AION™ is a trademark of Artema Medical AB.

D-Lite™ is a trademark of GE Medical Systems Information Technologies.

DRYLINE™ is a trademark of Artema Medical AB.

Gas Module II® is a U.S. registered trademark of Mindray DS USA, Inc.

Gas Module SE™ is a U.S. trademark of Mindray DS USA, Inc.

Nafion™ is a trademark of Perma Pure Inc.

Passport® XG is a U.S. registered trademark of Mindray DS USA, Inc.

Passport 2® is a U.S. registered trademark of Mindray DS USA, Inc.

Spectrum® is a U.S. registered trademark of Mindray DS USA, Inc.

Spectrum OR™ is a U.S. trademark of Mindray DS USA, Inc.

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Introduction

The Gas Module is a companion to several Patient Monitors. It is capable of automatically identifying and measuring five anesthetic agents (Desflurane, Enflurane, Sevoflurane, Halothane and Isoflurane), as well as N_2O, CO_2 and O_2. The unit monitors all gases via sidestream sampling.

The following models are referenced in this manual: Gas Module II, Gas Module SE, Gas Module SE with Spirometry, and Gas Module 3. When information is common to all models, the generic name "Gas Module" is used. Information that is unique to a specific model is identified accordingly.

The system connects to the Patient Monitor via an RS232 connector.

A special "Y" shaped power cord is used to supply AC voltage to both the Gas Module and the Monitor power supply. All Gas Module data displays on the monitor screen. All user commands are entered on the monitor and then electronically transmitted to the Gas Module.

This addendum provides Gas Module information on theory of operation, specifications, repair, parts, calibration and preventive maintenance. For related information on the Patient Monitor, refer to the associated Service Manual and Operating Instructions.

- Passport XG Operating Instructions
- Passport 2 Operating Instructions (Domestic)
- Passport 2 Operating Instructions (International)
- Expert Operating Instructions (Domestic)
- Spectrum Operating Instructions (Worldwide)
- Spectrum OR Operating Instructions (Worldwide)

NOTE: The Gas Module SE with Spirometry can only be used with the Spectrum OR monitor.

NOTE: The Gas Module 3 can only be used with Passport 2, Spectrum, and Spectrum OR monitors.

WARNING: Calibration gas is considered Dangerous Goods/Hazardous Materials per I.A.T.A. and D.O.T. Regulations.

It is a violation of federal and international law to offer any package or over pack of dangerous goods for transportation without the package being appropriately identified, packed, marked, classified, labeled and documented according to D.O.T. and I.A.T.A. regulations. Please refer to the applicable I.A.T.A. Dangerous Goods Regulations and/or the Code of Federal Regulations 49 (Transportation, Parts 171-180) for further information.

Warnings, Precautions and Notes

Please read and adhere to all warnings, precautions and notes listed here and in the appropriate areas throughout this manual.

A **WARNING** is provided to alert the user to potential serious outcomes (death, injury, or serious adverse events) to the patient or the user.

A **CAUTION** is provided to alert the user to use special care necessary for the safe and effective use of the device. They may include actions to be taken to avoid effects on patients or users that may not be potentially life threatening or result in serious injury, but about which the user should be aware. Cautions are also provided to alert the user to adverse effects on this device of use or misuse and the care necessary to avoid such effects.

A **NOTE** is provided when additional general information is applicable.

Warnings

WARNING: Always Remove Power from the Gas Module BEFORE Disassembly.

WARNING: Remove Power from the Gas Module BEFORE removing the Enclosure.

WARNING: If the water trap breaks or becomes damaged during operation, there is a risk that bacteria and/or mucus may contaminate the Gas Module.

WARNING: The airway adapter and sampling line are intended for single use only.

WARNING: The water trap, sampling line, and airway adapter should be disposed of in accordance with local regulations for contaminated and biologically hazardous items.

WARNING: To avoid high sampling flow with the Gas Module 3, do not use Adult/Pediatric water traps and/or sampling lines with neonates.

WARNING: Connect only approved gas sampling lines to the water trap.

WARNING: The Gas Module must not be used with flammable anesthetic agents.

WARNING: The use of gas sampling accessories other than specified may cause significant measurement errors and patient risk.

WARNING: With the Gas Module 3, use only Neonate sampling lines and water traps for Neonate patients. Do not use Neonate sampling lines and water traps for Adult/Pediatric patients.

WARNING: Do not allow the sampling tubing to become kinked.

WARNING: Do not reuse disposable devices.

WARNING: Trace Gas Hazard – When using the optional Gas Module, a health hazard exists when trace amounts of vaporized anesthetic agents are chronically inspired by operating room personnel. See Appendix A in NFPA 56A on Inhalation Anesthetics. During any procedure where such agents are employed, the Gas Module exhaust output should be connected to a medical gas-scavenging system.

WARNING: When monitoring CO_2, connection from the exhaust port to the hospital's waste gas-scavenging system is recommended to prevent exposure of hospital personnel to the patient's respiratory sample.

WARNING: Connection of the Gas Module exhaust port to the hospital's waste gas-scavenging system is recommended to prevent exposure of hospital personnel to the patient's respiratory sample. Vacuum (negative pressure) should not exceed 1 mmHg at the Gas Module exhaust fitting. Excessive scavenge vacuum may result in damage to the Gas Module's internal pump.

WARNING: Equipment not suitable for use in the presence of a flammable anesthetic mixture with air or with nitrogen or nitrous oxide.

WARNING: Do not connect devices that are not specified as part of the system.

WARNING: Do not clean the Gas Module while it is on and/or plugged in.

WARNING: The contents of the water trap should be handled as a potential infection hazard.

Cautions

CAUTION: The internal sampling system of the Gas Module does not need to be cleaned or sterilized. There is no reverse flow back to the patient. If the internal sampling system is suspected to be clogged or dirty, the module should be serviced by an authorized service person only.

CAUTION: If the dust filter for the fan cannot be cleaned or is damaged, replace it with part number 0378-00-0040. Use of another type of filter may decrease the cooling effectivity and cause damage to the Gas Module.

CAUTION: Do not disinfect or open the water trap. Do not touch the water trap membrane.

CAUTION: Dispose of the water trap in accordance with hospital policy.

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1.0 *Theory Of Operation*

Contents of this chapter ..... Page

This Theory of Operation section provides block diagrams, a functional overview of the main components and the gas sampling / measurement principle for the Gas Module.

The Gas Module consists of the following main components:

- Gas Sampling System
- Anesthetic Agent Sensor
- O_2 Sensor
- CPU Board
- O_2 Board
- Communications Interface Board
- Power Supply
- Spirometry Module (PVX unit)
- Water Trap
- Internal Tubing

1.1 Gas Sampling System

The sampling system draws in a patient sample to the analyzers at a fixed rate.

The gas sampling system draws patient sample into the module, and removes water and impurities from it in a water trap. The pump draws gas through the sampling line, through the water trap and into the gas measuring units. After the measurements, the gas is expelled through the exhaust port. The sample flow rates are as follows:

- For Gas Module II, Gas Module SE, and Gas Module SE with Spirometry, the sample flow rate is 200 ml/min.
- For Gas Module 3, the sample flow rate is 200 ml/min with the Adult/Pediatric water trap and 120 ml/min with the Neonatal water trap.

A number of flow restrictors are utilized to create a pressure difference with ambient pressure in the gas sensors.

A larger pressure difference makes the presentation of the gas concentration curves less sensitive to variations in the airway pressure thus meeting the accuracy requirements.

Refer to the FIGURE 1-1 and FIGURE 1-2 for the Gas Tubing Layout and Gas Sampling Component Block Diagram for Gas Module II, Gas Module SE, and Gas Module SE with Spirometry. Refer to the FIGURE 1-3 for the combination Gas Tubing Layout and Gas Sampling Component Block Diagram for Gas Module 3.

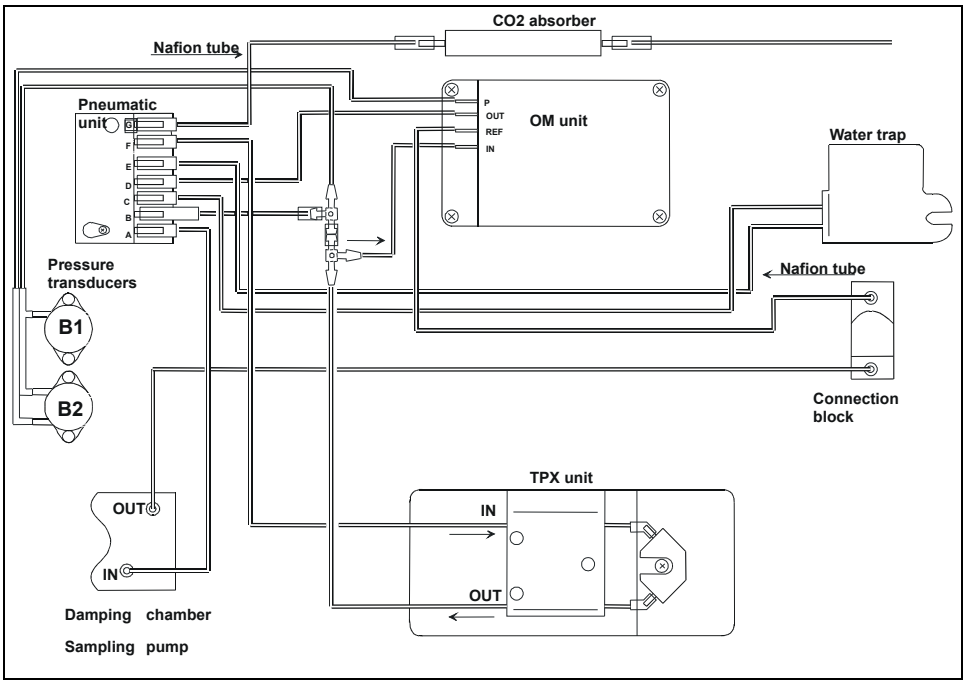


FIGURE 1-1 Gas Tubing Layout – Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

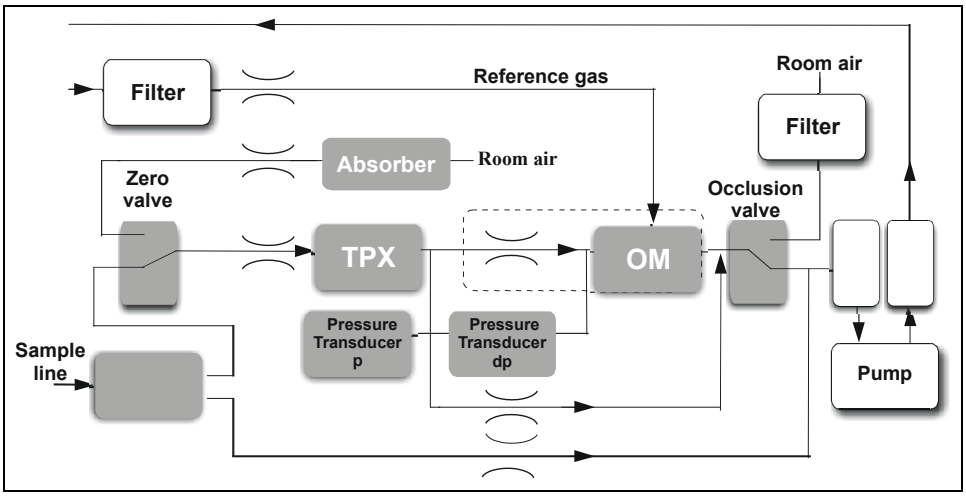


FIGURE 1-2 Gas Sampling Component Block Diagram – Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

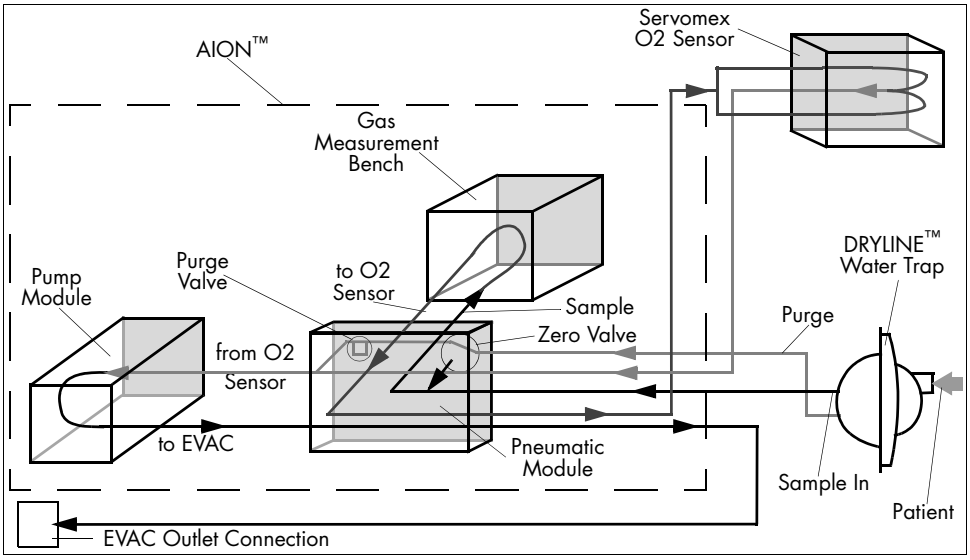


FIGURE 1-3 Combination Gas Tubing Layout and Gas Sampling Component Block Diagram – Gas Module 3

1.1.1 Water Trap

The sample is drawn through a sample line. Then gas enters the monitor through the water trap, where it is divided into two flows, a main flow and a side flow. The main flow goes into the analyzers. This flow is separated from the patient side by a hydrophobic filter. The side flow creates a slight subatmospheric pressure within the water trap which causes fluid removed by the hydrophobic filter to collect in the bottle.

The Gas Module 3 uses the DRYLINE™ water trap system.

1.1.2 Zero Valve and Absorber

The main flow passes through a magnetic valve before proceeding to the analyzers. This valve is activated to establish the zero points for the Anesthetic Agent and O_2 Sensors. When the valve is activated, room air is drawn through the absorber into the internal system and the gas sensors. Paralyme is used as the absorbent. The Absorber is for Gas Module II, Gas Module SE, and Gas Module SE with Spirometry.

1.1.3 Nafion™ Tube*

A nafion tube is used between the water trap and the zero valve to balance the sample gas humidity with that of ambient air. The tube will prevent errors caused by the effect of water vapor on gas partial pressure when the humid gases are measured after calibration with dry gases.

**Nafion is a trademark of Perma Pure Inc.*

1.1.4 Gas Analyzers

After the zero valve and nafion tube the gas passes through the Anesthetic Agent and O_2 Sensors. The oxygen sensor has two inputs. One input accepts the gas sample and the other draws room air for reference. The gas sample finally exits through the exhaust port on the rear of the unit. Refer to sections 1.2 and 1.3 for more information on the Anesthetic Agent and O_2 Sensors.

The Gas Module 3 uses an AION™ multigas analyzer and a Servomex Paramagnetic Oxygen Sensor. The AION™ multigas analyzer and Servomex Paramagnetic Oxygen Sensor must be a matched pair.

1.1.5 Sample Flow Differential Pressure Transducer

The sample flow differential pressure transducer (Gas Module II, Gas Module SE, and Gas Module SE with Spirometry) measures pressure drop across the O_2 Sensor inlet restrictor and calculates sample flow from the pressure difference.

1.1.6 Working Pressure Transducer

The working pressure transducer (Gas Module II, Gas Module SE, and Gas Module SE with Spirometry) measures absolute working pressure between the Anesthetic Agent and O_2 Sensors. It is used to detect situations which will post messages for occlusion and replace trap.

1.1.7 Pneumatic Unit

The pneumatic unit contains the zeroing valve, occlusion valve and tubing connections. There is a series of restrictors and chambers forming a pneumatic filter to prevent pressure oscillations in the pump from reaching the measuring units. Zeroing and occlusion valve connections to room air include a dust filter.

1.1.8 Connection Block

The connection block contains a sample gas outlet connector and an O_2 Sensor reference gas inlet. The inlet is equipped with a dust filter.

1.1.9 Occlusion Valve

The valve (Gas Module II, Gas Module SE, and Gas Module SE with Spirometry) is activated when the sample line gets occluded. The main flow is diverted to the side flow of the water trap to help remove the occlusion faster.

1.1.10 Sampling Pump and Damping Chamber

The Gas Module II, Gas Module SE, and Gas Module SE with Spirometry gas sampling pump is a membrane pump that is run by a brushless DC motor. The gas flow rate is measured with a sample flow differential pressure transducer across a known restriction. The motor is automatically controlled to maintain a constant flow, even when the water trap ages and starts to get occluded. It also enables use of sample tubes with varying lengths and diameters.

The damping chamber is used to even out the pulsating flow and silence the exhaust flow.

The Gas Module 3 pump module is a low power, high reliability membrane pump and flow controller including preamplifier and pump power driver.

NOTE: Flow is never reversed towards the patient.

1.2 Anesthetic Agent Sensor

1.2.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

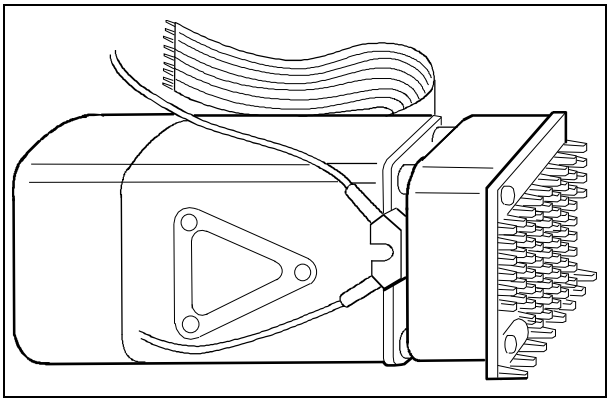


FIGURE 1-4 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry Anesthetic Agent Sensor

The Anesthetic Agent Sensor is a sidestream gas analyzer, measuring real time concentrations of CO_2, N_2O and five anesthetic agents (Halothane, Enflurane, Isoflurane, Desflurane, and Sevoflurane).

The Anesthetic Agent Sensor is a non-dispersive infrared analyzer, measuring absorption of the gas sample at seven infrared wavelengths, which are selected using optical narrow band filters. The IR lamp is a 4W filament, surrounded by thermal isolation. There is a hole in the isolation, passing the radiated light to a conical measuring chamber with a 4 mm length.

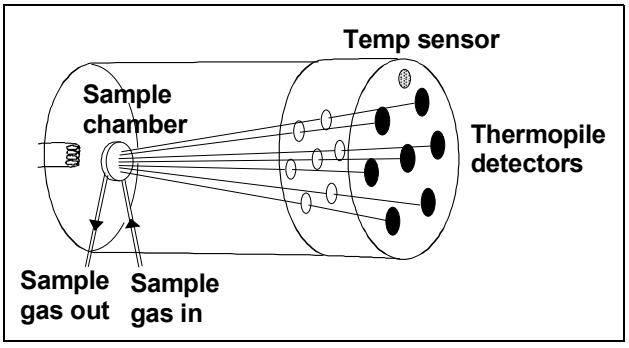


FIGURE 1-5 Anesthetic Agent Sensor Principle

From the sample chamber, radiated light goes into seven tubular light guides with reflective inner surfaces. At the other end of each light guide there is a thermopile infrared radiation detector with an optical filter in front of it.

The Temp sensor measures the Anesthetic Agent Sensor's temperature and uses it for temperature compensation.

Anesthetic agents or mixtures of two anesthetic agents are automatically identified and concentrations of the identified agents are measured. The Anesthetic Agent Sensor also detects mixtures of more than two agents.

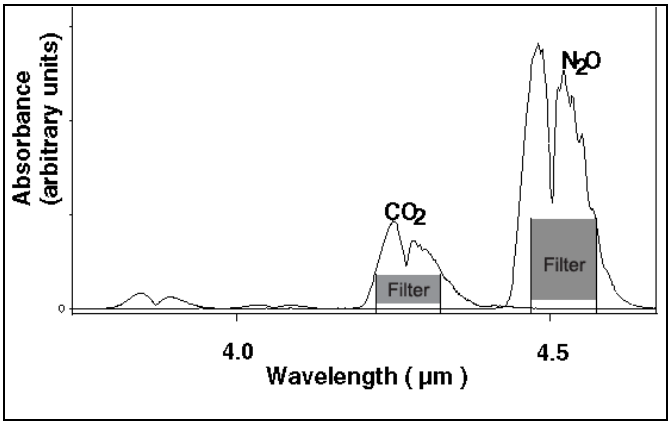


FIGURE 1-6 Infrared Absorbance of N_2O and CO_2

Concentrations of CO_2 and N_2O are calculated from the absorption measured at 3 to 5 µm.

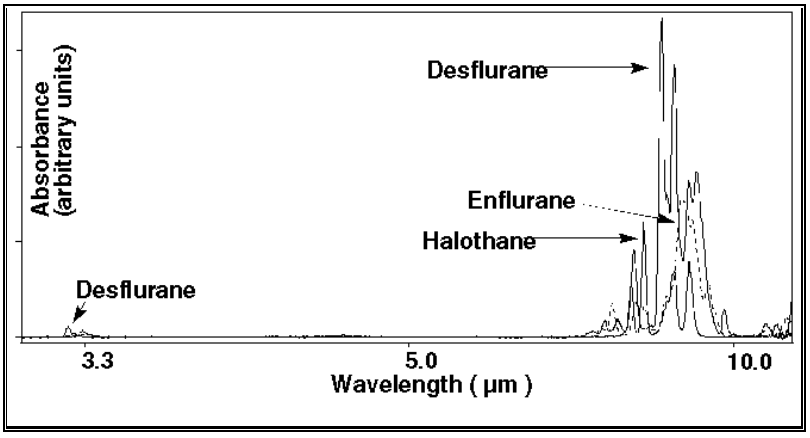


FIGURE 1-7 Infrared Absorbance of Anesthetic Agents

Identification of anesthetic agents and calculation of their concentrations is performed by measuring absorptions at five wavelengths in the 8 to 9 µm band and solving for the concentrations from a set of five equations.

The measuring accuracy is achieved utilizing numerous software compensations. The compensation parameters are determined individually for each Anesthetic Agent Sensor during factory calibration.

1.2.2 Gas Module 3

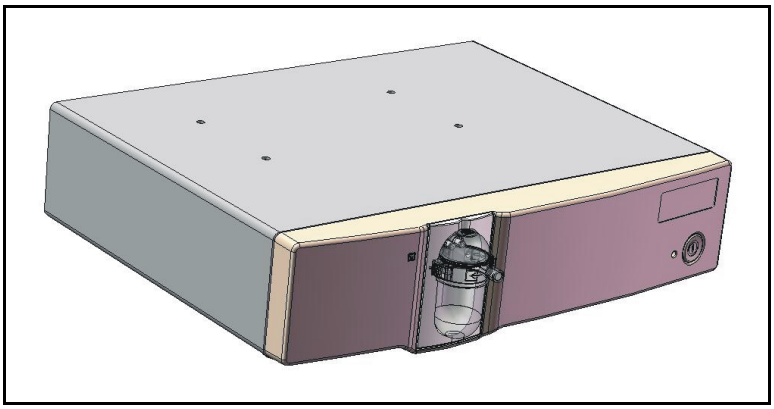


FIGURE 1-8 Gas Module 3

FIGURE 1-9 Gas Module 3 Anesthetic Agent Sensor

The Anesthetic Agent Sensor is a sidestream gas analyzer, measuring real time concentrations of CO_2, N_2O and five anesthetic agents (Halothane, Enflurane, Isoflurane, Desflurane, and Sevoflurane).

The Anesthetic Agent Sensor is a non-dispersive infrared analyzer, measuring absorption of the gas sample at up to eight infrared wavelengths, which are selected using optical narrow band filters.

Anesthetic agents or mixtures of two anesthetic agents are automatically identified and concentrations of the identified agents are measured. The Anesthetic Agent Sensor also detects mixtures of more than two agents.

The absorption spectra for CO_2, N_2O, and the five anesthetic agents Halothane, Enflurane, Isoflurane, Sevoflurane, and Desflurane are shown in FIGURE 1-10 and FIGURE 1-11.

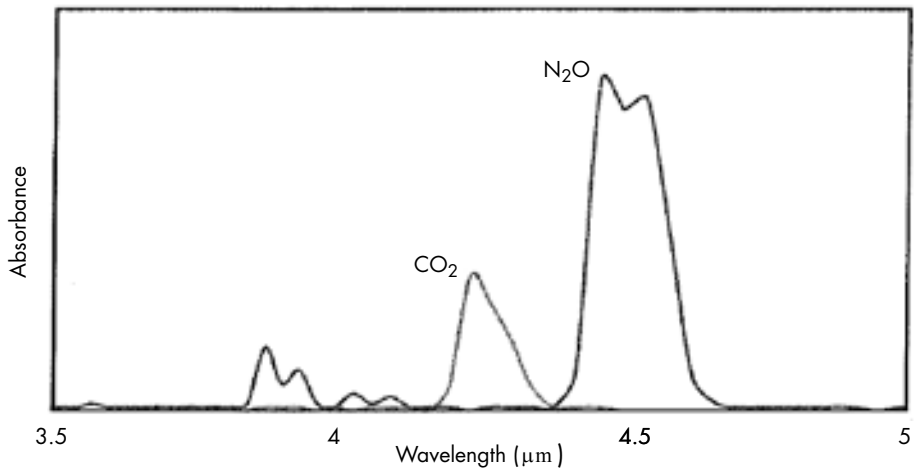


FIGURE 1-10 Infrared Absorption Spectra for N_2O and CO_2

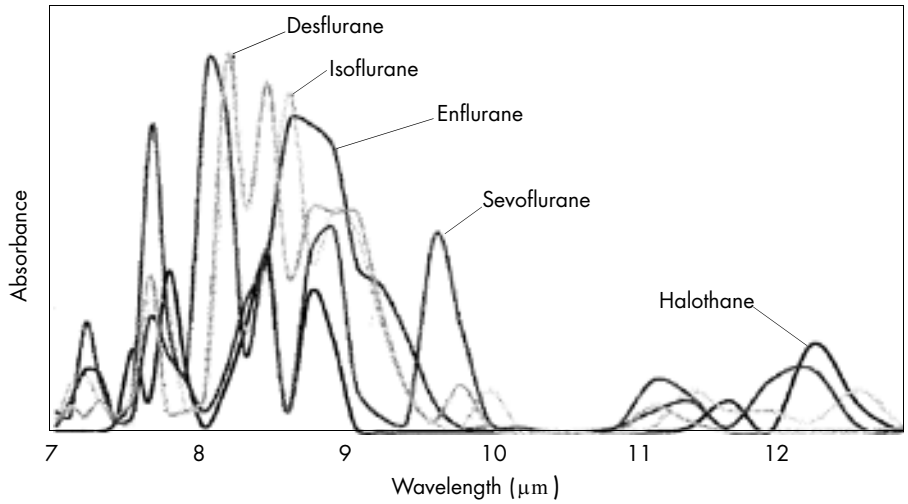


FIGURE 1-11 Infrared Absorption Spectra for Anesthetic Agents

To identify seven different gases in a mixture, measurements are done at seven different wavelengths. Measurements are done at an eighth wavelength for reference. The AION™ Multigas Analyzer uses the absorption peaks at 4.2 and 3.9 μm for measuring CO_2 and N_2O respectively and the absorption peaks in the 8–12 μm range for measuring anesthetic agents. See FIGURE 1-10 and FIGURE 1-11.

A set of narrow optical band pass filters intercepts a broadband infrared source to provide these wavelengths. The individual filters are mounted in a rapidly rotating filter wheel that intersects the light path. The filtered light passes into a cylindrical measurement chamber. At the other end of the chamber, there is an infrared radiation detector, whose output is directed to the host interface through the signal processor. See FIGURE 1-12.

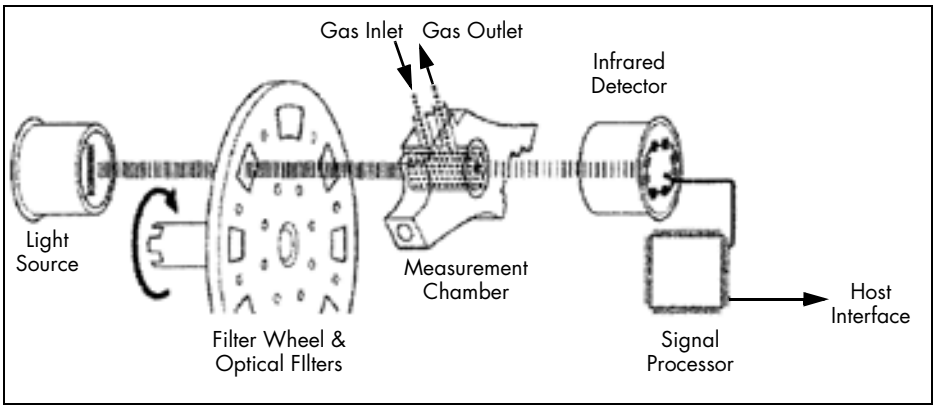


FIGURE 1-12 Optical Path

No radiation is absorbed if the measurement chamber is empty. The output signal from the detector is at maximum amplitude at a concentration of zero. Lower amplitudes indicate the presence of gases in the measurement chamber.

To establish the zero reference, the AION™ Multigas Analyzer occasionally switches the zero valve to direct ambient air through the measurement chamber.

1.3 O_2 Sensor

1.3.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

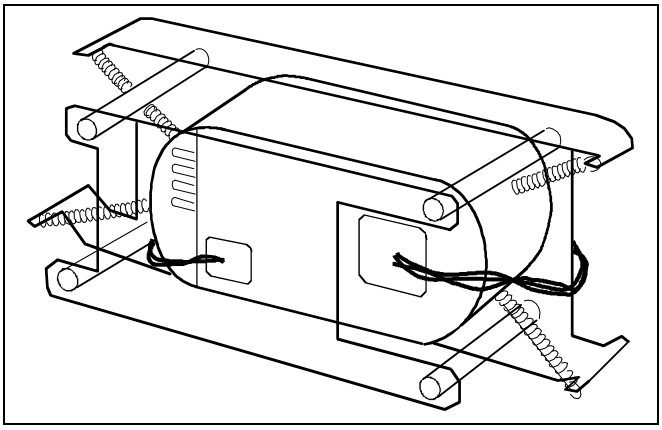


FIGURE 1-13 O_2 Sensor

The differential O_2 Sensor uses the paramagnetic principle in a pneumatic bridge configuration. The gas sample along with reference room air are conducted into a gap in an electromagnet with a strong magnetic field switched on and off at a frequency of approximately 165 Hz.

An alternating differential pressure is generated between the sample and reference inputs due to forces acting on the oxygen molecules in a magnetic field gradient.

The pressure is measured with a sensitive differential transducer, rectified with a synchronous detector and amplified to produce a DC voltage proportional to the O_2 concentration difference between the two gases to be measured.

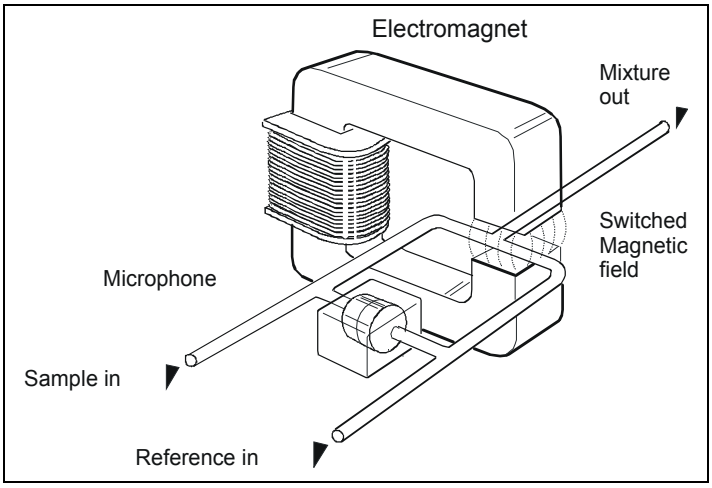


FIGURE 1-14 O_2 Measurement Principle

1.3.2 Gas Module 3

Oxygen measurements are essential for correct gas measurement in the AION™ Multigas Analyzer. Because oxygen does not absorb infrared light to the same extent as other breathing gases and must be measured using another method, there is no built in oxygen measurement module. The Gas Module 3 uses a Servomex Paramagnetic Oxygen Sensor.

FIGURE 1-15 Servomex Paramagnetic Oxygen Sensor

The Servomex Paramagnetic Oxygen Sensor uses the paramagnetic susceptibility of oxygen, which is physical property that distinguishes oxygen from most common gases. Inside the sensor are two nitrogen-filled glass spheres mounted on a strong rare metal taut-band suspension. The assembly is suspended in a symmetrical non-uniform magnetic field. In the presence of paramagnetic oxygen, the glass spheres are pushed further away from the strongest part of the magnetic field. The strength of the torque acting on the suspension is proportional to the oxygen concentration (see FIGURE 1-16).

Paramagnetic technology is non-depleting, which means there are no consumable parts, ensuring consistent performance over time. The selectivity of the paramagnetic measurement for oxygen means there is no interference from other respiratory gases. The small volume chamber allows a rapid gas exchange, giving the capability for fast response oxygen measurement.

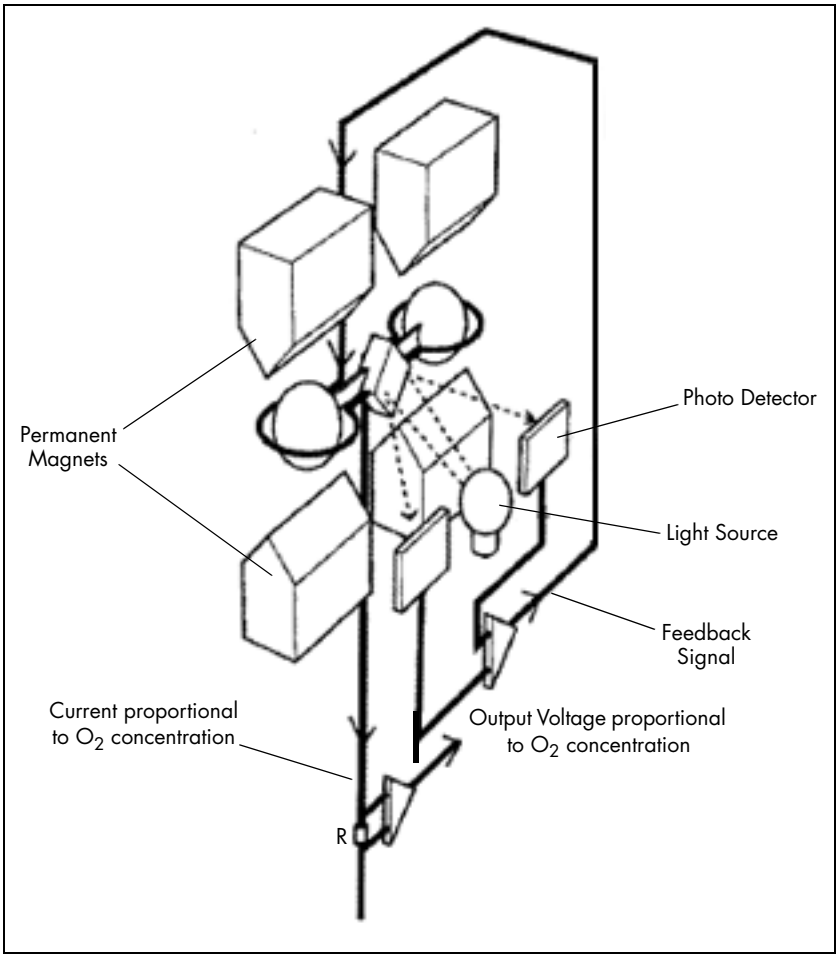


FIGURE 1-16 The Paramagnetic Oxygen Sensor Measurement Principle

1.4 CPU Board

1.4.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

The CPU board contains the processor, memory and A/D converters that are common to the whole module. The CPU board also contains preamplifiers for the Anesthetic Agent Sensor and the drivers for the valves, fan and pump. The module is connected to the module bus through a RS-485 serial channel.

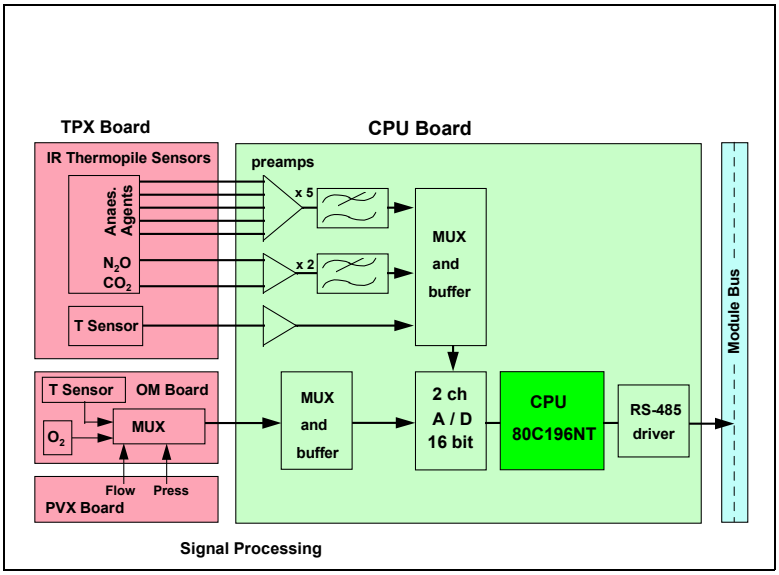


FIGURE 1-17 CPU Signal Processing

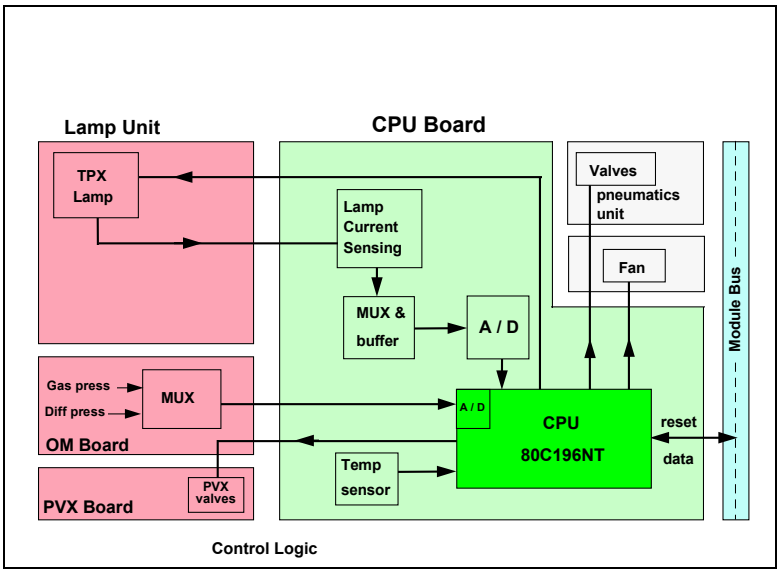


FIGURE 1-18 CPU Control Logic

1.4.2 Gas Module 3

1.4.2.1 PCB

Power is a dedicated routing from the 12 V power filter. Power ground and signal ground are connected on this board. The screws that attach the board to the enclosure are also connected to chassis ground.

1.4.2.2 Power

To reduce noise from the power supply, both the 5 V and 12 V power lines are filtered. A 5 V to 3.3 V linear regulator supplies power to the microcontroller. If the 5 V power supply drops below 4.3 V, a reset signal is sent to the microprocessor.

1.4.2.3 Microcontroller

The microcontroller supports the following communication ports:

- AION™
- Spirometry
- Patient Monitor
- Service

All ports use the RS-232 communication protocol. A real time clock (RTC) powered by either 3.3 V or by battery enables logging of malfunctions. If the RTC fails due to battery depletion during battery mode, functionality is not affected.

1.4.2.4 Battery

The battery that supports the RTC in the microcontroller has a minimum lifetime of 7 years. When the device is running on AC power, there is zero drain on the battery, thus prolonging its lifetime.

Immediately after installing a new battery, the device should be power cycled to avoid high battery currents (~540 µA). Follow the battery supplier's handling recommendations.

The battery is installed at component number B401 on the PCB. The battery positive node is marked with a "+" on the PCB and has two holes to differentiate it from the negative node which has one hole on the PCB.

1.4.2.5 SPI Memory

The 8 Mb capacity of the SPI memory can store an error log with timestamps to facilitate debugging and service.

1.5 O_2 Board

The O_2 board is only used in the Gas Module II, Gas Module SE, and Gas Module SE with Spirometry.

The O_2 board contains the specific electronics for the O_2 sensor. Sample flow measurement and sampling system pressure sensors are on this board. It also contains EEPROM's that store factory calibration data of both the Anesthetic Agent and O_2 sensors.

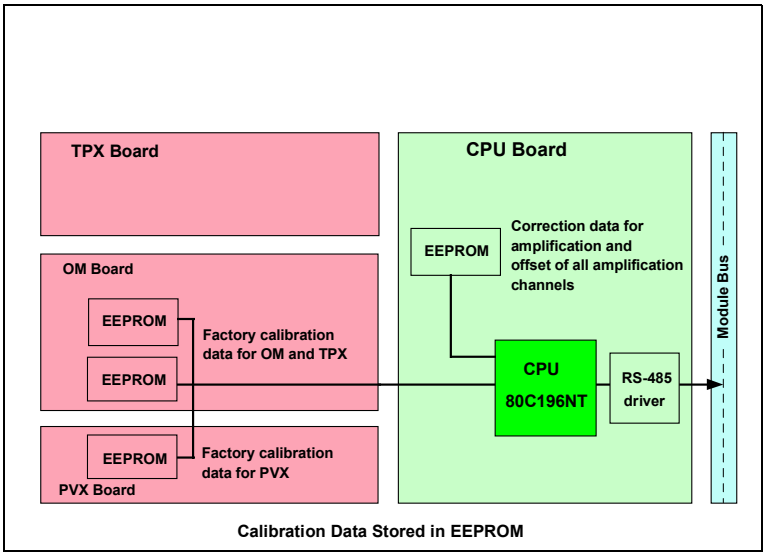


FIGURE 1-19 O_2 Board Calibration Data Stored in EEPROM

1.6 Communication Interface Board

1.6.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

This board is a converter between the Patient Monitor and the Gas Module. It converts the proprietary RS-232 hardware protocol to the Gas Module's RS-485 hardware protocol and vice versa. The board contains a programmable micro-processor (Intel 87C196KD), a QUART (Exar82C684CJ) and line drivers for RS-232 and RS-485 communication lines. For production test purposes the RS-485 lines have been connected to D-connector X2 pins 1,5,6 and 8. Refer to the figure below.

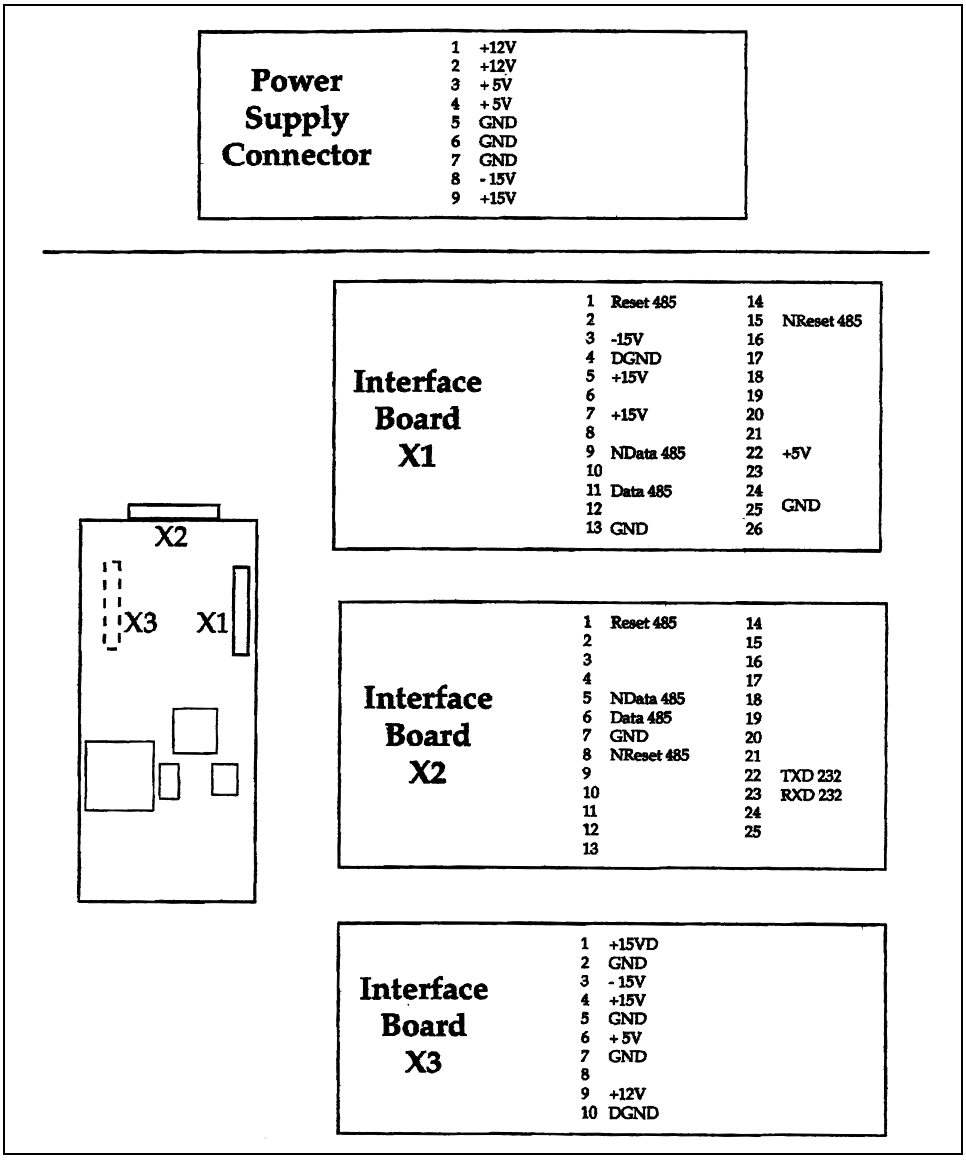


FIGURE 1-20 Connectors Pin Configurations

1.6.2 Gas Module 3

1.6.2.1 Patient Monitor

The interface to the patient monitor is a D-sub, 25-pin, female connector that uses the RS-232 communication protocol.

1.6.2.2 AION™

The interface to the AION™ is a 2 x 17-pin IDC with locking clips. Communication between the HOST and the AION™ is with the RS-232 communication protocol. 12 V power is distributed from the communication board to the AION™.

1.6.2.3 Servomex

The interface to the Servomex is a 2 x 8-pin IDC with locking clips. All communication is to the AION™ through the communication board.

1.6.2.4 DRYLINE™ Receptacle

The interface to the DRYLINE™ receptacle is a 4-pin picoblade. All communication is to the AION™ through the communication board.

1.6.2.5 OXIMA Receptacle

The interface to the OXIMA receptacle is a 10-pin DF20 from Hirose. All communication is to the AION™ through the communication board.

1.6.2.6 LED

Power ON indication is a green LED. Flash programming mode is indicated with a green LED close to the flash programming switch for the AION™.

1.6.2.7 Switches

- SW201 is the flash programming initialization button for the AION™
- SW202 is for future use
- SW501 is a reset switch for the microprocessor

1.7 Electrical Wiring Diagram

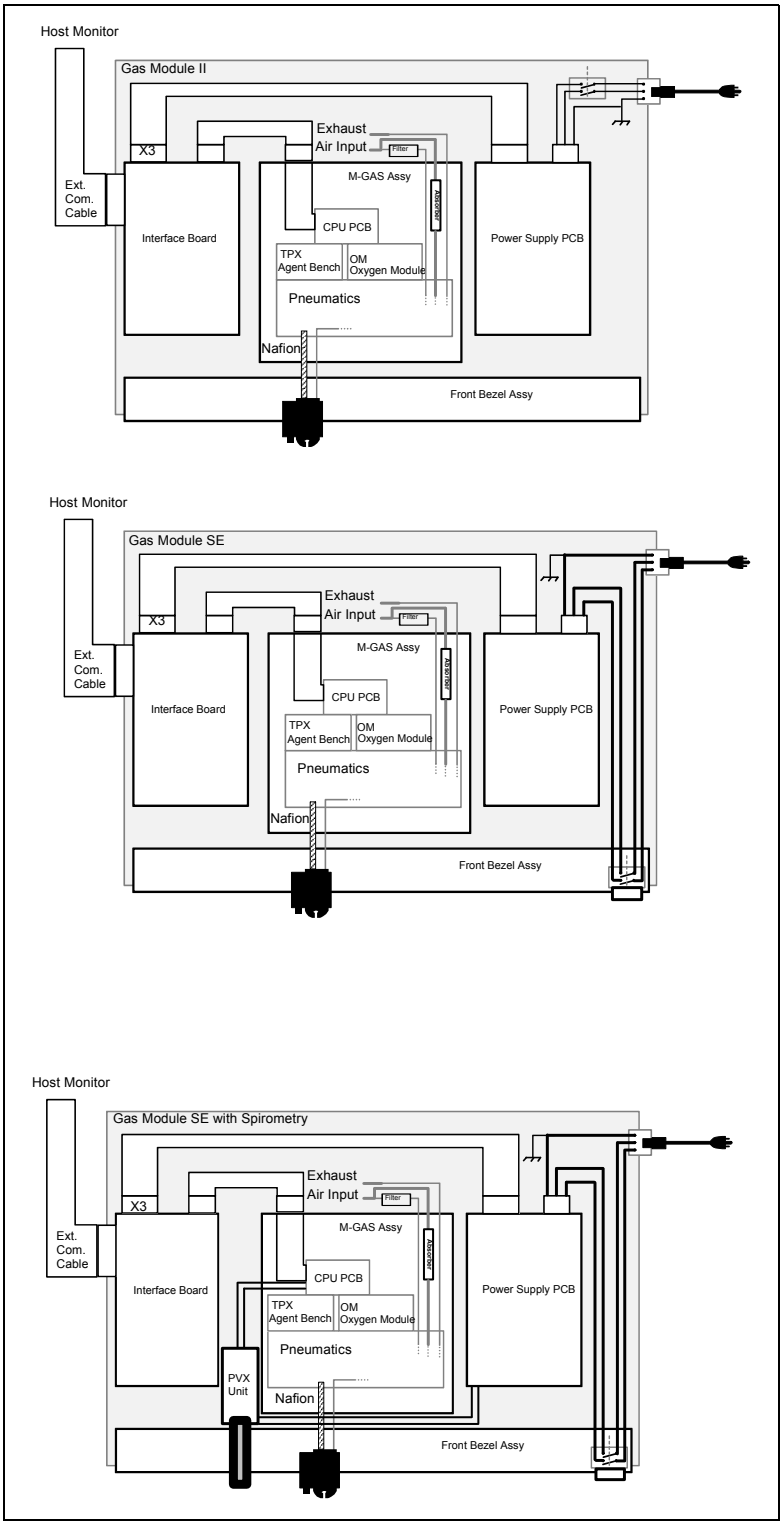


FIGURE 1-21

1.8 Gas Module 3 Electronics

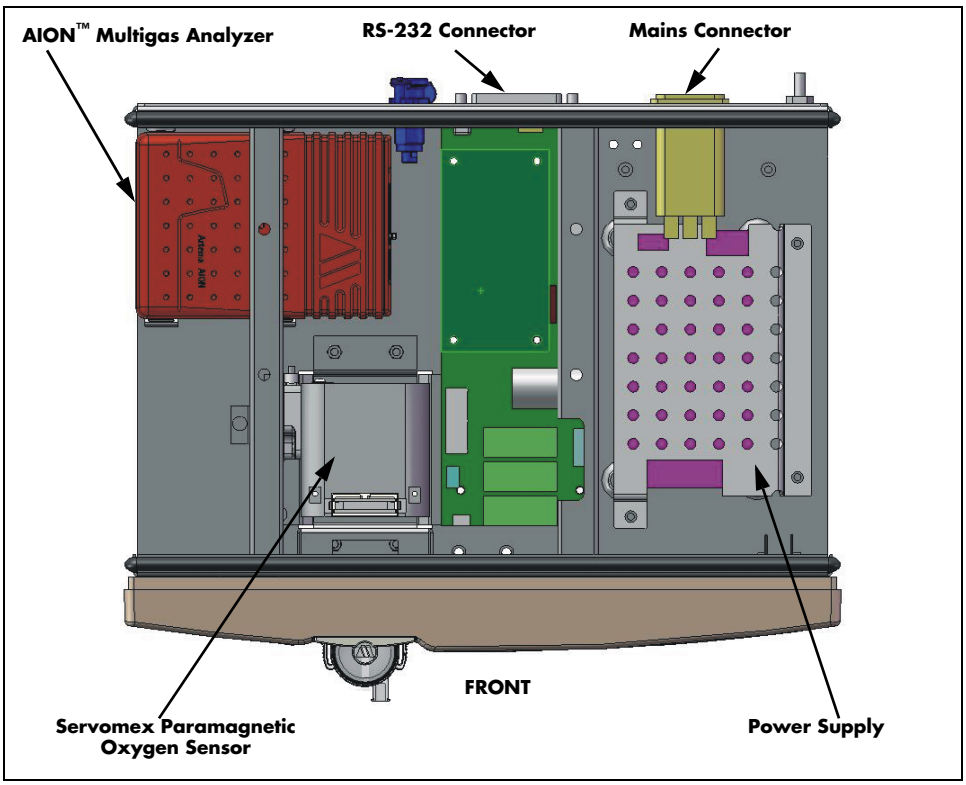


FIGURE 1-22 Top View of the Component Layout of Gas Module 3

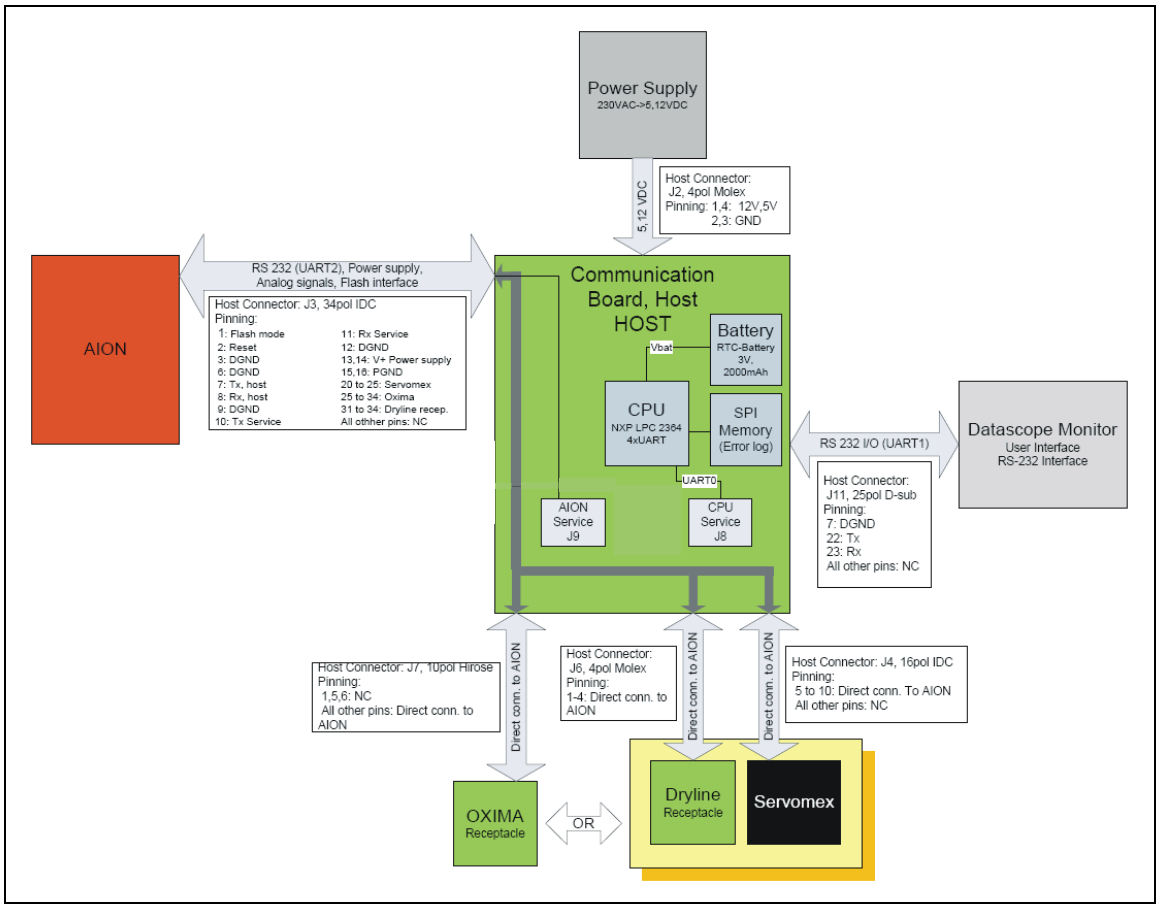


FIGURE 1-23 Overview of Gas Module 3 Electronics

There are no accessible electrical components in the Gas Module 3.

1.9 Power Supply

1.9.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

The MSP1306 is a quad-output 53W power supply. The key features of this off-line switching power supply are as follows:

- Wide-range AC input voltage —85 to 264 VAC,
- MOSFET based, current mode PWM converter stage,
- Fixed operating frequency —~ 62 kHz,
- Compliance with FCC and VDE Class B conducted EMI,
- Most outputs independently regulated,
- All outputs short-circuit protected,
- Output #1 is adjustable with overvoltage protection,
- Rated to operate from 0 to 50 °C.

NOTE: This description of circuit operation assumes a very basic understanding of power rectifier circuits and current mode pulse-width modulation (PWM) operation.

1.9.1.1 AC Input / Rectification

The input voltage is applied to the EMI filter through the fuse (F1). The input voltage must be AC, 90 to 264 VAC, of 47 to 63 Hz, with less than 5% distortion. The input fuse provides protection from fire hazard under catastrophic failure conditions. Under normal conditions, the control circuits provide overcurrent protection. Current flow raises the temperature of the thermistors, reducing their resistance and the inherent voltage drop across the thermistor to less than 1V. A bleeder resistor across the AC mains is provided to discharge the EMI capacitors when the AC power is interrupted. The input voltage is then rectified through a full-wave bridge rectifier and filtered by large electrolytic capacitors to provide DC voltage with a small ripple voltage at twice the input frequency. The peak ripple component is typically 0 to 20% of the peak input voltage.

1.9.1.2 Switching Converter Stage Operation

The switching converter stage chops and transforms the high voltage DC bus to multiple low voltage outputs. The DC bus voltage is always applied to one end of the primary winding of the power transformer.

Energy storage is possible since the power transformer is actually an inductor with multiple windings. Once the stored energy reaches a level determined by the control circuit, the gate voltage is rapidly removed from the power switch gates, switching them off. The interruption of current flow in the power transformer forces the voltage across the primary to reverse almost instantaneously, rising to the level required to provide a discharge of the flux built up in the power transformer. The action of the transformer is said to “fly back” to the clamping level, thus the popular term flyback converter.

The primary current is sensed by a power resistor in series with the source of the switch. The control circuit monitors the voltage analog of the primary current and shuts off the power switches early if excess current is detected (approx. 1V peak).

1.9.1.3 Output Rectifiers, Filters and Post-regulators

- Output #1—The output rectifier clamps the transformer windings directly to the filter capacitors for the +5V output.
- Output #2—Output #2 is regulated by a discrete linear regulator.
- Output #3—Output #3 is post-regulated by a conventional three-pin linear regulator.
- Output #4—Output #4 is also post-regulated with a three-pin regulator. An output rectifier provides rectified charge to the filter capacitor during the flyback cycle.

1.9.1.4 Control Circuits

Main Output Regulation and PWM Operation—The main 5 volt output voltage is controlled directly and thus sets the transformer voltage for all the other outputs. The output voltage is sensed through a resistor divider. The potentiometer adjusts the voltage ratio is applied to the 2.50V reference.

Normal switching operation will commence if the fault has been removed. If the fault is still present, the shutdown cycle will repeat. The power supply thus appears to be providing short bursts of power or “hiccuping”.

Overvoltage Protection—If the voltage of the main output increases beyond safe limits, the overvoltage protection zener diode begins to conduct. When sufficient current is available to raise the gate of SCR1 to approx. 0.7V, the SCR latches “On”, shorting the output causing a “hiccup” cycle that will repeat until the fault is removed or the power supply is repaired.

1.9.2 Gas Module 3

The power inlet is shielded, medical grade M5 with an integrated filter, a line fuse, and a neutral fuse. A double pole power switch ensures that power to the gas analyzer is ON or OFF due to its mechanical function.

The medical grade power supply can support an input range from 85 VAC to 264 VAC. Its 5 V and 12 V dual output can deliver a maximum power of 25 W. Power ON indication is a green LED that is itself powered from the 5 V output.

1.10 Spirometry (Gas Module SE with Spirometry Only) Overview

The Gas Module SE with spirometry option enables monitoring of the ventilator operation and the patient respiratory status: CO_2, O_2, N_2O, anesthetic agents, airway pressures, volumes, and lung mechanics.

In the spirometry measurement, the airway pressures are measured as close to the patient as possible, from the part between patient circuit and patient airway, using the adult and pediatric sensors. The same sensors are used for gas sampling.

The spirometry sensors are designed to measure kinetic pressure by a two-sided Pitot tube. Pressure is transferred to the monitor through a spirometry tube and measured by a pressure transducer on the PVX board. The pressure difference across a flow restrictor together with the gas concentration information is used to calculate flow. The volume information is obtained by integrating the flow signal.

1.10.1 Measured Parameters

- Inspiratory and expiratory tidal volumes (Vtinsp/exp)
- Inspiratory and expiratory minute volumes (MVinsp/exp)
- Airway pressure
  - Peak pressure (Ppeak)
  - Plateau pressure (Pplat)
  - Real-time pressure waveform
  - Positive end expiratory pressure (PEEP)
- Compliance (Compl)
- Airway resistance (Raw)
- Flow
  - Real time waveform (Flow)
- Ratio of the inspiratory and expiratory time (I:E)
- Pressure-volume loop (Paw-Vol. loop)
- Flow volume loop (Flow-Vol. loop)

NOTE: **With spontaneous breaths, compliance and airway resistance are not measured. With pressure supported breaths, airway resistance is not measured.**

1.10.2 Measurement Principles

- Ppeak is the maximum pressure during one breath
- Pplat is the pressure at the reversal point of the flow, at the end of the inspiration phase, after the inspiratory pause.
- Pmean is the average pressure during one breath.
- PEEP is the pressure in the lungs at the end of the expiration, measured at the moment when the expiratory phase changes to inspiratory flow.
- Compliance (Compl) is calculated for each breath from the following equation:

$$\mathrm{Compl} = \frac{\mathrm{Vtexp}}{\mathrm{Pplat} - \mathrm{PEEP}}$$

Compliance tells how big a pressure difference is needed to deliver a certain volume of gas into the patient.

- The airway resistance, **Raw**, is calculated from an equation that describes the kinetics of the gas flow between the lungs and the flow sensor. The pressure at the sensor can be derived at any moment of the breath cycle from the following equation:

$$p(t) = \frac{Ra \cdot \dot{V}(t) + V(t)}{\mathrm{Compl} + \mathrm{PEEP}}$$

where p(t), $\dot{V}(t)$ and V(t) are pressure, flow and volume measured at the sensor at a certain time (t).

1.10.3 PVX Measuring Unit

NOTE: **Never apply overpressure or negative pressure of more than 300 cmH_2O to the flow and volume tubing. Differential pressure maximum is 25 cmH_2O on one port at a time, e.g. when connecting tubes.**

When patient spirometry is used, a special sensor replaces the normal airway adapter in the patient circuit. A double lumen tubing is attached to the two connectors on the adapter and on the module front panel.

The PVX unit provides patient respiration monitoring capabilities using the adult and pediatric flow sensors.

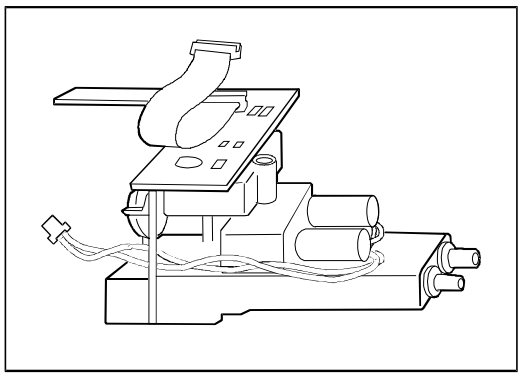


FIGURE 1-24 PVX measuring unit

The measurement is based on measuring the kinetic gas pressure and is performed using the Pitot effect. A pressure transducer is used to measure the Pitot pressure. The signal is then linearized and corrected according to the density of the gas. Speed of the flow is calculated from the pressure and Vt (Tidal Volume) is integrated from it.

The PVX unit consists of airway connections, two pressure transducers, valves and preamplifiers. The preamplifiers are connected to the A/D-converter on the main CPU module.

A patient's breathing flow passing through the adapter creates a pressure difference. This pressure difference is measured by pressure transducer, B1. Overpressure and negative pressure in airways are measured by another pressure transducer, B2.

2.0 *Specifications*

Contents of this chapter ..... Page

2.1 Performance Specifications

2.1.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

Sampling Rate:	200 ± 20 ml/min (with sampling line ≤ 6 meters, under normal conditions)
Sampling Delay:	2.5 seconds (with a 3 meter sampling line)
Total System Response Time:	2.9 seconds (with a 3 meter sampling line, including sampling delay and rise time)
Display Update Rate:	Breath-by-Breath
Compensation:	Automatic for pressure, CO_2-N_2O and CO_2-O_2 collision broadening effect
Warm-up Time:	Maximum 2 minutes to operation with CO_2, O_2, and N_2O 5 minutes to operation of anesthetic agents 30 minutes for full accuracy specifications
Autozeroing Interval:	At startup and at 2, 4, 10, 15, 30, 45, and 60 minutes of operation. Every 60 minutes thereafter.

2.1.2 Gas Module 3

2.1.2.1 General

Technology	NDIR type gas analyzer measuring at 3.9 – 12.8 µm with paramagnetic oxygen sensor. Pressure, temperature and full spectral interference correction.
Operating modes	• Startup • ISO accuracy • Full accuracy
Measured gases	CO_2, N_2O, O_2, HAL, ENF, ISO, SEV, DES
Measured parameters	• Momentary gas concentration • Inspired and expired concentrations of all gases • Breath rate
Resolution	CO_2 and agents: 0.01%; O_2 and N_2O: 0.1%
Warm-up time	ISO accuracy within 45 s, full accuracy within 10 min
ISO Accuracy Specifications[1]	As Full Accuracy Specifications, but de-rated as follows: • Add ± 0.3% ABS to inaccuracy for CO_2 • Add ± 8% REL to inaccuracy for all Agents • N_2O inaccuracy is ± (8% REL + 2% ABS) • O_2 no addition
Rise times[2] ($t_{10–90\%}$) @200 ml/min	• CO_2 250 ms (fall time 200 ms) • N_2O 250 ms • O_2 500 ms • HAL, ISO, SEV, DES 300 ms • ENF 350 ms

1 Includes interference from other gases.
2 The step rise time specification at 200 ml/min sample flow includes DRYLINE™ Water Trap, Adult/Pediatric and DRYLINE™ Sampling Line, Adult/Pediatric 2.5 m.
3 The step rise time specification at 120 ml/min sample flow includes DRYLINE™ Water Trap, Neonate and DRYLINE™ Sampling Line, Neonate 2.5 m.
4 The delay time specification is valid both for 120 ml/min sample flow (using DRYLINE™ Water Trap, Neonate and DRYLINE™ Sampling Line, Neonate 2.5 m) and for 200 ml/min sample flow (using DRYLINE™ Water Trap, Adult/Pediatric and DRYLINE™ Sampling Line, Adult/Pediatric 2.5 m).
5 For HAL, add 0.1% ABS to threshold values.

Rise times[3] ($t_{10–90\%}$) @120 ml/min	• CO_2	250 ms (fall time 200 ms)
	• N_2O	250 ms
	• O_2	600 ms
	• HAL, ISO, SEV, DES	300 ms
	• ENF	350 ms
Delay time[4] ($t_{0–10\%}$)	< 4 s	
Identification	Dual agent	
Primary agent ID threshold[5]	0.15% (0.4% during ISO accuracy mode)	
Secondary agent ID threshold[5]	0.3% (0.5% during ISO accuracy mode) or 5% REL (10% REL for Isoflurane) of primary agent if primary agent >10%	
Agent ID time	Three breaths - Typically less than 10 s	
Display Update Rate:	Breath-by-Breath	
Main Fuse:	2x T0.8A 250V	

1 Includes interference from other gases.

2 The step rise time specification at 200 ml/min sample flow includes DRYLINE™ Water Trap, Adult/Pediatric and DRYLINE™ Sampling Line, Adult/Pediatric 2.5 m.

3 The step rise time specification at 120 ml/min sample flow includes DRYLINE™ Water Trap, Neonate and DRYLINE™ Sampling Line, Neonate 2.5 m.

4 The delay time specification is valid both for 120 ml/min sample flow (using DRYLINE™ Water Trap, Neonate and DRYLINE™ Sampling Line, Neonate 2.5 m) and for 200 ml/min sample flow (using DRYLINE™ Water Trap, Adult/Pediatric and DRYLINE™ Sampling Line, Adult/Pediatric 2.5 m).

5 For HAL, add 0.1% ABS to threshold values.

2.1.2.2 Pneumatic

Technology	Side-stream gas sampling
Pneumatic modes	• Room air reference measurement: Automatic • Sampling system purge: Automatic
Pump	Flow controlled dual membrane
Gas sampling rate[1]	with DRYLINE™ Water Trap, Adult/Ped: 200 ml/min with DRYLINE™ Water Trap, Neonate: 120 ml/min
Occlusion alarm	Actual flow < 40 ml/min
Room air reference measurement	Automatic when gas measurement bench temperature change is > 1°C or time since last ref. measurement is > 4 h
Reference measurement interval	ISO Accuracy Mode > 30 s Full Accuracy Mode > 4 h
Reference measurement duration	Typical 5 s, Max 9 s
Purge cycle	Automatic when occlusion detected
Change water trap alarm	Actual flow < 75% of set flow and purge cycle has failed
Pressure difference[2]	-40 hPa < ($P_{Sampling\ point} - P_{Evac}$) < + 30 hPa

1 The Gas Module 3 measures volumetric flow at actual barometric pressure, normalized to room air at 21 ˚C and 0% RH. The use of other gas mixtures the room air for flow calibration may cause flow measurement errors.

2 For a complete system with DRYLINE™ gas sampling accessories.

2.2 Gas Measurements

2.2.1 Normal Conditions

(after 30 minute warm-up period)

2.2.1.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

Ambient temperature	18 – 28 °C within ± 5 °C of calibration
Ambient pressure	500 – 800 mmHg, ± 50 mmHg of calibration
Ambient humidity	20 – 80% RH, ± 50% RH of calibration
Room air reference measurement for Gas Module 3	Automatic when gas measurement bench temperature change is > 1 °C or time since last ref. measurement is > 4 h

2.2.1.2 Gas Module 3

Ambient temperature	10 – 55 °C within ± 5 °C of calibration
Ambient pressure	525 – 900 mmHg
Ambient humidity	10 – 95% RH

2.2.2 Non-disturbing Gases

2.2.2.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

Ethanol C_2H_5OH	in concentrations < 0.3%
Acetone	in concentrations < 0.1%
Methane CH_4	in concentrations < 0.2%
Nitrogen N_2	in any concentration
Carbon monoxide CO	in any concentration
Nitric Oxide NO	in concentrations < 200 ppm
Water vapor	in any concentration

2.2.3 Disturbing Gases

2.2.3.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

Helium	Decreases CO_2 readings < 0.6 vol% typically Decreases O_2 readings < 3 vol% typically
Xenon	Decreases CO_2 readings < 0.4 vol% typically

2.2.4 Gas Module 3 Interference Specifications

2.2.4.1 Gas Interference [%ABS]

NOTE: The following is the maximum interference from each gas at concentrations within specified accuracy ranges for each gas. Total interference for all gases is never larger than 5% REL. Multiple agent interference on CO_2, N_2O, and O_2 is typically the same as single agent interference.

CO_2	N_2O: 0.1 O_2: 0.1 Any agent: 0.1
N_2O	CO_2: 0.1 O_2: 0.1 Any agent: 0.1
HAL, ENF, ISO	CO_2: 0 N_2O: 0.1 O_2: 0.1 Second agent: 0.1 (typical)
SEV	CO_2: 0 N_2O: 0.1 O_2: 0.1 Second agent: 0.1 (typical)
DES	CO_2: 0 N_2O: 0.1 O_2: 0.1 Second agent: 0.1 (typical)
O_2	CO_2: 0.2 N_2O: 0.2 Any agent: 1.0

2.2.4.2 Contaminant Interference

	INTERFERENCE [%ABS]			
CONTAMINANT	**CO_2**	**N_2O**	**AGENTS**	**O_2**
< 100% Xenon	0.1	0	0	0.5%
< 50% He	0.1	0	0	0.5%
Metered dose inhaler propellants	Unspecified	Unspecified	Unspecified	0.5%
< 0.1% Ethanol	0	0	0	0.5%
Saturated Isopropanol vapor	0.1	0	0	0.5%
< 1% Acetone	0.1	0.1	0	0.5%
< 1% Methane	0.1	0.1	0	0.5%

2.2.5 CO_2

2.2.5.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

Measurement Range:
0 – 15 vol%
0 – 15 kPa
0 – 113 mmHg
0 – 113 Torr

Measurement Rise Time: < 400 ms

Accuracy: ± (0.2 vol% + 2% of reading)

Cross Effects: < 0.2 vol% for O_2, N_2O, and anesthetic agents

Threshold: 0.1 vol% (If value < 0.1%, 0.0 is displayed)

Respiration Rate:
Breath Detection - 1% change in CO_2 level
Measurement Range - 4 to 60 bpm

2.2.5.2 Gas Module 3

Measurement Range:
0 – 10 vol%
0 – 10 kPa
0 – 75 mmHg
0 – 75 Torr

Measurement Rise Time:
250 ms for 200 ml/min
250 ms for 120 ml/min

Accuracy:
± 0.1% of Reading @ 0 – 1% of volume
± 0.2% of Reading @ 1 – 5% of volume

	± 0.3% of Reading @ 5 – 7% of volume ± 0.5% of Reading @ 7 – 10% of volume Unspecified @ > 10% of volume
Cross Effects:	N_2O – 0.1% of Reading O_2 – 0.1% of Reading Any Agent – 0.1% of Reading
Threshold:	0.1 vol% (0.3% during ISO accuracy mode) If value < 0.1%, 0.0 is displayed
Respiration Rate:	Breath detection > 1% change in CO_2 concentration Measurement Range 2 – 100 bpm with accuracy ± 1 bpm @ < 60 bpm

2.2.6 O_2

2.2.6.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

Measurement Range:	0 – 100 vol%
Measurement Rise Time:	< 400 ms
Accuracy:	± (1 vol% + 2% of reading)
Cross Effects:	< 2 vol% for N_2O < 1 vol% for anesthetic agents
O_2 Fi - Et difference:	0.1 vol% resolution

2.2.6.2 Gas Module 3

Measurement Range:	0 – 100 vol%
Measurement Rise Time:	< 400 ms for 200 ml/min < 450 ms for 120 ml/min
Accuracy:	± 1% of Reading @ 0 – 25% of volume ± 2% of Reading @ 25 – 80% of volume ± 3% of Reading @ 80 – 100% of volume
Cross Effects (maximum):	CO_2 – 0.2% of Reading

	N_2O – 0.2% of Reading Any Agent – 1.0% of Reading
O_2 Fi - Et difference:	< 0.1 vol% resolution

2.2.7 N_2O

2.2.7.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

Measurement Range:	0 – 100% N_2O
Measurement Rise Time:	< 400ms
Accuracy:	± (2 vol% + 2% of reading)
Gas Cross Effects:	< 2 vol% anesthetic agents

2.2.7.2 Gas Module 3

Measurement Range:	0 – 100% N_2O
Measurement Rise Time:	< 250 ms for 200 ml/min < 250 ms for 120 ml/min
Accuracy:	± 2% of Reading @ 0 – 20% of volume ± 3% of Reading @ 20 – 100% of volume
Cross Effects (maximum):	CO_2 – 0.1% of Reading O_2 – 0.1% of Reading Any Agent – 0.1% of Reading
Threshold:	3 vol% (3% during ISO accuracy mode) If value < 3%, 0.0 is displayed

2.2.8 Anesthetic Agents

2.2.8.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

Measurement Range:	Halothane, Enflurane and Isoflurane - 0 to 6.0 vol% Sevoflurane - 0 to 8 vol% Desflurane - 0 to 20 vol%

Measurement Rise Time:	Enflurane, Isoflurane, Sevoflurane, Desflurane - < 600 ms Halothane - < 1000 ms
Accuracy:	± (0.15 vol% + 5% of reading)
Gas Cross Effects:	< 0.15 vol% N_2O
Resolution:	Two digits for Anesthetic Agent concentrations < 1.0 vol% If Anesthetic Agent concentration is below 0.1 vol%, 0.0% is displayed
Threshold:	0.15 vol%
Identification Time:	< 20 seconds (for single agents)
Mixture Identification Threshold for second agent:	0.2 vol% + 10% of total concentration

2.2.8.2 Gas Module 3

Measurement Range:	0 – 5 vol% of ENF, HAL, ISO 0 – 8 vol% of SEV 0 – 18 vol% of DES
Measurement Rise Time:	DES, HAL, ISO, SEV: 300 ms for 200 ml/min ENF: 350 ms for 200 ml/min DES, HAL, ISO, SEV: 300 ms for 120 ml/min ENF: 350 ms for 120 ml/min
Accuracy:	± 0.15% of Reading @ 0 – 1% of DES, ENF, HAL, ISO, SEV volume ± 0.2% of Reading @ 1 – 5% of DES, ENF, HAL, ISO, SEV volume Unspecified @ > 5% of ENF, HAL, ISO volume ± 0.4% of Reading @ 5 – 8% of SEV volume Unspecified @ > 8% of SEV volume ± 0.4% of Reading @ 5 – 10% of DES volume ± 0.6% of Reading @ 10 – 15% of DES volume ± 1% of Reading @ 15 – 18% of DES volume

	Unspecified @ > 18% of DES volume
Cross Effects:	CO_2 – 0% of Reading N_2O – 0.1% of Reading O_2 – 0.1% of Reading 2nd Agent – 0.1% of Reading
Threshold:	Primary Agent ID 0.15% (0.4% during ISO accuracy mode) Secondary Agent ID 0.3% (0.5% during ISO accuracy mode) 5% of volume (10% of volume for Isoflurane) of primary agent > 10%

2.2.9 Accuracy specifications at conditions exceeding normal

NOTE: Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

1.	Ambient temperature:	10 – 40 °C, within ± 5 °C of calibration
	Ambient pressure:	500 – 800 mmHg, ± 50 mmHg of calibration
	Ambient humidity:	10 – 98% RH, ± 20% RH of calibration
2.	During warm-up:	2 to 10 minutes (anesthetic agents 5 - 10 minutes), under normal conditions
3.	During warm-up:	10 to 30 minutes, under normal conditions
4.	N_2O:	> 85%

2.2.9.1 CO_2

Accuracy:	± (0.3 vol% + 4% of reading) (at 5 vol% error ± 0.5 vol%) **1, 3** ± (0.4 vol% + 7% of reading) (at 5 vol% error ± 0.75 vol%) **2**

2.2.9.2 O_2

Accuracy:	± (2 vol% + 2% of reading) **1, 3** ± (3 vol% + 3% of reading) **2**

2.2.9.3 N_2O

Accuracy: ± (3 vol% + 3% of reading) **1, 3**
± (3 vol% + 5% of reading) **2**
± (2 vol% + 8% of reading) **4**

2.2.9.4 Anesthetic Agents

(Halothane, Enflurane, Isoflurane, Sevoflurane, Desflurane)

No extended measuring range, but a warning of exceeding measuring range.

Accuracy: ± (0.2 vol% + 10% of reading) **1, 3**
± (0.3 vol% + 10% of reading) **2**

2.2.10 ISO Mode Accuracy specifications for Gas Module 3

2.2.10.1 CO_2

Accuracy: ± 0.4% of Reading @ 0 – 1% of volume
± 0.5% of Reading @ 1 – 5% of volume
± 0.6% of Reading @ 5 – 7% of volume
± 0.8% of Reading @ 7 – 10% of volume
Unspecified @ > 10% of volume

2.2.10.2 N_2O

Accuracy: ± (10% of Reading + 2% of volume) @ 0 – 20% of volume
± (11% of Reading + 2% of volume) @ 0 – 20% of volume

2.2.10.3 O_2

Accuracy: ± 1% of Reading @ 0 – 25% of volume
± 2% of Reading @ 25 – 80% of volume
± 3% of Reading @ 80 – 100% of volume

2.2.10.4 Halothane, Enflurane, and Isoflurane

Accuracy: ± (0.15% of Reading + 8% of volume) @ 0 – 1% of volume

± (0.2% of Reading + 8% of volume)
@ 1 – 5% of volume

Unspecified @ > 5% of volume

2.2.10.5 Sevoflurane

Accuracy:

± (0.15% of Reading + 8% of volume)
@ 0 – 1% of volume

± (0.2% of Reading + 8% of volume)
@ 1 – 5% of volume

± (0.4% of Reading + 8% of volume)
@ 5 – 8% of volume

Unspecified @ > 8% of volume

2.2.10.6 Desflurane

Accuracy:

± (0.15% of Reading + 8% of volume)
@ 0 – 1% of volume

± (0.2% of Reading + 8% of volume)
@ 1 – 5% of volume

± (0.4% of Reading + 8% of volume)
@ 5 – 10% of volume

± (0.6% of Reading + 8% of volume)
@ 10 – 15% of volume

± (1.0% of Reading + 8% of volume)
@ 15 – 18% of volume

Unspecified @ > 18% of volume

2.3 Patient Spirometry

2.3.1 Normal Conditions for Gas Module SE with Spirometry

(after 10 minute warm-up period)

Ambient temperature	10 – 40 °C
Ambient pressure	500 – 800 mmHg
Ambient humidity	10 – 98% RH
Airway humidity	10 – 100% RH
Respiration rate	4 – 35 breaths/min (adult) 4 – 50 breaths/min (pediatric)
I:E ratio	1:4.5 – 2:1
Intubation tube	5.5 – 10 mm (adult) 3 – 6 mm (pediatric)

2.3.1.1 Airway Pressure (Paw)

Measuring range:	-20 to +100 cmH_2O
Resolution:	0.5 cmH_2O
Accuracy:	± 1 cmH_2O

2.3.1.2 Flow

Measurement range (for both directions):	1.5 – 100 l/min (adult) 0.25 – 25 l/min (pediatric)

2.3.1.3 Tidal Volume

Measurement range:	150 – 2000 ml (adult) 15 – 300 ml (pediatric)
Resolution:	1 ml
Accuracy:	± 6% or 30 ml (adult) ± 6% or 4 ml (pediatric)

2.3.1.4 Minute Volume

Measurement range:	2 – 20 l/min (adult) 0.5 – 5 l/min (pediatric)
Resolution:	0.1 l/min

2.3.1.5 Compliance

Measurement range:	4 – 100 ml/cmH_2O (adult) 1 – 100 ml/cmH_2O (pediatric)
Resolution:	1 ml/cmH_2O (adult) 0.1 ml/cmH_2O (pediatric)

2.3.1.6 Airway Resistance

Measurement range:	0 – 40 cmH_2O/l/s
Resolution:	1 cmH_2O/l/s

2.3.2 Accuracy specifications at conditions exceeding normal

During warm-up:	2 to 10 minutes

2.3.2.1 Airway Pressure (Paw)

Accuracy:	± 2 cmH_2O

2.3.2.2 Tidal volume

Accuracy:	± 10% or 100 ml (adult) ± 10% or 10 ml (pediatric)

2.4 Power Input Ratings

Gas Module II/SE/SE with Spirometry: 100 to 240 VAC ± 10% (90 to 264 VAC), 50/60Hz, 18 W

Gas Module 3: 100 to 240 VAC ± 10% (90 to 264 VAC), 50/60Hz, < 15 W

2.5 Environmental Conditions

2.5.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

Transport and Storage Temperature:	-20 °C to +60 °C
Transport and Storage Humidity:	5 to 95%, non-condensing
Operating Altitude:	Sea Level to 8,000 feet
Operating Temperature:	10 °C to 35 °C
Operating Humidity:	10 to 95% RH, non-condensing (in Airway: 0-100% RH, non-condensing)

2.5.2 Gas Module 3

Transport and Storage Temperature:	-40 °C to +70 °C
Transport and Storage Humidity:	5 to 100%, condensing[a]
Operating Altitude:	Sea Level to 8,000 feet
Operating Temperature:	10 °C to 40 °C
Operating Humidity:	10 to 95% RH, non-condensing (in Airway: 0-100% RH, non-condensing)

a. After storage in a condensing atmosphere, the unit shall before use be kept for more than 24 h in an environment equivalent to the operating atmosphere.

2.6 Physical Characteristics

2.6.1 Gas Module II

Size:	12.5" wide x 9.6" deep x 4.2" high (31.7 cm wide x 24.3 cm deep x 10.6 cm high)
Weight:	10.0 lbs. (4.54 kg) max

2.6.2 Gas Module SE

Size:	11.85″ wide x 10.0″ deep x 4.2″ high (30.1 cm wide x 25.4 cm deep x 10.6 cm high)
Weight:	9.6 lbs. (4.35 kg) max

2.6.3 Gas Module 3

Size:	11.9″ wide x 10.4″ deep x 3″ high (30.16 cm wide x 26.35 cm deep x 7.63 cm high)
Weight:	6.2 lbs (2.8 kg) max

2.7 Agency Compliance

The Gas Module is registered with CSA-Canada

The Gas Module complies with the requirements of the medical device directive 93/42/EEC.

The Gas Module is designed to comply with the following industry standards:

2.7.1 Gas Module II

CSA C22-2 No. 125-M 1984	IEC 601-2-30: 1995
UL 544, Third Edition	IEC 601-2-34: 1994
IEC 601-1: 1988/EN60601-1:1990	ISO 9919: 1992
IEC 601-2-27: 1994	ISO 9918: 1993
	EN60601-1-2: 1995

2.7.2 Gas Module SE

Performance:	EN ISO 21647:2004
Safety standards:	IEC 60601-1:1988 +A1:1991 +A2:1995 UL 2601-1:1997 CSA Standard C22.2 No. 60601.1M90 EN60601-1-1:2001/IEC 60601-1-1:2000 EN60601-1-4:1996 + A1:1999/ IEC 60601-1-4:1996 + A1:1999 EN ISO 14971:2000 + A1:2003
EMC standards:	IEC 60601-1-2:Ed. 2.1
Mechanical stress:	IEC 60068-2-6 Fc Sinusoidal Vibration IEC 60068-2-27 Shock IEC 60068-2-29 Eb Bump IEC 60068-2-32 Ed Drop IEC 60068-2-64 Broad Band Random Vibration ISO 2244 Shock
Temperature and humidity stress:	IEC 60068-2-1 Ab, Ad IEC 60068-2-2 Bb, Bd IEC 60068-2-14 Na, Nb IEC 60068-2-30 Db IEC 60068-2-56 Cb

2.7.3 Gas Module 3

EN 60601-1/IEC 60601-1+A1+A2	UL 60601-1
CAN/CSA–C22.2 NO. 601.1-M90	EN 60601-1-1 / IEC 60601-1-1
EN 60601-1-4 / IEC 60601-1-4	EN ISO 21647

2.7.3.1 Safety designations per IEC 60601-1

Type of protection against electrical shock:	Class 1 Equipment
Degree of protection against electric shock:	Type BF Applied Part

Supply Connection:	100 – 240 VAC 50 – 60 Hz 10 W 0.22 – 0.10 A
Mode of Operation:	Continuous
Protection Against Hazards of Explosion:	Not Protected (ordinary)
Protection Against Ingress of Liquids:	Not Protected (ordinary)
Degree of Electrical Connection between Equipment and Patient:	Equipment designed as non-electrical connection to the patient
Degree of Mobility:	Transportable, Intra-Hospital

WARNING: Equipment not suitable for use in the presence of a flammable anesthetic mixture with air or with nitrogen or nitrous oxide.

WARNING: Do not connect devices that are not specified as part of the system.

NOTE: If an MPSO (Multiple Portable Socket Outlet) is used with the system, the maximum permitted load is 1.42 Amps. Do not connect electrical equipment that has not been supplied as part of the system.

3.0 *Repair Information*

3.1 Introduction

This chapter of the Service Manual provides the necessary technical information to perform repairs to the instrument. The most important prerequisites for effective troubleshooting are a thorough understanding of the instrument functions, as well as an understanding of the theory of operation. Therefore, if necessary, refer to the Patient Monitoring Operating Instructions which describes the instrument functions and features, and refer to Chapter 2.0 of this manual which provides a theory of operation.

3.2 Safety Precautions

In the event that the instrument covers are removed, observe the following warnings and general guidelines.

A. Do not short component leads together.

B. The troubleshooting charts are not intended as a rapid course on how to repair devices of this type. Rather, they are intended as a guide for qualified technical personnel only. The instrument covers must not be removed by other than technically qualified personnel who have received supplementary instructions regarding maintenance of medical electronic equipment or have equivalent experience in this area.

3.3 Troubleshooting

3.3.1 General Troubleshooting Guidelines

In an instrument as complex as this, it is virtually impossible to list each and every potential problem and appropriate action. Any given problem, however, can be effectively identified through an understanding of the instrument features and the theory of operation. These are prerequisites for repair. If necessary, read the Operating Instructions Manual and study the theory of operation presented in Chapter 2.0 of this manual. The benefits of the time spent reading and absorbing this information is generally realized by a reduction in repair time and, ultimately, in the overall experience of service personnel.

1. **IDENTIFY THE PROBLEM.** Due to the wide ranges of potential symptoms, certain problems may be more subtle than others. One approach to trouble-shooting is to set-up the instrument for testing as described in Chapter 5.0 and attempt testing. If successful, there is a reasonable assurance that there is no problem. By contrast, the fact that a particular test is not successful is generally indicative of a failure in that specific area.
2. **AVOID SHORTING COMPONENT LEADS.** During repair procedures, it can become tempting to make a series of quick measurements. Always turn off the power before connecting and disconnecting test leads and probes. The accidental shorting of component leads can easily over stress components, resulting in a second unnecessary failure (aside from creating a possible safety risk).
3. **USE THE PROPER EQUIPMENT.** The equipment listed in Section 5.3 is suggested to fulfill a wide range of troubleshooting requirements. Use a soldering iron of the appropriate wattage for a given job. For example, use a pencil-type iron (25 watts max.) for repairs to printed wiring boards and a pistol-grip (75 watts) for repairs requiring this much power. Do not use the high powered iron to repair the printed wiring boards as the conductors will lift from the board under the extreme heat, thus ruining it.
4. **CLEAN THE REPAIR AREA.** After soldering operations, clean off the repaired area with alcohol and a stiff hair brush. This will remove residual solder flux, making the repaired area more visible for inspection and returning the instrument to its original, neat appearance. Removal of the flux will also facilitate making electrical measurements in the affected area.

3.3.2 Gas Module Technical Troubleshooting

To begin the technical troubleshooting session perform the following steps first:

1. Check that the line voltage cable is plugged in securely, the power switch is set to 1 (ON), and the green front panel lamp is illuminated.
2. Check that the interface cable is installed correctly and securely to both the Gas Module and the display monitor.
3. Substitute a fully operational display monitor and interface cable to eliminate them as possible causes of the problem. If the problem persists, it can be assumed that the Gas Module is causing the problem.
4. Consult the table below for specific error conditions and error messages.
5. Before replacing any components on the Gas Module II, Gas Module SE, and Gas Module SE with Spirometry, verify that all power supply voltages are present and that the +5V and +12V supplies are calibrated. Refer to section 5.0 for more details on power supply calibration.

STATUS MESSAGES AND OTHER SYMPTOMS	SOLUTION (STEP 1)	SOLUTION (STEP 2)	SOLUTION (STEP 3)
GM: Warming up message appears for too long. The warm-up period should last for approximately two (2) minutes.	Check all connections and patient accessories, Turn the unit off and on again.	Replace the Interface board.	If the Interface board does not solve the problem, replace the M-GAS module.
GM: Agent Warming Up message appears for too long. The warm-up period should last for approximately five (5) minutes. Does not apply to Gas Module 3.	Check all connections and patient accessories, Turn the unit off and on again.	Replace the Interface board.	If the Interface board does not solve the problem, replace the M-GAS module.
GM: Exhaust Blocked	Check for obstruction of the Exhaust port. Remove any tube that may be obstructing.	Visually inspect the tubing in and around the M-GAS module.	Replace the defective pneumatic component.
GM: Mixed Agents	Verify that one agent is being applied. Has an agent vaporizer been incorrectly filled?	Replace the M-GAS Module.	If the M-GAS module does not solve the problem, replace the interface board.
GM: Agent Mismatch	The agent labeled on the monitor is not the same as the agent applied. To automatically identify the applied agent, select Auto-ID from the Gas Menu.	Replace the M-GAS Module.	If the M-GAS module does not solve the problem, replace the interface board.

STATUS MESSAGES AND OTHER SYMPTOMS	SOLUTION (STEP 1)	SOLUTION (STEP 2)	SOLUTION (STEP 3)
GM: Unknown Agent	An non-recognizable agent (Halothane, Isoflurane, Enflurane, Desflurane or Sevoflurane) is being applied.	Replace the M-GAS Module.	If the M-GAS module does not solve the problem, replace the interface board.
GM: Air Leak	This message indicates that the moisture trap is not connected or an internal leak exists.	Reinstall the moisture trap. If GM: Pump Off appears, restart the pump via the Gas Menu.	Replace the M-GAS module.
	Sample Catheter not connected or disconnected	Ensure Sample Catheter is connected and restart pump from the monitor Gas Menu, if needed.	Replace Sample Catheter
	Moisture Trap may not be seated	Re-seat trap and restart pump from the monitor Gas Menu, if needed.	Replace Moisture Trap
	Monitor turned off or in Standby mode for an extended period with Gas Module turned on.	Restart pump from the monitor Gas Menu	Turn both Gas Module and monitor off, then on again.
GM: Pump Off message appears. No sound from the pump is heard.	This happens when a leak has been detected for more than 45 seconds. Restart the pump via the Gas Menu.	Replace the Interface board.	If the Interface board does not solve the problem, replace the M-GAS module.
GM: Replace Trap message caused by a partial blockage in the water trap.	The flow rate fell below 150 mL/ minute. Replace the water trap.	Replace the M-GAS Module.	If the M-GAS module does not solve the problem, replace the interface board.
GM:... Uncalibrated - the identified channel is not able to display accurate data.	Calibrate that channel or the entire group of gas channels.	Replace the M-GAS Module.	If the M-GAS module does not solve the problem, replace the interface board.
GM: Occlusion	Replace the sample line. If the message persists with the sample line removed, replace the water trap.	Visually inspect the tubing in and around the M-GAS module	Replace the defective pneumatic component. Check exhaust line for blockage and clear if possible.
GM: Cannot Zero... Retrying	Retry calibration. See the Operating Instructions for details. Try calibrating each channel individually.	Replace the M-GAS Module.	If the M-GAS module does not solve the problem, replace the interface board.

STATUS MESSAGES AND OTHER SYMPTOMS	SOLUTION (STEP 1)	SOLUTION (STEP 2)	SOLUTION (STEP 3)
GM: Disconnected	Verify that a fully operational monitor and interface cable is attached. Ensure the line cord is plugged in and the power switch is turned on.	Replace the Interface board.	If the Interface board does not solve the problem, replace the M-GAS module.
GM: Failed	An internal failure exists.	Replace the Interface board.	If the Interface board does not solve the problem, replace the M-GAS module.
Erroneous concentration for CO_2, N_2O, O_2, or Agent is suspected.	Check the value of each gas channel using a precision calibration gas can. See the Operating Instructions for gas channel specifications. If necessary, calibrate all gas channels or the individual channels that are out of specification.	Replace the M-GAS Module.	If the M-GAS module does not solve the problem, replace the interface board.
Erroneous display of concentrations for CO_2, N_2O, O_2 or Agent are suspected.	Measure the parameters outputs while testing with a calibrated standard cal gas can. Are there any leak messages?	1. If a "Leak" message appears, inspect all pneumatic tubes in and around the M-GAS module. 2. If a "Leak" message does not appear, try to calibrate each gas channel.	If calibration is impossible, replace the M-GAS module.
No CO_2 response to a patient breathing	Sample line or moisture trap is blocked, loose, or improperly connected, or the moisture trap is full. Reconnect or replace related accessories.	Replace the Interface board.	If the Interface board does not solve the problem, replace the M-GAS module.
Sudden increase in gas display.	Moisture Trap malfunction. Replace it.	Replace the Interface board.	If the Interface board does not solve the problem, replace the M-GAS module.
Abnormally high (or low) responses to all gases, or intermittent or sudden occlusion message.	Check that the sample line or moisture trap is not blocked, loose, or improperly connected. Reconnect or replace related accessories.	Replace the Interface board.	If the Interface board does not solve the problem, replace the M-GAS module.
GM: Zero Error	Remove any tube that may be connected to the air intake port on the rear panel. Retry calibration.	Replace the M-GAS Module.	If the M-GAS module does not solve the problem, replace the interface board.

STATUS MESSAGES AND OTHER SYMPTOMS	SOLUTION (STEP 1)	SOLUTION (STEP 2)	SOLUTION (STEP 3)
GM: Sampling Error	Check the cal gas canister contents. Ensure the gas regulator is operating in the green zone throughout the calibration. Retry calibration.	Visually inspect the tubing for leaks and occlusions.	Replace the M-GAS Module.
GM: Zero in Progress	This message should last approximately 20 seconds.	Replace the M-GAS Module.	If the M-GAS module does not solve the problem, replace the interface board.

3.3.3 Patient Spirometry Trouble Shooting

NOTE: Gas Module SE with Spirometry only

PROBLEM	POSSIBLE CLINICAL CAUSE	POSSIBLE TECHNICAL CAUSE	ACTION
Insp Vt>Exp Vt	• Leak in lungs • ET tube cuff leak	• Spirometry tube leak • Water inside sensor or tubings • Another side stream gas sampling between sensor and patient	• Check leakages - perform leak test • Change tubings and sensor • Don't use active humidification • Connect gas sampling line only and always to spirometry sensor
Exp Vt>Insp Vt		• Spirometry tube leak • Water inside sensor or tubings	• Check leakages - perform leak test • Change tubings and sensor • Don't use active humidification
Loop overscale		• Wrong scale selected	• Change scaling
Monitored volumes <set volumes		• Leak between ventilator and sensor	• Check ventilator connections

PROBLEM	POSSIBLE CLINICAL CAUSE	POSSIBLE TECHNICAL CAUSE	ACTION
Strongly vibrating loop	Mucus in ET tube	• Water or secretions in hoses of sensor	• Suction the patient • Change dry sensor and/or empty the water from hoses
Too large or too small volumes		• Wrong mode vs. sensor selection • Incompatible between selected sensor and sensor used	• Check mode and sensor size
Fluctuating Raw	• Mucus in airways or tubing • Breathing effort against the ventilator • Patient triggered breaths	• Ventilator exp. valve causes fluctuations during exp. flow	• Clean expiratory valve
Too high Raw	• Kink in tubing • Mucus • Asthmatic patient • Bronchospasm • Spontaneous breaths • Breathing efforts against the ventilator • Patient triggered breaths		
Raw value invalid	• Spontaneous breaths • Breathing efforts against the ventilator • Patient triggered breaths		
Too high Ppeak	• Bronchospasm • Patient is coughing • Patient breaths against the ventilator • Obstruction in airway • HME obstructed		
Compl value invalid	• Spontaneous breaths		

3.3.4 Exchange Program

An exchange program for certain assemblies in the instrument is available. In many cases, replacement of the complete assembly will result in the most expedient repairs. See section 4.3 for details concerning the exchange program.

3.4 Equipment and Special Tools Required

Description	Specification
Volt Meter	Standard
Calibration Gas 2% DES, 5% CO_2, 55% O_2, 33% N_2O	P/N 0075-00-0028
Calibration Gas Regulator	P/N 0119-00-0166
Sample Line for Gas Module II, Gas Module SE, and Gas Module SE with Spirometry	P/N 0683-00-0451-XX
Sample Line for Gas Module 3	Adult/Ped: P/N 0683-00-0525-XX Neonate: P/N 0683-00-0524-XX
Spirometry Tester	P/N 0138-00-0011

3.5 Disassembly Instructions

3.5.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

Before disassembling the unit, perform the following:

1. Power down the Gas Module and remove the AC power cable.
2. Remove the interface cable from the Passport XG, Expert, Passport 2, Spectrum or Spectrum OR. These instructions do not apply to the Gas Module 3.
3. Perform work on an anti-static mat at a grounded ESD workstation.

NOTE: The numbers in parentheses () refer to the isometric drawings.

WARNING: Always Remove Power from the Gas Module BEFORE Disassembly.

The six major assemblies of the Gas Module are: The Power Supply, the Interface board, the front bezel, the main chassis, the Spirometry Module (PVX unit) and the M-GAS module. The M-GAS module's replaceable components include: the Nafion Tube, the Drive Pump, the Valve Module, and the Fan. The M-GAS anesthetic agent and O_2 analyzer, and their CPU board are not available separately or as a sub module. In cases of component failure in these assemblies, replacement M-GAS modules will be available. In addition there are three cables, a dust filter cover, and a front panel moisture trap assembly. This section will detail the most economical way to remove each assembly. Refer to the isometric drawings in section 4.7.

A. Removing the Enclosure (10):

WARNING: Remove Power from the Gas Module BEFORE removing the Enclosure.

1. Remove the four screws attaching the Monitor mounting bracket to the Gas Module.
2. Remove the four screws attaching the bottom of the Gas Module's enclosure to the chassis (11).

NOTE: In the next step, use care not to bend or distort the EMC guard fingers while sliding the enclosure.

3. Slide the enclosure back to expose the internal electronics.
4. To re-install, perform the above steps in the reverse order.

B. Replacing the Power Supply (26):

1. Remove the four screws attaching the Power Supply assembly to the chassis.
2. Slide the Power Supply assembly out the open side of the chassis.
3. Unplug the two keyed connectors on the Power Supply assembly.
4. Remove the clear plastic shield (13) and retain to install on the replacement part.
5. To install the replacement part, perform the above steps in the reverse order.

C. Replacing the Line Voltage Receptacle (20):

1. Remove the two screws attaching the line voltage receptacle to the chassis.

2. Remove the spade lugs from the rear of the line voltage receptacle, noting each one's position. When installing the replacement part, reinstall the spade-lugged wired on to the terminals they were removed from.

3. To install the replacement part, perform the above steps in the reverse order.

D. Replacing the Gas Module II Line Voltage Power Switch (21)

1. Remove the spade lugs from the line voltage power switch, noting each one's position. When installing the replacement part, reinstall the spade-lugged wired on to the terminals they were removed from.

2. The line voltage power switch is snapped into the rear chassis. To release the switch, pinch the plastic retainers and push the switch out.

3. To install the replacement part, perform the above steps in the reverse order.

E. Replacing the Gas Module SE Line Voltage Power Switch (21)

1. Remove the spade lugs from the line voltage power entry receptacle on the rear panel, noting each one's position. When installing the replacement part, reinstall the spade-lugged wires onto the terminals they were removed from.

2. Remove the line voltage power switch connector from the power supply and remove the ground wire lug from the chassis.

3. Remove the PVX unit (see step O).

4. Remove the Front Bezel (see step J).

5. Remove the two screws holding the switch to the Front Bezel.

6. To install the replacement part, perform the above steps in reverse order.

F. Replacing the Interface Board (1):

1. Remove the two jack-posts attaching the rear panel interface connector to the rear panel. This interface connector is part of the Interface Board.

2. Remove the two screws (Gas Module II) or 1 screw (Gas Module SE) attaching the Interface Board to the Interface board bracket.

3. Unplug the Power Supply Interface Board Cable from the Interface Board.

4. Unplug the 26 pin cable connector.

5. To install the replacement part, perform the above steps in the reverse order.

G. Replacing the Power Supply to Interface Board Cable (2):

1. Unplug the Power Supply to Interface cable at the Power Supply assembly

2. Unplug the Cable at the Interface board.

3. Carefully pull the Cable through the M-GAS module's sub-chassis and through the cable retainer on the rear of the chassis.

4. To install the replacement part, perform the above steps in the reverse order.

H. Replacing the M-GAS Module (4):

1. Remove the shield, from the chassis, that exposes the M-GAS module Interface board.

2. Remove the four screws attaching the M-GAS module's sub-chassis to the main chassis.

3. Lift the M-GAS until the (M-GAS) rear connector comes in contact with the rear panel of the chassis.

4. Tilt the M-GAS module slightly to release it's rear panel connector.

5. Unplug the M-GAS's rear panel connector.

6. Remove the four pneumatic tubes that connect to the chassis fittings. Note the position of each tube.

7. To install the replacement part, perform the above steps in the reverse order.

I. Replacing Specific Parts of the M-GAS Module (Pump, Fan, Valve Module):

See "L. Preventive Maintenance Items:" for Nafion Tube replacement details

The agent analysis sensor and O_2 sensor and the Main CPU board are a matched set and must be replaced as an assembly. Problems in these areas will require replacing the M-GAS assembly. Specific parts may be replaced.

1. Remove the M-GAS module from the chassis. Follow the steps in section H for details.

2. Remove the five, 1/4 inch screws that attach the M-GAS sub-chassis to the inner-sub-chassis.

3. Remove the single, 1 1/4 inch long screw (that passes through two standoffs) that attaches the circuit board to the sub-chassis.

4. Carefully lift the inner-sub-chassis away from the sub-chassis enough to unplug the O_2 sensor's two cable connectors. Be sure to note the orientation of these connectors.

5. The Pump (17) is attached to the inner-sub-chassis with a tie-wrap. Cut the tie-wrap to remove it.

6. The Fan (15) is attached by four screws, accessible through access holes in the fan's four corners.

7. The Valve module snaps into a spring-steal bracket of the inner-sub-chassis.

8. When disconnecting any pneumatic component, always note the orientation of that component's pneumatic tube connections.

9. To install the replacement part, perform the above steps in the reverse order.

J. Replacing the Front Bezel (6):

1. Remove the M-GAS, Interface board, PVX unit and the Power Supply assemblies. See sections B, F, H and O for details.

2. Remove the four large screws holding the Bezel to the Main Chassis.

3. Pull the front Bezel away from the chassis.

4. To install the replacement part, perform the above steps in the reverse order.

K. Replacing the Chassis (11):

1. Replacing the main chassis requires removing each assembly. Remove each assembly in the order given in these instruction.

2. To install the replacement part, perform the above steps in the reverse order.

L. Preventive Maintenance Items:

The PM items are; The Moisture Trap (7), The Nafion Tube (25), the *CO_2 Absorber (30), and the O_2 Sensor Filter (24). Refer to the isometric drawing for details.

M. The Nafion Tube can be replaced without disassembling the inner-sub-chassis:

1. Remove the M-GAS module. See Section H for details.

2. Locate the cut-out window on the bottom of the M-GAS.

3. Using a tool, pull the Nafion tube away from its pneumatic port on the valve module.

4. Remove the other end of the Nafion tube from the Moisture Trap housing.

**CO_2 absorber will not be present in units S/N 4314008 or lower.*

N. Replacing the Cooling Fan's Dust Filter (18):

1. Remove the filter cover by pulling it straight out.

2. Replace the filter or rinse the filter with mild soap and water solution.

NOTE: Ensure the filter material dries completely before re-installing.

O. PVX unit

1. Disconnect the ribbon cable and power connector (4 black wires) from the PVX unit.

2. Detach the PVX unit from the front panel (1 screw).

3. To install replacement part, perform the above steps in reverse order.

3.5.2 Gas Module 3

Before disassembling the unit, perform the following:

1. Power down the Gas Module and remove the AC power cable.

2. Remove the interface cable from the Passport 2, Spectrum or Spectrum OR.

3. Perform work on an anti-static mat at a grounded ESD workstation.

WARNING: Always Remove Power from the Gas Module BEFORE Disassembly.

A. Removing the Enclosure

WARNING: Remove Power from the Gas Module BEFORE removing the Enclosure.

1. Remove the four screws attaching the Monitor mounting bracket to the Gas Module.

2. Remove the four screws attaching the bottom of the Gas Module's enclosure to the chassis.

3. Slide the enclosure back to expose the internal modules. Be careful not to damage the EMC gaskets.

4. To re-install, perform the above steps in the reverse order. Before sliding the enclosure on inspect the EMC gaskets for damages or wear. Damaged or much worn EMC gaskets must be replaced. Replacement of EMC gaskets is to be performed at factory.

3.6 Mounting Hardware and Accessories

3.6.1 Passport XG/Gas Module Mounting

NOTE: For Gas Module II and Gas Module SE only

Refer to the diagrams on the next page for exploded views of the mounting hardware.

The following is a listing of the parts shown on the isometric drawings.

FIGURE NO.	DESCRIPTION	P/N
1	Gas Module SE	0998-00-0481-01
1	Gas Module II	0998-00-0143
2	*Plate	0386-00-0232
3	*10-32 X .31 Flat HD Screws (Qty. of 4)	0216-04-1005
4	External Interface Cable 6′	0012-00-1278
4	External Interface Cable 24″	0012-00-1082
5	Power Pack AC/DC Universal Input (9" cable)	0014-00-0173-04
6	Y-Shaped Power Cord (Domestic)	0012-00-1081-01
6	Y-Shaped Power Cord (International)	0012-00-1081-02
6	Y-Shaped Power Cord (Britain/Ireland)	0012-00-1081-03
7	8-32 X .375 Flat HD Screws (Qty. of 8)	0212-14-0806
8	Plate	0386-00-0156
10	Mounting Bracket	0406-00-0729-01
11	Wall Mount Assembly	0040-00-0232-02
12	Rolling Stand Assembly	0040-00-0232-01

* *Mounting Plate and screws are part of rolling stand or wall mount.*

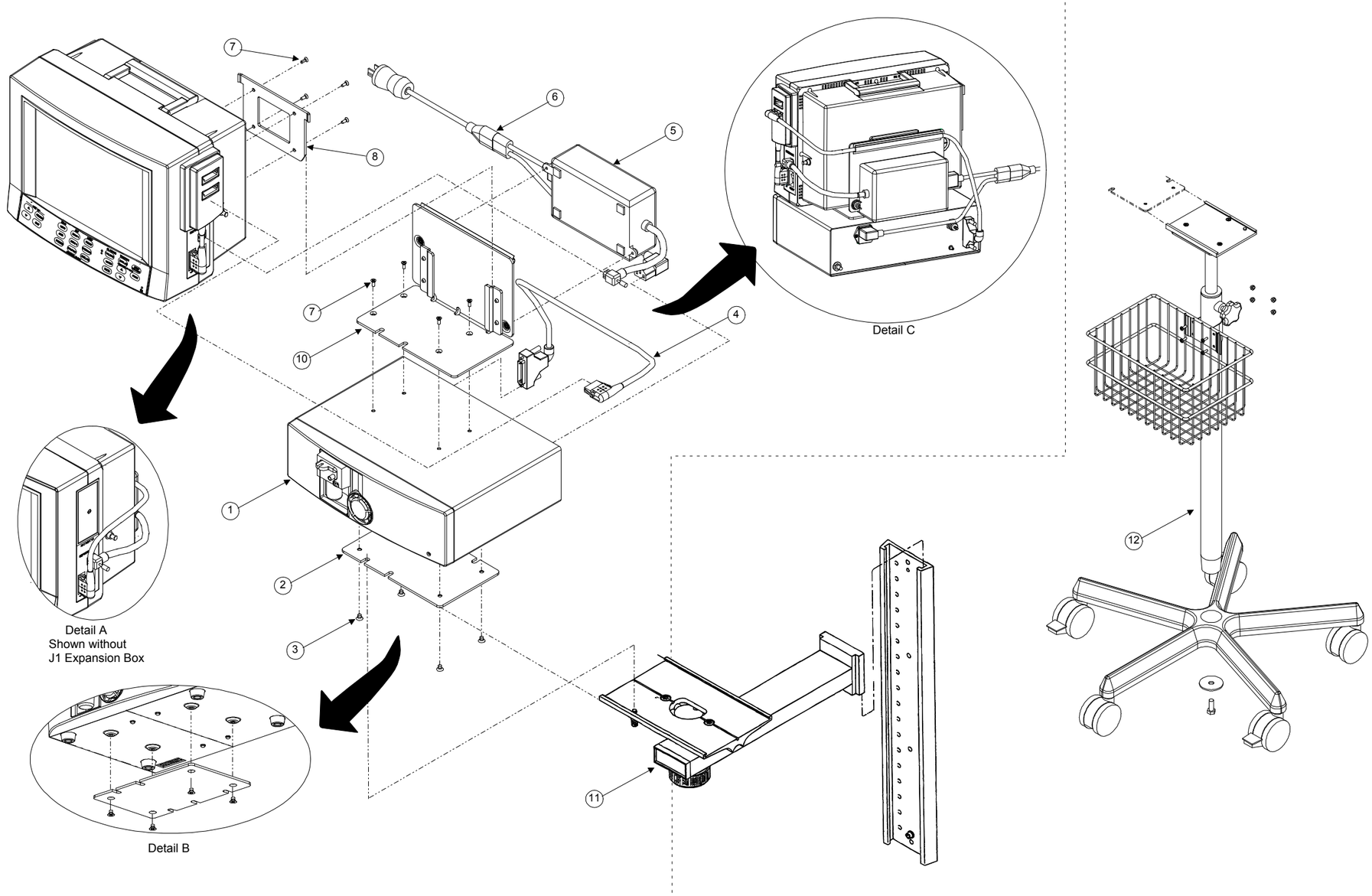


FIGURE 3-1 Passport XG/Gas Module Mounts

3.6.2 Expert/Gas Module Mounting

NOTE: For Gas Module II and Gas Module SE only

Refer to the diagrams on the next page for exploded views of the mounting hardware.

The following is a listing of the parts shown on the isometric drawings.

FIGURE NO.	DESCRIPTION	P/N
1.	Screw, Panhead, Metric (4)	0211-13-0410
2.	Plate, Mounting Expert/Gas Module	0386-00-0245
3.	Screw, Plate Mounted on Gas Module (4)	0212-14-0806
4.	Cable Assembly Interface Expert/Gas Module, 14"	0012-00-1213-01
4.	Cable Assembly Interface Expert/Gas Module, 72"	0012-00-1213-02
5.	Channel, Mounting Expert/Gas Module	0436-00-0154
6.	Gas Module II	0998-00-0143
6.	Gas Module SE	0998-00-0481-01
7.	Plate, Mounting	0386-00-0232
8.	10-32 X .31 Flat Head Screws (4)	0216-04-1005
9.	Wall Mount w/Arm	0436-00-0119
10.	Expert Rolling Stand	0436-00-0123
11.	Expert Main Unit	0997-00-0471-01
11.	Expert Display	0997-00-0480-01
12.	"Y" Shaped Power Cord (Domestic)	0012-00-1081-01
12.	"Y" Shaped Power Cord (International)	0012-00-1081-02
12.	"Y" Shaped Power Cord (Britain/Ireland)	0012-00-1081-03

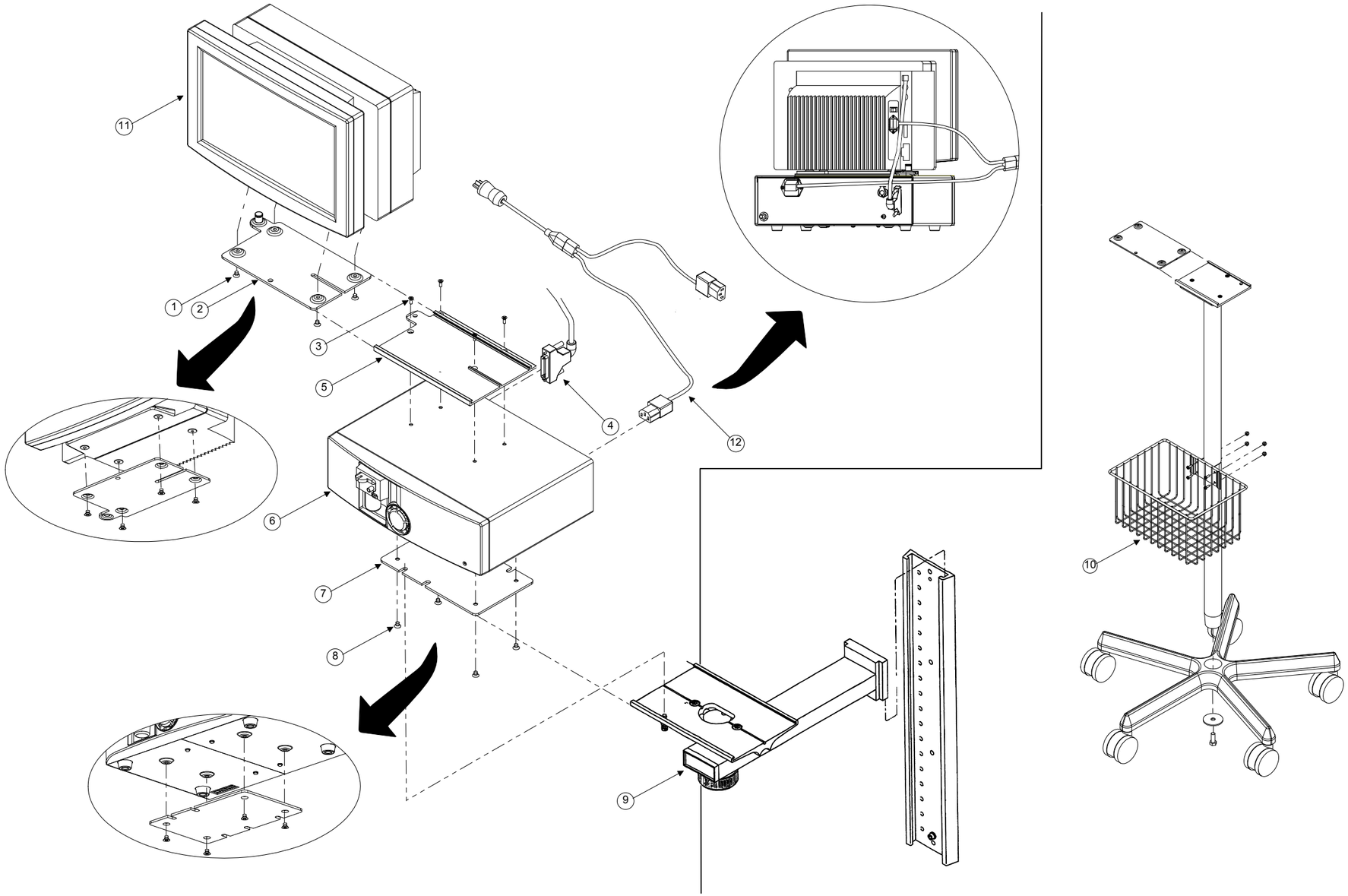


FIGURE 3-2 Expert / Gas Module Mounts

3.6.3 Passport 2/Spectrum/Spectrum OR Gas Module Mounting

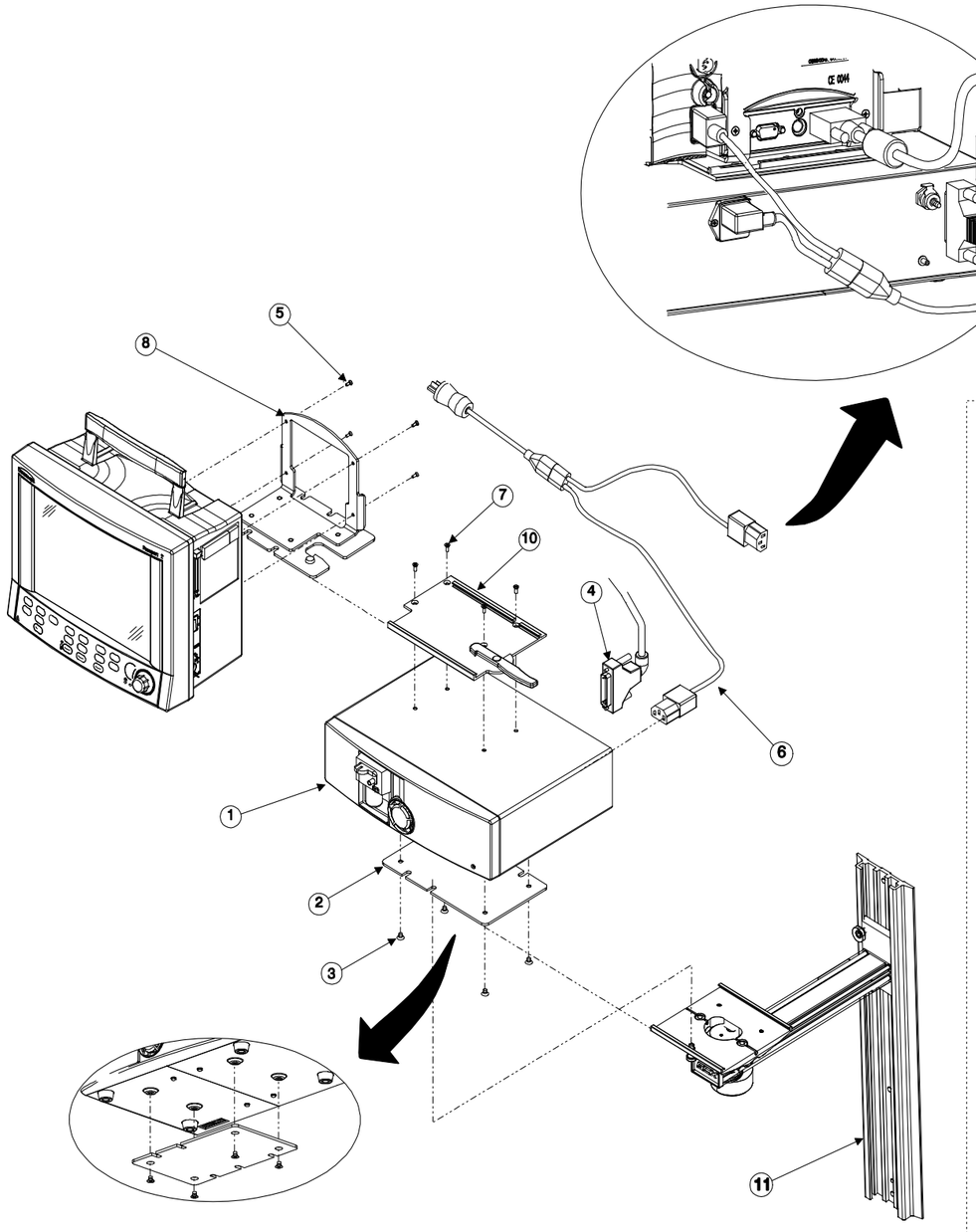
3.6.3.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

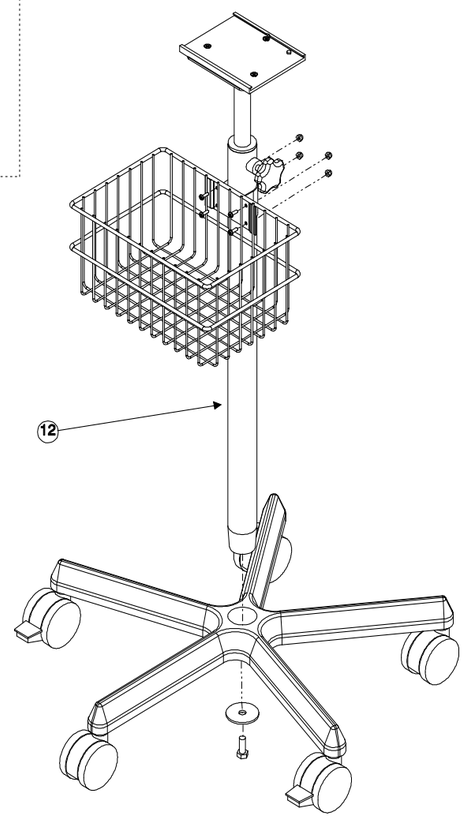
Refer to the diagrams on the next page for exploded views of the mounting hardware.

The following is a listing of the parts shown on the isometric drawings.

FIGURE NO.	DESCRIPTION	P/N
1	Gas Module SE	0998-00-0481-01
1	Gas Module II	0998-00-0143
2	*Plate for Gas Module II and Gas Module SE	0386-00-0232
3	*10-32 X .31 Flat HD Screws (Qty. of 4)	0216-04-1005
4	External Interface Cable12″	0012-00-1276-01
4	External Interface Cable 6′	0012-00-1276-02
5	Screws (Quantity of 4)	0212-17-0606
6	Y-Shaped Power Cord (Domestic)	0012-00-1081-01
6	Y-Shaped Power Cord (International)	0012-00-1081-02
6	Y-Shaped Power Cord (Britain/Ireland)	0012-00-1081-03
7	8-32 X .375 Flat HD Screws (Qty. of 4)	0212-14-0806
8	Stationary Mounting Bracket (with screws)	0040-00-0299-02
10	Mounting Plate	0436-00-0160
11	Wall Mount Assembly	0040-00-0232-02
12	Rolling Stand Assembly	0040-00-0232-01

* *Mounting Plate and screws are part of rolling stand or wall mount.*





Passport 2 / Gas Module Mounts

FIGURE 3-3 Passport 2/Spectrum/Spectrum OR Gas Module Mounts

3.6.3.2 Gas Module 3

Refer to the diagrams on the next page for exploded views of the mounting hardware.

The following is a listing of the parts shown on the isometric drawings.

FIGURE NO.	DESCRIPTION	P/N
1	Gas Module 3	0998-00-1900-01
2	*Plate for Gas Module 3	0386-00-0344
3	Screw, M5 X 8 mm	0211-03-5008
4	External Interface Cable12"	0012-00-1276-01
4	External Interface Cable 6'	0012-00-1276-02
5	Screws (Quantity of 4)	0212-17-0606
6	Y-Shaped Power Cord (Domestic)	0012-00-1081-01
6	Y-Shaped Power Cord (International)	0012-00-1081-02
6	Y-Shaped Power Cord (Britain/Ireland)	0012-00-1081-03
7	Screws, M4 X 8 mm (Qty. of 4)	0211-04-4008
8	Stationary Mounting Bracket (with screws)	0040-00-0299-02
10	Mounting Plate	0436-00-0160
11	Wall Mount	0436-00-0061-01

* *Includes 4 screws, Part Number 0211-03-5008*

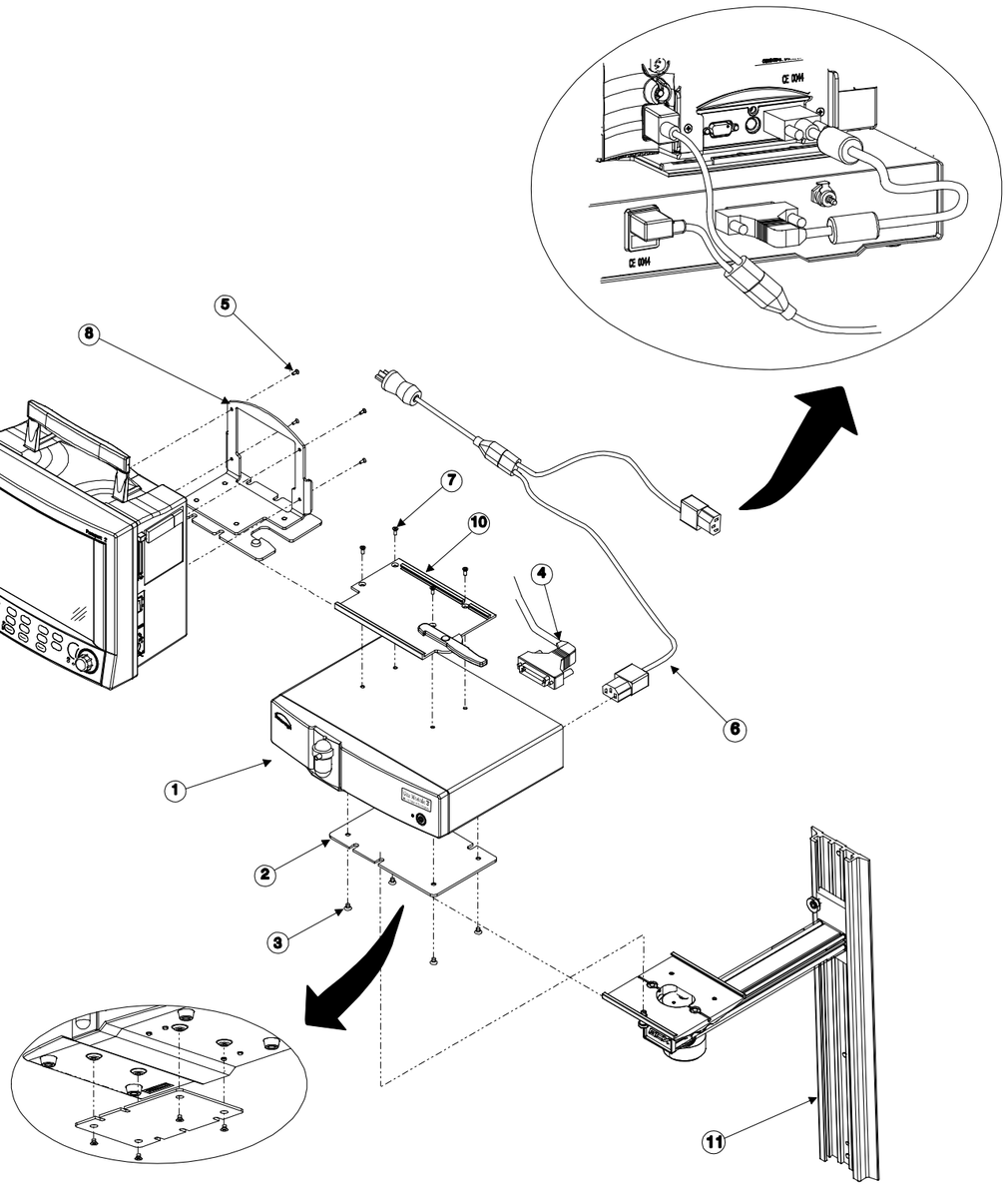


FIGURE 3-4 Passport 2/Spectrum/Spectrum OR Gas Module Mounts

3.7 Gas Module II/Gas Module SE Accessories

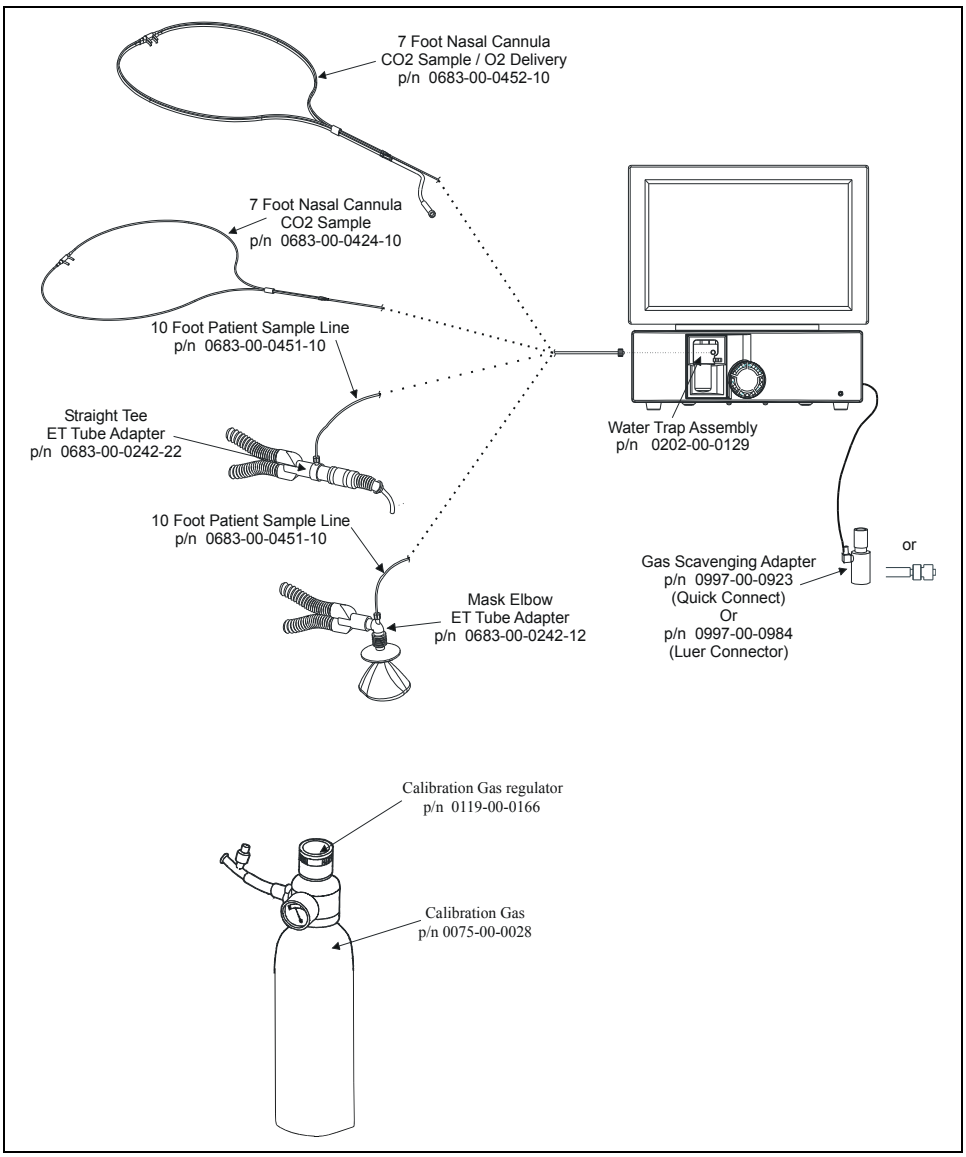


FIGURE 3-5 Gas Module II/Gas Module SE Accessories

3.8 Gas Module SE with Spirometry Accessories

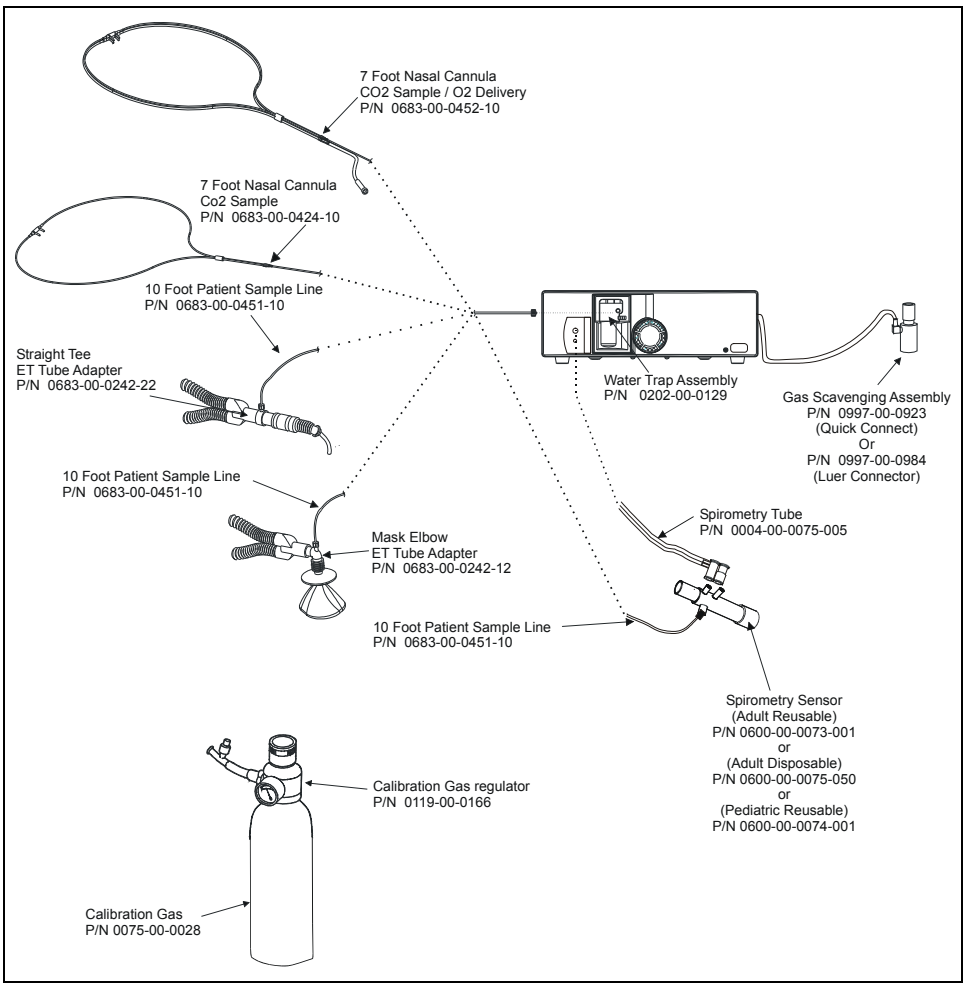


FIGURE 3-6 Gas Module SE with Spirometry Accessories

3.9 Gas Module 3 Accessories

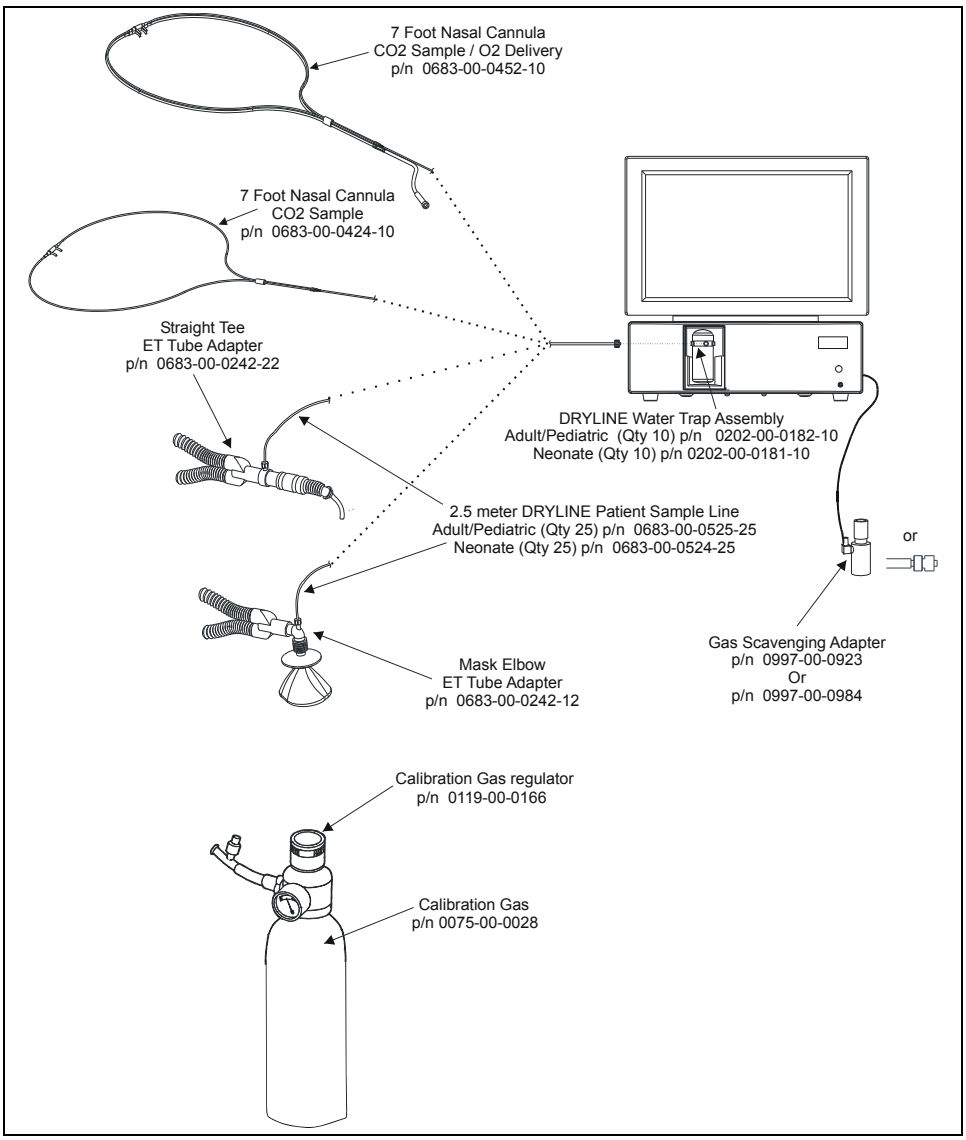


FIGURE 3-7 Gas Module 3 Accessories

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4.0 *Replacement Parts*

Contents of this chapter ..... Page

4.1 Introduction

This chapter of the Service Manual provides information necessary to identify the replacement parts and assemblies of the instrument.

4.2 Available Replacement Parts and Sub-Assemblies

The parts listings which follow are divided into two sections. The Isometric Drawings and the accompanying parts lists identify the available chassis mounted components.

4.3 Exchange Program

An exchange policy for the M-Gas Module is available. This program may provide the most expedient method of servicing the equipment. A standard charge for this service is made. Contact the Service Department for details concerning this exchange program.

Many circuit boards make extensive use of multilayer technology and high density packaging. Individual component replacement is not recommended on these boards unless the technician is properly equipped to repair multilayer circuit boards.

Circuit boards, returned as parts of the exchange program, that show evidence of improper repair techniques and are damaged in the process are not considered for exchange. Damaged boards will be invoiced at full value and no exchange credit will be applied.

4.4 Replacement Parts Pricing Information

Current parts prices and exchange charges can be determined by contacting our Order Entry Department.

4.5 Ordering Information

Replacement parts and assemblies are available from Mindray DS USA, Inc. Please follow these guidelines when ordering replacement items for the instrument.

1. Include the Model and Serial Number of the instrument.
2. Include the Part Number exactly as it appears in the Parts List under the column, "Part Number."
3. Include a description of the item.

EXAMPLE ORDERS: (1) ea. P/N 0671-00-0127

PC Board, Interface (Connection C), Gas Module II Serial No. XXXX

(4) ea. P/N 0216-04-1005

Screw, #10-32 x .31 Flat Head,

Gas Module SE Serial No. XXXX

NOTE: Mindray DS USA, Inc. maintains a policy of continuous development for product improvement and reserves the right to change materials, specifications, and prices without notice.

NOTE: Many components are described with sufficient detail to permit procurement through local commercial channels. This applies to hardware, such as screws and fasteners, as well as to certain electronic components, such as resistors, capacitors, certain integrated circuits and transistors. However, in some cases, components are selected to meet special performance criteria above and beyond the component manufacturer's specifications. The use of other components in these applications may result in degradation of reliability or instrument performance characteristics.

4.6 Abbreviations

The following abbreviations may appear in the parts listings which follow and/or through the manual.

ABBREVIATION	TERM	ABBREVIATION	TERM
A/D	Analog to Digital	MYLR	Mylar
AMP	Amplifier	NTWK	Network
BUF	Buffer	OP	Operational
CAP	Capacitor	PB	Push Button
CC	Carbon Composition	PIA	Peripheral Interface Adaptor
CER	Ceramic	POT	Potentiometer
CERM	Ceramic	PRESS	Pressure
CNTR	Counter	PWR	Power
CONN	Connector	RAM	Random Access Memory
CONT	Controller	REC	Receiver
CONV	Converter	RECT	Rectangular
CPU	Central Processing Unit	REG	Regulated RES Resistor
DCDR	Decoder	STG	Stage
DIFF	Differential	STK	Stacked
DIA	Diastolic	SUP	Supply
DIO	DiodeS	SW	Switch
D/A	Digital to Analog	SYST	Systolic
ELEC	Electrolytic	TANT	Tantalum
EPROM	Erasable Programmable Read Only Memory	TRANS	Transistor
		TRANSIS	Transistor
FXD	Fixed	VAR	Variable
I.C.	Integrated Circuit	VIA	Versatile Interface Adapter
INT. CKT.	Integrated Circuit	XDCR	Transducer
KYBD	Keyboard	XFMR	Transformer
LED	Light Emitting Diode	XSTL	Crystal
MF	Metal Film	XSTR	Transistor
MONO	Monostable		

4.7 Isometric Drawing and Parts Lists

Gas Module II and Gas Module SE

FIGURE NO.	DESCRIPTION	P/N
1	PC Board, Interface Gas Module II (Connection C)	0671-00-0127
1	PC Board, Interface Gas Module SE (Connection C)	0671-00-0226
2	Gas Module II Cable, Power (Connection B)	0012-00-1086
2	Gas Module SE Cable, Power (Connection B)	0012-00-1408
3	Gas Module II Cable, Interface (Connection C)	0012-00-1088
3	Gas Module SE Cable, Interface (Connection C)	0012-00-1409
4	Gas Module SE Gas Unit, M-Gas	0992-00-0157
5	Housing, Moisture Trap	0380-00-0337
6	Gas Module II Front Bezel	0200-00-0319
6	Gas Module SE Front Bezel	0200-00-0326
7	Water Trap Assembly Gas Module II and Gas Module SE	0202-00-0129
8	LED Cable (Connection A)	0012-00-1393
9	PVX Module (Spirometry)	0992-00-0156
10	Enclosure Gas Module II	0202-00-0128
10	Enclosure Gas Module SE	0202-00-0148
11	Chassis Gas Module II	0441-00-0099
11	Chassis Gas Module SE	0441-00-0174
12	Support Bracket, Interface PC Board Gas Module II	0406-00-0735
13	Guard, Power Supply Board	0337-00-0114
14	Shield (EMC)	0337-00-0115
15	Fan	0119-00-0165
16	Tubing Kit Includes: Tubing, Outer, Exhaust - Connection H (PVC, 2.70 mm - ID) Tubing, Inner, Exhaust - Connection H (PE, 1.65 mm - ID) Tubing, sump inlet - Connection G (PE, 0.30 mm - ID) Tube, Connecting - Connection D (Silicone, 1.70 mm - ID)	0040-00-0233
17	Pump	0104-00-0020
18	Filter, Dust	0378-00-0040
19	Cover, Dust Filter Gas Module II	0198-00-0025
19	Cover, Dust Filter Gas Module SE	0198-00-0048
20	Input Receptacle, AC Mains	0131-00-0245
21	Gas Module II Switch, DPST, AC Mains	0261-00-0193
21	Gas Module SE Switch, DPST, AC Mains	0012-00-1410
22	Fuse, 1Amp, 250 V, 5x20mm	0159-00-0038
23	Ground Lug, Equipotential	0124-00-0104-01
23A	Flat washer, Equipotential Lug	0124-00-0104-02
23B	Lock washer, Equipotential Lug	0124-00-0104-03

* *Numbers for metric screws correspond to nominal size and length in millimeters.*
** *Numbers for metric nuts correspond to nominal nut (thread) diameter.*
*** *DIN is the German Industrial Standard.*

FIGURE NO.	DESCRIPTION	P/N
23C	Nut, Equipotential Lug	0124-00-0104-04
24	Filter, O_2	0378-00-0041
25	Tube, Nafion (Connection F)	0008-00-0307
26	PC Board, Power Supply	0014-00-0183
27	Foot (Diameter=22.2 mm, Height=10.0 mm)	0348-00-0186
28	Exhaust Port (Connection H)	0103-00-0453
30	CO_2 Absorber	0378-00-0046
31	Power Switch Button	0200-00-0327
32	Port Cover	0198-00-0047
N/S	Enclosure Label Gas Module II	0334-00-1468
N/S	Enclosure Label Gas Module SE	0334-00-2561
N/S	Rear Chassis Label Gas Module II	0334-00-2545
N/S	Rear Chassis Label Gas Module SE	0334-00-2560

* *Numbers for metric screws correspond to nominal size and length in millimeters.*
** *Numbers for metric nuts correspond to nominal nut (thread) diameter.*
*** *DIN is the German Industrial Standard.*

Gas Module 3

FIG NO.	DESCRIPTION	ASSOCIATED CONNECTION(S) (IF APPLICABLE)	NOTE	P/N
1	Exchange Multigas & O2 Analyzer Assembly	C, G		0992-00-0290E
2	Receptacle with tubing	D, E	For GM3 S/N below 10001000 only	0380-00-0635-02
2a	Receptacle with tubing	D, E	For GM3 S/N above 10001000 only	0380-00-0635-01
N/S	O-ring kit DRYLINE Receptacle			0040-00-0453
3	Nafion Assembly GM3	E	For GM3 S/N below 10001000 only	0008-00-0376-02
3a	Nafion Assembly GM3	E	For GM3 S/N above 10001000 only	0008-00-0376-01
4	AION System Tubing PUR 1.4 mm / 2.8 mm	A, B, D, F	Sold per meter	0008-00-0374
5	SPIRIT Tubing 2,4/3,6 mm PUR	A, B, D, F	Sold per meter	0008-00-0375
6	EVAC Coupling GM3	F		0103-00-0707
*7	Servomex Cable GM3	C	For GM3 S/N below 10001000 only	0012-00-1808-02
*7a	Servomex Cable GM3	C	For GM3 S/N above 10001000 only	0012-00-1808-01
*8	AION Cable GM3	G	For GM3 S/N below 10001000 only	0012-00-1809-02

** Cables not shown. Refer to associated connections.*

FIG NO.	DESCRIPTION	ASSOCIATED CONNECTION(S) (IF APPLICABLE)	NOTE	P/N
*8a	AION Cable GM3	G	For GM3 S/N above 10001000 only	0012-00-1809-01
9	Power Inlet GM3	M, N, P		0131-00-0301
10	Fuse Holder GM3			0131-00-0302
11	Power Supply GM3	H, K, L, P		0014-00-0096
*12	Power Cable GM3	K, L, M, N, P		0012-00-1810
*13	Low Voltage Power Cable GM3	H		0012-00-1811
14	Communication Board GM3	C, G, H, J	For GM3 S/N below 10001000 only	002-000024-00
14a	Communication Board GM3	C, G, H, J	For GM3 S/N above 10001000 only	0671-00-0275
*15	Equipotential Cable GM3	P		0012-00-1812
16	Bezel Assembly GM3	J	For GM3 S/N below 10001000 only	0997-00-0647-02
16a	Bezel Assembly GM3	J	For GM3 S/N above 10001000 only	0997-00-0647-01
17	Power Switch GM3	K, L, M, N		0012-00-1813
18	Sheet Metal Cover GM3		For GM3 S/N below 10001000 only	0202-00-0185-02
18a	Sheet Metal Cover GM3		For GM3 S/N above 10001000 only	0202-00-0185-01
19	Rubber Feet GM3, set of 4			0202-00-0184-02
20	Equipotential Connector GM3			0124-00-0149-02
21	EMC Frame / Cage		For GM3 S/N above 10001000 only	099-000114-00
N/S	Water Trap Assembly Adult/Pediatric			0202-00-0182-10
N/S	Water Trap Assembly Neonate			0202-00-0181-10
22	Screws, Top and Bottom Cover			0211-03-4006

** Cables not shown. Refer to associated connections.*

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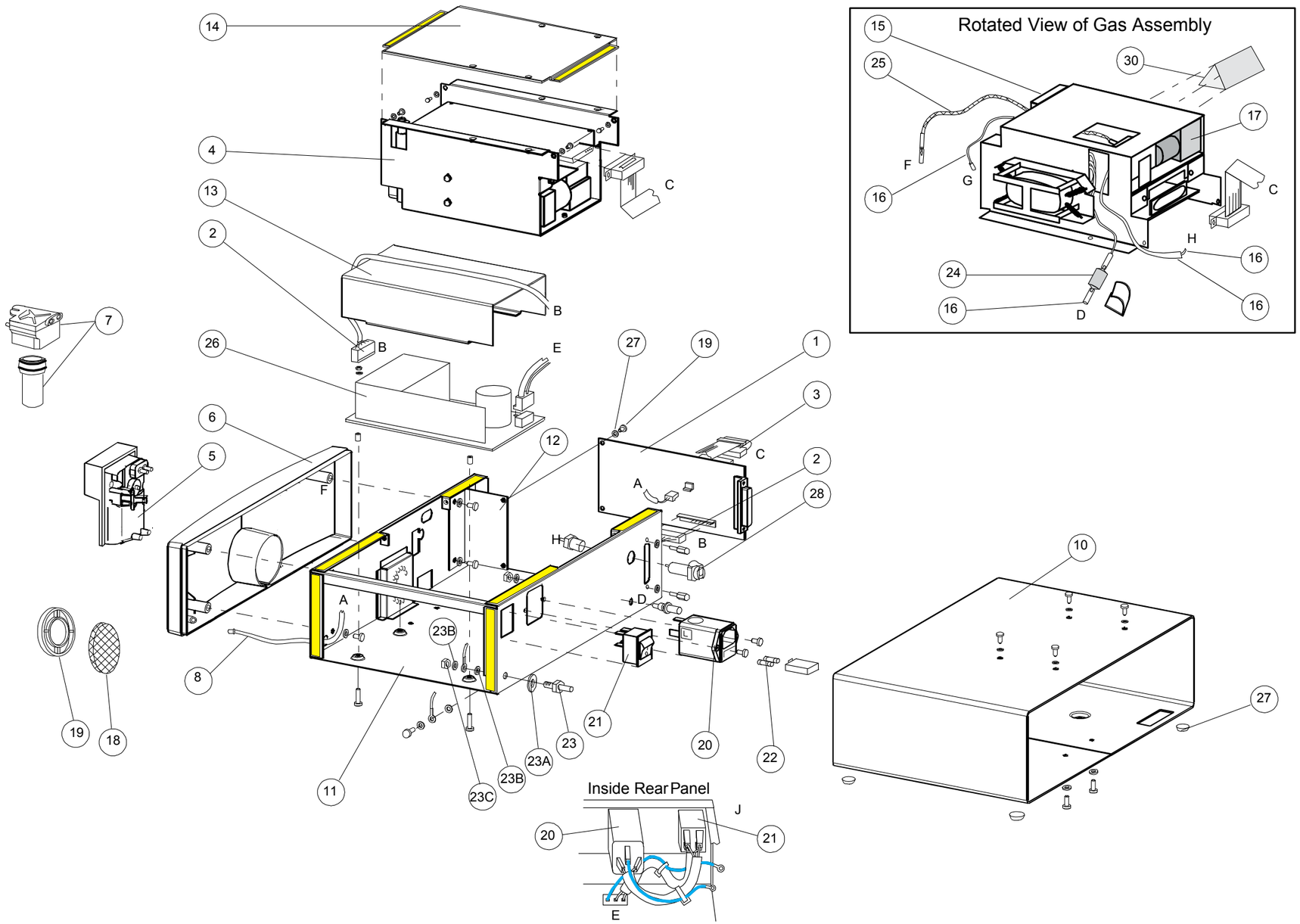


FIGURE 4-1 Isometric Drawing Gas Module II

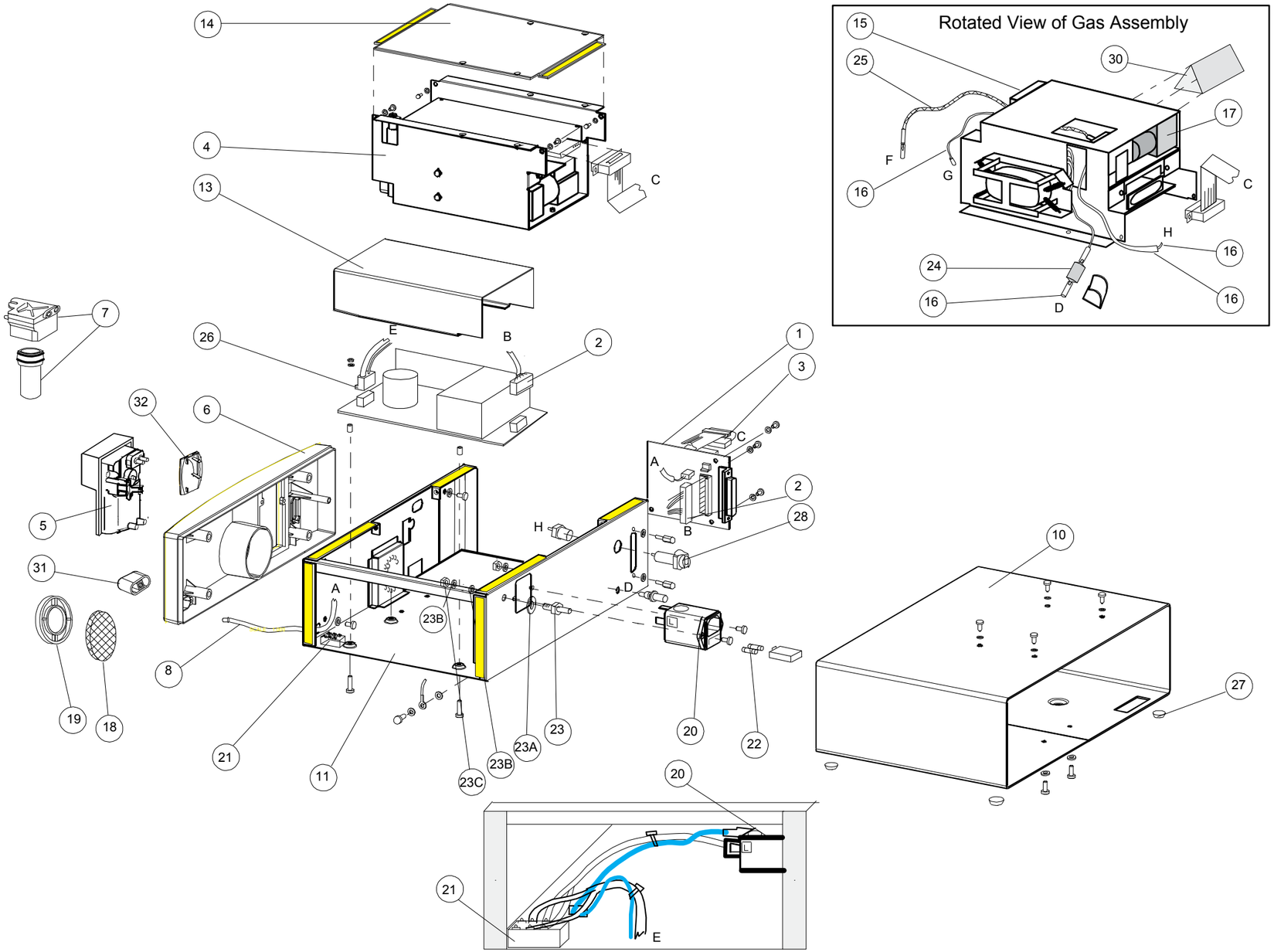


FIGURE 4-2 Isometric Drawing Gas Module SE

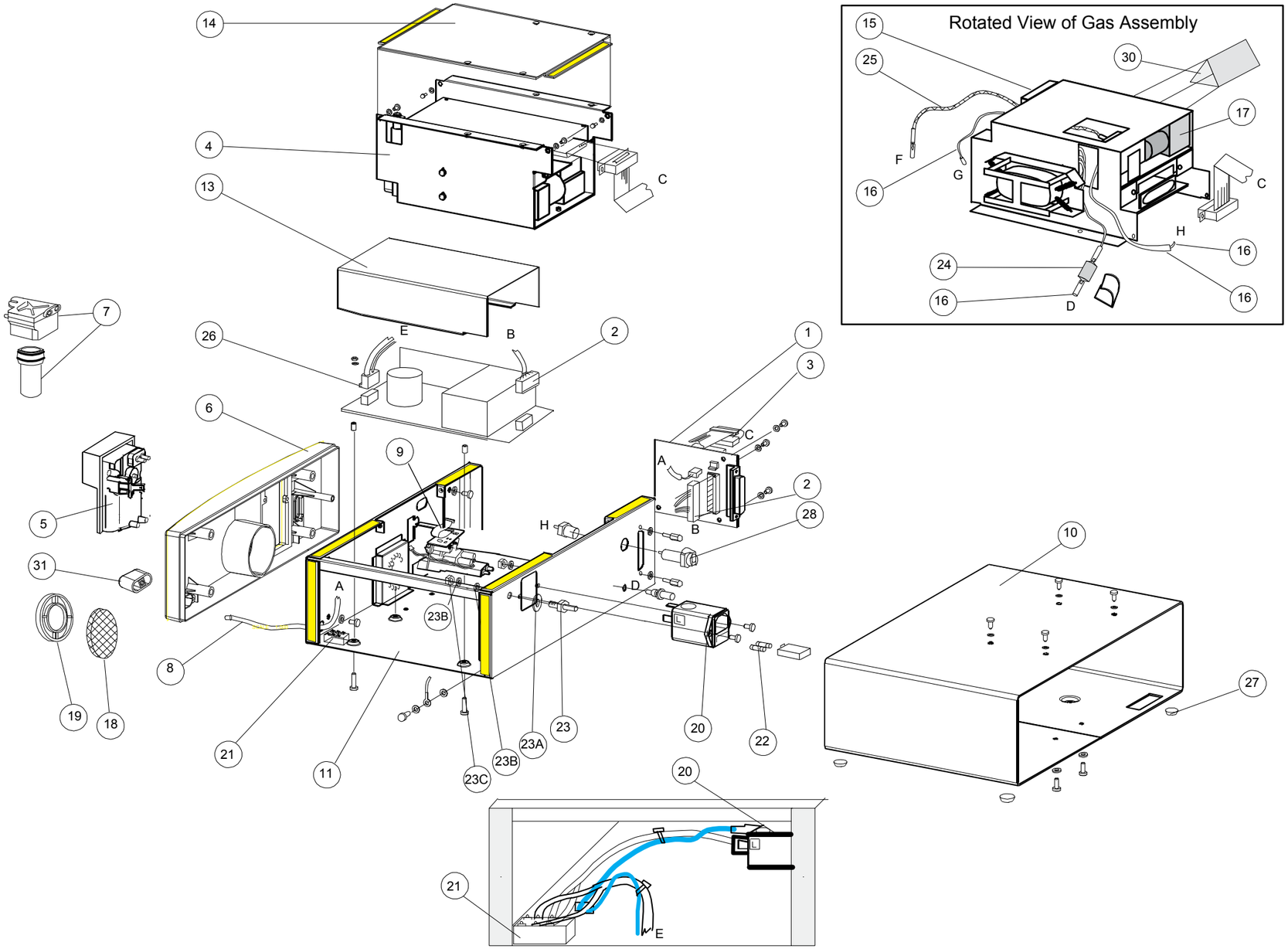


FIGURE 4-3 Isometric Drawing Gas Module SE with Spirometry

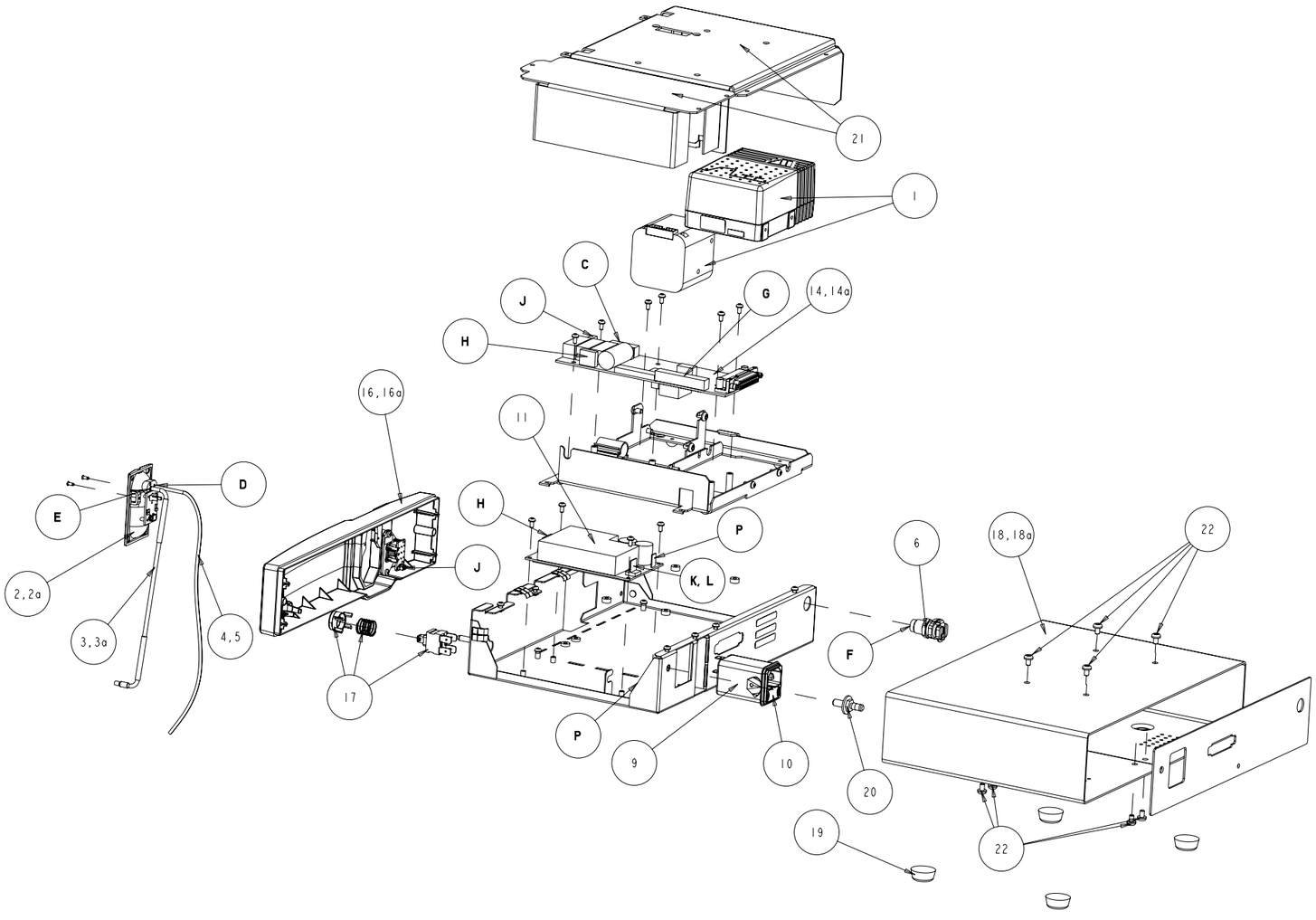
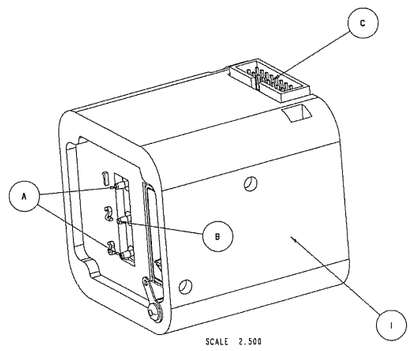
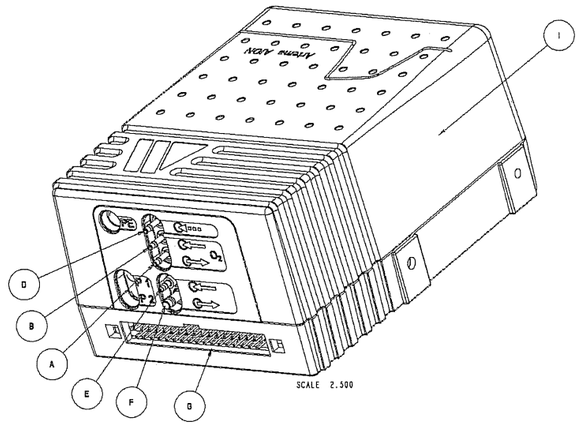
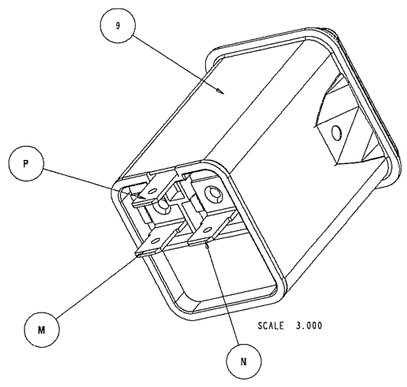


FIGURE 4-4 Isometric Drawing Gas Module 3







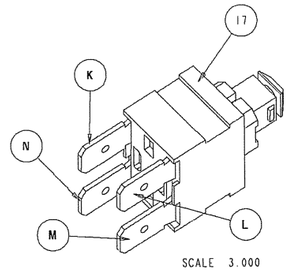


FIGURE 4-5 Isometric Drawing Gas Module 3 Interface Connectors

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5.0 *Calibration*

Contents of this chapter ..... Page

5.1 Introduction

The following procedures are provided to verify the proper operation, calibration and maintenance of the Gas Module.

5.2 Warnings and Guidelines

In the event that the instrument covers are removed, observe these following warnings and general guidelines:

- Do not short component leads together.
- Perform all steps in the exact order given.
- Use extreme care when reaching inside the opened instrument. Do not contact exposed metal parts which may become live.
- Read through each step in the procedure so it is understood prior to beginning the step.

5.3 Test Equipment and Special Tools Required

Description	Specification
Volt Meter	Standard
Calibration Gas 2% DES, 5% CO_2, 55% O_2, 33% N_2O	P/N 0075-00-0028
Calibration Gas Regulator	P/N 0119-00-0166
Sample Line for Gas Module II, Gas Module SE, and Gas Module SE with Spirometry	P/N 0683-00-0451-XX
Sample Line for Gas Module 3	Adult/Ped: P/N 0683-00-0525-XX Neonate: P/N 0683-00-0524-XX
Spirometry Tester	P/N 0138-00-0011

5.4 Power-Up Verification

5.4.1 Passport XG Configuration for Gas Module

The Passport XG must be configured to communicate with the Gas Module. To configure the Passport XG for use with the Gas Module:

1. Turn on the Passport and wait for the "Diagnostics in Progress" message to appear.
2. While the message is displayed press and hold the **FREEZE** key until the User Configuration screen appears.
3. Use the down arrow to choose **Serial Output Type**.
4. Press **SELECT** to activate the sub-menu.
5. Press either arrow until **Gas Module** appears in the highlighted area.
6. Press **SELECT**, then press and hold the **EXIT** key for three (3) seconds to return to normal operation.

NOTE: Setting the "Serial Output Type" to any other selection activates the Passport XG's on-board CO_2 function and deactivates the Gas Module.

Electrical Connection and Power On

Verify that the Interface cable is connected between the Passport XG's J1 connector and the Gas Module's rear panel Interface connection. Attach a sample line to the front panel water trap inlet. Turn on the Gas Module by switching its power switch to "1".

Warm Up

The Gas Module begins its warm up by changing the "Disconnected" message to "Warming Up" approximately 15 seconds after turn on. The messages "Warming up", "Agent Warming Up", and "Zero in Progress" alternate in the message area for approximately two (2) minutes. After two (2) minutes the CO_2, N_2O, O_2, and respiration displays become active. The agent display becomes active after approximately five (5) minutes. Automatic zeroing of all Gas channels will take place at 5, 10, 15 and 30 minutes after turn-on and at 60 minute intervals thereafter.

5.4.2 Expert Configuration for Gas Module

The Expert must be configured to communicate with the Gas Module. To configure the Expert to be used with the Gas Module perform the following steps:

1. Under the Service Panel of the Expert, set Dip switch #5 to ON to accept Gas Module II information. Refer to the Expert Operating Instructions, section 2.2 "Main Control Unit" for information on the location of the dip switch.
2. Set the soft switch for the CO_2 Source to "GAS monitor". Refer to section 3.29.15 of the Expert Operating Instructions for more information on the soft switch setting.
3. For more information on the Gas Module Operation with the Expert, refer to section 3.21.2 of the Expert Operating Instructions.

Electrical Connection and Power On

Verify the interface cable is connected between the Expert RS-232C connector and the Gas Module rear panel interface connection. Attach a sample line to the front panel water trap inlet. Turn on the Gas Module by switching it's power switch to "1".

Warm Up

The Gas Module begins its warm up by changing the "Disconnected" message to "Warming Up" approximately 15 seconds after turn on. The messages "Warming Up," "Agent Warming Up" and "Zero in Progress" alternate in the message are for approximately two (2) minutes. After two (2) minutes the CO_2, N2O, O_2 and respiration displays become active. The agent display becomes active after approximately five (5) minutes. Automatic zeroing of all Gas channels will take place at 5, 10, 15 and 30 minutes after turn-on and at 60 minute intervals thereafter.

5.4.3 Passport 2/Spectrum/Spectrum OR Configuration for the Gas Module

The Passport 2, Spectrum and Spectrum OR must be configured to communicate with the Gas Module as follows:

1. Access the Installation Menu by pressing and holding the **DISCHARGE** key (**Passport 2/Spectrum®**) or the **TRENDS** key (**Spectrum OR™**) while powering **ON** the monitor.
2. Rotate to the **Set up Serial Port 1** menu choice and press the Navigator knob.
3. Rotate to **GMII** or **Gas Module** and press the Navigator knob to accept the selection.
4. Rotate to the **Save Current** menu choice and press the Navigator knob.
5. Powering **OFF** the monitor. Wait 3 seconds and power **ON** the monitor.

NOTE: Setting Serial Port 1 to any other selection activates the monitor's on board CO_2 function and deactivates the Gas Module.

Electrical Connection and Power On

Verify the Interface cable is connected between the Passport 2/Spectrum/Spectrum OR SP1 connector and the Gas Module's rear panel Interface Connection. Attach a sample line to the front panel water trap inlet. Turn on the Gas Module by switching its power switch to "1".

Warm Up

Gas Module II, Gas Module SE, and Gas Module SE with Spirometry – The Gas Module begins its warm up by changing the "Disconnected" message to "Warming Up" approximately 15 seconds after turn on. The messages "Warming Up", "Agent Warming Up" and "Zero in Progress" alternate in the message area for approximately two (2) minutes. Automatic Zeroing of all channels will take place at 2, 4, 10, 15 and 30 minutes after turn on and at 60 minute intervals thereafter.

Gas Module 3 – "Warming Up" is displayed until ISO accuracy is reached (approximately 45 seconds). During this period, two room air reference measurements are taken. Thereafter they occur automatically whenever the bench temperature has changed 1°C. When the Gas Module 3 has reached full accuracy (approximately 10 minutes), reference measurements are taken every 4 hours.

5.5 Gas Module 3 Pneumatic Leakage Test

This test does not require any extra equipment. It is recommended that this test be performed prior to each use.

1. Start the multigas system and occlude the gas sample inlet of the water trap.
2. Verify that the Gas Module 3 reports occlusion and enters purge mode.
3. Wait 10 seconds for stabilization.
4. Verify that the gas flow reported by the Gas Module 3 is less than 7 ml/min.

NOTE: At occlusion, gas trapped in the pump may oscillate and make the Gas Module 3 flow meter report a false flow reading, even though the actual flow is 0 ml/min.

If the pneumatic leakage test fails, the pneumatic system should be carefully checked for leaks and damaged tubing, the water trap should be replaced and the test should then be repeated.

5.6 Gas Module 3 Zero Reference Valve Test

NOTE: An incorrect zero reference measurement can occur if ambient CO_2 is too high. The limits for ambient CO_2 concentration are: 300 – 800 ppm.

1. Power up the system and allow it to enter mode (10 minutes).
2. Note the CO_2 level.
3. Run gas through the system.
4. Perform a manual calibration.
5. After the calibration procedure, verify that the CO_2 level is close to the level that was noted in step 2.

5.7 Calibration

5.7.1 Passport XG Gas Calibration

Accuracy verification of the Gas Module is recommended at six (6) month intervals or whenever gas readings appear to be in error. The date of the last successful mixture calibration appears at the bottom of the "Gases" menu. The operator may elect to perform a Zero calibration (lasting approximately 10 seconds) or a Span calibration (lasting approximately 2 minutes) at any time. During the calibration session gas readings and all other gas functions are not available.

Zero calibration is a single action command that compensates all gas channels for the effects of offset drift. Zero calibration may be performed on command and also takes place automatically at preset intervals. To manually perform a Zero cal, choose 'YES' from the Zero calibration gas menu (refer to Gas Monitor Calibration section of the Passport Operating Instructions).

Span calibration is a set of prompted commands that enables the operator to align the gas display(s) to specific gas concentration(s) within the Calibration Gas canister. Span calibration can be initiated by the operator any time the gas module's readings are suspected to be inaccurate. Span calibration should be performed if after performing a Zero cal, the gas readings do not display the accurate valves.

Always verify accuracy using a full canister of approved precision calibration gas, after calibration is performed. Never use calibration gas that has expired, has a different concentration, or a canister that is indicating low pressure. The pressure indicator on the gas regulator must operate in the green zone during the entire calibration session.

NOTE: **The Gas Module must be fully warmed up before performing a gas calibration. For maximum accuracy, a warm-up time of 30 minutes is recommended.**

1. Select Start Calibration and "Yes" within the Gas Module Menu (refer to section Gas Monitor Calibration section of the Passport Operating Instructions). The menu shown on the next page will appear:

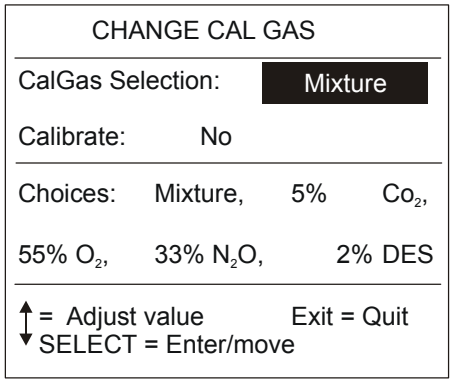

FIGURE 5-1 Start Calibration Menu

2. Select the calibration gas type from the choices, and "Yes" to start calibration.

3. If Mixture has been selected, the following window will appear:

CALIBRATION DATA
Co_2 O_2 N_2O DES:
Zero In Progress
Exit = Cancel Calibration

FIGURE 5-2 Calibration Data

4. At the start of the calibration, the Gas Module will zero the gas channels. After a successful zeroing, the Gas Module will request the calibration gas.

NOTE: **If the Gas Module cannot zero, a "zeroing error" will be displayed and the previous calibration data will be restored. Repeat the calibration procedure from step 1. If problems persist, call for service.**

5. The message "Feed Calibration Gas" will appear. At this point, attach the calibration gas canister to the regulator and turn it on. Increasing gas values will appear in the window as the Gas Module samples the calibration gas.

6. When sampling is complete, a "Continue?" message will appear below the gas monitor's currently measured values. Selecting "Yes" will set these currently measured values to the following specified values; 5.0% CO_2, 55% O_2, 33% N_2O, and 2.0% Desflurane. The operator must take care that the cal gas being applied matches the value that the gas monitor will set them to. If for any reason it is desirable to cancel the calibration, i.e. the cal gas does not contain the correct gas concentrations, press **EXIT** to abandon the calibration attempt. If the values are acceptable, press the **SELECT** key. The entire calibration must be accepted as a whole or not at all.

NOTE: **To avoid premature emptying of the gas canister, always remove the regulator at the end of the procedure, prior to storage.**

7. The message "Calibration Complete" will appear when all the channel(s) have been successfully calibrated. Any channel that has been adjusted will display "Adj".

CALIBRATION DATA		
Co_2	5.0%	ADJ
O_2	55%	ADJ
N_2O	33%	ADJ
DES:	2.0%	ADJ
Calibration Complete		
Exit = Quit		

FIGURE 5-3 Calibration Completed

NOTE: **If any channel cannot be calibrated due to a sampling error, the "Sampling Error" message will appear under the "Continue?" message and "ERR" will be displayed next to any channels with a sampling error. Pressing select will calibrate only those channels that do not have a sampling error.**

If any channel fails calibration, the gas value will be "XXX". These channels will appear as "XXX" in the normal run mode as well. Repeat procedure from step 1. If problems persist, call for service.

5.7.2 Expert Gas Module Calibration

Accuracy verification of the Gas Module is recommended at six (6) month intervals or whenever gas readings appear to be in error. The date of the last successful mixture calibration appears in the Gas Calibration menu. The operator may elect to perform a Zero calibration (lasts approximately 10 seconds). During the calibration session gas readings and all other gas functions are not available.

Zero calibration is a single action command that compensates all gas channels for the effects of offset drift. Zero calibration may be performed on command and also takes place automatically at preset intervals. To manually perform a Zero calibration, press the gas numeric window, then press the Start zeroing button.

Always verify accuracy using a full canister of approved precision calibration gas, after calibration is performed. Never use calibration gas that has expired, has a different concentration, or a canister that is indicating low pressure. The pressure indicator on the gas regulator must operate in the green zone during the entire calibration session.

NOTE: **The Gas Module must be fully warmed up before performing a gas calibration. For maximum accuracy, a warm-up time of 30 minutes is recommended.**

1. Select System Config. from the main menu. Press the Pre-Set button followed by the Gas Calibration button. The following menu will appear.

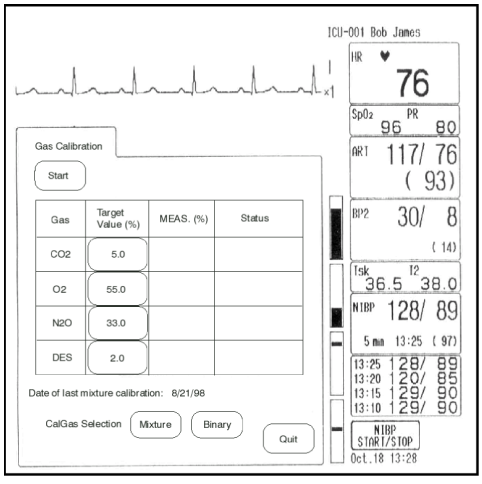

FIGURE 5-4

2. Select either Mixture or Binary (individual gases). If Binary is selected, press the appropriate gas to be calibrated.

3. Press Start to begin the gas calibration routine.

4. At the start of the calibration, the Gas Module will zero the gas channels. After a successful zeroing, the Gas Module will request the calibration gas.

NOTE: **If the Gas Module cannot zero, a "zeroing error" will be displayed and the previous calibration data will be restored. Repeat the calibration procedure from step 1. If problems persist, call for service.**

5. The message "Feed Calibration Gas" will appear. At this point, attach the calibration gas canister with regulator to the Gas Module trap and turn it on. Increasing gas values will appear in the window as the Gas Module samples the calibration gas.

6. When sampling is complete, a "Continue?" message will appear. If the values are acceptable, press the YES button. If for any reason, it is desired to cancel calibration, press NO to re-install the previous calibration values. The entire calibration must be accepted as a whole or not at all.

NOTE: **To avoid premature emptying of the gas canister, always remove the regulator at the end of the procedure, prior to storage.**

7. The message "Calibration Complete" will appear when all the channel(s) have been successfully calibrated. Any channel that has been adjusted will display "Adj".

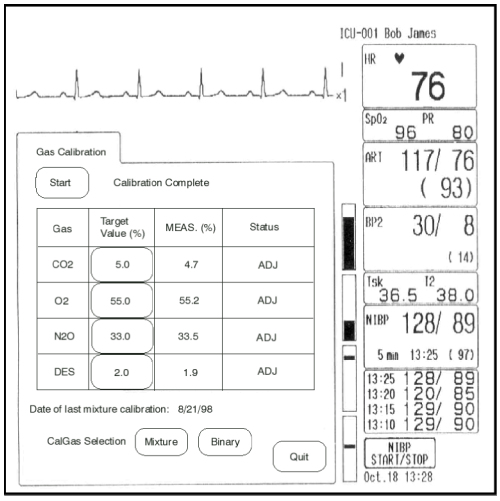

FIGURE 5-5

NOTE: **If any channel cannot be calibrated due to a sampling error, the "Sampling Error" message will appear and "ERR" will be displayed next to any channels with a sampling error. Pressing YES will calibrate only those channels that do not have a sampling error.**

If any channel fails calibration, the gas value will be "XXX". These channels will appear as "XXX" in the normal run mode as well. Repeat procedure from step 1. If problems persist, call for service.

5.7.3 Gas Monitor Calibration - Passport 2/Spectrum/Spectrum OR

Accuracy verification of the Gas Module II, Gas Module SE, and Gas Module SE with Spirometry is recommended at six (6) month intervals or whenever gas readings appear to be in error. Accuracy verification of the Gas Module 3 is recommended at one (1) year intervals or whenever gas readings appear to be in error.

The date of the last successful mixture calibration appears at the bottom of the gas **Calibration Menu**. During the calibration session gas readings and all other gas functions are not available.

Span calibration is a set of prompted commands that enables the operator to align the gas display(s) to specific gas concentration(s) within the Calibration Gas canister. Span calibration can be initiated by the operator any time the gas module's readings are suspected to be inaccurate.

Always verify accuracy using a full canister of approved precision calibration gas, after calibration is performed. Never use calibration gas that has expired, has a different concentration, or a canister that is indicating low pressure. The pressure indicator on the gas regulator must operate in the green zone during the entire calibration session.

NOTE: The Gas Module II, Gas Module SE, and Gas Module SE with Spirometry must be fully warmed up before performing a gas calibration. For maximum accuracy, a warm-up time of 30 minutes is recommended.

NOTE: The Gas Module 3 must be fully warmed up before performing a gas calibration. For maximum accuracy, a warm-up time of 10 minutes is recommended.

5.7.3.1 Passport 2/Spectrum

1. Select **Calibrate** from the **Gas Menu**. The **Calibration Menu** opens.
2. Select **Gas Selection** from the **Calibration Menu** and choose the calibration gas type. Choices are: Mixture, 5% CO_2, 55% O_2, 33% N_2O and 2% Des.
3. Select **Start** to begin calibration.
4. At the start of the calibration, the Gas Module will zero the gas channels. After successful zeroing, the Gas Module will request the calibration gas.

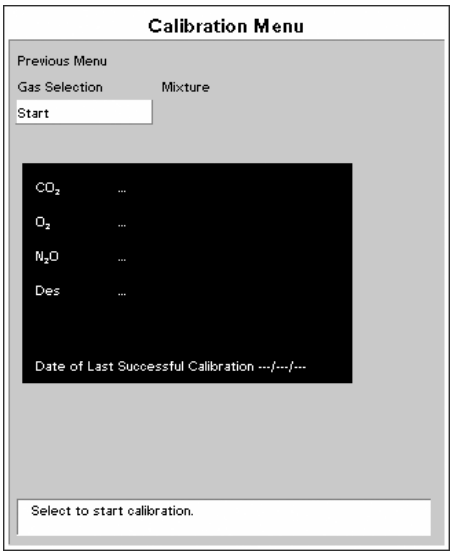

FIGURE 5-6 Calibration Menu

NOTE: **If the Gas Module cannot zero, a zeroing error will be displayed and the previous calibration data will be restored. Repeat the calibration procedure from step 1. If problems persist, contact Technical Support.**

5. The message **Feed Calibration Gas** will appear. At this point, attach the calibration gas canister to the regulator and turn it on. Increasing gas values will appear in the window as the Gas Module samples the calibration gas.

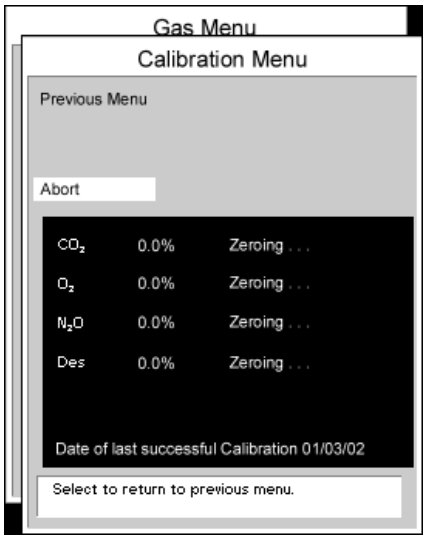

FIGURE 5-7 Gas Calibration Menu

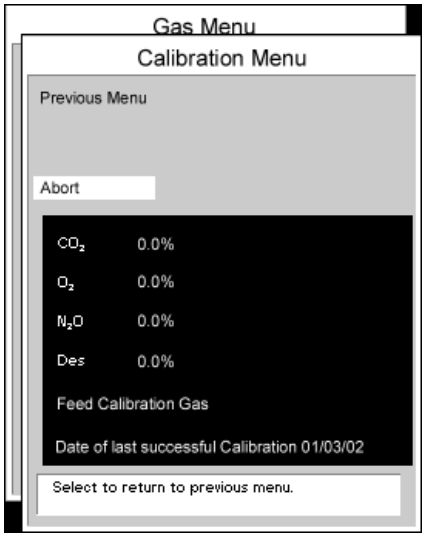

FIGURE 5-8 Gas Calibration Menu

6. When sampling is complete, the **Feed Calibration Gas** message will disappear and **Adjusting** will appear next to each value. An **Accept** menu item will also appear. If the values are acceptable, select **Accept**. To cancel calibration and re-install the previous calibration values, select **Abort**.

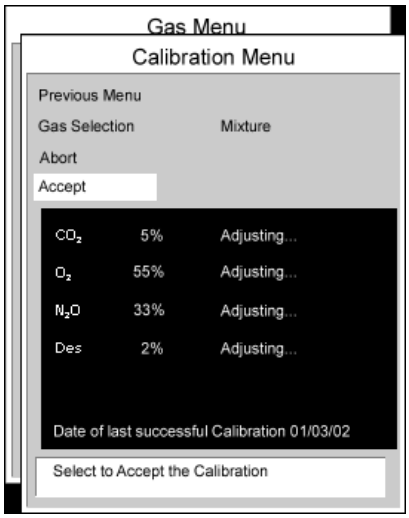

FIGURE 5-9 Gas Calibration Menu

NOTE: **To avoid premature emptying of the gas canister, always remove the regulator at the end of the procedure.**

NOTE: **For Gas Module II and SE, if any channel cannot be calibrated due to a sampling error, the "Sampling Error" message will appear. Selecting the "Accept" button will calibrate only those channels that do not have a sampling error. If any channel fails calibration, the gas value will be "XXX". These channels will appear as "XXX" in the normal run mode as well. Repeat procedure from step 1. If problems persist, contact Technical Support.**

NOTE: **For Gas Module 3, if any input data is corrupt or if there are other errors, a "Calibration Error" message will appear after the "Accept" button is selected. The Gas Module 3 will not accept span calibration with errors in any channel.**

5.7.3.2 Spectrum OR

1. Select **Calibrate** from the **Gas Menu**. The **Calibration Menu** opens.

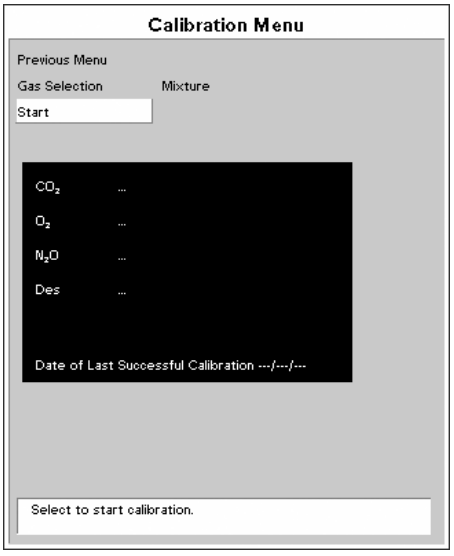

FIGURE 5-10 Calibration Menu

2. Select **Gas Selection** from the **Calibration Menu** and choose the calibration gas type. Choices are: Mixture, 5% CO_2, 55% O_2, 33% N_2O and 2% Des.

3. Select **Start** to begin calibration. At the start of the calibration, the message **Zeroing...** will be initially displayed for each of the gas labels as the Gas Module zeros the gas channels. After successful zeroing, the Gas Module will request the calibration gas as indicated in the next step.

NOTE: **If the Gas Module cannot zero, a zeroing error will be displayed and the previous calibration data will be restored. Repeat the calibration procedure from step 1. If problems persist, contact Technical Support.**

4. The message **Feed calibration gas** will be displayed. At this point, attach the calibration gas canister to the regulator and turn it on. Increasing gas values will appear in the window as the Gas Module samples the calibration gas.

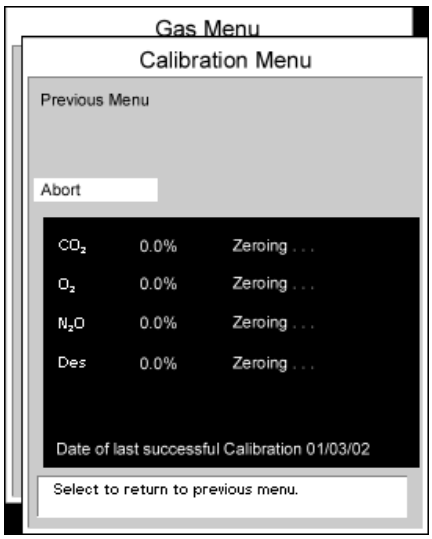

FIGURE 5-11 Gas Calibration Menu

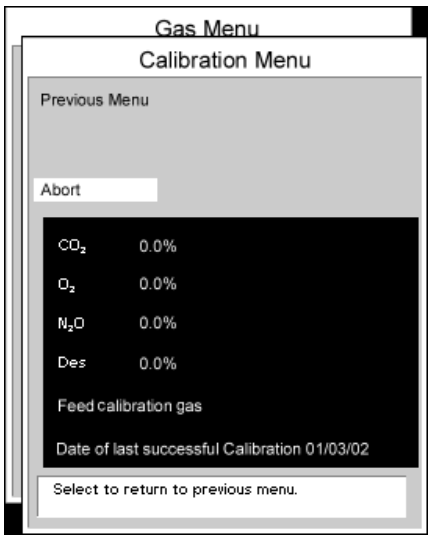

FIGURE 5-12 Gas Calibration Menu

5. When calibration is complete, the **Feed calibration gas** message will be removed from the display and the message **Complete** will be displayed next to each value that was successfully measured. If at least one gas was successfully measured, the **Accept** menu choice will become available. If the values are acceptable, select **Accept**. To cancel calibration and re-install the previous calibration values, select **Abort**.

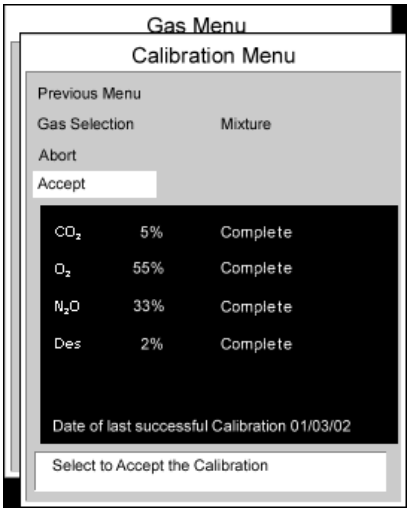

FIGURE 5-13 Gas Calibration Menu

NOTE: **When the "Accept" menu choice is selected, the message "Disconnect calibration gas." will be displayed. To avoid premature emptying of the gas canister, always remove the regulator at the end of the procedure.**

NOTE: **For Gas Module II, Gas Module SE, and Gas Module SE with Spirometry, if any channel cannot be calibrated due to a sampling error, the "Sampling Error" message will be displayed. Selecting the "Accept" button will calibrate only those channels that do not have a sampling error. If any channel fails calibration, the gas value will be "XXX". These channels will appear as "XXX" in the normal run mode as well. Repeat the procedure from step 1. If problems persist, contact Technical Support.**

NOTE: **For Gas Module 3, if any input data is corrupt or if there are other errors, a "Calibration Error" message will appear after the "Accept" button is selected. The Gas Module 3 will not accept span calibration with errors in any channel.**

5.7.4 Power Supply PC Board Calibration

NOTE: Required for Gas Module II, Gas Module SE, and Gas Module SE with Spirometry only.

Preliminary Steps: The Power Supply PC Board is located inside the Gas Module. Remove the enclosure by removing the eight screws (four on top, four on bottom) that secure it to the main chassis.

1. Use a volt meter to measure the voltages at connector X3 on the Interface PC Board (see FIGURES 5-14 and 5-16). The preset voltages shall be within the specifications stated below:

INTERFACE PC BOARD CONNECTOR	SPECIFIED VOLTAGE	TOLERANCE
Pin 1	+15 volts DC	± 0.25 volts DC
Pin 3	-15 volts DC	± 0.25 volts DC
Pin 4	+15 volts DC	± 0.25 volts DC
Pin 9	+12 volts DC	± 0.25 volts DC
Pins 2, 5, 7	Analog Ground	
Pin 10	Digital Ground	

2. Adjust the +5 volt potentiometer on the Power Supply Board for 5.00 ±.1 volts DC, measured between X1 Pin 25 (+5 volts DC) and X1 Pin 7 (Ground) on the Gas Measurement Board (see FIGURE 5-14).

3. Adjust the +12 volt potentiometer on the Power Supply Board for 12.0 ±.25 volts DC, measured at X3 Pin 9 on the Communication Interface PC Board (see FIGURE 5-16).

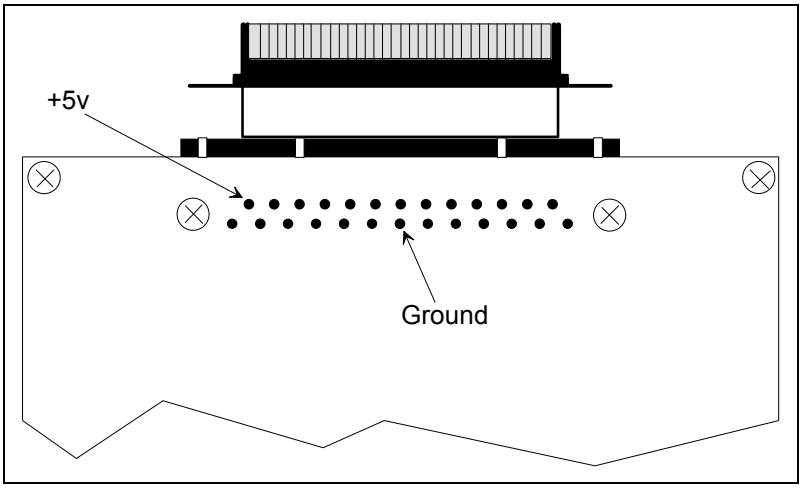

FIGURE 5-14 Gas Measurement Board

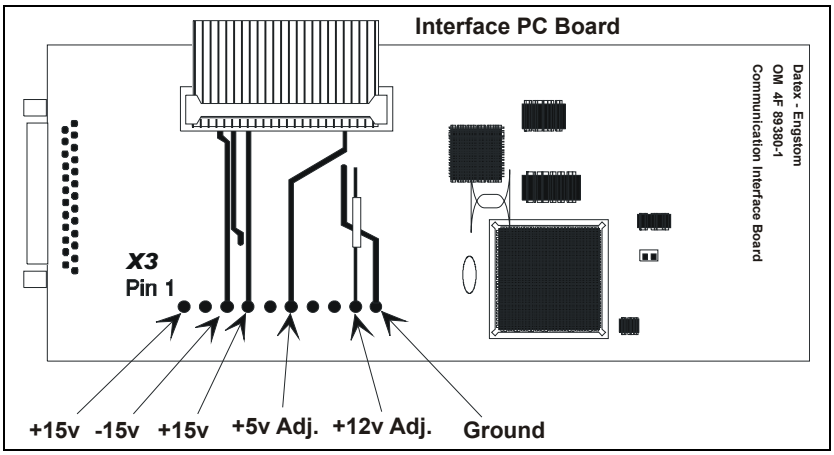

FIGURE 5-15 Test Points

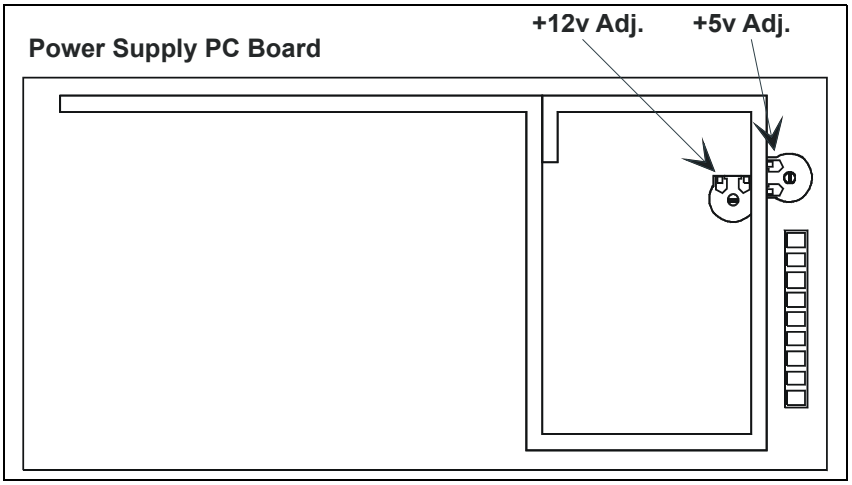

FIGURE 5-16 Potentiometers

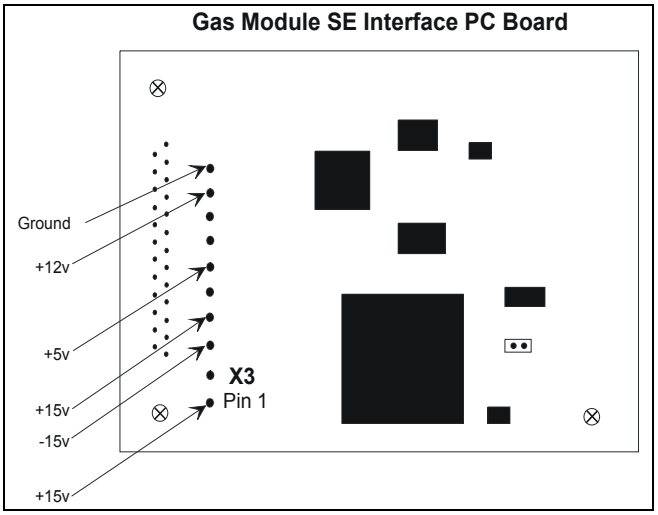

FIGURE 5-17 Test Points

5.7.5 Patient Spirometry Calibration Measurement (Spectrum OR only)

NOTE: Required for Gas Module SE with Spirometry only.

NOTE: An anesthesia machine is required for proper verification.

1. Connect a gas sampling catheter and spirometry tube to the Gas Module. Turn the Gas Module and host monitor on and leave in the normal operating mode.
2. Fill the spirometry tester half full with room temperature water (see FIGURE 5-18).

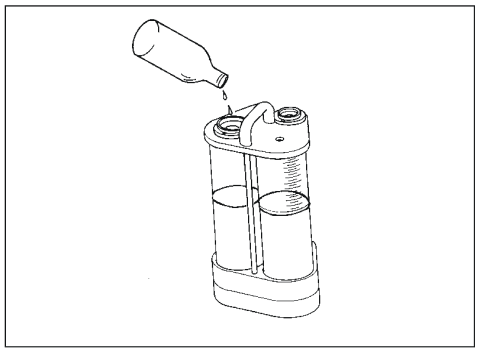

FIGURE 5-18

3. Check the ventilator for leaks and adjust tidal volume for the patient size to be tested (typically 500 ml for adult, 100 ml for pediatric).
4. Connect the spirometry tube and sample catheter to the spirometry sensor.
5. Connect the spirometry sensor to the ET tube. Use a right angle connector, if that is typically used in the anesthesia setup.
6. Insert the ET tube 8 mm – 9 mm in the appropriate tester hole and inflate the cuff to seal the ET tube in the tester. Add water over the cuff to check for leaks.
7. Connect the spirometry sensor to the breathing circuit of the anesthesia machine and let the ventilator run for 2 – 3 minutes (see FIGURE 5-19).

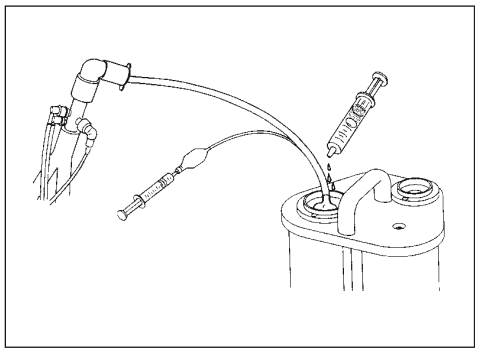

FIGURE 5-19

8. Move the tester's scale so that zero is at the lowest water level (at the end of expiration) (see FIGURE 5-20).

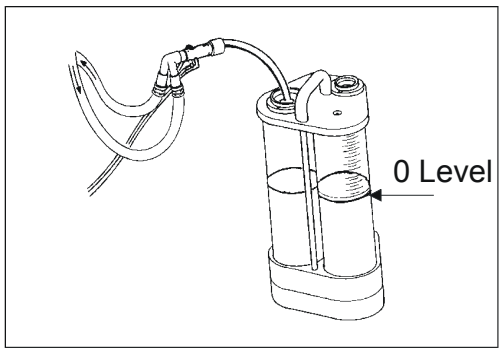

FIGURE 5-20

9. Read the Vt at the tester's highest water level and compare to the reading with the INSP Vt reading on the host monitor. If unit does not meet accuracy specification (±6% of Vt), discontinue use and call for service (see FIGURE 5-21).

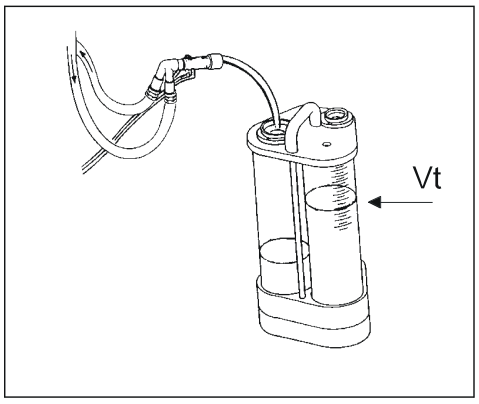

FIGURE 5-21

10. Disconnect the spirometry sensor from the ventilator BEFORE turning the ventilator off.

11. Empty the spirometry tester.

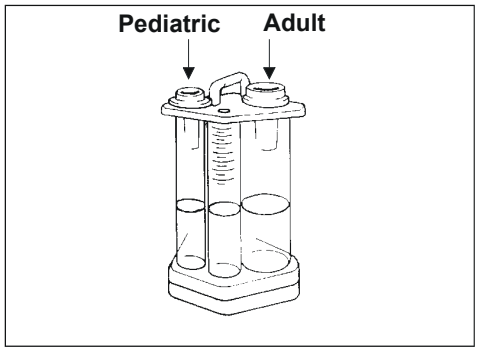

FIGURE 5-22

5.7.6 Patient Spirometry Leak Test Verification (Spectrum OR Only)

NOTE: Required for Gas Module SE with Spirometry only.

Prior to verification - Make sure the Gas Module SE w/ Spirometry is on for at least 30 minutes before performing a Leak test.

1. Connect the Double Lumen Spirometry tube to the Monitor and the D-Lite™ Spirometry sensor.
2. Disconnect the sampling line from the D-Lite™ Spirometry sensor and lock the sampling port with a luer stopper. (See figure A.)

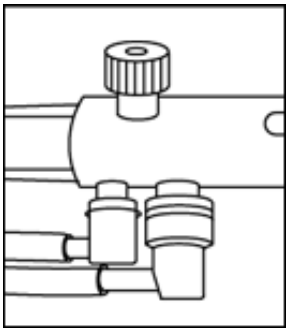

FIGURE 5-23

3. Select the pressure waveform scale to -20 to 20 cmH_2O and the flow waveform scale to -20 to 20 l/min.
4. Take the D-Lite™ and occlude both ends tightly with your fingers (See figure B). Pressing firmly with the fingers creates a pressure inside the D-Lite™. Check that at least 10 cmH_2O pressure is generated.

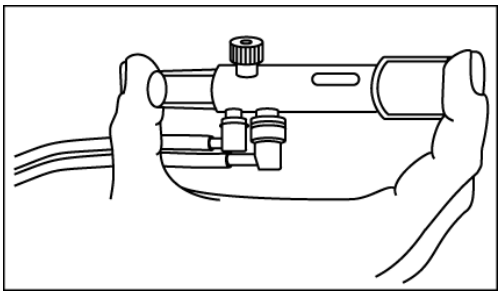

FIGURE 5-24

5. If no pressure is generated the system is leaking heavily. Check the tightness of all connections and try again.
6. Look at the flow waveform and check if the flow is zero. If there is a leak in the connections the monitor will measure a positive pressure or a negative pressure depending on which connector is leaking.
7. To correct the leak, check the tightness of all connections again and retry the test. If a persistent leak remains replace the tubing or D-Lite™.

5.8 Gas Module Leakage Current Checks

Source Current, Chassis Case to Ground Leakage (Test 1 on Model 431 Dempsey).

1. Plug the unit into the safety analyzer, as shown in the figure below. Connect the Case ground lead of the analyzer to the GND lug on the rear panel.
2. Perform the test under the following conditions, with the unit fully ON:
   a. Case Grounded:
      - Polarity Normal
      - Polarity Normal with open neutral
   b. Case Ungrounded:
      - Polarity Normal
      - Polarity Normal with open neutral
      - Reverse Polarity

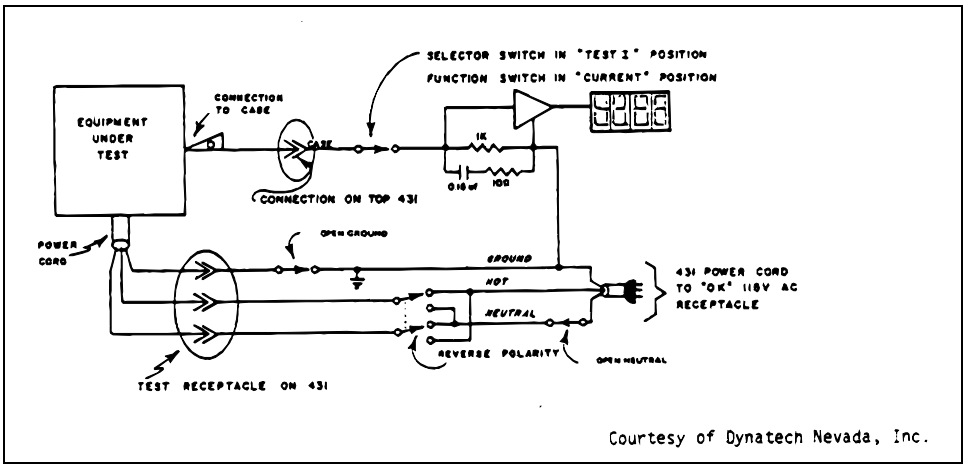

FIGURE 5-25 Dynatech

Specification: Verify the current reading for any test is less than 100uA.

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6.0 *Preventive Maintenance*

Contents of this chapter ..... Page

6.1 Preventive Maintenance Introduction

This section of the manual outlines routine maintenance that should be performed by service. The Gas Module is designed for stable operation over long periods of time and under normal circumstances should not require technical maintenance beyond that described in this section. However, it is recommended that routine maintenance calibration and safety checks be performed at least once a year, or more often as required by local statutory or hospital administration practice.

6.2 Preventive Maintenance Schedule

The following is a list of activities required for periodic maintenance of the Gas Module. The physical inspections, replacements of consumable items and performance checks are suggested to be performed at the recommended intervals stated below. Mindray DS USA, Inc. is not responsible for component failure or loss resulting from the use of stated consumable items beyond their recommended replacement interval.

6.3 Performance Verification

6.3.1 Perform as required, or at 6 month intervals

- For Gas Module II, Gas Module SE, and Gas Module SE with Spirometry, verify gas accuracy by performing Gas Calibration - Section 5.7

6.3.2 Perform as required, or 1 Year intervals

- For Gas Module 3, verify gas accuracy by performing Gas Calibration - Section 5.7

6.3.3 Patient Spirometry Leak Test Verification (Spectrum OR Only) (see section 5.7.6)

6.4 Mechanical / Physical / Visual Inspection

6.4.1 Perform at 6 month intervals.

- Outer Case,
- AC line cord, Interface cable,
- Rolling stand, Wall mounts,
- Clean the Water Trap bottle.
- Clean the Dust Filter.

6.5 Consumable Item Replacement

6.5.1 Replace at 1 month intervals

- Gas Module 3 Water Trap Assembly (Adult/Pediatric P/N 0202-00-0182-10; Neonate P/N 0202-00-0181-10)

6.5.2 Replace at 2 month intervals

- Gas Module II, Gas Module SE, and Gas Module SE with Spirometry Water Trap Assembly (P/N 0202-00-0129)

6.5.3 Replace at 12 month intervals

- Internal Nafion Tube moisture trap to manifold (P/N 0008-00-0307)
- Gas Module II, Gas Module SE, and Gas Module SE with Spirometry O_2 Filter (P/N 0378-00-0041)
- Gas Module II, Gas Module SE, and Gas Module SE with Spirometry Dust Filter (P/N 0378-00-0040)
- Gas Module II, Gas Module SE, and Gas Module SE with Spirometry Small Diameter Tubing connecting to the O_2 Filter and O_2 Sensor —use P/N 082-001845-00
- Gas Module 3 Internal Nafion Tube moisture trap to manifold:
  GM3 S/N 10001000 and lower — use P/N 0008-00-0376-02.
  GM3 S/N 10001001 and higher — use P/N 0008-00-0376-01

6.5.4 Replace at 24 month intervals

- Gas Module II, Gas Module SE, and Gas Module SE with Spirometry CO_2 Absorber (P/N 0378-00-0046)
- Gas Module II, Gas Module SE, and Gas Module SE with Spirometry Internal Nafion Tube, CO_2 Absorber to manifold (P/N 0008-00-0307)

6.6 Internal Adjustments/Calibration

NOTE: For Gas Module II, Gas Module SE, and Gas Module SE with Spirometry only

6.6.1 Perform at 12 month intervals or as required

- Power Supply PC Board Calibration - Section 5.7.2

6.6.2 Patient Spirometry Calibration Measurement (Spectrum OR only) (see section 5.7.5)

6.7 Care and Cleaning of Gas Module

6.7.1 Gas Module II, Gas Module SE, and Gas Module SE with Spirometry

WARNING: Do not clean the Gas Module while it is on and/or plugged in.

1. The Gas Module enclosure may be cleaned with a mild soap and water solution or ammoniated window cleaner. Apply cleaning solution to the cloth, not directly onto the Gas Module. DO NOT apply large amounts of liquid. DO NOT use abrasive cleaning agents or organic solvents.

Check unit for any obvious signs of physical damage, (e.g., bent/cracked frames or scratches) and replace as required.

CAUTION: The internal sampling system of the Gas Module does not need to be cleaned or sterilized. There is no reverse flow back to the patient. If the internal sampling system is suspected to be clogged or dirty, the module should be serviced by an authorized service person only.

2. The front panel should be cleaned carefully in order to prevent scratches. Dust, dirt particles, finger-prints and stains may be removed by using a soft cloth. Do not wipe a dry screen. Do not use alcohol or chlorinated hydrocarbon solvents. Inspect the front panel for scratches and other physical damage, replace if required.

3. Check all panel hardware for looseness and panel clearance.

4. Check line cord for wear, damage and proper strain relief.

5. Check all graphics and labeling for wear and scratches.

6. The fan dust filter should be checked and cleaned on a regular basis, at least once every two months.

- Locate fan on front panel.
- Remove the filter by pulling the dust filter cover.
- Remove the dust from the filter.
- Let the filter soak in a mild detergent solution.
- Rinse the filter and let dry completely before re-installing.

CAUTION: If the dust filter for the fan cannot be cleaned or is damaged, replace it with part number 0378-00-0040. Use of another type of filter may decrease the cooling effectivity and cause damage to the Gas Module.

7. The Water Trap Reservoir must be checked and emptied whenever changing patients or if it is more than half full.

- To remove the water trap, push the water trap latch to the right. The water trap is spring loaded and will pop out. An **Air Leak** message will be displayed. The monitor will suspend sampling.
- Detach the reservoir from the water trap assembly by pulling it down carefully.
- Empty the reservoir and rinse with water only.
- Re-attach the reservoir to the assembly tightly.
- Re-install the whole unit into the Gas Module making sure the latch is set. Check that the **Air Leak** message disappears and monitoring resumes.

NOTE: Do not disinfect or open the water trap. If an "Occlusion" message appears, it may be necessary to replace the Water Trap Assembly (P/N 0202-00-0129).

NOTE: The Water Trap Assembly must be replaced every two months.

6.7.2 Gas Module 3

WARNING: Do not clean the Gas Module while it is on and/or plugged in.

1. The Gas Module enclosure may be cleaned with a mild soap and water solution or ammoniated window cleaner. Apply cleaning solution to the cloth, not directly onto the Gas Module. DO NOT apply large amounts of liquid. DO NOT use abrasive cleaning agents or organic solvents.

Check unit for any obvious signs of physical damage, (e.g., bent/cracked frames or scratches) and replace as required.

CAUTION: The internal sampling system of the Gas Module does not need to be cleaned or sterilized. There is no reverse flow back to the patient. If the internal sampling system is suspected to be clogged or dirty, the module should be serviced by an authorized service person only.

2. The front panel should be cleaned carefully in order to prevent scratches. Dust, dirt particles, finger-prints and stains may be removed by using a soft cloth. Do not wipe a dry screen. Do not use alcohol or chlorinated hydrocarbon solvents. Inspect the front panel for scratches and other physical damage, replace if required.

3. Check all panel hardware for looseness and panel clearance.

4. Check line cord for wear, damage and proper strain relief.

5. Check all graphics and labeling for wear and scratches.

6. The DRYLINE™ Water Trap Assembly consists of a filter housing and reservoir that must be checked and emptied whenever changing patients or if it is more than half full.

WARNING: The contents of the water trap should be handled as a potential infection hazard.

NOTE: Replace the complete DRYLINE™ Water Trap Assembly every month or more often if indicated on the monitor.

- To remove the DRYLINE™ Water Trap Assembly from its receptacle, press the lugs on its sides and pull out. An **Air Leak** message will be displayed. The monitor will suspend sampling.
- Detach the reservoir from the filter housing by twisting and separating these two parts.
- Empty the reservoir and rinse with water only.
- Tightly re-attach the reservoir to the filter housing.
- Re-install the DRYLINE™ Water Trap Assembly into the Gas Module, ensuring that it snaps into place. Check that the **Air Leak** message disappears and monitoring resumes.

NOTE: Only the reservoir of the DRYLINE™ Water Trap Assembly may be cleaned and/or disinfected.

NOTE: If an "Occlusion" message appears, it may be necessary to replace the DRYLINE™ Water Trap Assembly (Adult/Pediatric P/N 0202-00-0182-10; Neonate P/N 0202-00-0181-10).

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