proportional to the concentration of O_2.

10 Pneumatic System

The Anesthetic Gas Subsystem includes a gas sampling system which accurately controls the flow rate of gas through the analyzer system. Nafion® tubing, a hygroscopic material made from Teflon and polypropylenesulfonic acid copolymer, is added to the sampling line inside the Anesthetic Gas Subsystem to eliminate residual water. Anesthetic agents, N_2O, and CO_2 are impermeable to the tubing.

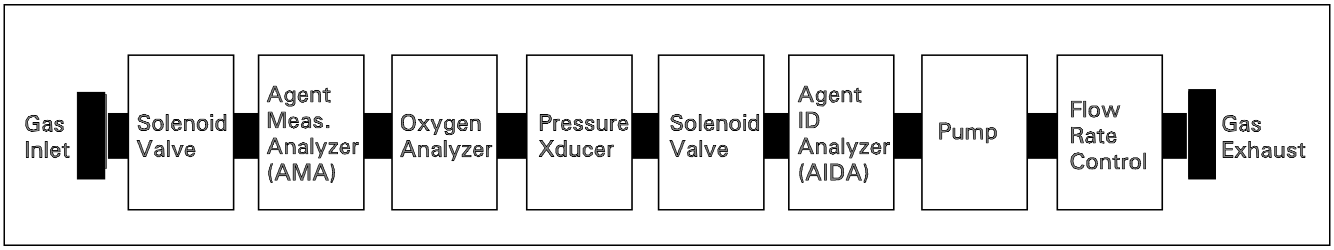


Figure 2-5 Pneumatics Block Diagram (excerpt from Figure 2-2.)

As illustrated in Figure 2-5, pneumatic solenoid valves are incorporated in the gas stream to switch between the patient gas stream (normal operation) and room air (during Zero calibration). The selected gas (patient or room air) is directed to the Agent Measurement Analyzer, O_2 analyzer, and Agent Identification Analyzer.

A servo controlled pump is attached to the exhaust of the analyzer. The pump generates the flow through the system and pulls the gas from the airway adapter through the analyzers to the exhaust outlet. It also delivers the Zero calibration gas to the sample cells of the analyzer subsystems for the periodic zero procedures, and exhausts the patient's sample gas, zero calibration and field calibration gases. The pump can be operated at four different flow rates, which are hardware-adjusted during factory calibration of the MGM. See Table 2-1.

Table 2-1 Pump Flow Rates

Flow Type	**Flow Rate**	**Description**	
Idle	No Flow	Pump switched off	
Low	120 ml/min	With Paramagnetic O_2 analyzer	With Electrochemical O_2 analyzer
		Used for analysis of patient gas samples	Optionally used for analysis of patient gas samples.
High	200 ml/min	With Paramagnetic O_2 analyzer	With Electrochemical O_2 analyzer
		Used for purging Agent Measurement and paramagnetic O_2 analyzers before and after zero calibration	Used for normal analysis of patient gas samples
Purge	350 ml/ min	With Paramagnetic O_2 analyzer	With Electrochemical O_2 analyzer
		Used for purging the Agent Identification Analyzer before and after Zero calibration	Used for purging the Agent Measurement and Agent Identification Analyzers before and after Zero calibration

A flow sensor, consisting of a differential pressure transducer, a dampener, and a flow restrictor, is used to determine, stabilize and limit the flow rate of the sampled gas. The output from the pressure transducer is used in a servo system to control the drive power to the pump. The dampener (a 15cc container) isolates the sample cells of the analyzer subsystems from pulsations, enabling a smooth flow through the system. The flow rate control logic works as hard as necessary to maintain the selected flow rate. A partial occlusion, or an inefficient pump, result in the pump being driven harder. A serious occlusion results in the pump being driven at or near its maximum drive. A sense circuit is then triggered to report an occlusion.

11 Self-Test

A power-up self-test is performed to validate the contents of firmware memory (ROM), read/write memory (RAM) and non-volatile memory (NVRAM), and to verify errorless access to these storage devices for read and write operations.

12 Calibration

In order to guarantee long-time stable measurement performance the MGM must be enabled to cope with three types of conditions that can lead to measurement errors:

- Small differences among the components of a subsystem (e.g., caused by limitations in manufacturing precision)
- Changes of the physical properties of some components over time (e.g., caused by aging or pollution)
- Limitations in the compensation for certain effects (e.g., changes in cell temperature/pressure or cross-gas interference)

Each of these conditions can be handled by an appropriate calibration process performed either during original manufacture, as part of normal preventive maintenance, or during normal use.

12.1 Factory Calibration

During factory calibration, the individual performance of each subsystem unit is measured. Polynomial coefficients are then calculated from these individual response curves and stored in the unit itself. These coefficients are later used to compensate for possible unit-to-unit component differences.

12.2 Field Span Calibration

During field Span calibration, accurately known concentrations of each gas of interest are introduced into the AMA and O_2 Analyzer sample cells and measured. Differences between the known and the measured values are used to calculate the appropriate coefficients for compensation of these differences.

Field Span calibration of the anesthetic agent, CO_2 and N_2O channels is typically part of preventive maintenance.

The paramagnetic O_2 analyzer typically does not require Span calibration.

When an electrochemical O_2 sensor is in use, the O_2 channel must periodically be Span calibrated.

12.3 Zero Calibration

During Zero calibration, the analyzer subsystems are purged with room air or nitrogen to eliminate any gas of interest (concentration of these gases is “zero”). Oxygen or nitrogen are convenient “Zero calibration gases” since they do not absorb infrared radiation in the wavelengths used by the AMA and AIDA. Since atmospheric air is composed primarily of oxygen and nitrogen, with small amounts of water and CO2, normal room air is used for zeroing the MGM system. Optionally, the MGM can be Zero calibrated with 100% dry nitrogen.

Since changes of physical properties of subsystem components have the same effect on room air measurement performance, this is used as a reference and therefore to calculate new coefficients which help compensate for such changes. Zero calibration of the MGM analyzer subsystem is requested by the MGM as follows:

- after certain time intervals
- after certain changes in operation
- after certain operational failures have been detected.

The Zero calibration process measures the infrared signal strength (transmittance) when no IR absorbing gases are in the sample cell. AMA and AIDA field calibration software compensates for the small absorption from atmospheric CO_2.

12.4 Storage of Calibration Data

With one exception, all Zero calibration data is stored in and used from volatile RAM memory. The Zero calibration data calculated by the first successful Zero calibration after is stored in non-volatile NVRAM memory for use after subsequent resets.

All Span calibration data is stored in non-volatile NVRAM memory. Critical data is replicated into a second location in both RAM memory (for immediate use) and NVRAM memory.

Block checksums are used to confirm continued validity of NVRAM and RAM data. Power cycling does not affect this data

Both the AMA and AIDA subsystems have their own NVRAM memory for storing their own calibration data, enabling interchangeability of these subsystems with system boards.

Calibration data for the oxygen analyzer is stored in AMA NVRAM memory.

12.5 Calibration of Agent Measurement Analyzer

12.5.1 Factory Calibration

Factory calibration compensates for small differences among the following components: pressure transducer, infrared (IR) light source, sample cell thermistor, filter heater element, filter cavity thermistor, each of the IR bandpass filters, IR detector, and thermo-electric cooler. Near the end of the manufacturing process, binary gases are used to characterize each AMA. The characterization process also analyzes individual cross-gas interference. The last function performed during characterization is to verify performance by sampling cocktail gases. Each unit ends up with is own unique set of response curves, and the ability to accurately report gas concentrations based on its individual parts and characteristics.

12.5.2 Field Span Calibration

The AMA should be calibrated by trained service personnel once every 12 months using precision calibration gases. The resulting Span calibration data is stored in NVRAM memory. The host system can replace field calibration data with the original factory calibration data via software command.

12.5.3 Zero Calibration

To maintain the highest gas concentration measurement accuracy possible, the MGM requests that the host command Zero calibration at the following time intervals The Zero calibration is performed automatically, requiring no user intervention.

:

Zero Calibration	Time Interval
1st	8 minutes after power-up or reset
2nd	15 minutes after power-up or reset
3rd	30 minutes after power-up or reset
4th	45 minutes after power-up or reset
5th	90 minutes after power-up or reset
next	8 hours after previous calibration

12.6 Agent Identification Analyzer

12.6.1 Factory Calibration

Factory calibration compensates for small differences among the following components: infrared (IR) light source, detector thermistor, each of the seven IR bandpass filters, and each of the seven IR detectors. Near the end of the manufacturing process, binary gases are used to characterize each AIDA. The last function performed during characterization is to verify performance by sampling cocktail gases. Each Analyzer ends up with its own unique set of response curves, and the ability to accurately measure and identify anesthetic agents based on its individual parts and characteristics.

12.6.2 Field Span Calibration

The function of the AIDA is to measure accurately very low gas concentrations, most critically in the range of 0.0% to 0.5% where identification thresholds are set. Since field Span calibration would not influence the performance of the Analyzer in this very narrow range, none is required.

12.6.3 Zero Calibration

As with the AMA, regular Zero calibration is required. The Zero calibration process is exactly the same as for the AMA, but the time intervals are slightly different. The first Zero calibration is performed automatically (without host involvement) 2 minutes after power-up. Other Zero calibrations are requested of the host system as described in Section 12.5.3.

12.7 Paramagnetic O_2 Analyzer

12.7.1 Factory Calibration

The paramagnetic O_2 analyzer is calibrated with potentiometers at the 0% and 100% point of its measurement range.

12.7.2 Field Span Calibration

The paramagnetic O_2 analyzer may be Span calibrated in the field via Span calibration commands using appropriate precision calibration gases.

The resulting Span calibration data is stored in NVRAM memory. The host can replace field calibration data with the original factory calibration data via software command.

12.7.3 Field Zero Calibration

Zero calibration of the paramagnetic O_2 analyzer is performed with room air. This is done every time the AMA is Zero calibrated.

12.8 Fuel Cell Type O_2 Analyzer Calibration

12.8.1 Factory Calibration

The fuel cell type O_2 analyzer does not require “characterization” or factory calibration. In the case where a fuel cell type O_2 analyzer is installed prior to original equipment shipment, field Span and Zero calibration are performed.

12.8.2 Field Span and Zero Calibration

The fuel cell type O_2 analyzer must be periodically Span calibrated since its output is continually degrading during use. Fuel cell type O_2 analyzer Span and Zero calibration is performed using the MGM 2-point Span calibration command as discussed in Section 12.7.2. The resulting O_2 calibration data is stored in NVRAM memory.

12.8.3 Field Zero Calibration

Separate Zero calibration of the fuel cell type O_2 analyzer is not required.

12.9 Pneumatic System Calibration

12.9.1 Factory Calibration

The pneumatic system of the Agent Analyzer Subsystem is factory-calibrated by performing range adjustments. A flow meter is used to adjust the four possible flow rates in which the pump can operate. These values are set by appropriately adjusting three potentiometers.

The specific flow rates listed below are representative of one MGM configuration. Other configurations may use slightly different flow rates.

Flow Type	Flow Rate
Idle	No flow
Low	120 ml/min
High	200 ml/min.
Purge	350 ml/min.

12.9.2 Field Flow Rate Calibration

Trained service personnel may perform a field calibration of the pneumatic system. A field calibration consists of the same range adjustments done during the factory calibration.

13 Software

Figure 2-6 on page 16 shows a functional block diagram of MGM software. Each bubble indicates a submodule of that software and represents a functional task that is described in more detail below. Each box indicates a hardware part controlled by the firmware. Figure 2-6 also shows that the AIDA Control and Data Processing submodules run on its own AIDA Electronics Subsystem while all remaining submodules are executed by the MGM/AMA Electronics Subsystem, both shown in Figure 2-6.

13.1 AMA Data Acquisition

The AMA Data Acquisition submodule, physically located on the AMA, acquires IR detector output signal pulses, sample cell pressure, sample cell temperature, filter wheel cavity temperature, and IR detector temperature data from the AMA. Additional data acquired by the submodule includes ambient temperature, pump flow rate, four MGM system board voltage measurements and the output of the O_2 analyzer.

These analog signals are digitized by an A-D converter in the MGM/AMA Electronics Subassembly. The submodule stores this raw data in shared RAM memory so that the AMA Signal Processing and the Control submodules can access and further process them.

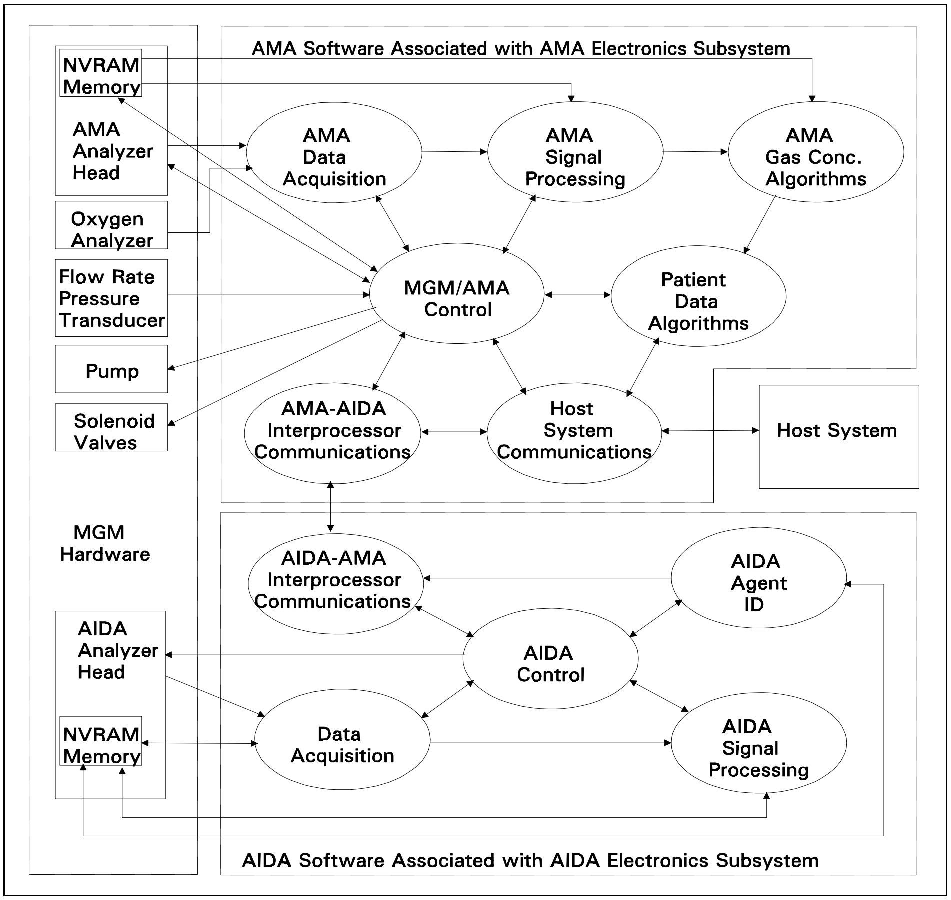


Figure 2-6 Software Functional Block Diagram

The AMA Data Acquisition and Control submodules send control signals to the AMA to control its IR source, TE cooler temperature, filter wheel motor speed, and filter wheel heater temperature.

Additional data acquired by the submodule includes ambient temperature, pump flow rate, four MGM system board voltage measurements and the output of the O_2 analyzer.

These analog signals are digitized by an A-D converter in the MGM/AMA Electronics Subassembly. The submodule stores this raw data in shared RAM memory so that the AMA Signal Processing and the Control submodules can access and further process them.

The AMA Data Acquisition and Control submodules send control signals to the AMA to control its IR source, TE cooler temperature, filter wheel motor speed, and filter wheel heater temperature.

The Data Acquisition submodule checks the digitized data against A-D converter boundary conditions and issues an A-D limit error to the MGM/ AMA Control submodule if necessary.

13.2 AMA Signal Processing

The AMA Signal Processing submodule reads the AMA IR detector output data from RAM memory, takes an average of four samples and normalizes this average by multiplying the zero constant offset determined during the last Zero calibration of the AMA. This zero constant is read from the AMA RAM memory. The normalized data is stored in RAM memory from where it is read and further processed by the AMA Gas Concentration Algorithms submodule.

The AMA Signal Processing submodule then checks the normalized data against an allowable input range stored in NVRAM during factory calibration. In case the normalized data is out of that range, an overrange or underrange error is flagged to the MGM/AMA Control submodule.

During Zero calibration of the AMA, the AMA Signal processing submodule is triggered by the MGM/AMA Control submodule to compute a new zero constant based on the current average. This average is interpreted as "zero gas concentration." The AMA Signal Processing then stores that new zero constant offset into AMA NVRAM and into AMA RAM memory.

13.3 AMA Compensation

The AMA Gas Concentration Algorithms submodule reads the normalized sample data from RAM memory and corrects for sample cell pressure and sample cell temperature.

Since the spectra of the various measured gases partly overlap, the AMA Gas Concentration Algorithms submodule performs necessary corrections to compensate for the effects of this overlapping (called "cross-channel. This compensation is based on the characteristics of each gas spectrum as they were stored into NVRAM memory during factory calibration.

The submodule then applies the field calibration factor. The field calibration factor is read from AMA NVRAM. The resulting gas concentration data is stored in RAM memory for further processing.

The submodule checks the compensated data for mathematical errors (as recognized by the floating point part of the CPU, e.g., a number going to infinity or out of the floating point range), against the allowable absorption data range (as stored in NVRAM during factory calibration), and against the minimum and maximum reporting range limits (stored in ROM memory). In case of wrong or out-of-range data, errors are issued to the MGM/AMA Control submodule.

During field Span calibration of the AMA, the AMA Gas Concentration Algorithms submodule is triggered by the MGM/AMA Control submodule to compute new field Span calibration factors based on current gas concentration data. The AMA Gas Concentration Algorithms submodule then stores the new field Span calibration factors in AMA NVRAM memory.

13.4 Patient Data Derivation

The Patient Data Algorithms submodule reads the compensated sample data (wave samples) from RAM memory and derives the following numerical values from them:

- Breath Rate
- Inspired values for CO_2, N_2O, and anesthetic agent; Inspired value for O_2
- Expired end-tidal values for CO_2, N_2O, and anesthetic agent; Expired end-tidal value for O_2

Breath rate is calculated based on the time between two breaths. The inspired and expired end-tidal values are calculated from the wave samples which were valid at the beginning and end of a breathing cycle. Patient data is stored in RAM memory from where it can be read and transmitted to the host system. If the Patient Data Algorithms submodule cannot derive numerics from the wave sample data, e.g., if the patient stops breathing, it issues a status message to the MGM/AMA Control submodule.

13.5 Host System Communications

The Host System Communications submodule reads the wave samples, patient data numerics and status/error information from RAM memory and transmits them to the host.

The submodule receives commands from the host (e.g., requests to Zero calibrate, requests to field Span calibrate, requests to format data in certain units) and executes them either by itself or by passing them on the MGM/AMA Control submodule or, via AMA-AIDA interprocessor communications to the AIDA Control submodule. Thus, the Host System Communications submodule is the only one that communicates directly with the host system.

13.6 Anesthetic Gas Subsystem / Host System Communications

Communications between the Anesthetic Gas Subsystem and the host system consists of communications between the Host System Communication submodule and the host's communications software over the external RS-232 interface of the MGM. All messages from and to the MGM include a checksum to assure the detection of communication interferences. Moreover, a message length is defined for the commands sent to the MGM and their corresponding responses to enable a check on the format of the received message.

The AMA-AIDA Interprocessor Communications submodule in the MGM/AMA Electronics subsystem serves as the communication link between the MGM/AMA Electronics Subsystem and the AIDA electronics subsystem. It communicates directly with its counterpart, the AIDA-AMA Interprocessor Communications submodule in the AIDA Electronics Subsystem, using the same communications protocol that the Host System Communications submodule uses to communicate with the host.

It is controlled by the MGM/AMA Control submodule (e.g., to synchronize Zero calibration of both the AMA and the AIDA). It exchanges status information with the MGM/AMA Control submodule and the Host System Communications submodule.

13.7 AIDA Communication

The AIDA-AMA Interprocessor Communications submodule serves as the communication link between the AIDA electronics subsystem and the MGM/AMA electronics subsystem. It communicates directly with its counterpart, the AMA-AIDA Interprocessor Communications submodule, using the same communications protocol that the Host System Communications submodule uses to communicate with the host.

It exchanges status/control information with the AIDA Control submodule and receives data from the AIDA Agent Identification submodule via RAM memory and passes them on to the AMA-AIDA Interprocessor Communications submodule for further transmission to the Host System Communications submodule.

13.8 MGM/AMA Control

The MGM/AMA Control submodule performs a variety of control tasks:

It receives commands, e.g., requests to Zero or field Span calibrate, from the Host System Communications submodule and triggers the AMA Data Acquisition, AMA Signal Processing, AMA Gas Concentration Algorithms, and Patient Data Algorithms submodules accordingly.

It receives error messages from the AMA Data Acquisition, AMA Signal Processing, AMA Gas Concentration Algorithms, and Patient Data Algorithms submodules, and passes them on with other status information to the Host System Communications submodule.

The MGM/AMA Control submodule is also involved in controlling the pump: The pump control hardware reads the current gas flow rate from the flow sensor and controls the pump to guarantee a stable gas flow through the system. The flow rate is monitored by the MGM/AMA Control submodule. Also, the pump control hardware sends status messages to the Host System Communications submodule, reporting occlusion (detected by pump running at upper limit).

During Zero calibration, the MGM/AMA Control submodule is triggered by the Host System Communications submodule to send the appropriate control signals to the pump and solenoid valves. At the end of the Zero calibration, it switches the pump and valves back to normal operation.

13.9 AIDA Data Acquisition

The AIDA Data Acquisition submodule, physically located on the AIDA, acquires output data from the AIDA, consisting of signal pulses from the thermopile infrared (IR) detectors and detector temperature. These signals are digitized by an A-D converter in the AIDA electronics subsystem. The Data Acquisition submodule stores this data in AIDA RAM memory so that the AIDA Signal Processing submodule can access and further process it.

The Data Acquisition submodule also sends control signals back to the AIDA to control its light chopper motor speed and thermopile detector temperature. These control signals are computed by the AIDA Control submodule and written to another area of RAM memory so that it can be read by the AIDA Data Acquisition submodule.

Finally, the AIDA Data acquisition submodule checks the raw data against the A-D converter boundary conditions and issues an A-D limit error to the AIDA Control submodule, if necessary.

13.10 AIDA Signal Processing

The AIDA Signal Processing submodule reads the AIDA sample data from RAM memory, takes a moving average of 22 samples and normalizes this average by adding the Zero constant offset determined during the last AIDA Zero calibration. This Zero constant is read from the AIDA RAM memory. The normalized data is stored in RAM memory from where it is read and further processed by the AIDA Agent Identification submodule.

The AIDA Signal Processing submodule then checks the normalized data against an allowable input range stored in NVRAM memory during factory calibration. In case the normalized data is out of that range, an overrange or underrange error is flagged to the AIDA Control submodule.

During AIDA Zero calibration, the AIDA Signal Processing submodule is triggered by the AIDA Control submodule to compute a new Zero constant based on the current average. This average is interpreted as “zero gas concentration.” The AIDA Signal Processing submodule then stores that new Zero constant offset into AIDA RAM memory.

13.11 AIDA Agent Identification

The AIDA Agent Identification submodule reads the averaged gas concentration data supplied by the seven thermopile IR detectors and identifies the most dominant agent contained in the gas sample.

The relationship of gas concentration and absorption is expressed by quite elaborate non-linear equations, with the number of experimentally determined parameters varying with the particular gas species and IR filter. Since AIDA agent identification is able to simultaneously detect the presence of as many as all five possible agents, an equation is set up for each IR channel that expresses the transmitted signal as a function of the absorption by all five agents, where the only unknowns are the desired gas concentrations. These five gas concentrations are then determined iteratively by solving the resulting set of seven non-linear equations.

The final computed gas concentrations for each set of gas samples are then tested against the thresholds for primary and secondary agent identification. This is achieved by first identifying all agents whose gas concentrations exceed their corresponding threshold for primary agent detection. If there is only one such agent, it is flagged as being the primary agent. If there is more than one agent, the agent with the highest concentration is flagged as being the primary agent. In this case, the concentrations of the remaining agents are tested to determine if they exceed their corresponding thresholds for secondary agent, (or contamination), thresholds. Any agents for which this criterion is true are flagged as secondary agents. If a secondary agent has been identified, this is flagged to the AIDA Control submodule.

If any of the calculated agent concentrations are more negative than the negative of the corresponding agent thresholds, it is assumed that a gas is present for which the AIDA agent identification has not been calibrated. In this case nothing can be said about the composition of the mixture other than that it is unknown.

If a set of gas samples were to be detected for which no solution existed, the algorithm will detect this quickly and terminate the iterative process and return a set of zero gas concentrations, and flag an error. The AIDA Agent Identification submodule stores its results in RAM memory where they can be read by the AIDA-AMA Interprocessor Communications submodule to be passed on to the host via the AIDA/AMA Interprocessor Communications and Host System Communications submodules.

13.12 AIDA Control

The AIDA Control submodule performs various control tasks.

It receives commands, e.g., a request to Zero calibrate, from the Host System Communications submodule via the AMA-AIDA Interprocessor Communications and the AIDA-AMA Interprocessor Communications submodules and triggers the AIDA Data Acquisition, AIDA Signal Processing, and AIDA Agent Identification submodules accordingly.

It also receives error/status messages from the AIDA Data Acquisition, AIDA Signal Processing, and AIDA Agent Identification submodules and passes them on with other status information to the Host System Communications submodule (again via the AMA-AIDA Interprocessor Communications and AIDA-AMA Interprocessor Communications submodules.

Chapter 3 Removing / Installing Parts

1 Introduction

Warning

All parts of a MultiGas/+ module that either directly or indirectly come in contact with the patient's airway (such as all internal and external tubing, water trap and water trap manifold, and filters) may be contaminated. Handle according to the hospital's procedures and guidelines for handling infectious substances. Also, see Disease Prevention in this Service Manual.

Caution

Open MultiGas/+ module only in a static-protected environment. Observe standard precautions for protecting the equipment from static electricity.

1.1 Opening Module

To access internal components and subassemblies in the MultiGas/+ module, do the following:

1. Turn off power to MGM module, and also unplug AC line cord.
2. Remove and save four Phillips-head screws located near back on bottom of outer case.
3. Slide entire internal subassembly out of case, from front of module.

The following procedures describe removing and replacing parts listed below.

- Pneumatics Subssemblies (MGM+)
- Pneumatics Subasssemblies (MGM)
- Nafion® or other Tubing
- Room Air Filter
- Pump
- Pump filter
- AMA Analyzer Head
- AMA Sample Cell
- AIDA Analyzer Head
- MGM System Board
- Fast O_2 Sensor Assembly
- CAN PC Board
- Power Supply
- Solenoid #1 & #3
- Solenoid #2

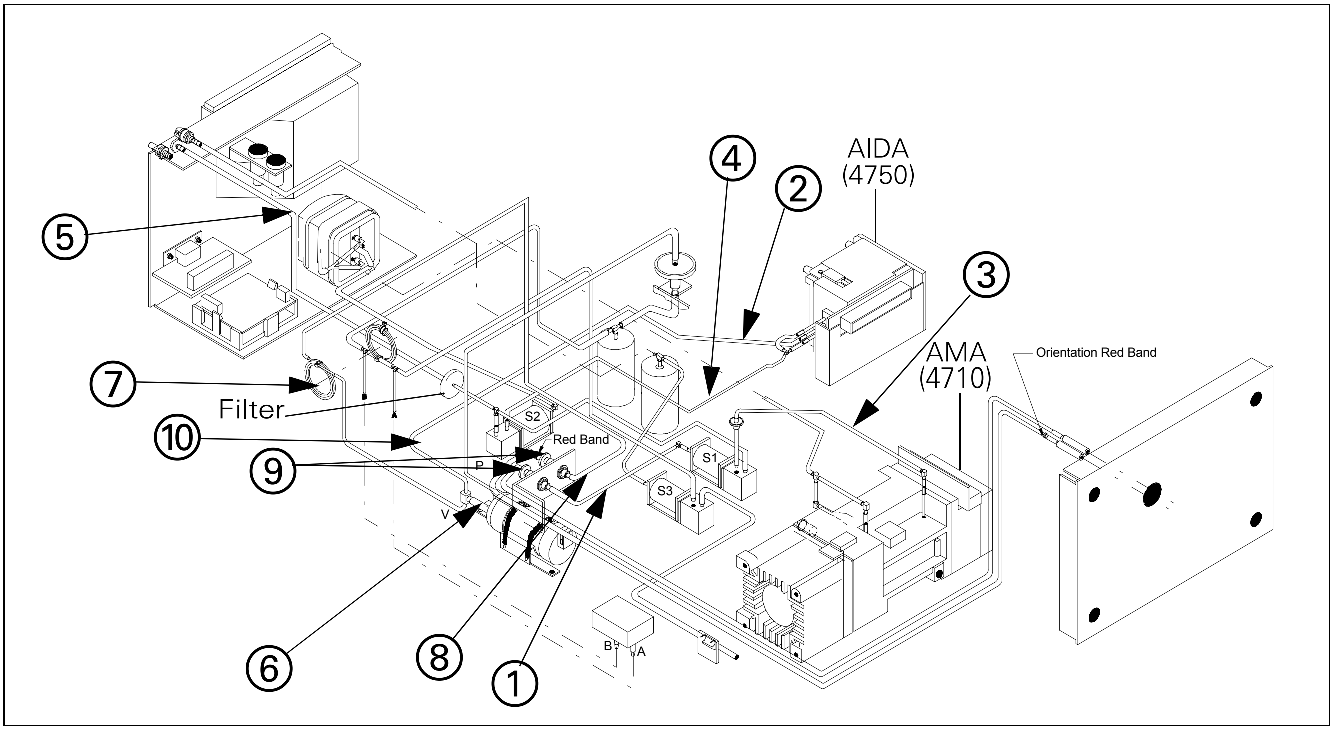


Figure 3-1 Pump and Pneumatic Subassemblies in MGM+

2 MGM+

2.1 Pneumatic Tubing Subassemblies

All pneumatic tubing subassemblies in the MGM+ Module are replaced as complete subassemblies. Refer to Figure 3-1.

2.1.1 Removing Pneumatic Subassemblies

1. Open Module. See “Introduction” on page 21.
2. Disconnect and discard tubing between input filter holder and S1(① in Figure 3-1).
3. Disconnect and discard tubing subassembly from water input (center port) on bulkhead at AIDA-head (4750) (② in Figure 3-1), vacuum input of pump (⑦ in Figure 3-1), and input filter holder (⑧ in Figure 3-1).
4. Disconnect and discard tubing and filter between AMA-head (4710) and S1(③ in Figure 3-1).
5. Disconnect and discard remaining tubing from S1 to S2 (④ in Figure 3-1) and room air inlet filter (including filter). (Do NOT remove inlet tubing (⑤ in Figure 3-1) from back of module to filter!)
6. Do either a or b.
   a If replacing pump, go to Section 4.1.
   b If replacing only pneumatic tubing, continue.

2.1.2 Installing Pneumatic Subassemblies

Note: Carefully inserting the tip of long-nose pliers into the end of polyurethane ether tubing to partially stretch it, can significantly aid in connecting tubing. **Be careful, however, not to overstretch the material.** Doing so could permanently damage the tubing, resulting in intermittent pneumatic leaks and performance problems.

1. Install tubing assembly 450334-001 between S1 and S2 (④ in Figure 3-1), and insert filter into inlet hose from back of unit (⑤ in Figure 3-1).

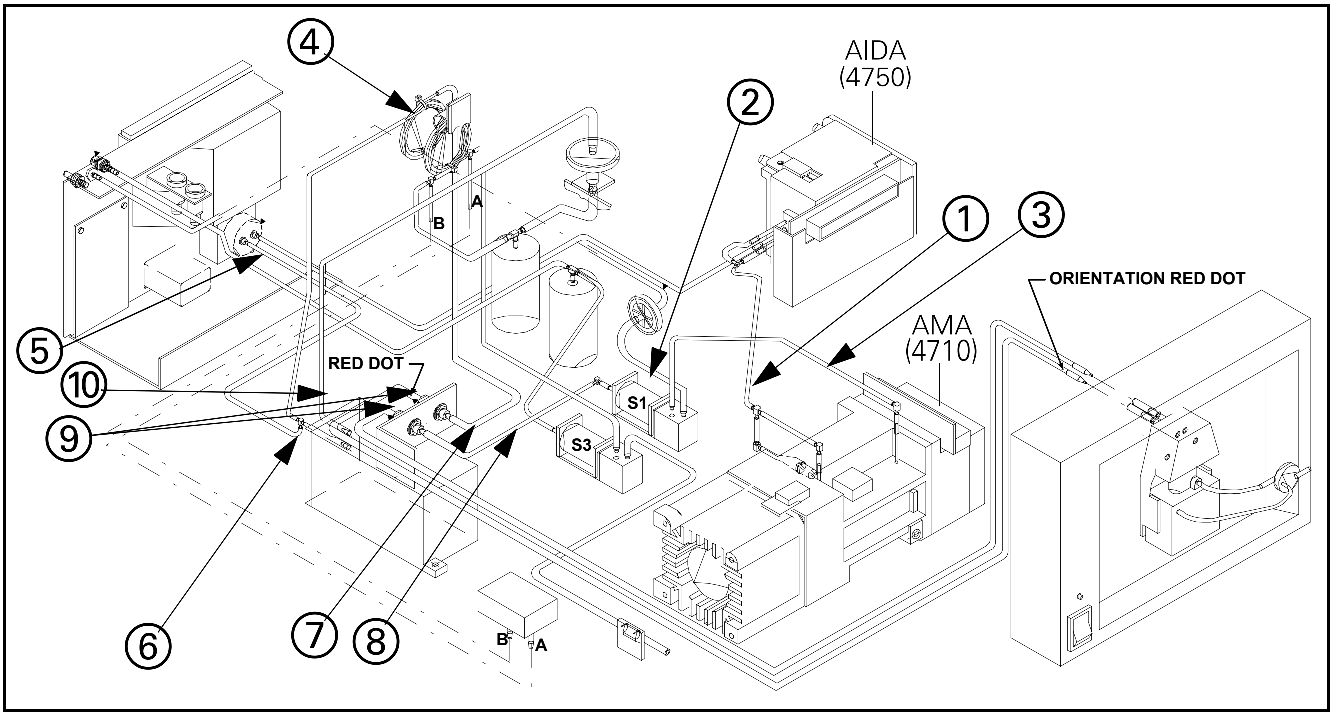


Figure 3-2 Pump and Pneumatic Subassemblies in MGM (Slo-O2)

2. Install tubing assembly 450321-001 connecting AMA-head (4710) and S1(③ in Figure 3-1).
3. Connect end of tubing assembly 450349-000 (② in Figure 3-1) from **T**-piece to center port on AIDA-head (4750) and then secure restrictor (⑦ in Figure 3-1) in holder.
4. Connect tubing from **T**-piece of tubing subassembly 450349-000 into vacuum input on pump (⑥ in Figure 3-1).
5. Connect remaining end of tubing subassembly 450349-000 into water line on input filter holder (⑧ in Figure 3-1).
6. Do either a or b.
   a If replacing pump, go to Section 4.2.
   b If only replacing pneumatic tubing, continue.
7. Connect tubing subassembly 450323-001 between S1 and input line filter holder (① in Figure 3-1).
8. Check all connections, reinstall cover (See “Opening Module” on page 21.), and functionally verify proper operation of MGM+ Module. Refer to procedures in “Functional Verification” on page 45.

3 MGM (Slo-O2)

3.1 Replacing Pneumatic Subassemblies

Refer to Figure 3-2.

3.1.1 Removing Pneumatic Tubing

1. Open Module. See “Introduction” on page 21.
2. Disconnect and discard tubing from input filter to S1(⑧ in Figure 3-2).
3. Disconnect and discard tubing from AMA-head (4710) to AIDA-head (4750) (① in Figure 3-2).

4. Disconnect and discard tubing and filter from S1 to room air input line (② in Figure 3-2).
5. Disconnect and discard remaining tubing from S1 to AMA-head (4710) (③ in Figure 3-2).
6. Disconnect entire subassembly, including restrictor (④ in Figure 3-2), from O2 cell (⑤ in Figure 3-2), pump input (⑥ in Figure 3-2), and connection to water input filter holder (on bracket above pump) (⑦ in Figure 3-2).
7. Do either a or b.
   a If replacing pump, go to Section 4.1.
   b If replacing only pneumatic tubing, continue.

3.1.2 Installing Pneumatic Tubing

1. Install tubing subassembly 450328-001between AMA-head (4710) and AIDA-head (4750) (① in Figure 3-2).
2. Install tubing subassembly 450321-001 between AMA-head (4710) and S1(③ in Figure 3-2).
3. Connect end of tubing subassembly 450353-000 to water input filter holder (on bracket above pump) (⑦ in Figure 3-2), and then route restrictor (④ in Figure 3-2) through holder.
4. Connect tubing from **T**-piece on tubing subassembly 450353-000 to pump input (⑥ in Figure 3-2).
5. Connect remaining end of tubing subassembly 450353-000 to O2 cell input (⑤ in Figure 3-2).
6. Connect tubing and filter subassembly 450284-002 (② in Figure 3-2) between S1 and room air input line.
7. Connect tubing subassembly 450323-001 between S1 and sample input line filter holder (⑧ in Figure 3-2).
8. Do either a or b.
   a If replacing pump, go to Section 4.2.
   b If only replacing pneumatic tubing, continue.
9. Check all connections, reinstall cover (See "Opening Module" on page 21.), and functionally verify proper operation of MGM Module. Refer to procedures in "Functional Verification" on page 45.

4 Replacing Pump

Use the following procedure to replace pump.

4.1 Removing Pump

Note: Pump replacement requires that all pneumatic subassemblies referenced in Section 2.1 also be replaced.

1. After completing steps of Section 2.1.1 (if MGM+) or Section 3.1.1 (if MGM), disconnect nafion lines (gas and water) (⑨ in Figure 3-1 on page 22 or Figure 3-2 on page 23) from bracket above pump.

   Note: Observe that gas input line is unmarked and water input line is marked with a red band.

2. Remove and save Phillips-head screw from filter bracket above pump.
3. Disconnect tubing (⑩ in Figure 3-1 on page 22 or Figure 3-2 on page 23) from pump filter port.
4. Loosen wire guides on side of AMA.

5. Disconnect pump wires from system board connector, J8. (See Figure 3-3 on page 27.)
6. Cut and remove any wire ties holding pump wire assemblies in place, and remove wire harness.

   Note: Carefully note location(s) of wire ties and routing of pump wires.
7. Remove and save two screws holding pump assembly in place, and remove pump and attached pneumatic subassembly.
8. Install pneumatic subassemblies before installing pump. Refer to Section 2.1.2 for an MGM+ and to Section 3.1.2 for an MGM (Slo-O2).

4.2 Installing Pump

1. Secure new pump assembly in base of unit with two mounting screws removed in step 7 of Section 4.1 above.
2. Reinstall tubing (⑩ in Figure 3-1 on page 22 or Figure 3-2 on page 23) on pump filter port.
3. Route pump wires and secure wires to solenoid harness using wire ties, as noted in step 6 of Section 4.1 above.
4. Reinstall filter bracket and reconnect Nafion lines. Be sure that line with red band is connected as illustrated in Figure 3-1 on page 22 or Figure 3-2 on page 23.
5. Go to Section 2.1.2 to complete installation of pneumatic tubing subassemblies in MGM+ Module or to Section 3.1.2 to complete installation of pneumatic tubing subassemblies in MGM Module.

5 Pump Filter Removal/Replacement Procedure

5.1 Removal

1. Open Module. See "Introduction" on page 21.
2. Disconnect tubing from Pump Filter.
3. Remove Pump Filter from holding clamp.

5.2 Replacement

1. Reverse steps in Section 5.1 to install replacement Pump Filter.
2. Functionally verify proper operation of the MGM. Refer to procedures in "Functional Verification" on page 45.

6 Nafion® or other Tubing Removal/Replacement Procedure

6.1 Removal

1. Open Module. See "Introduction" on page 21.
2. Disconnect and remove defective tubing. If another part must be removed to access tubing, follow procedure for that part also.

6.2 Replacement

1. Install new tubing in same position, **using same type and length of tubing as was originally installed**.
2. Reverse procedure of Section 1.1 on page 21 to replace top cover.
3. Functionally verify proper operation of the MGM. Refer to procedures in "Functional Verification" on page 45.

7 Room Air Filter Removal/Replacement Procedure

7.1 Removal

1. Open Module. See "Introduction" on page 21.
2. Unscrew room air filter bracket from pneumatics chassis.
3. Disconnect tubing going to Room Air Filter.
4. Remove piece of tubing that holds Room Air Filter onto bracket.
5. Extract room air filter out of hole in bracket.

7.2 Replacement

1. Put replacement Filter through hole in bracket and secure with short piece of tubing.
2. Connect tubing going to Room Air Filter.
3. Screw room air filter bracket back on to pneumatics chassis.
4. Reverse procedure of Section 1.1 on page 21 to replace top cover.
5. Functionally verify proper operation of the MGM. Refer to procedures in "Functional Verification" on page 45.

8 AMA Analyzer Head Removal/Replacement Procedure

8.1 Removal

1. Open Module. See "Introduction" on page 21.
2. Perform NVRAM Transfer Procedure (refer to "NVRAM Transfer Procedure" on page 31).

   Note: This is necessary when an AMA Analyzer Head is replaced (and the AMA Analyzer Head is mounted onto the Pneumatics Assembly). If the same AMA Analyzer Head is to be reinstalled, go on to step 4.
3. Remove 1 ribbon cable and 3 tubes connected to AMA Analyzer Head.
4. Remove 4 screws that hold Pneumatics Assembly to bottom chassis.
5. Lift (do NOT need to remove all cables and tubing) Pneumatics Assembly.
6. Remove 3 mounting screws holding AMA Analyzer Head to Pneumatics Assembly.

8.2 Replacement

1. Reverse steps in Section 8.1 to install replacement Analyzer Head.
2. Functionally verify proper operation of the MGM. Refer to procedures in "Functional Verification" on page 45.

9 AMA Sample Cell Removal/Replacement Procedure

9.1 Removal

1. Open Module. See "Introduction" on page 21.
2. Remove 3 tubes connected to AMA Sample Cell.
3. Remove 4 screws that hold Pneumatics Assembly to bottom chassis.
4. Lift (do NOT need to remove all cables and tubing) Pneumatics Assembly.
5. Remove 4 mounting screws holding AMA Sample Cell into AMA Analyzer Head.
6. Gently pull and slide Sample Cell out of AMA Analyzer Head.

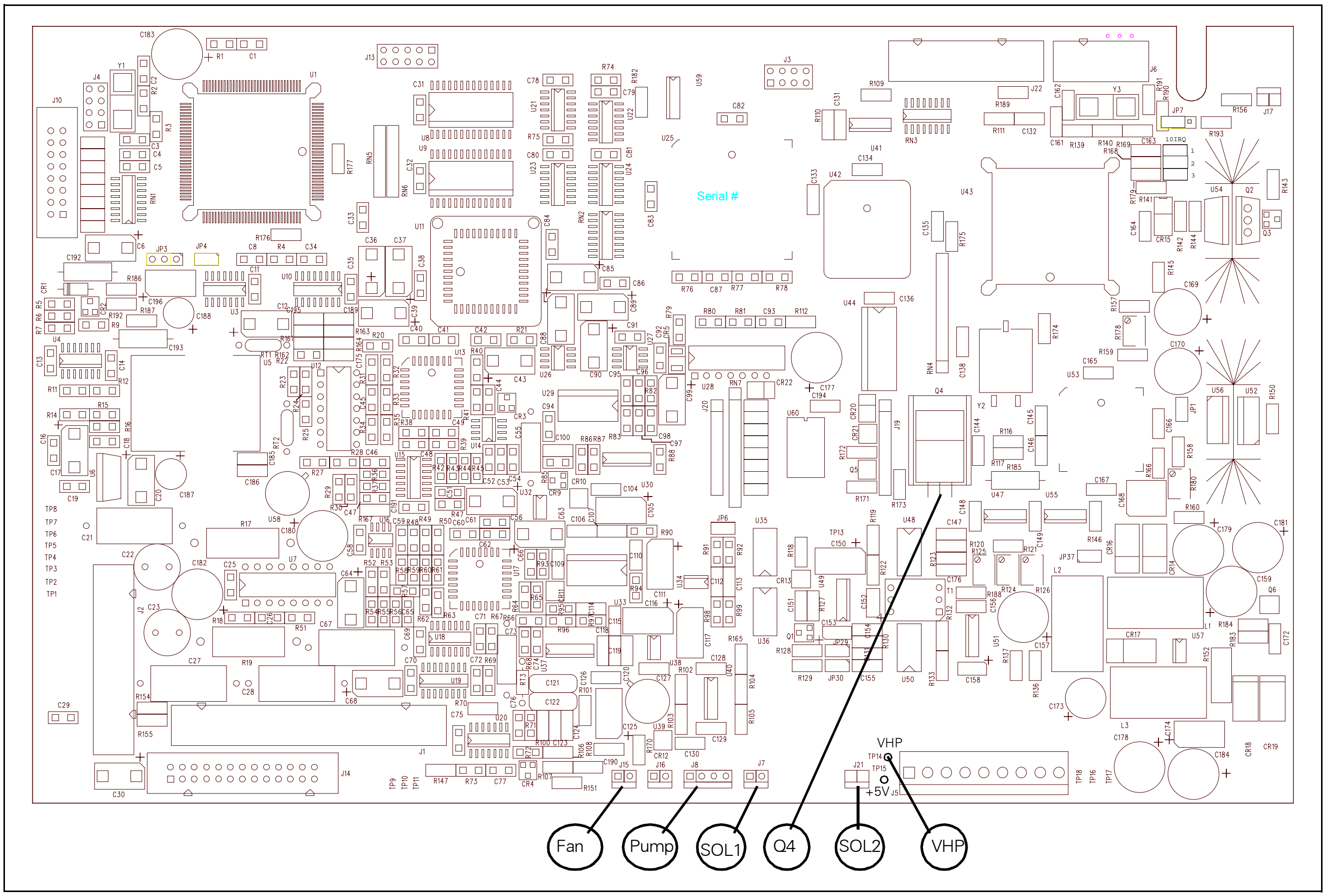


Figure 3-3 System PC Board

9.2 Replacement

1. Reverse steps in Section 9.1 to install replacement AMA Sample Cell.
2. Functionally verify proper operation of the MGM. Refer to procedures in Functional Verification.

10 Agent ID Analyzer Removal/Replacement Procedure

10.1 Removal

1. Open Module. See “Introduction” on page 21.
2. Remove 3 tubes connected to Agent ID Analyzer’s Sample Cell.
3. Remove 4 screws that hold Pneumatics Assembly to bottom chassis.
4. Remove 4 screws that hold Agent ID Analyzer to Pneumatics Assembly.

10.2 Replacement

1. Reverse steps in Section 10.1 to install replacement Agent ID Analyzer.
2. Functionally verify proper operation of the MGM. Refer to procedures in “Functional Verification” on page 45.

11 MGM System Board Removal/Replacement Procedure

11.1 Removal

1. Open Module. See “Introduction” on page 21.
2. Disconnect all cable connectors and tubing connected to MGM System Board.
3. Remove mounting screws that hold MGM System Board to chassis.

11.2 Replacement

1. Reverse steps in Section 11.1 to install MGM System Board.
2. Functionally verify proper operation of the MGM. Refer to procedures in "Functional Verification" on page 45.

12 Fast O2 Sensor Assembly Removal/Replacement Procedure

Note: The O_2 Sensor comes with its own control board attached. The sensor module and board are calibrated as one unit and must stay together.

12.1 Removal

1. Open Module. See "Introduction" on page 21.

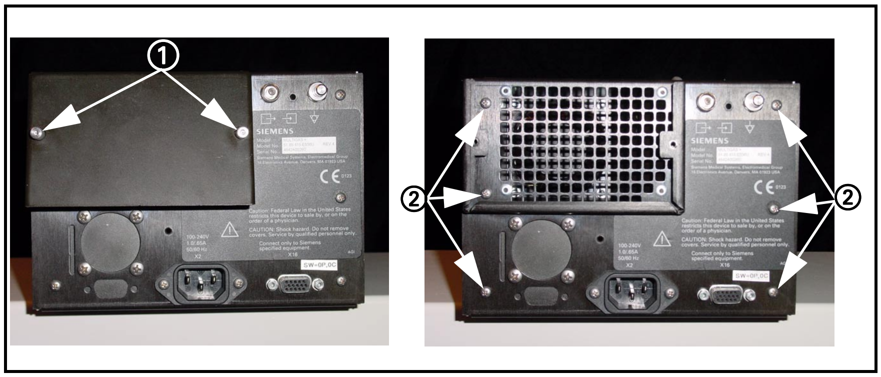


Figure 3-4 MGM Module Rear View

2. Remove and save knurled screws (① in Figure 3-4) that secure filter cover to rear panel, and remove cover and filter.
3. Note routing of fan cable so that it can be properly routed during reassembly, and unplug cable from Fan1 connector on System Board.
4. Remove and save six screws (② in Figure 3-4) that secure rear panel subassembly to MGM main chassis.

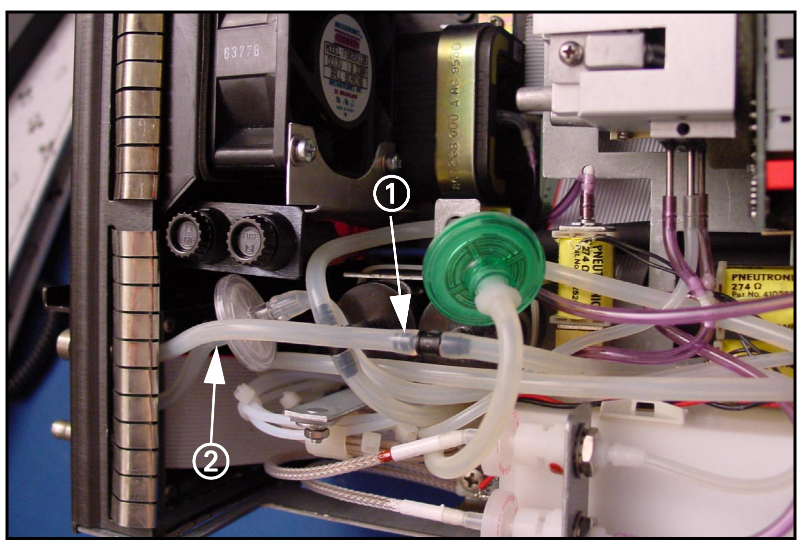


Figure 3-5 Pneumatic Tubing Disconnection Points

5. Disconnect tubing connecting patient sample gas outlet port to pulse dampener at pulse dampener (① in Figure 3-5).
6. Disconnect tubing connecting zero gas inlet port to zero gas dust filter at dust filter (② in Figure 3-5, shown partially obstructed).

7. Carefully cut and remove nylon tie wrap that secures four AC wires to AC line fuse holders. Be sure to reinstall replacement tie wrap when reassembling module.
8. Note polarity so that wires can be properly reinstalled, and unplug two AC cable wires from AC line fuse holders.

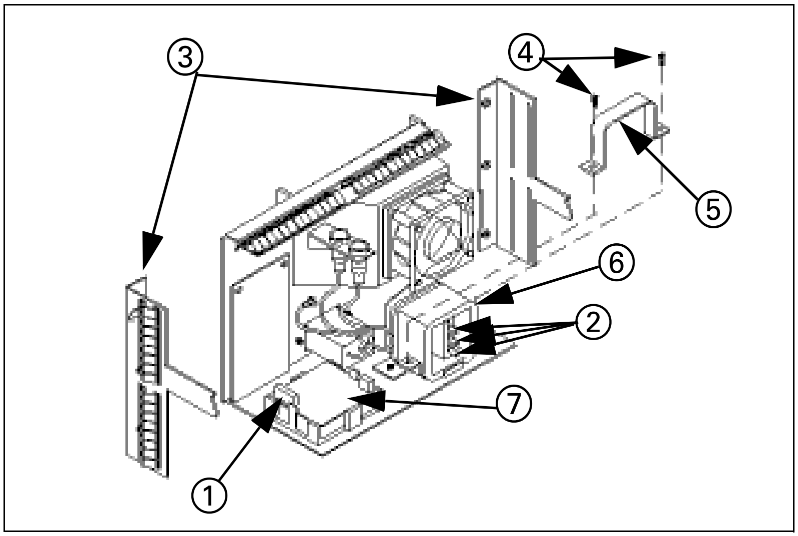


Figure 3-6 Rear Panel Subassembly

9. Unplug 26 conductor flat cable from O_2 sensor board (① in Figure 3-6).
10. Note scheme for connecting tubing to O_2 sensor (so that tubing can be properly reconnected to replacement sensor) and disconnect tubing from sensor (② in Figure 3-6).
11. Slightly spread rear sides of main chassis (③ in Figure 3-6) while pulling rear panel towards rear.

    Note: The Rear Panel Subassembly is now virtually free and can be moved to provide easy access to the O_2 Sensor and sensor PCB.
12. Remove screws (④ in Figure 3-6) from clamp (⑤ in Figure 3-6) holding O_2 Sensor to bracket on chassis.
13. Remove O_2 Sensor (⑥ in Figure 3-6) and Sensor PCB (⑦ in Figure 3-6) from Rear Panel Subassembly.

    Note: The sensor PCB snaps into its plastic holder. Spread the two latches while lifting up on the board to remove it.

12.2 Replacement

1. Reverse steps in Section 12.1 to install new O_2 Sensor Assembly.
2. Functionally verify proper operation of the MGM. Refer to procedures in "Functional Verification" on page 45.

13 CAN PC Board Removal/Replacement Procedure

13.1 Removal

1. Open Module. See "Introduction" on page 21.
2. Remove the filter shroud and filter from the back panel.
3. Remove six screws securing back panel to chasssis.
4. Disconnect CAN board ribbon cables from J14 and J22 on the MGM System Board.

5. Remove hex screws securing RS-232 connector to rear panel (see Figure 1-1 on page 1).
6. Separate back panel from chassis.
7. Remove two screws securing CAN board to rear panel. Refer to Figure B-3 or Figure B-4.
8. Remove CAN PC Board.

13.2 Replacement

1. Reverse steps in Section 13.1 to install replacement board.
2. Functionally verify proper operation of the MGM. Refer to procedures in Functional Verification.

14 Power Supply Removal/Replacement Procedure

14.1 Removal

1. Open Module. See "Introduction" on page 21.
2. Unplug power cable connector from power supply PC Board.
3. Remove 4 mounting screws holding Power Supply to chassis.

14.2 Replacement

1. Reverse steps in Section 14.1 to install Power Supply.
2. Verify power supply voltages at test points on MGM System Board (refer to Table 5-9 in Troubleshooting).
3. Reverse procedure of Section 1.1 on page 21 to replace top cover.
4. Functionally verify proper operation of the MGM. Refer to procedures in "Functional Verification" on page 45.

15 Solenoid #1 & #3 Removal/Replacement Procedure

15.1 Removal

1. Open Module. See "Introduction" on page 21.
2. Remove Solenoid #1 & #3 cable connector located at MGM System Board (see Figure 3-3 on page 27), and free wires of cable from cable clamps.
3. Remove tubing attached to Solenoid #1 & #3.
4. Remove 4 screws holding Solenoid #1 & #3 to Pneumatics Assembly.

15.2 Replacement

1. Reverse steps in Section 15.1 to install replacement Solenoid #1 & #3.
2. Functionally verify proper operation of the MGM. Refer to procedures in Functional Verification.

16 Solenoid #2 Removal/Replacement Procedure

16.1 Removal

1. Open Module. See "Introduction" on page 21.
2. Unplug Solenoid #2 power cable connector from MGM System Board (see Figure 3-3 on page 27), and free cable wires from cable clamps.
3. Remove screw holding Solenoid #2 bracket.
4. Remove tubing from ports on Solenoid #2.
5. Remove 2 screws holding Solenoid #2 to its' bracket.

16.2 Replacement

1. Reverse steps in Section 16.1 to install replacement Solenoid #2.
2. Functionally verify proper operation of the MGM. Refer to procedures in "Functional Verification" on page 45.

17 NVRAM Transfer Procedure

17.1 Introduction

When replacing AMA analyzer heads, essential system information (such as flow rate limits, system ID, etc.) stored in the NVRAM of the old head must be transferred to the replacement head.

Note: The NVRAM of a faulty head can still be read (and transferred to a new head), except in the case of a NVRAM failure.

The purpose of the NVRAM Transfer board (NTB) is to transfer the information of a non-operational analyzer head to a replacement head in the field.

17.2 Equipment required

The following equipment is required:

- Replacement AMA analyzer head
- NVRAM Transfer board (NTB)
- Hand tools (screwdriver, etc.) for removal and installation of an analyzer head. (Refer to Section 8 on page 26, AMA Analyzer Head Removal/Replacement Procedure.)

17.3 NVRAM Transfer procedure

1. Open Module. See “Introduction” on page 21.
2. Connect 40-pin cable of NTB into 40-pin connector of new replacement analyzer head.
3. Connect 10-pin cable of NTB into top cover connector (J6) on MGM System Board.
4. Power MGM on, and observe LED on NTB. See Notes on next page.

   Note: For about the first five seconds, the LED on the NTB appears amber. Whenever the LED appears amber, the NTB is processing information and the operator is to stand by until the LED changes color again. During the first five seconds, the NVRAMs of both the old and the new analyzer heads are being read and checked. If the LED changes to a solid green color, the NVRAM transfer process can begin. **Go to step 5 if the LED is green**.

   If either NVRAM cannot be read, it may take up to one minute before LED changes color. Identify error condition as either a or b.

   a) If the LED changes to a solid red color, a problem reading the old analyzer head has occurred.

      a.1 Turn OFF power and verify all connections.

      a.2 Make sure ribbon cables are not broken and are fully seated.

      a.3 Try to repeat the process, starting at step 4.

   If the LED is still on red, turn power off and proceed with installation of the new analyzer head regardless. The NVRAM transfer is not possible, but the replacement head has default information for pump hours and a serial number. However, before installing the new analyzer head, you need to verify that the new head is indeed functional. Replace the old analyzer head with the new one and repeat the NVRAM transfer procedure starting at step a.1. If the LED begins blinking alternately green and red, the head is functional and you can continue with the installation of the new head. If the LED is solid red, however, either the new analyzer head and/or the cable from the head to the MGM System Board is defective. In this case, you will need to replace the head, the cable, or both.

Note: When installing a new analyzer head and using the default NVRAM data, a flow rate calibration MUST be executed because no flow rates will be transferred. If no flow rate calibration is performed, a problem with the pneumatic system will be flagged during module operation. (Note that in addition to conditions requiring potentiometer adjustment, an unsuccessful NVRAM transfer procedure is another condition which requires flow rate calibration in the field.)

b) If the LED begins blinking alternately green and red, a problem reading the new analyzer head occurred.

b.1 Turn OFF power and verify all connections.

b.2 Make sure ribbon cables are not broken and are fully seated in place.

b.3 Try to repeat the process, starting at step 4.

If the LED is still blinking green and red, verify that the failed NVRAM transfer procedure is not due to a defective NTB and/or cable connection.

b.4 Turn off power, and replace old analyzer head with new one.

b.5 Repeat NVRAM transfer procedure starting at step 4.

- If LED is solid red, new analyzer head is indeed defective. In this case, use a new replacement analyzer head, and return to step 2.
- If LED begins blinking alternately green and red, NTB and/or attached cables are defective. In this case, use a new NTB, or else install new analyzer head with default NVRAM data.

5. Once LED is green, press momentary push-button switch on NTB to begin NVRAM transfer process. The LED changes to amber for about five seconds followed by solid green, indicating a good transfer of NVRAM data.

   If LED blinks red, either no transfer or a bad transfer of NVRAM data occurred. Proceed with installation of new analyzer head regardless. NVRAM transfer will not be possible, but new replacement head has default information for pump hours and a serial number. However, it is very **IMPORTANT** that **a flow rate calibration MUST be executed** because no flow rates will be transferred. If no flow rate calibration is performed, a problem with the pneumatic system will be flagged during module operation.

   Note: In addition to conditions requiring potentiometer adjustment, an unsuccessful NVRAM transfer procedure is another condition requiring flow rate calibration in the field.

6. After successful completion of step 5, turn module power off and disconnect NTB.
7. Remove old analyzer head and install new head. (Refer to AMA Analyzer Head Removal/Replacement Procedure on page 26)
8. Reinstall all cables and tubing, and perform all procedures required after repair or replacement as stated in replacement procedures.
9. When returning defective analyzer head for repair, **make sure to return NVRAM transfer board** along with the head as a return kit.

Chapter 4 Adjustment / Calibration

> **Caution**
>
> Always perform a leakage test before initiating any calibration or adjustment procedures.

1 Recommended Tools & Test Equipment

- SC 9000, SC 7000/SC 9000XL Patient Monitor with CPS/IDS (with installed MIB Option + CAN), or SC 8000 (with installed Adv Com Option), or KION
- Appropriate communication cables (from host to MGM).
- Siemens Calibration Kit - SVC TOOL MGM/MGM+ CAL KIT, Art. No. 52 07 415 E536U, containing the following:

  Calibration gas - contains 3.00% Isoflurane, 5.00% CO_2, 40.00% N_2O, 52% Oxygen (with a 1% gas concentration accuracy), Siemens Art. No. 57 36 322 E536U.

  Gas Regulator

  Tubing w/ Luer-lock fittings

  T-Piece w/ Luer-lock fittings

  Two-way valve w/ Luer-lock fittings

  Gas collection bag
- Flow meter with a range of minimum 0 - 350 ml/min, accuracy ±5% or better, (Sierra Flow Control Model 822-13-OV1-PV1-V1 calibrated for "standard - l/min" is recommended
- Pressure Gauge: Setra Digital Pressure Gauge, Model 370 or equiv. is recommended.

  Note: Pressure gauge required only if verifying and/or calibrating the pressure channel. The hospital and/or a local weather station or airport may be able to provide a reading.
- Exhaust system (for exhausting calibration gas).
- Digital Voltmeter w/ 3½ digit resolution (minimum)
- Oscilloscope (optional)
- Hand tools:
  - — Medium sized Phillips screwdriver
  - — Medium sized flat head screw driver
  - — Wire cutters
  - — Non - serrated needle nose pliers
- Loctite adhesive or equivalent

2 Leakage Check Procedure

Run MGM for at least 8 minutes (warm-up time).

1. Connect flow meter to exhaust port.
2. Block MGM Patient sample port (inlet) by using your finger tip.
3. Verify that value on flow meter decreases to 0 ±5 ml/min.

3 Pump Test

1. Ensure that power is removed from unit.
2. Remove and save four screws securing cover.
3. Remove cover and set aside.
4. Perform pneumatic leak test if not already performed in Section 1 above.
5. Remove water trap from unit. See **Warning** on page 2.
6. With unit turned topside down, connect DMM negative lead to drain (center lead) of Q4. Connect positive lead to test point labeled VHP (TP14), located next to J5 and connector for solenoid 2. See Figure 3-3 on page 27.
7. Carefully return unit to upright position, and connect flow meter to exhaust port on back of MGM.
8. Connect unit to known functional CPS/IDS (or KION) and SC 9000 or SC 7000 patient monitor. Apply power to both and allow to stabilize.
9. Connect power to MGM and switch power to on. Allow two minutes for MGM to initialize.

> **Warning**
> A potential shock hazard exists when voltage is applied to the MGM with outer cover removed. Use extreme care to avoid contact with exposed terminals and components in power supply.

10. Set DMM to 10 volt scale. Verify that a dc voltage is present between Q4 drain and VHP, and that air flow is indicated on flow meter.
11. If flow has ceased and unit is indicating occlusion, check all pneumatic connections for obstructions. If unit continues to present an occlusion error, replace pump. Refer to procedure in 2. Otherwise, continue.
12. On SC 9000, select Monitor Setup → Biomed → Service, and enter **4712**. Set flow rate to 350 ml.
13. Observe display on DMM, and note results.
14.
    - If DMM measures ≤ 10.5 volts dc, pump is OK. Go on to Section 4.
    - If DMM measures > 10.5 volts dc, pump is defective and must be replaced. See “Replacing Pump” on page 24.

4 O_2 Calibration

The paramagnetic oxygen sensor typically does not require Span calibration in the field. For the galvanic or Slo-O_2 type of sensor, perform an O_2 Span calibration before Span calibrating the Agent, N_2O, or CO_2 channels.

A typical single-point Span calibration of O_2 channel uses room air, ≈21% O_2, for calibration gas.

A typical 2-Point O_2 Span calibration uses room air (≈21% O_2) and 100% O_2 for calibration gases.

To perform either the single-point Span calibration or the 2-Point O_2 Span calibration, refer to procedures in the User Guide.

5 Pump Flow Rate Adjustment Procedure

Refer to Figure B-7 on page 59 for locations of adjustment potentiometers referenced in the following procedure.

1. Connect flow meter to exhaust port.
2. Remove water trap.
3. Set flow rate to 350 ml/min (Purge).
4. Verify that the flow rate is 350 ±15 ml/min.

   Note: It has been observed that on some MGM's the water trap causes an "Occlusion" error message at flow rates above 300 ml/min. If this occurs, remove the water trap and repeat the procedure.
5. Adjust R125 on MGM System board for 350 ml/min if required.
6. Set flow rate to 200 ml/min (High).
7. Insert water trap.
8. Verify that flow rate is 200 ±10 ml/min.
9. Adjust R124 on MGM System Board for 200ml/min if required.
10. Set flow rate to 120 ml/min (Low).
11. Verify that flow rate is 120 ±6 ml/min.
12. Adjust R126 on MGM system Board for 120ml/min if required.
13. If any flow rate had to be adjusted, repeat this process until each selected flow rate can be selected and verified without adjustment.

    Note: If flow rates cannot be adjusted to within specification, troubleshoot and repair pneumatics, and recalibrate MGM.
14. **Perform Save Flow Rate command**.

6 Agent Detection and Analysis Calibration

Annually, or at any time reported values of cal gas disagree with cal gas specifications by amounts > the ranges specified above, perform calibration of agent detection and analysis components.

The following procedures should be performed by only qualified biomedical service personnel.

1. Verify that module is being operated within its ambient humidity, temperature, and pressure specifications, as follows:

   Temperature range: 10°C to 40°C (50°F to 104°F)

   Relative humidity: 0% to 95%, non-condensing

   Atmospheric pressure: 525 to 795 mmHg (70 to 106kPa)
2. Select Agent parameter box.
3. Select ID Override and set to ISO.
4. Select Sample Flow Rate. Set for 120 ml/min. Password = 375 (4712).
5. Press "Menu" and select following: Monitor Setup - Biomed - Service (4712) - MGM Calibration - MGM Advanced cal. - MGM Pressure Cal.
6. Adjust Pressure to reading of barometric pressure gauge (or hospital-supplied value), if "Current Setting" different from barometric pressure.

7. •If change required, select "Calibrate." When "MultiGas Zero Accepted" message displays, select "Cancel."

   •If no change to present setting required, select "Cancel."

8) Continue flowing room air through the MGM for an additional 15 min.

9. Select MGM Calibration.

10. When "Supply Gas Mixture and then Press Continue" displays, connect standard cal gas to MGM as illustrated in Figure 4-1.

> **Warning:**
>
> The calibration gas contains substances that may be detrimental to your health. Assure that the MGM/MGM+ is connected to the hospital's EVAC system during calibration.

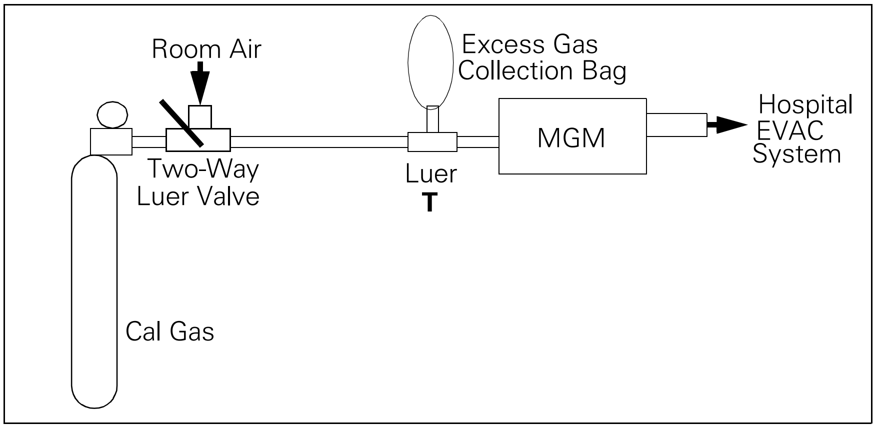


Figure 4-1 Gas Calibration / Test Setup

11. Apply calibration gas at a flow rate of 150 ±10ml/min.(preset flow from cal. gas regulator), and let cal gas flow until readings on monitor are stable.

12. Select "Continue."

    Note: The MGM performs an internal calibration, and displays the status (pass/fail) for each gas on the patient monitor.

13. If calibration successful, as indicated by a "PASS" status for all gases, skip step 14 and go on to step 15.

14. If calibration NOT successful, select "Restore Factory Defaults" and then return to step 9. If calibration process fails a second time, remove MGM module from clinical service and proceed in accordance with Siemens Service Policy.

15. press Main Screen key to return to the *MAIN* screen.

16. Select MGM Calibration once again to perform a zero.

    Note: This must be done to activate the stored O2 calibration data. Otherwise, old data is used until next automatic zero is performed.

17. Abort further calibration by pressing Main Screen key to return to *MAIN* screen.

18. Functionally verify proper operation of MGM. See "Functional Verification" on page 45.

Chapter 5 Troubleshooting

Refer to Figure B-7 on page 59 for locations of test points referenced in the following Tables.

1 Agent Measurement Analyzer Head)

Table 5-1 AMA Analyzer Head Problems

Possible Cause	Action
Bad or Dirty AMA Sample Cell	Refer to Bad or Dirty AMA Sample Cell procedure in Table 5-2.
Bad Analyzer Head	Check Analyzer Head -- with voltmeter: * Measure IR Source voltage at TP6 on MGM System Board. Use TP1 for Ground. Voltage should be 7.87vdc (±20mv) If voltage is okay, proceed to next action. If voltage is not within spec, disconnect AMA Analyzer Head cable from MGM System Board and measure again (turn off power before disconnecting cable). If voltage is now okay, replace AMA Head. If voltage is not okay, replace MGM System Board. * Measure TE Cooler voltage at TP7 on MGM System Board. Use TP1 for Ground. Voltage should be ≈ 250mv±100mv, and should be more stable as unit warms up. -- with oscilloscope: * Measure Preamp Signal at TP3 on MGM System Board. Use TP1 for Ground, and TP2 for Ext. trigger. Voltage should be $400mv_{p-p}$ (±30mv). * Check for presence of A/D Signal at TP4 on MGM System Board. Use TP1 for Ground, and TP2 for Ext. trigger.
Bad Cable	Check/Replace cable.
Bad Power Supply	Refer to Bad Power Supply procedure in Table 5-4.
Bad MGM System Board	If troubleshooting has isolated problem to MGM System Board, replace MGM System Board.

2 Agent Measurement Analyzer Optical Path

Table 5-2 AMA Optical Path Problems

Possible Cause	Action
Bad AMA Analyzer Head	Refer to Bad AMA Analyzer Head procedure in Table 5-1.
Bad MGM System Board	If troubleshooting has isolated problem to MGM System Board, replace MGM System Board.

Table 5-2 AMA Optical Path Problems (Continued)

Possible Cause	Action
Bad or Dirty AMA Sample Cell	Check IR signal: – With voltmeter: * Measure IR Source voltage at TP6 on MGM System Board. Use TP1 for Ground. Voltage should be 7.87vdc ±20mv If voltage okay, proceed to next action. If voltage not within spec, disconnect AMA Analyzer Head cable from MGM System Board and measure again (turn off power before disconnecting cable). If voltage now okay, replace Head. If voltage not okay, replace MGM System Board. – With oscilloscope: * Measure Preamp Signal at TP3 on MGM System Board. Use TP1 for Ground, and TP2 for Ext. trigger. Voltage should be 400mvp-p ±30mv. If voltage not okay, sample cell may be dirty and needs to be replaced.

3 Agent Identification Analyzer Head

Table 5-3 AIDA Analyzer Head Problems

Possible Cause	Action
Bad AIDA Analyzer Head	Check Analyzer Head: – With voltmeter: * Measure IR Source voltage at TP11 on MGM System Board. Use TP1 for Ground. Voltage should be 7.92vdc ±20mv. If voltage okay, proceed to next action. If voltage not within spec, disconnect AIDA Analyzer Head cable from MGM System Board and measure again (turn off power before disconnecting cable). If voltage now okay, replace AIDA Analyzer Head. If voltage not okay, replace MGM System Board. – With oscilloscope: * Check for presence of A/D Signal at TP10 on MGM System Board. Use TP1 for Ground, and TP2 for Ext. trigger. If voltage not okay, replace MGM System Board.
Bad Cable	Check/Replace cable.
Bad Power Supply	Refer to Bad Power Supply procedure in Table 5-4.
Bad MGM System Board	If troubleshooting has isolated problem to MGM System Board, replace MGM System Board.

4 Power Supply

Table 5-4 Power Supply Problems

Possible Cause	Action
Bad Power Supply	Check power supply voltages. Replace power supply if necessary. Connector voltages at power supply and at MGM System Board should be as follows: Pin 1 = +12vdc±600mv Pin 2 = +12vdc±600mv Pin 3 = +5vdc±250mv Pin 4 = +5vdc ±250mv Pin 5 = Ground Pin 6 = Ground Pin 7 = Ground Pin 8 = -12vdc ±600mv Pin 9 = +12vdc ±600mv
Bad Cable	Check/Replace cable.
Bad MGM System Board	If troubleshooting has isolated problem to MGM System Board, replace MGM System Board.

5 O_2 Sensor

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Table 5-5 O_2 Problems

Type of Problem	Possible Cause	Action
O_2 Zero Fail Verify that only Zero gas is present at room air port.	Zero on wrong gas	Check/Replace filter.
	Air reference filter bad	Diagnose and repair occlusion.
	Occlusion present, Bad O_2 Sensor	Check/Replace O_2 Sensor.
	Bad MGM System Board	If troubleshooting has isolated problem to MGM System Board, replace MGM System Board.
O_2 Span Fail	Span on wrong gas.	Verify/correct span gas being used.
	Wrong gas tag value.	Verify/correct gas tag value being used.
	Occlusion present Bad O_2 Sensor	Check/Replace O_2 Sensor.
	Bad MGM System Board	If troubleshooting has isolated problem to MGM System Board, replace MGM System Board.
Data Limit Error	Same reasons as for O_2 Zero fail and/or O_2 Span fail	Perform corrective action(s) as stated above for O_2 Zero fail and/or O_2 Span fail.

Table 5-5 O_2 Problems (Continued)

Type of Problem	Possible Cause	Action
	O_2 Jumpers Configured Wrong	Verify that O_2 jumpers MGM System Board are configured correctly for the configuration in use. (Especially important if the MGM System Board has just been replaced.) Refer to Table 5-11 and Table 5-12 in Section 9 for O_2 Jumper Configurations.
	Defective O_2 Sensor	Using a voltmeter, check the following: 1. Connect the voltmeter ground lead to TP1 on MGM System Board. 2. Measure TP8 voltage. It should vary according to the O_2 concentration (can breathe into, or run gas with O_2 into sample port to see change in O_2 concentration). Room air should read about 208mv (actually calculated as: 208 * actual pressure at O_2 sensor) / 760, and can use AMA reported sample cell pressure for estimated "actual pressure at O_2 sensor"). If voltage is within ±30% (but >5% off) of accurate voltage for gas present, adjust O_2 Zero and Span pots as follows (applies to Paramagnetic Oxygen Sensors only): Zero Adjust: If gas does not contain any O_2 (e.g.,100% Nitrogen), run gas into sample port and adjust RV2 potentiometer on Paramagnetic O_2 PCB until voltage is 0mv ±.1mv. If you do not have this type of gas, perform only the span adjustment. Span Adjust: Flow room air through the sample port, and adjust RV1 potentiometer on Paramagnetic O_2 PCB for 208mv (or actual calculated voltage corresponding to the actual room air O_2 concentration) ±1mv. 3. Measure ±5V at Pin 4 of IC5 on the Paramagnetic O_2 PCB, and -5V at Pin 11 of IC5. If correct voltage is not present, check for bad O_2 sensor, O_2 sensor cable, or MGM System Board.
	Bad MGM System Board	If troubleshooting has isolated problem to MGM System Board, replace MGM System Board.

Additional Notes on O_2

- If O_2 is reading 45% Digital, and want to get out of the Digital O_2 mode, the unit has to be powered cycled. However, the unit will continue to read 45% Digital if there is still a problem with O_2, because this is the default for O_2 failure. The unit will also read 45% Digital if there is no O_2 sensor present (or it is not connected).
- Do not flow gas through the O_2 sensor if the O_2 sensor is not powered up (such as if the O_2 sensor cable was disconnected, but the O_2 sensor was still plumbed in pneumatically and had the pump running room air or calibration gas in). Damage to O_2 sensor can occur.

6 Sample Delivery Subsystem

Table 5-6 Sample Delivery Subsystem Problem

Possible Cause	Action
Occlusion	Check for an occlusion, such as bent or collapsed tubing, dirty air reference filter, etc. Repair or replace the necessary part(s) to eliminate the occlusion.
Pressure Transducer Tubes Reversed	Verify that tube A is going to Port A and tube B is going to Port B of Pressure Transducer on MGM System Board, and correct if necessary.
Flow Rate Not Within Selected Range	Verify the flow rate settings. Perform save flow calibration.
Bad Pump	Check/Replace pump.
Bad MGM System Board	If troubleshooting has isolated problem to MGM System Board, replace MGM System Board.

7 Gas Flow Problems

Table 5-7 Gas Flow Problems

Symptom	Possible Cause	Action
Insufficient Air Circulation	Blocked or dirty fan entrance	Unblock and/or clean fan entrance.
	Bad Fan	Check/Replace fan.
	Module Environment	Do not operate the unit in an environment that does not fall within Product Specifications.
	Bad AMA Analyzer Head	Refer to Bad AMA Analyzer Head procedure in Table 5-1.
	Bad MGM System Board	If troubleshooting has isolated problem to MGM System Board, replace MGM System Board.

8 Bad MGM System Board suspected

Table 5-8 MGM System Board Problems

Possible Cause	Action
Bad Power Supply	Refer to Bad Power Supply procedure in Table 5-4.

Table 5-8 MGM System Board Problems (Continued)

Possible Cause	Action
Bad MGM System Board	– With voltmeter: * Measure IR Source voltages on MGM System Board. Use TP1 for Ground. Voltage at TP6 should be 7.87vdc ±20mv. Voltage at TP11 should be 7.92vdc ±20mv. * Measure TE Cooler voltage at TP7 on MGM System Board. Use TP1 for Ground. Voltage should be approx. 250mv ±100mv, and should be more stable as unit warms up). * Measure Pump Control Voltage at TP5 on MGM System Board. Use TP1 for Ground. Voltage should be ≈ 5vdc. – With oscilloscope: * Measure Preamp Signal at TP3 on MGM System Board. Use TP1 for Ground, and TP2 for Ext. trigger. Voltage should be 400mvp-p ±30mv. * Check for presence of A/D Signal at TP4 on MGM System Board. Use TP1 for Ground, and TP2 for Ext. trigger. If voltages not okay, replace MGM System Board.

9 MGM System Board Test Points, Jumpers, & Connectors

Table 5-9 MGM System Board Test Points

Test Point	Signal Name	Signal
TP1	Analog Ground 1	
TP2	Analog Dark Level Clamp	
TP3	AMA Preamp Signal	400mv±30mv
TP4	AMA A/D Converter Input	
TP5	Pump Flow Control Signal	Signal ≈ 3-4 volts with Pump at low flow rate, may go to ≥7volts at Purge flow rate. If >10volts, pump reaching maximum flow rate ("occlusion" mode). (varies because of tolerances of pumps, pneumatic parts, etc.)
TP6	Source Voltage Plus to AMA Analyzer Head	7.87volts±20 mv
TP7	Thermal Electric Cooler Drive Voltage to AMA Analyzer Head	250mv±100mv (after at least 15 min. warm-up)
TP8	Oxygen Transducer Signal Output	Signal varies with Oxygen concentration, e.g., 20.8% O_2 ≈ 208mv, 50.0% O_2 ≈ 500mv)
TP9	Analog Ground 2	

Table 5-9 MGM System Board Test Points (Continued)

Test Point	Signal Name	Signal
TP10	AIDA A/D Converter Input	
TP11	AIDA Source Voltage	7.92 volts±20mv
TP13	Isolated Ground for isolated RS-232 communications with Host Computer via J14	
TP14	+12VHP	+12 volts±600mv
TP15	+5V	+5 volts±250mv
TP16	-12V	-12 volts±600mv
TP17	+12V	+12 volts±600mv
TP18	Analog Ground 3	

Table 5-10 Connector Functions

Connector	Function
J1	AMA Analyzer Head
J2	AIDA Analyzer Head
J3	Factory use only for software development
J4	Factory use only for software development
J5	DC Power: +12VHP, +5V, GND (DGND), AGND, AGND1-6, +12V, -12V
J6	Front Panel P.C. Board, also for using AMA Service Board (AMA NVRAM Transfer)
J7	Solenoid driver (SOL1 & 3) for Air Source Solenoid
J8	Pump driver for DC Pump or AC Pump (DC PUMP/AC PUMP)
J10	Oxygen Transducer Signals
J13	Factory use only for direct communications with AIDA processor
J14	Connection to Host Computer for communications, RS-232.
J15	Fan power (FAN1)
J16	Fan power (FAN2) (not used)
J17	LED power
J19	Optional for AC Pump Daughter Board
J20	Optional for AC Pump Daughter Board
J21	O_2 Solenoid (SOL 2)
J22	Optional Front Panel I/O

Table 5-11 Jumpers, Functions, and Settings

Jumpers	Function and Setting
JP3	For Normal operation pins 2 & 3 closed. For AIDA direct communications pins 1 & 2 closed.
JP4	For Normal operation pins 1 & 2 closed. For AIDA direct communications pins 1 & 2 open.

On EP3 and EP4 revisions of the MGM System Board, IRQ lines one (IRQ1), two (IRQ2), and three (IRQ3) jumper options select which oxygen transducer you would like to interface. Up to eight different options for oxygen transducers can be selected according to the following jumper table:

Table 5-12 O_2 Jumper Configuration

IRQ1	IRQ2	IRQ3	Transducer Number	Transducer Name
No Jumper	No Jumper	No Jumper	0	None
Jumper	No Jumper	No Jumper	1	Fuel Cell
No Jumper	Jumper	No Jumper	2	Unassigned
Jumper	Jumper	No Jumper	3	Unassigned
No Jumper	No Jumper	Jumper	4	Paramagnetic
Jumper	No Jumper	Jumper	5	Unassigned
No Jumper	Jumper	Jumper	6	Unassigned
Jumper	Jumper	Jumper	7	Unassigned

Note: All three IRQ lines are pulled down to ground when they are not jumpered. Adding a jumper pulls the IRQ line up to Vcc. The unassigned transducer names are available for any type of oxygen transducer.

Chapter 6 Functional Verification

Set up MGM in accordance with instructions in "Supplemental Documentation" on page 67. Record results of functional verification testing on the form in Appendix C on page 61. The form should be copied and retained in hospital records. If the MGM should fail any test, remedy the cause and repeat the test. The MGM must pass all functional verification tests before being subjected to clinical use.

1 Pneumatics Leakage Check

1. Connect flow meter to exhaust port.
2. From $etCO_2$ menu, click Sample Flow Rate
3. Set flow rate to either 120ml/min or 200ml/min. (you can also set the sample rate from the O_2 menu)
4. Type in clinical password.
5. Block MGM Patient Sample port by using your finger tip.
6. Verify that value on flow meter decreases to 0 ±5ml/min.

2 Pump Flow Rate Verification

1. Connect flow meter to exhaust port.
2. Remove water trap.
3. Set flow rate to 350 ml/min (Purge).
4. Verify that flow rate is 350 ±15 ml/min.
5. Set flow rate to 200 ml/min (High).
6. Verify that flow rate is 200 ±10 ml/min.
7. Set flow rate to 120 ml/min (Low).
8. Verify that flow rate is 120 ±6 ml/min.

3 Gas Identification Verification

1. Plug in module and turn on power switch.
2. Assure that module is being operated within its ambient humidity, temperature, and pressure specifications, as follows:

   Temperature range: 10°C to 40°C (50°F to 104°F)

   Relative humidity: 0% to 95%, non-condensing

   Atmospheric pressure: 525 to 795 mmHg (70 to 106kPa)
3. Make sure that MGM has been running for ≥8 minutes to assure that MGM has finished start-up tests and has come out of reduced accuracy mode.
4. From Agent menu, select ID Override OFF.
5. From Agent menu, select Sample Flow Rate of 120 ml/min.
6. Enter clinical password (375) (4712 in SCx000 SW version VE).
7. Continue flowing room air into MGM for an additional 15 min.
8. From Agent menu, select ID Override OFF.
9. Apply calibration gas at a flow rate of 150 ±10 ml/min., as provided from regulator in Siemens kit, to MGM as illustrated in Figure 6-1.

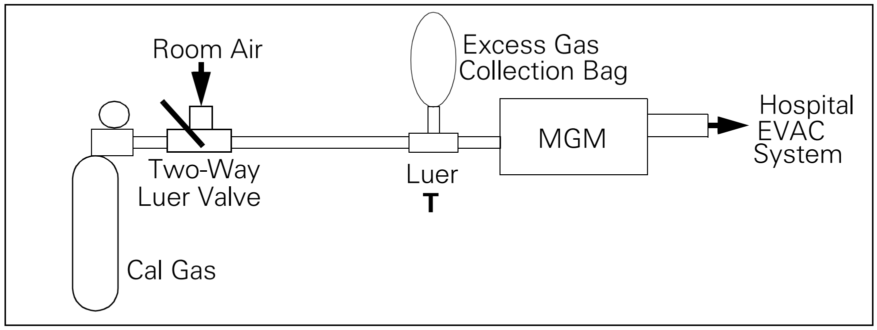


Figure 6-1 Gas Calibration / Test Setup

> **Warning:**
>
> Calibration gas may be detrimental to your health. **Assure MGM / MGM+ is connected to hospital's EVAC system**.

10. Verify following values display on Patient Monitor:

$etCO_2$	-	38 ±1.5%
O_2	-	52% ±2.5% absolute and ±5% relative
N_2O	-	40% ±1.5% absolute and ±5% relative
ISO	-	3% ±0.1% absolute and ±4% relative

4 Safety Tests

4.1 Resistance Test

1 Using DMM (Fluke, model 8050A or equivalent) measure resistance between ground stud on rear panel and ground pin of attachment plug. Flex power cord at connection to attachment plug and at connection to strain relief on chassis during resistance measurement.

2. Verify that resistance < 0.50Ω.

4.2 Chassis Leakage Current Tests

Perform leakage current tests with MGM connected as in Figure 6-2. Be sure that MGM-CPS/IDS cable is unplugged from the MGM.

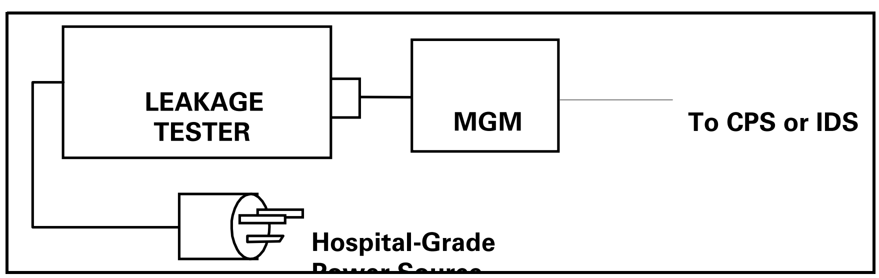


Figure 6-2 Leakage Current Tests Block Diagram

1 Use leakage tester manufacturer's instructions to measure chassis leakage current for condition a and condition b below.

Note: Assure that no wires are connected to potential equalization stud on rear panel of MGM when performing chassis leakage tests.

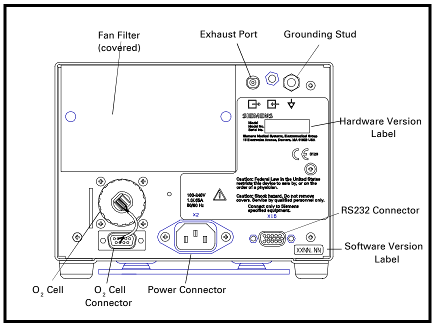
a. Power plug connected normally and MGM switched on

b. Power plug connected normally and MGM switched off

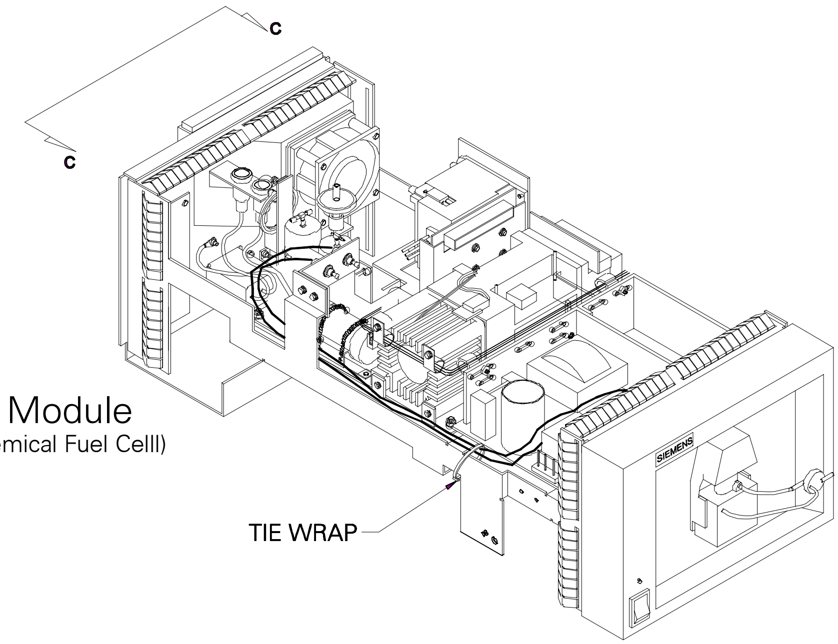
2. Verify that leakage current is as follows, for each of above conditions.

<300μa @ 120VAC or <500μa @ 240VAC

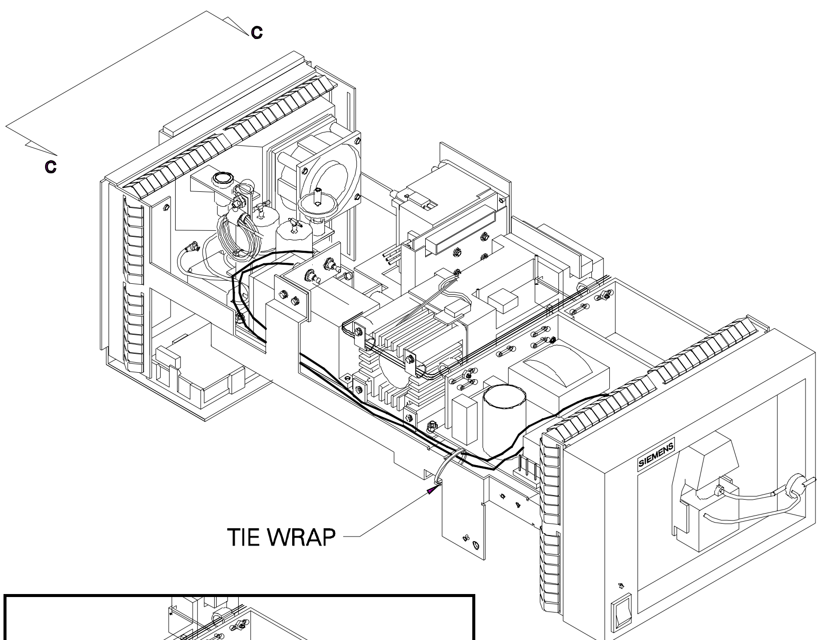
Appendix A Spare / Exchange Parts

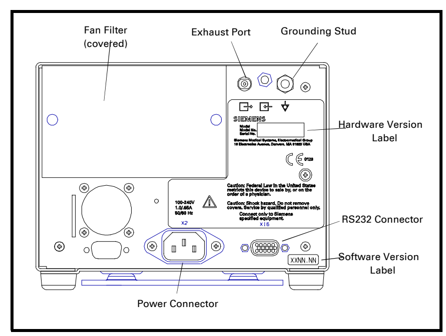


MultiGas Module
Section c-c
Rear View



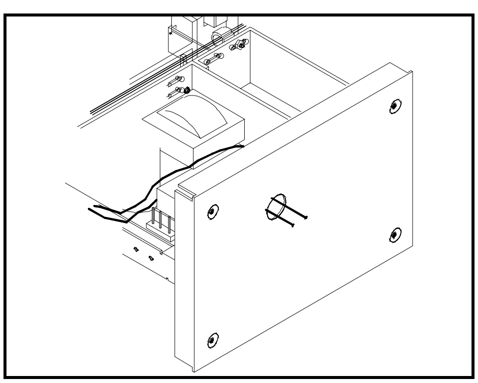
MultiGas Module
(uses Electrochemical Fuel Celll)





MultiGas+ Module
Section c-c
Rear View

PCS and LSS* MultiGas+ Module
(uses Paramagnetic Fuel Cell)



LSS Version Front Panel

*LSS version does not use front bezel with water trap and power switch as shown on PCS version. See illustration at left.

MGM w/ Top Cover Removed

Item No.		Item Name	Siemens Art. No.	Figure No.
1	E/M SPR MGM TUBING KIT		52 06 821 E536U	
	.1	Upgrade Tubing MGM+ - 453194-000		A-2
		Zero Gas and Filter, Fast O2 - 450334-001		
		Water Ch. Restrictor, Fast O2 - 450349-000		
	.2	Upgrade Tubing MGM - 453195-000		A-1
		Water Ch. Restrictor, Slow O2 - 450353-000		
		4710 Pressure Xducer, Slow O2 - 450328-001		
		Zero Gas (and filter) - 450284-002		
	.3	Upgrade Tubing MGM & MGM+ - 453196-000)		A-1, A-2
		Sol#1 to 4710 Inlet NATVAR - 450321-001		
		Patient Inlet to Sol#1, NATVAR - 450323-001		
2	E/M SPR PREVENT MAINT KIT		52 06 854 E536U	
	.1	Internal Nafion Tubing Assy (Qty=2)		A-1, A-2
	.2	Water Trap		A-1, A-2
	.3	Water Trap seals (Qty=2)		A-1, A-2
	.4	Room Air Filter		A-1, A-2
	.5	Internal Bacterial Filter (Qty=2)		A-1, A-2
	.6	Pump Filter		A-1, A-2
	.7	Fan Filter (see Filter, Dust, in Figs. B-3, B-4)		A-1, A-2
3		E/M SPR MGM SOLENOID ASY #2	55 84 623 E536U	A-1, A-2
4		E/M SPR MGM SOLENOID ASY #1 & #3	55 84 631 E536U	A-1, A-2
5		E/M SPR WATER TRAP MANF	55 84 748 E536U	A-1, A-2
6		E/M SPR MGM PUMP W/FILTER (2.6)	55 84 649 E536U	A-1, A-2
7	E/M SPR MGM AGENT ANALYZER KIT		55 84 656 E536U	
	.1	AMA Measurement Head		A-1, A-2
	——–	NVRAM Transfer PCB (Service Tool) & Procedure		
8		E/M SPR MGM AGENT ID ANALYZER	55 84 664 E536U	A-1, A-2
9		O_2 SENSOR W/ O-RING	64 19 332 E380E	A-1
10		E/M SPR MGM PARAMAG SENSOR	55 84 615 E536U	A-2
11		E/M SPR MGM GAS OUTLET KIT	55 84 607 E536U	A-1, A-2

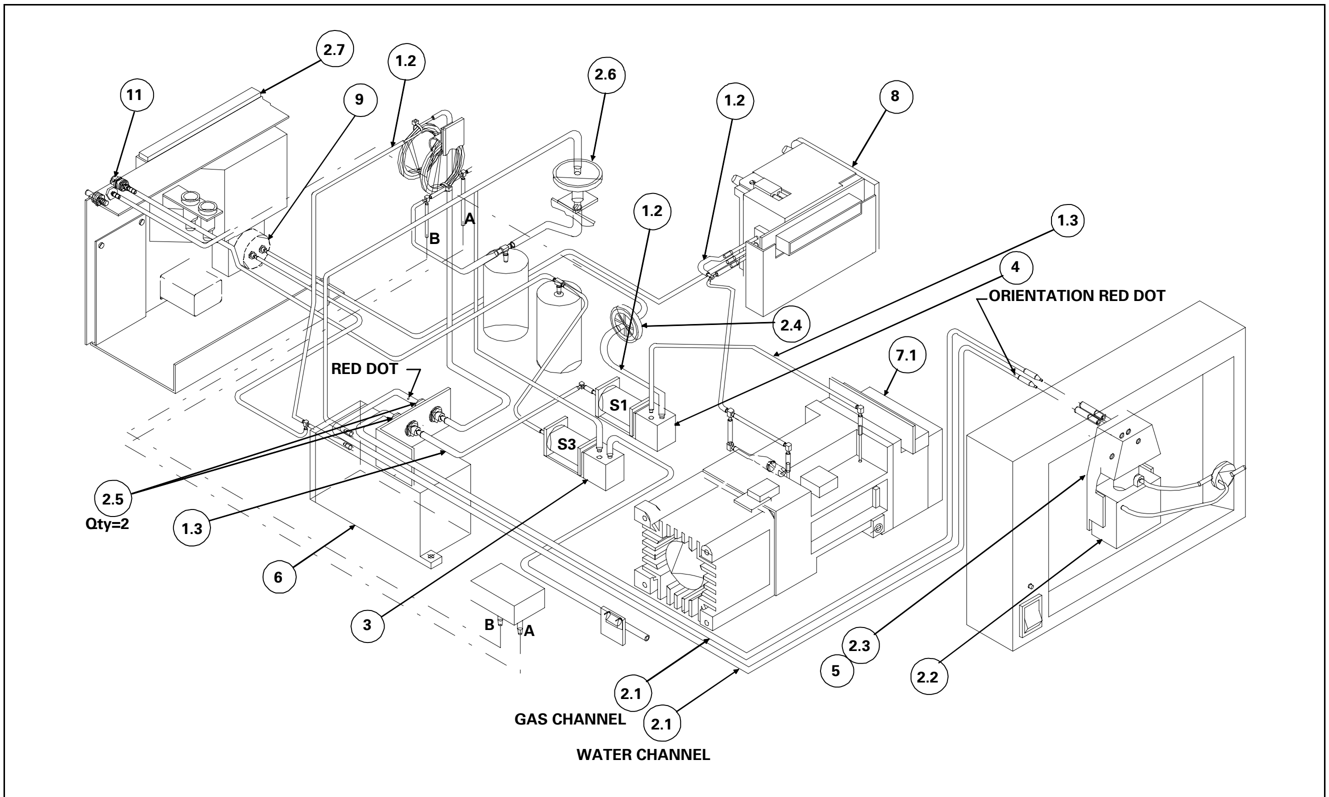


Figure A-1 MultiGas Module (Fuel Cell Type Sensor) Pneumatics

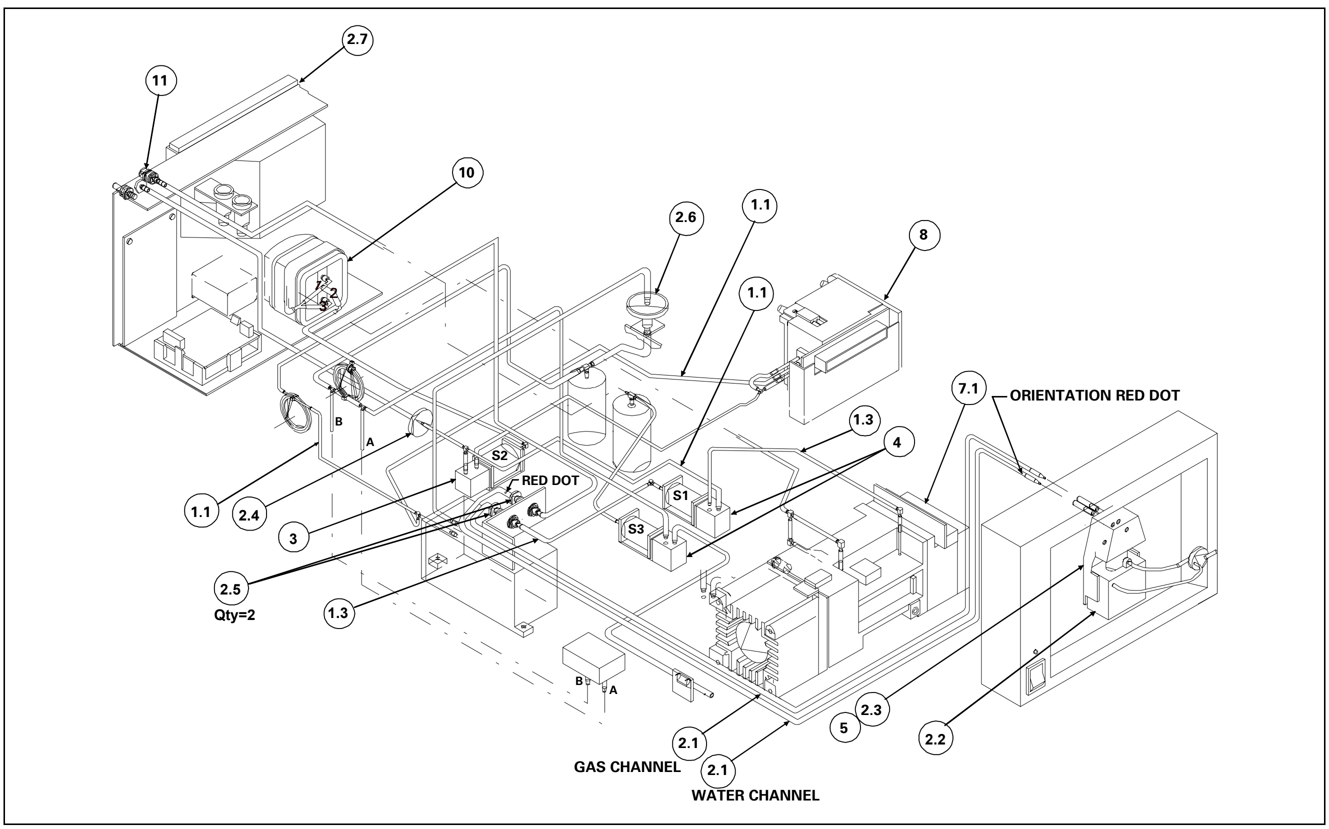


Figure A-2 MultiGas+ Module (Paramagnetic Sensor) Pneumatics

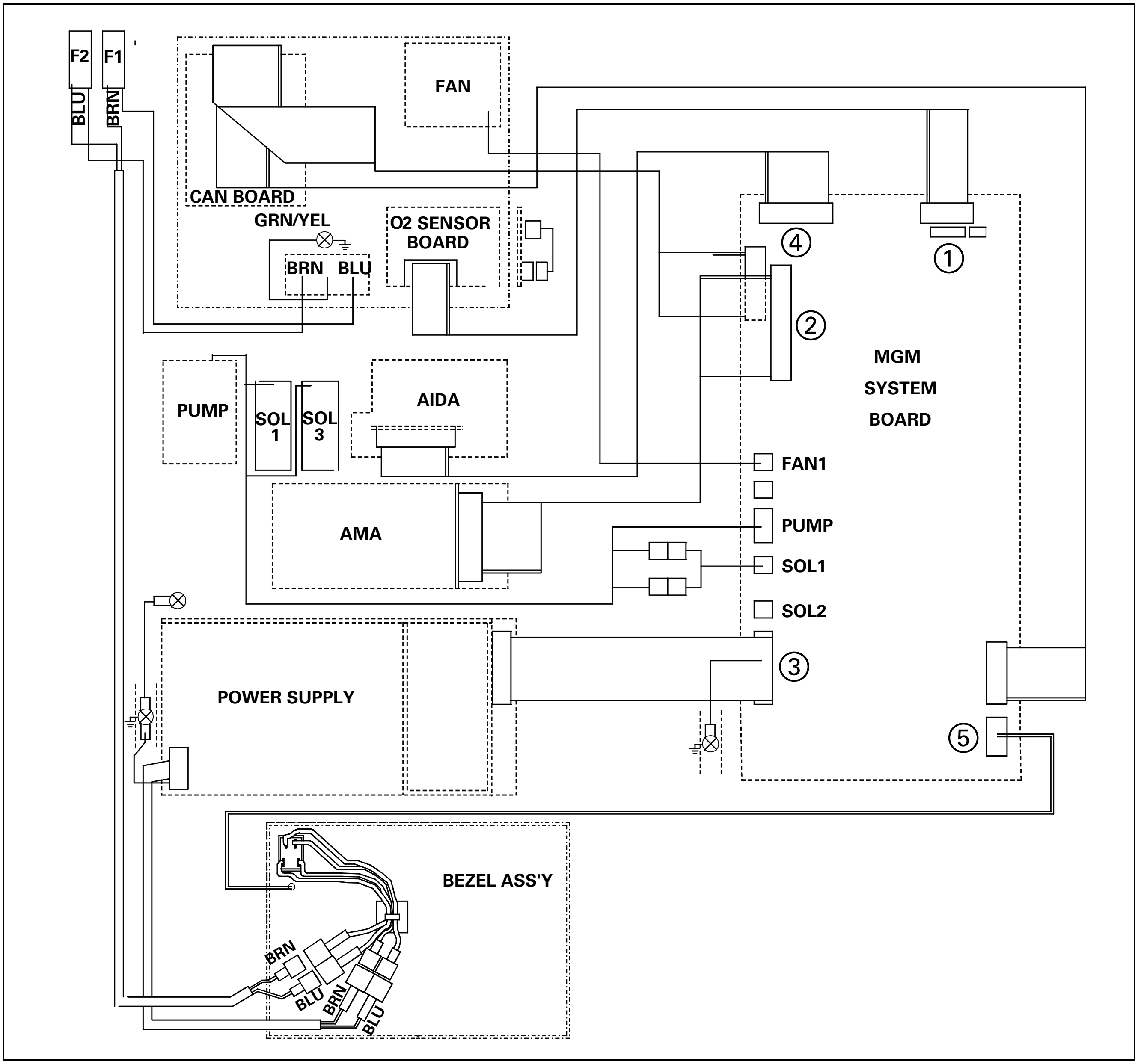


Figure A-3 MultilGas Module (Fuel Cell Type Sensor) Cable Interconnections

Item No.	Item Name	Siemens Art. No.	Figure No.
	E/M SPR MGM CABLE ASY KIT	52 06 797 E536U	A-3
1	Cable, Assy, Flat, 16 pin (O_2 PCB to MGM System Board)		
2	Cable, Assy, Flat, 40 pin (AMA to MGM System Board)		
3	Cable, Assy, 9 pin (Power supply to MGM System Board)		
4	Cable, Assy, Flat, 26 pin (AIDA to MGM System Board)		
5	Cable, Assy, 2 pin with LED		

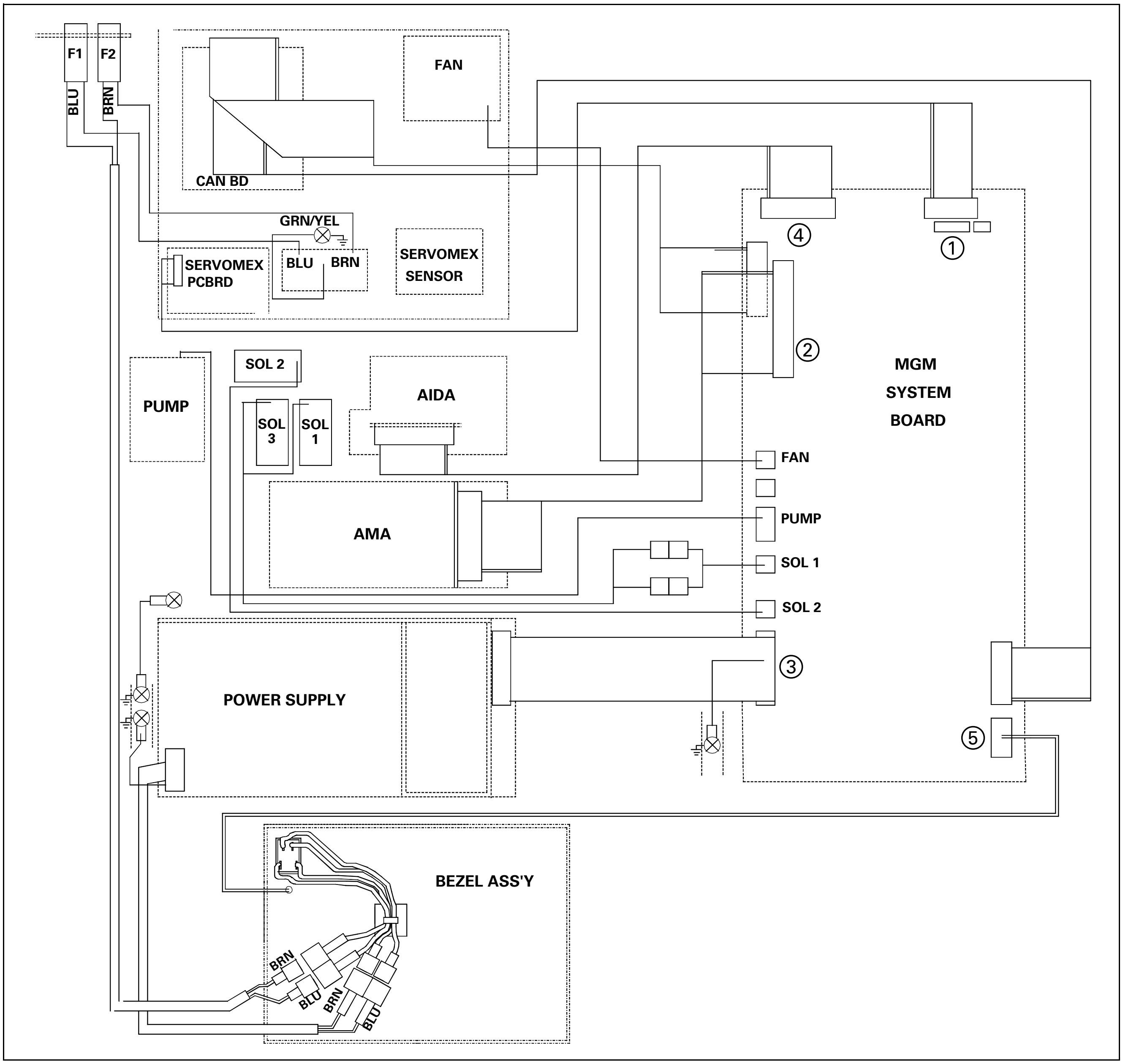


Figure A-4 MultilGas+ Module (Paramagnetic Sensor) Cable Interconnections

Item No.	Item Name	Siemens Art. No.	Figure No.
	E/M SPR MGM CABLE ASY KIT	52 06 797 E536U	A-4
1	Cable, Assy, Flat, 16 pin (O_2 PCB to MGM System Board)		
2	Cable, Assy, Flat, 40 pin (AMA to MGM System Board)		
3	Cable, Assy, 9 pin (Power supply to MGM System Board)		
4	Cable, Assy, Flat, 26 pin (AIDA to MGM System Board)		
5	Cable, Assy, 2 pin with LED		

Item No.	Item Name	Siemens Art. No.	Figure No.
1	E/M SPR MGM AC PWR SUPPLY	52 06 813 E536U	A-5
2	E/M SPR MGM SYSTEM BOARD	55 84 599 E536U	A-5
3	E/M SPR MGM FAN ASY KIT	52 06 847 E536U	A-5
4	E/M SPR MGM SHROUD FAN KIT	52 06 771 E536U	A-5
5	E/M SPR MGM AC PWR ENTRY ASY	52 06 839 E536U	A-5
6	E/M SPR PCS COVER KIT	52 06 789 E536U	A-6
7	E/M SPR MGM MOUNT KIT (4/KIT)	55 84 573 E536U	A-6
8	E/M SPR PCS MGM/MGM+ CAN BD, PC 1714	63 89 881 E392E	A-6
--------	E/M SPR MGM AMA SAMPLE CELL (Installed under cover plate on bottom of AMA)	55 84 581 E536U	Not Shown

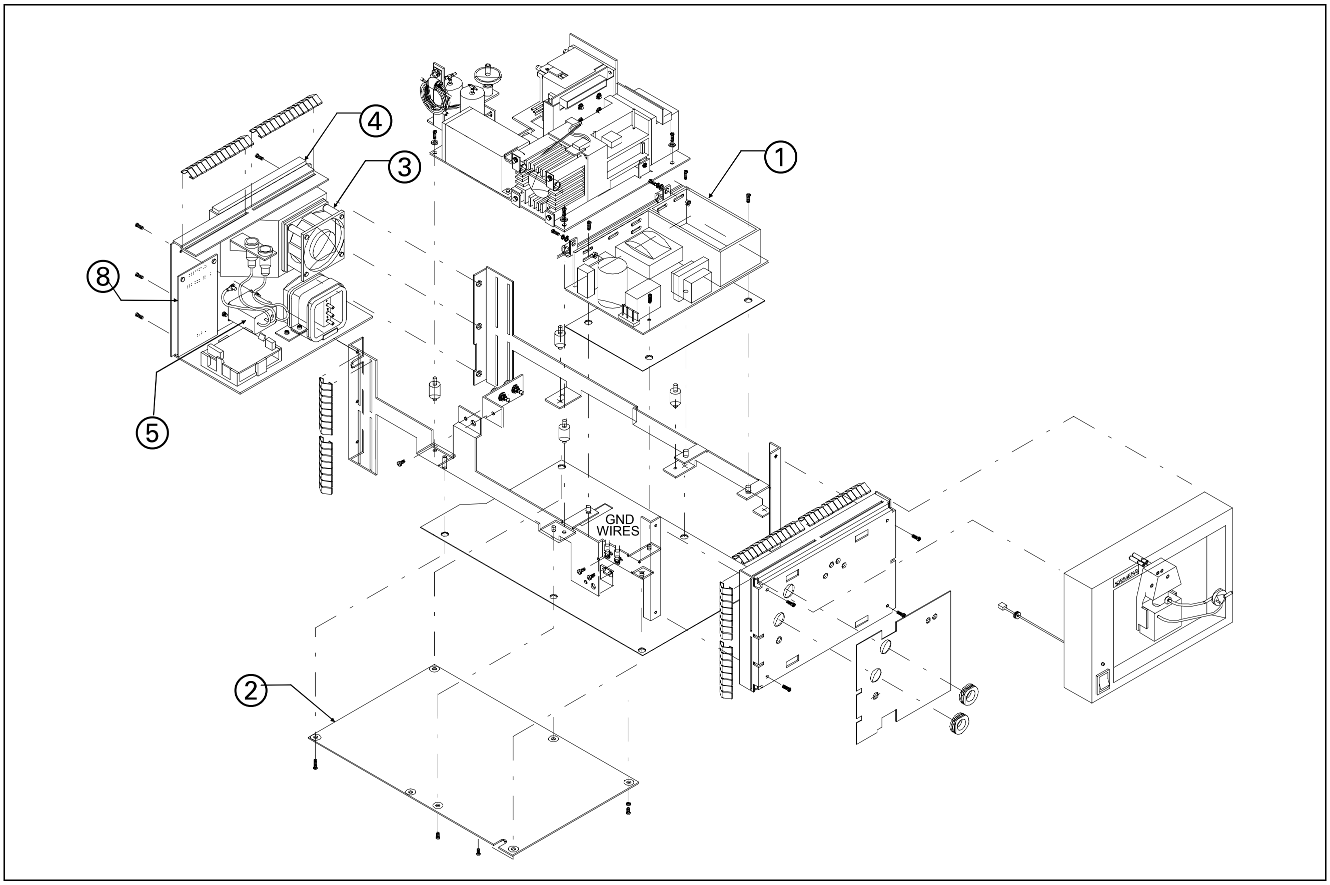


Figure A-5 MGM / MGM+ Selected Component Locations

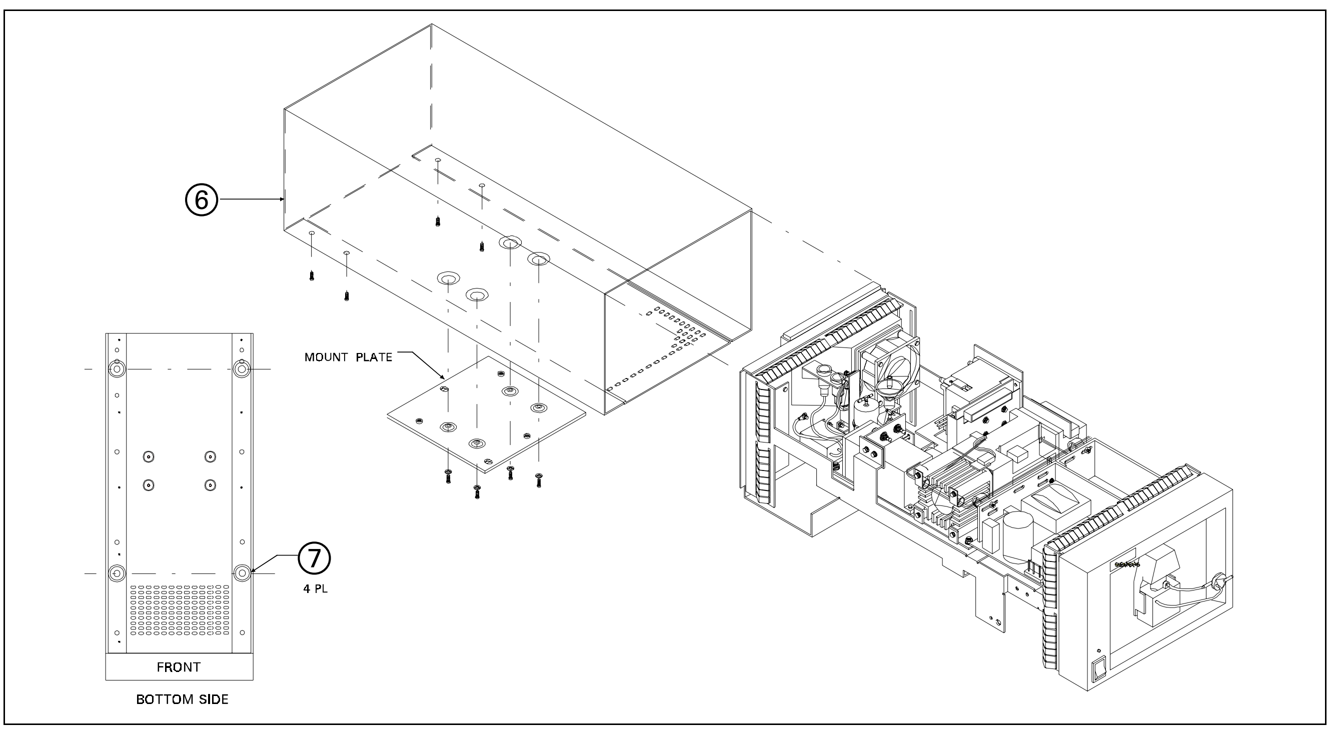


Figure A-6 MGM / MGM+ Cover and Mounting Feet

Figure A-7 MULTIGAS / MULTIGAS+ Modules

Item No.	Item Name	Siemens Art. No.	Figure No.
------	SHP EXC MULTIGAS MODULE (exchange unit)	52 01 368 EE56U	A-7
------	SHP EXC MULTIGAS+ MODULE (exchange unit)	52 01 350 EE56U	A-7
------	Kion Exchange MGM MODULE	64 71 945 E392E	A-7
------	MULTIGAS/+ - CPS Cable, 3M	51 90 447 E536U	Not Shown
------	MultiGas/+ - CPS Cable, 10M	51 90 454 E536U	Not Shown

Appendix B Exploded-View Drawings

Note: Drawings in this section are included in this Manual as aids to assembly/disassembly. Only components listed in Appendix A can be ordered as spare parts.

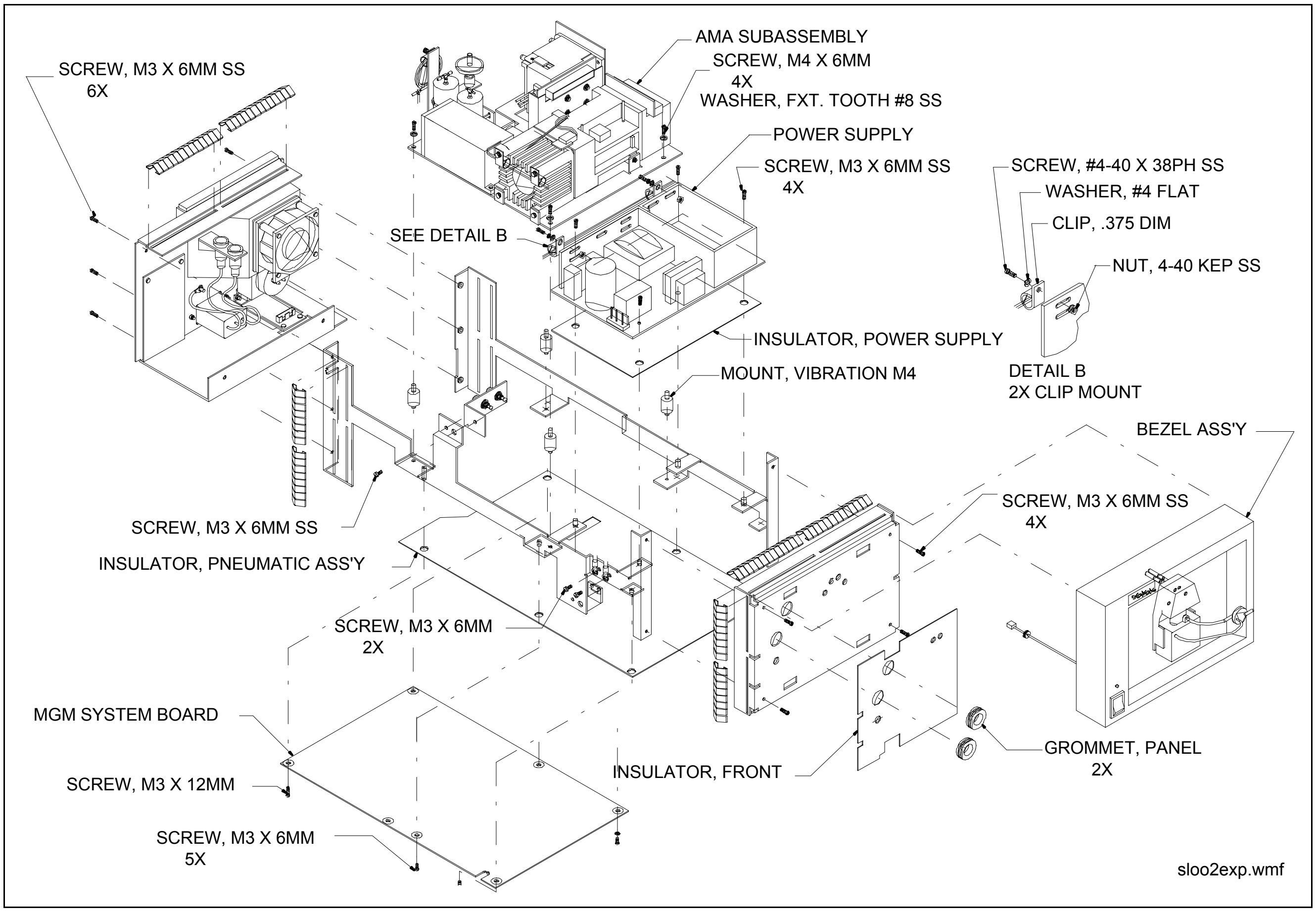


Figure B-1 MULTIGAS Module - Exploded View

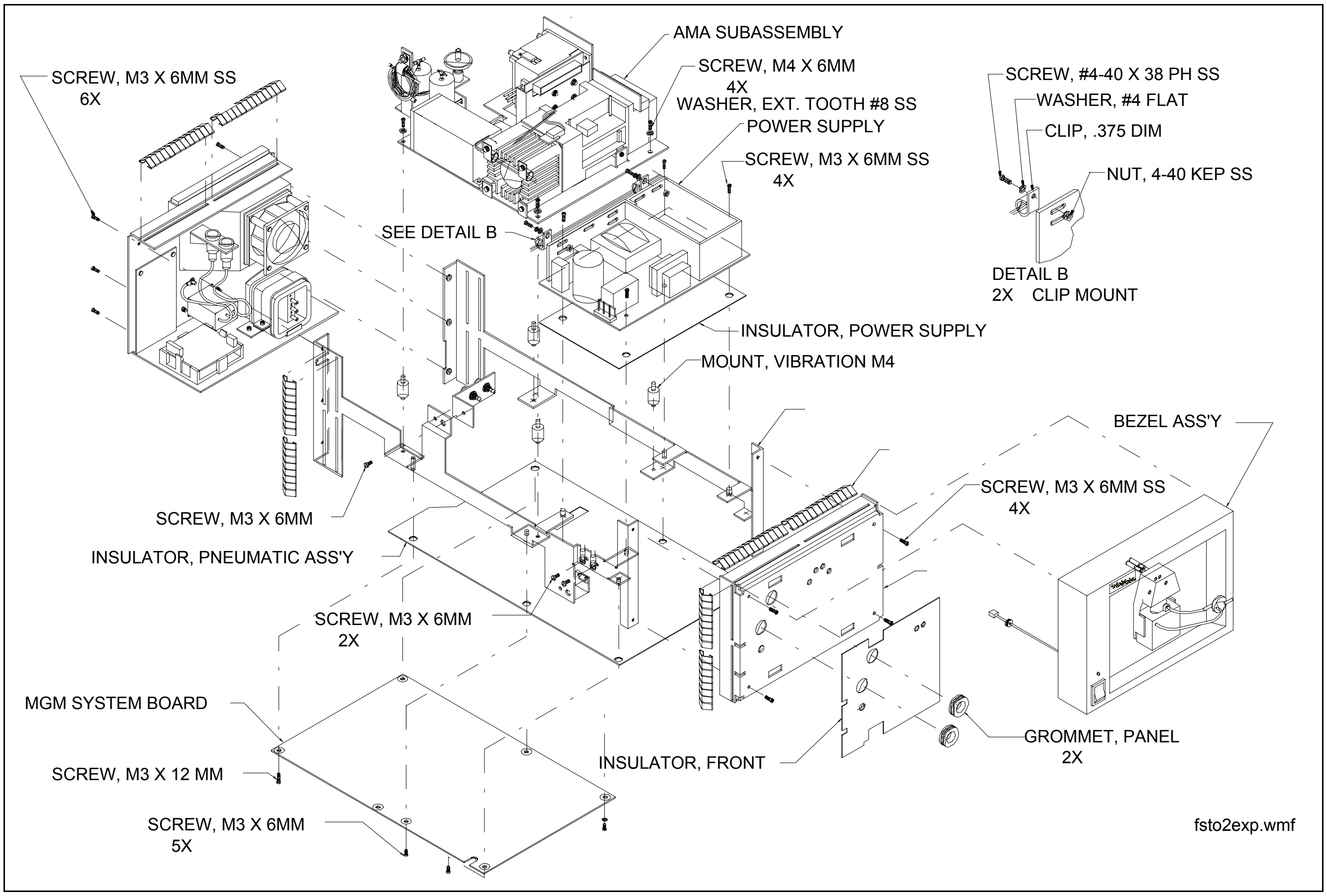


Figure B-2 MULTIGAS+ Module - Exploded View

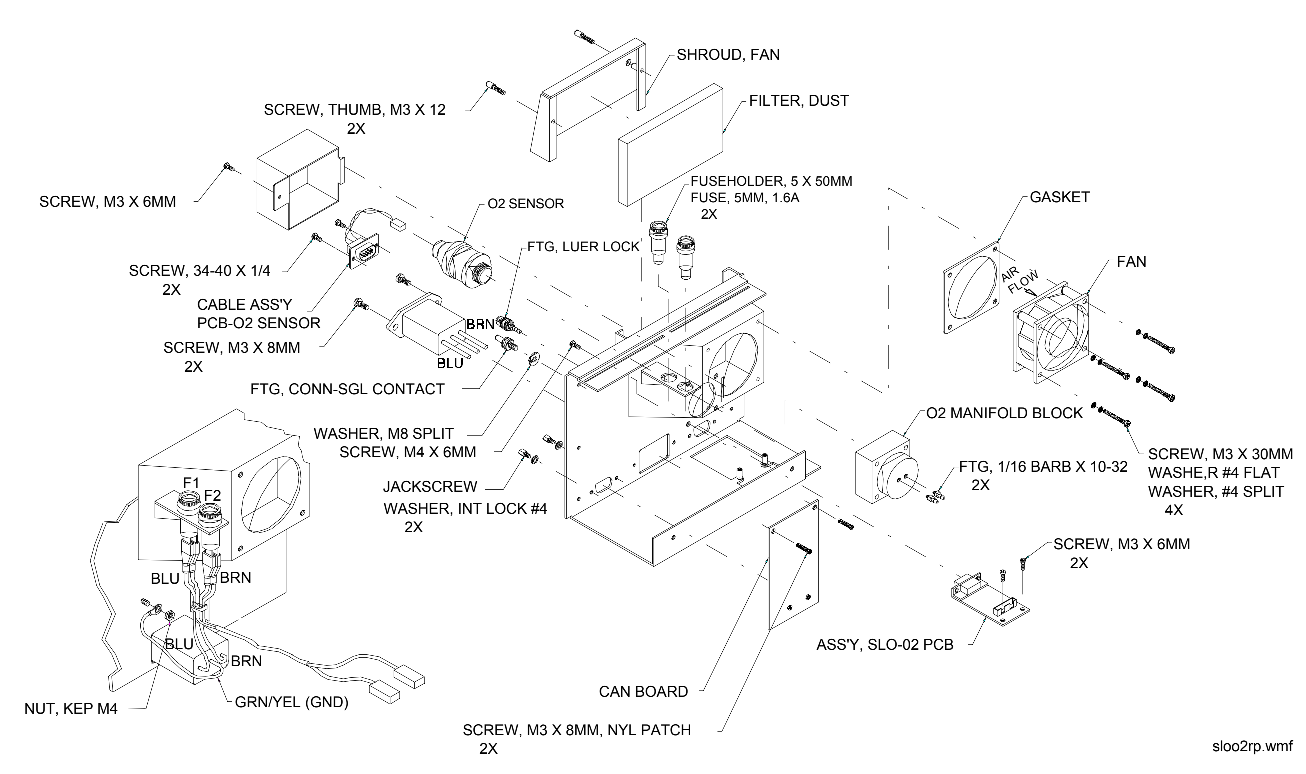


Figure B-3 MULTIGAS Module Rear Panel Subassembly

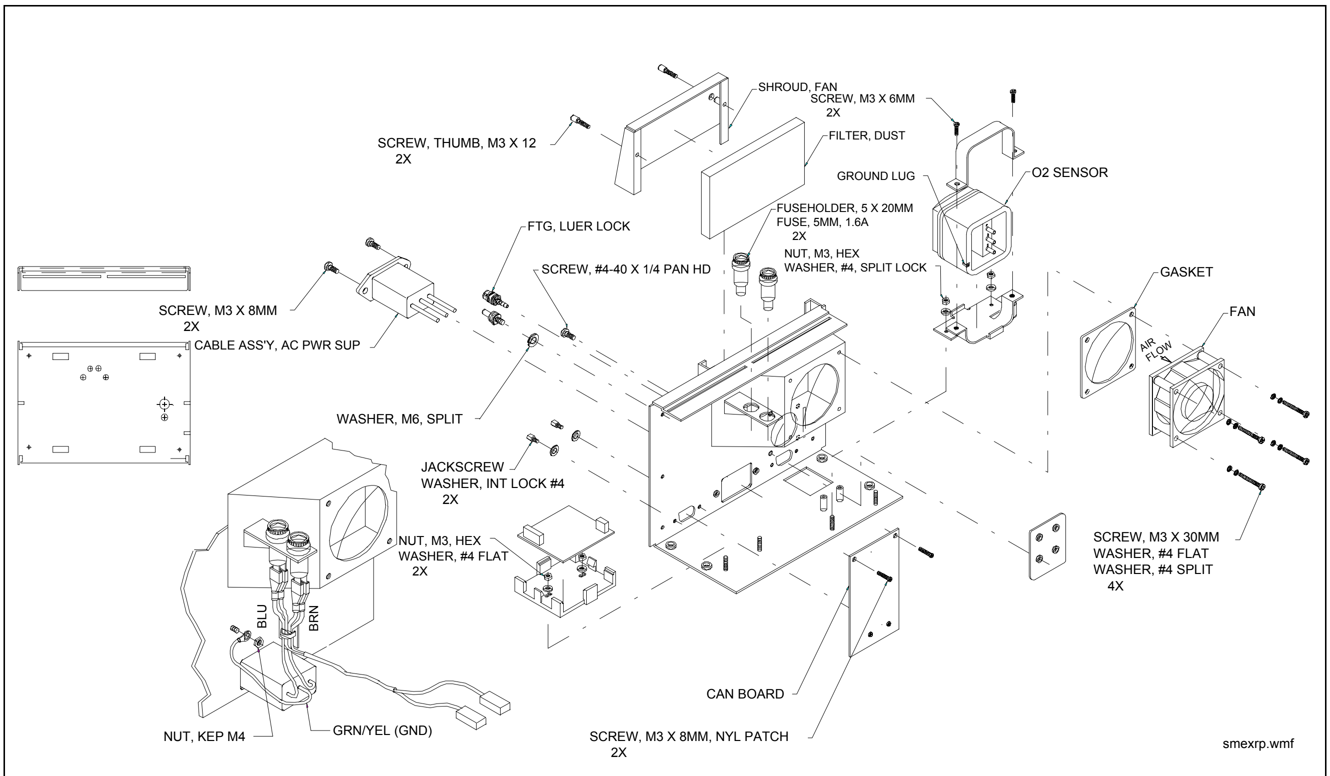


Figure B-4 MULTIGAS+ Module Rear Panel Subassembly

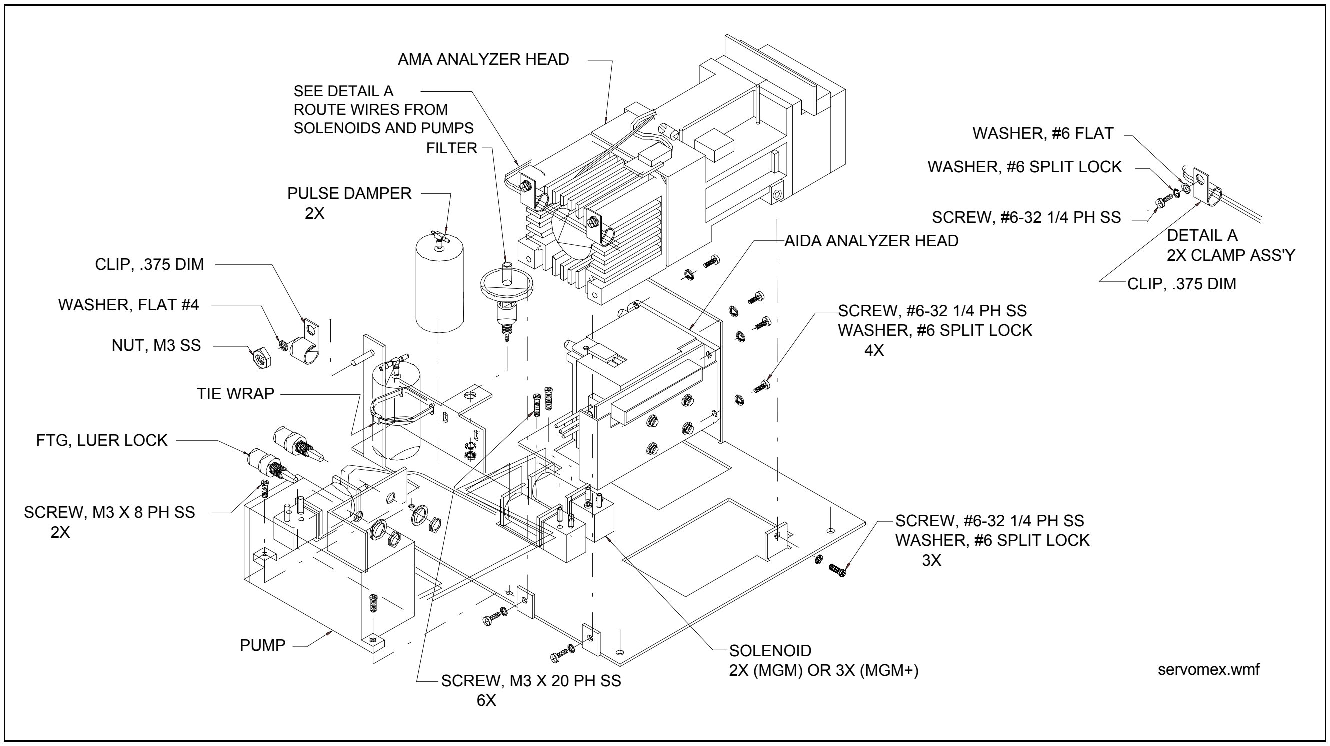


Figure B-5 Agent Measurement Analyzer / Agent Identification Analyzer Subassembly

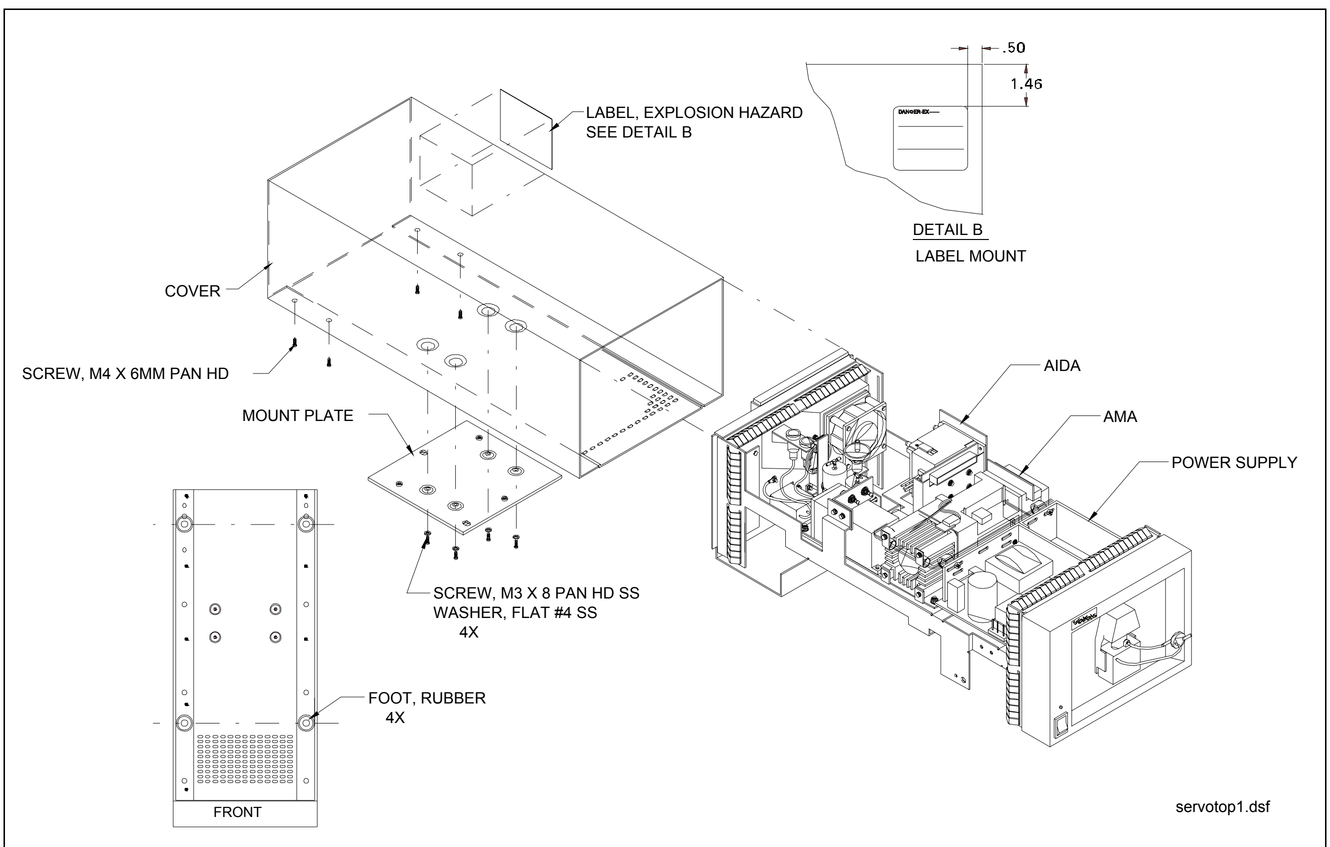


Figure B-6 MGM Top Cover and Mount

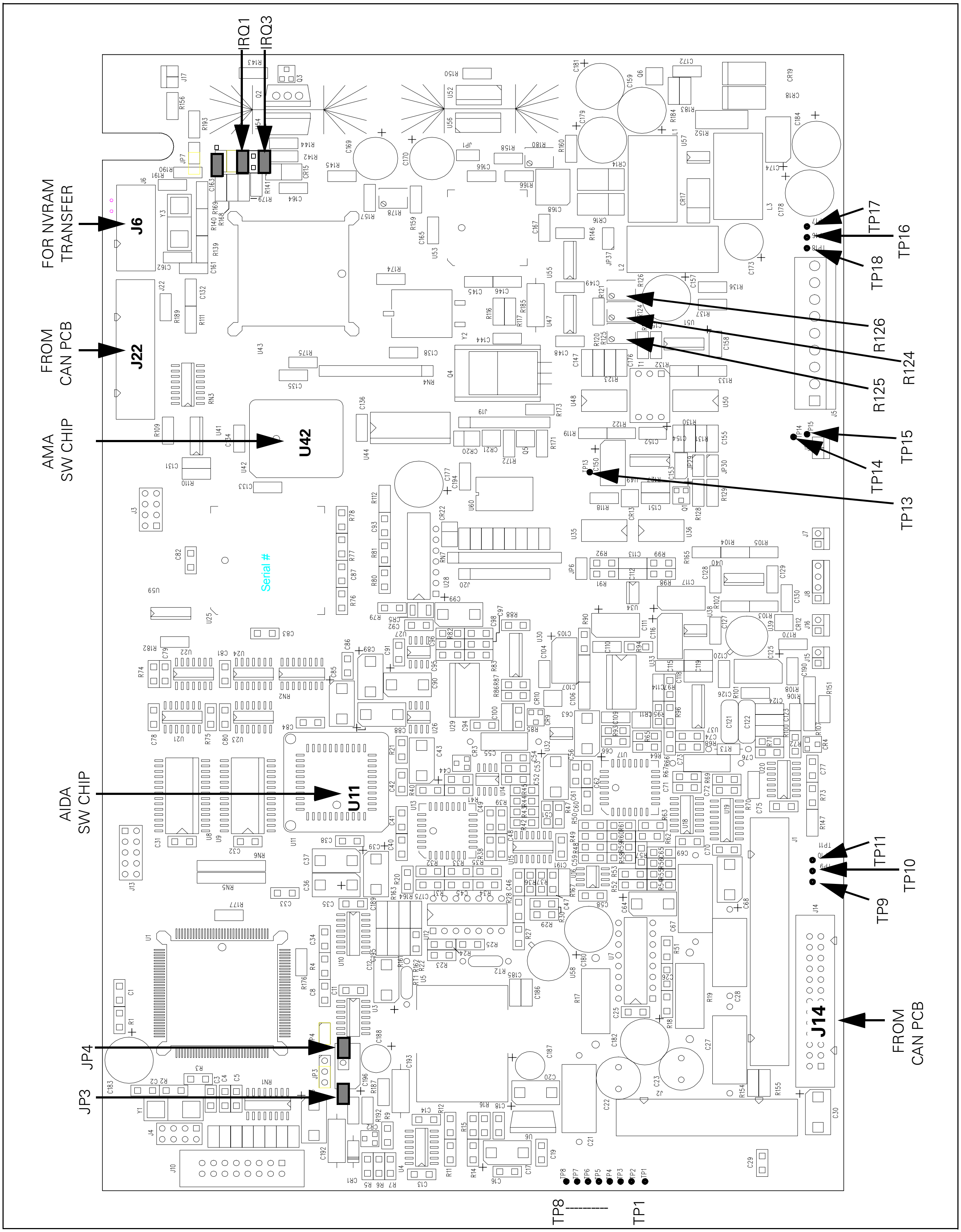


Figure B-7 MGM System Board Layout

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Appendix C Functional Verification

Circle Type of Module: MULTIGAS Module MULTIGAS+ Module

Serial Number of MGM:___________________

Software Version:____________________

Note: Step numbers below refer to the step in the corresponding procedure in Chapter 6. Circle “Passed” when test has been successfully completed.

Pneumatics Leakage Check

Step 6 - Flow meter reading = 0 ±5ml/min. Passed

Pump Flow Rate Verification

Step 3 - Flow rate is 350 ±15ml/min Passed

Step 5 - Flow rate is 200 ±10ml/m. Passed

Step 7 - Flow rate is 120 ±6ml/min. Passed

Gas Identification Verification

Step 10 - Reported data is accurate in accordance with cal gas used Passed

Safety Tests

Resistance <0.5Ω		Passed
Leakage Tests	condition a	Passed
	condition b	Passed

All of the above tests have been passed successfully.

____________________________________ __________________________ ___________

Name (Printed) Signature Date

Clinical Site Report

Clinical Site Name: ______________________________ Date: ________________

Address: ______________________________

______________________________ Clinical Site Facility Manager: ________________

______________________________ Clinical Site Contact Person: ________________

Tel. No: ________ ______________ ________ FAX No. ______________________
Int'l Code Number Ext:

Monitoring Unit ______________________

Care Unit ________________

Host Monitor (check one): SC 7000 ____ SC 9000XL ____ SC 8000 ____ SC 9000 ____

Monitor Serial No. ________________

Siemens Service Representative:

______________________	______________________	____________
Name (Print)	Signature	Date

Clinical Site Representative:

______________________	______________________	____________
Name (Print)	Signature	Date

Appendix D Disease Prevention

1 Siemens Disease Prevention Policy Statement

It is Siemens policy to take every possible precaution to ensure that all of its employees are protected from exposure to contagious diseases.

The information in this Appendix is under continuous review and will be updated when necessary to allow service personnel to be as confident and safe as possible.

The following disease prevention procedure helps control risks of service personnel becoming infected by pathogens in the working environment. To control these risks, you must:

- Know the facts about infectious diseases in the environment.
- Develop methods to control environmental pathogens and safely service the product.

2 Know the Facts

2.1 Types of Viruses

Viruses are a large group of microscopic infective agents that typically have a protein coat surrounding an RNA or DNA genetic core. Viruses grow only inside living cells and are capable of causing various diseases in humans, lower animals, and plants. There are two basic groups of virile infections:

- air-borne viruses
- body fluid-borne viruses

Air-borne viruses are infections that are transmitted through the air and can enter the body through the nose, eyes, or mouth. These viruses can also be transmitted by the exchange of bodily fluids. These types of viruses are often termed "floating". Such viruses include chicken pox, staff infection, measles, and tuberculosis.

Body fluid-borne viruses do not float. They generally need a warm, moist environment to live for any length of time. These infections are transmitted by direct exchange of bodily fluid, such as blood to blood or from a contaminated object or surface to an open wound or mucus membrane such as the eye. Common methods of transmission are through sexual intercourse, sharing of intravenous needles, being transfused with infected blood, and allowing fresh infected blood to enter an open wound or exposed mucus membrane. These viruses include hepatitis, mononucleosis, and AIDS.

2.2 Facts About ARC, AIDS, Hepatitis B, and TB

The following facts are from the Federal Register, Department of Labor's OSCA CFR Part 1910 "Occupational Exposure to Hepatitis B Virus and Human Immuno-deficiency Virus; Advance Notice of Proposed Rule Making":

Acquired Immune Deficiency Syndrome (AIDS) is a condition that breaks down parts of the body's immune system. Without the immune system, the body cannot fight off infection. This leaves the person with AIDS open to opportunistic infections. The most common of these are pneumocystic carinii pneumonia (PCP) and kaposi sarcoma (KS).

Many people have symptoms of AIDS related immune disorder who suffer from less severe infections such as chronic Oral Thrush, persistent fevers, weight loss, lymphadenopathy, diarrhea, fatigue and night sweats. These people have AIDs-Related Complex (ARC). Not everyone who tests positive for having human immunodeficiency virus (HIV) antibodies develops AIDS or even becomes ill. But he/she can transmit the disease to others by the above-stated methods.

Current medical evidence suggests that the AIDS virus cannot be transmitted by casual contact. This includes working in a group setting, using the same phone, the same water fountain, shaking hands, or using the same bathroom facilities. The virus has been isolated in tears and saliva.

There is no single, simple test for AIDS at the present time. However, there is a test used for screening donated blood. This test detects antibodies to the HIV (AIDS) virus. Antibodies are substances produced in the blood to fight disease organisms. This test is called the ELISA Test or the Enzyme-Linked Immunosorbent Assay. The ELISA Test is not foolproof. Sometimes positive results are in error (false positives). For example, when a woman is pregnant she develops antibodies to her own fetus. These antibodies occasionally show positive on the test. In such cases the Western blot test is performed to rule out the possibility of HIV. If the Western blot test is "indeterminate," more sophisticated testing needs to be done at a referred center.

Hepatitis B, a liver disease, is caused by the hepatitis B virus. Many people who are infected with HBV never have symptoms. The usual symptoms of acute infections are flu-like and include fatigue, mild fever, muscle and joint aches, nausea, vomiting, loss of appetite, abdominal pain, diarrhea and jaundice. Although most infected persons recover, severe HBV infections may be fatal.

The usual modes of transmission of HBV and HIV are contaminated blood to blood and other body fluids, sexual contact, needle sharing, and from infected mother to infant.

Occupational exposure occurs with cuts from contaminated surfaces, splashes of contaminated body fluids onto non-intact skin or mucus membranes (such as the eye).

It is important to note that HIV and Hepatitis virus are both very delicate and will die if exposed to air in about 3 hours time, making the chances of getting infected from contact with components of an MGM very low.

TB is caused by airborne bacteria that damages lung tissue. Symptoms include fatigue, fever, chronic cough and weight loss.

To become infected with TB from a contaminated MCM, the TB would have to be aerialized and inhaled, making the chances of getting infected from an MGM very low.

3 Environmental Controls

The pneumatics section of any MGM must be treated as contaminated with infectious material. This includes the water trap, water trap manifold, and gas outlet port.

To prevent possibly contaminated pneumatic components from infecting yourself and others take precautions when handling and disposing of the pneumatic section's components. See Section 4.

Not all equipment and body fluids are contaminated with infectious diseases, but for personal safety always take appropriate precautions as if they were (universal precautions).

4 Protocol for Servicing the MGM

When servicing an MGM, use disease prevention precautions. The principle is to keep body fluids and air borne contaminants from entering non-intact skin, your eyes, mouth and respiratory tract. To service the MGM you need the following supplies:

- Disinfectant soap for hands
- Disinfectant solution for instruments: a 10% bleach and water solution (1 part bleach to 9 parts water) or a 70% rubbing alcohol (Isopropanol) and water solution (7 parts alcohol to 3 parts water)
- Latex gloves
- Goggles

You can obtain the above material at the hospital if servicing the unit on site, or order it from Siemens (see Section 6).

The work area for replacing pneumatics should be a bench surface that can be easily and completely cleaned. Surfaces such as antistatic mats or butcher block tables are not appropriate.

4.1 Preparation for Repair

Use the following precautions when servicing the MGM's pneumatics:

1. Wear latex gloves. (Wear two pair if there is an open cut on the hand)
2. Wear goggles.
3. Remove the water trap and dispose of it in a biohazards bag.
4. Swab the water trap manifold and tubing connector ports on the front panel with a Q-tip soaked in disinfectant solution.
5. Swab the gas outlet port with a Q-tip soaked in disinfectant solution.
6. Wipe down the entire exterior of the MGM with a cloth soaked in disinfectant solution.

4.2 Precautions During Repair

During the repair process, take the following additional precautions:

1. Take extraordinary care to avoid accidental wounds from sharp objects.
2. Make as few pneumatic disconnections as are necessary. Remove the defective pneumatic section in one piece if possible.
3. When disconnecting pneumatics, use care to minimize drips or splashes.
4. Use diagonal cutters to cut hoses that are difficult to disconnect.
5. Place the pneumatic components directly into doubled biohazard bags. Do not temporarily rest the components on a table or floor while doing something else.
6. If spills occur inside or outside of the unit, wipe them with disinfectant solution.

4.3 After Repair

After the repair is completed, do the following:

1. Completely wipe down the unit, work area, and tools with a disinfectant solution.
2. Discard all clean-up material and gloves, **in that order**, into double biohazard bags.

3. After removing gloves and goggles, thoroughly wash your hands before leaving service area. Routine cleansing includes a vigorous wash with soap under a stream of water for at least 10 seconds.
4. Dispose of all articles contaminated with body fluids as discussed under Section 4.4 including putting items into biohazard bags. Normal hospital procedures require separation of this waste from other waste.
5. Clean all equipment or instruments contaminated with body fluids with a disinfectant solution. Household bleach at a 1:10 dilution with water is an acceptable disinfectant.

4.4 Disposing of Pneumatic System Components

You cannot simply discard infectious material like any other waste. In the hospital infectious material is sterilized before being discarded, or is incinerated.

After sealing biohazardous waste in doubled biohazard bags, dispose of it in one of two ways:

- Take the biohazardous waste back to the hospital from where the unit was removed.
- Use the waste handling procedure approved for your repair facility.

5 Accidental Skin Puncture Procedure

If a skin puncture occurs when servicing the pneumatics do the following:

1. Immediately wash the wound with disinfectant.
2. Contact your physician and supervisor immediately.

6 Disease Prevention Supplies

Siemens offers the following disease prevention supplies:

- Box of 100 Large Latex Gloves:Art. No. 28 61 669 EE54U
- Box of 100 Medium Latex Gloves:Art. No. 28 61 651 EE54U
- Goggles with Vented Cap: Art. No. 28 61 644 EE54U
- Box of 10 Biohazard Disposal Bags:Art. No. 28 61 677 E500U

Appendix E Supplemental Documentation

The following information is excerpted from the Hardware Installation / Calibration Instructions distributed with the MultiGas/+ module as document no. ASK-T879-xx-7600, at time of original delivery of the unit. It has been modified and is included here as a convenience for use by field service personnel in reinstalling an MGM after servicing.

1 Introduction

MultiGas™ and MultiGas+™ modules (MGM and MGM+) are free-standing units that perform sidestream measurements of respiratory and anesthetic gases. The modules identify and measure five common anesthetic agents (Isoflurane, Halothane, Enflurane, Sevoflurane, Desflurane), and report an agent detected and its measurement data to an SC 9000, SC 7000, SC9000XL, or SC 8000 Patient Monitor, or KION. The modules also monitor respiratory gases CO_2, N_2O, and O_2, and report the measurements to a Monitor as waveforms (except N_2O) and parameters.

MultiGas and MultiGas+ modules differ only in the way that they measure O_2. The basic MultiGas module measures O_2 using a galvanic cell, and calculates average inspiratory values for O_2 (labeled iO2). The MultiGas+ module incorporates a faster-acting paramagnetic sensor that provides both inspired and expired O_2 measurements (iO_2 and etO_2). The outward appearance of the modules differs only in the rear view. The O_2 galvanic cell is visible on the rear panel of the MultiGas module. The paramagnetic cell is internal in the MultiGas+ module. See Figure E-1. In this document, the term MultiGas is used synonomously with MultiGas+ unless specifically stated otherwise.

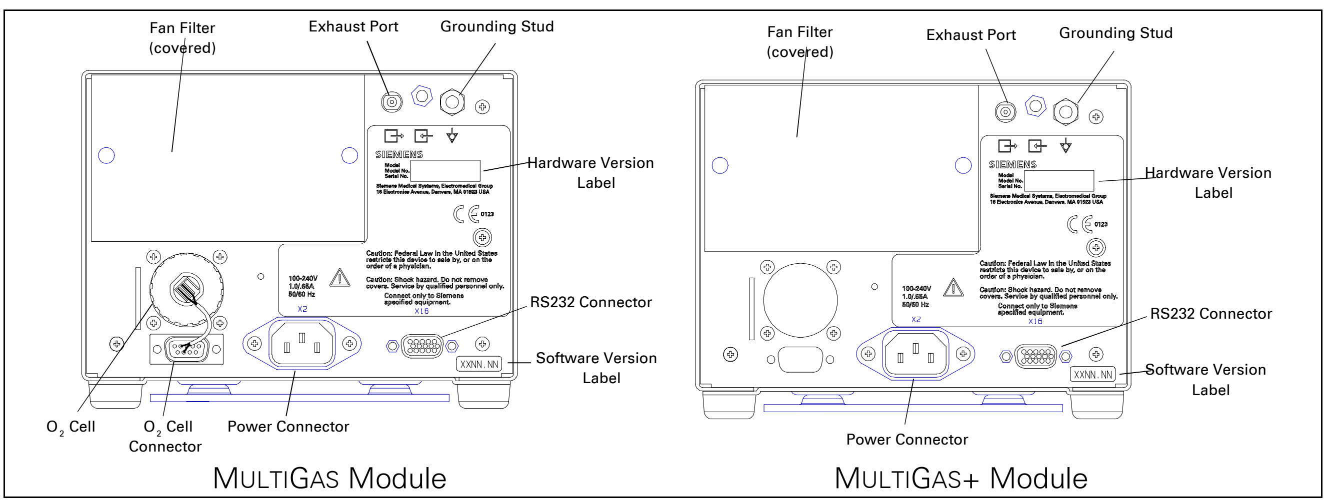

Figure E-1 MultiGas and MultiGas+ Modules - Rear Views

2 Hardware Installation

1. Plug CPS - MGM cable into RS-232 Connector, and power cable into power connector on rear of module. See Figure E-1.
2. Position MGM in location in which it is to be used, and connect MGM exhaust port to hospital exhaust system.
3. Plug CPS - MGM cable into X12 on CPS, IDS, or connector on Adv Comm Option of SC 8000, and power cable into hospital-grade power source.

4. Install water trap and airway adapter. Refer to MULTIGAS Modules section of SC 9000, SC 7000, SC 9000XL, or SC 8000, User Guide for software versions ≥VB1.1, or KION for detailed instructions.
5. Functionally verify proper operation of the MGM. Refer to procedures in Functional Verification *(on page 45 of this Service Manual).*

If procedures in this Manual are performed by other than Siemens service personnel, for more information contact your local Siemens service representative. Technical support for Siemens service personnel is available as follows:

In North, Central, and South America:

Siemens Medical Systems, Inc.

EM-PCS

Technical Support and Services

16 Electronics Avenue

Danvers, MA 01923 USA

Tel: (978) 907-7500

FAX (978) 907-7546

In Europe, Asia, Africa, Australia, and New Zealand:

Siemens-Elema AB

EM

Technical Support and Services

171 95 Solna, Sweden

Tel: Int+46-8-730-7851

FAX: Int+46-8-986 662

MULTIGAS and MULTIGAS+ Modules - Service Manual
Order No. 72 66 419 E536U

ASK-T876-02-7600
E341.E536U.061.01.02.02

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