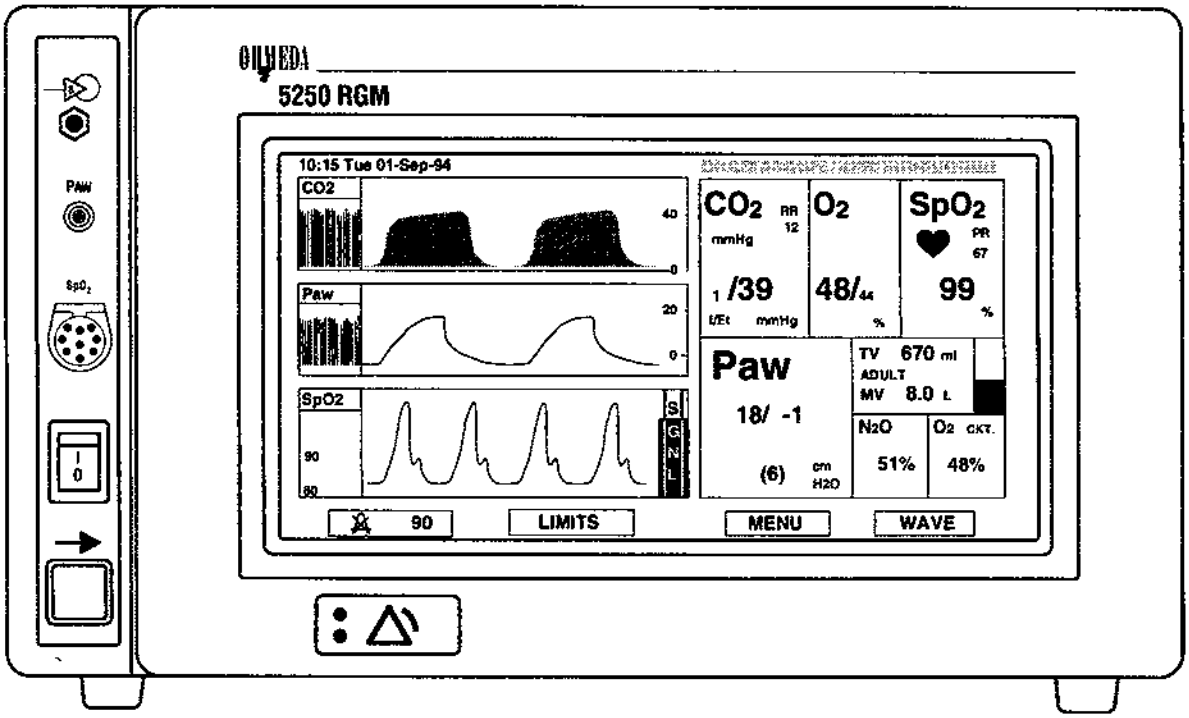
OHMEDA

THE BOC GROUP

5250 Respiratory Gas Monitor

Operation and Maintenance Manual



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5250 Respiratory Gas Monitor

Operation and Maintenance Manual

Important

This manual is subject to periodic review, update, and revision. Customers are cautioned to verify that the manual's information applies to the software and hardware present in the equipment.

This product performs as described in this manual, and in accompanying labels and/or inserts, when assembled, operated, maintained, and repaired in accordance with the instructions provided.

This product must be cleaned and checked periodically. Do not use a defective product. Parts that are broken, missing, plainly worn, distorted, or contaminated should be replaced immediately. If repair or replacement become necessary, call or write to request service advice from the nearest Ohmeda Service Center (listed on back cover). Do not repair this product or any of its parts other than in accordance with written instructions provided by Ohmeda and by Ohmeda-trained personnel.

The product must not be altered without the prior written approval of Ohmeda's Safety Department. The user of this product shall have the sole responsibility for any malfunction that results from improper use, faulty maintenance, improper repair, unauthorized service, damage, or alteration by anyone other than Ohmeda.

The safety, reliability, and performance of this device can only be assured under the following conditions:

- If the device has been used according to the accompanying operating instructions.
- If fittings, extensions, readjustments, changes, or repairs have been carried out by Ohmeda's authorized agents.
- If it is used in buildings having ground equalization wiring that complies with relevant IEC or local standards and regulations (UL, ETL, CSA, BSI, TUV, etc.).

Text revised October 1995

1/Overview

2/Operations

2/Operations (continued)

3/Messages and Troubleshooting

4/Maintenance, Calibration, and Service

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D/78xx Ventilator Interface

Warranty

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1/Overview

This chapter includes the following descriptions and information:

- RGM general features
- Front panel features
- Back panel features
- Screen displays
- Precautions you must follow when operating the monitor.

The features and functions described in this manual apply to revision 5.10 or higher of the display processor software and revision 5.00 or higher of the signal processor software. The Service screen shows your current revision level. You have one of the following units:

Not CE/EMC Units

Basic 5250 Respiratory Gas Monitor (RGM) 6051-0000-009

Includes CO_2, O_2, N_2O, airway pressure, tidal and minute volume, respiratory rate, and circuit O_2.

RGM with SpO_2 and pulse rate 6051-0000-010

RGM with agent (ACX-100 photometer) 6051-0000-011

RGM with agent, SpO_2, and pulse rate (ACX-100 photometer) 6051-0000-012

RGM with ACX-200 photometer 6051-0000-026

Has the capability for upgrading for use with sevoflurane and desflurane.

RGM with SpO_2 and the ACX-200 photometer 6051-0000-027

Has the capability for upgrading for use with sevoflurane and desflurane.

CE/EMC Units

Basic 5250 RGM 6051-0000-094

Includes CO_2, O_2, N_2O, airway pressure, tidal and minute volume, respiratory rate, and circuit O_2.

RGM with SpO_2 and pulse rate 6051-0000-093

RGM with ACX-200 photometer 6051-0000-092

Has the capability for upgrading for use with sevoflurane and desflurane.

RGM with SpO_2 and the ACX-200 photometer 6051-0000-091

Has the capability for upgrading for use with sevoflurane and desflurane.

Features

- The RGM uses microprocessor technology to measure CO_2, O_2, N_2O, and airway pressure. Anesthetic agent airway pressure (PAW), pulse oximetry (SpO_2 and pulse rate), and patient circuit O_2 are monitoring options.
- All the available parameters are displayed on a 10 cm x 20 cm (4 in. x 8 in.) flat electroluminescent (EL) screen and are integrated with an alarm-management system.
- You operate the monitor by touching the screen; you can remove the screen for easy access and viewing.
- Software upgrades and future options are simple to install. You access the computer program cartridges through the rear panel of the main unit and through the side panel of the display.
- RGM features include auto zeroing and an easy calibration procedure. The last calibration date appears on the calibration screen.
- An RS-232 interface provides communication to a printer, computer, blood pressure monitor, or to an Ohmeda 78xx ventilator (where "xx" represents one of the 78xx series ventilators).
- Through an analog port, seven analog output channels are available on the rear panel for connection to a chart recorder.
- You can view and/or change all the alarm limits on one screen. On this same screen you may choose to automatically save the alarm limits in effect when the RGM is powered off. When you power on the RGM, you can choose to use these previously selected alarm limits, set new ones, or use the default limits.
- A Digital Trend screen provides trend data every five minutes for the last hour.
- You can clear all trend information from memory.

Note: Throughout this manual, illustrations and explanations refer to an RGM with all its options. If your unit does not have the option being discussed, the information will not apply to your operation of the unit.

Front panel

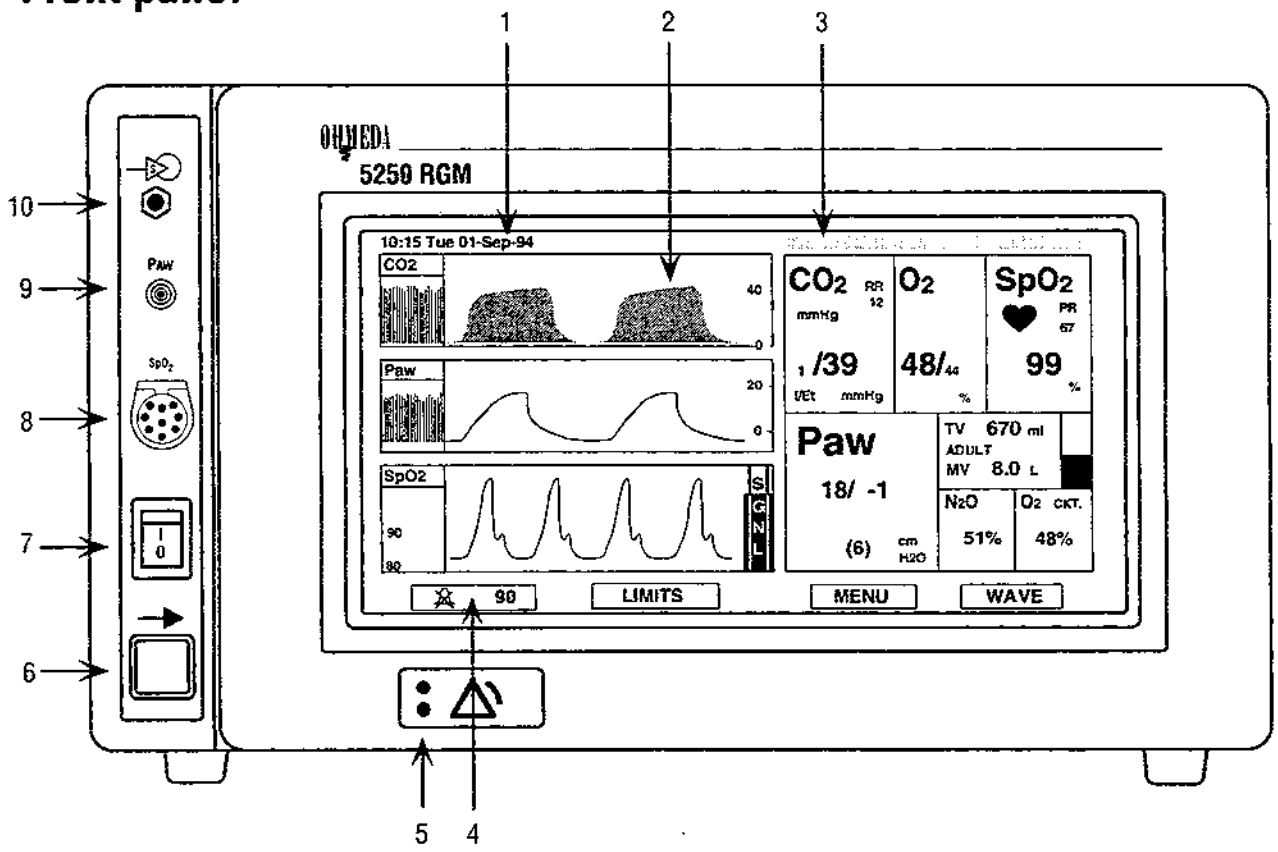


Figure 1-1. Front panel

1	Clock/calendar display	6	Display Release
2	Graphic display	7	Power switch
3	Message area	8	SpO_2 connector
4	Alarm silence	9	Paw inlet
5	Alarm lights	10	Sample inlet

1 Clock/calendar display

The current time—as HH:MM (24-hour clock in hours and minutes)—and date (week day, date, month, and year) appear here. The time and date are maintained when the power is switched off.

To set the time and date:

1. On the display screen, select (touch) MENU.
2. On the menu that appears, select (touch) SETUP.
3. On the Setup screen that appears, select CLOCK SET
4. Make the time and date changes on the screen.

Notes:

- Check your entries to make sure they are correctly set. It is possible to set an invalid date; i.e. 33 Jan 95
- Some older monitors do not have this feature; no time and date appear on the screen and no CLOCK SET option is available.

2 Graphic display

The entire graphic display area is covered by a matrix of infrared targets. Available options appear on this screen and you simply touch an option to **select** (activate) it. You do not need to exert pressure on the screen; an infrared beam is broken as your finger nears the option and it is then selected. See "Screen displays" in this chapter for more detail of the areas you see on this display.

3 Message area

Alarm messages and system information (i.e., INVALID SPAN) appear here.

4 Alarm lights

These lights indicate the type of alarm condition present: emergency alarms activate a flashing red light; warning alarms activate a flashing yellow light; system failure alarms activate a steady yellow light. See "Alarm types" in 2/Operations for detailed information.

5 Alarm silence

Touching this control mutes audible alarms for the indicated time period. A **new** alarm during this mute period resets the alarm silence condition and allows the alarm to sound.

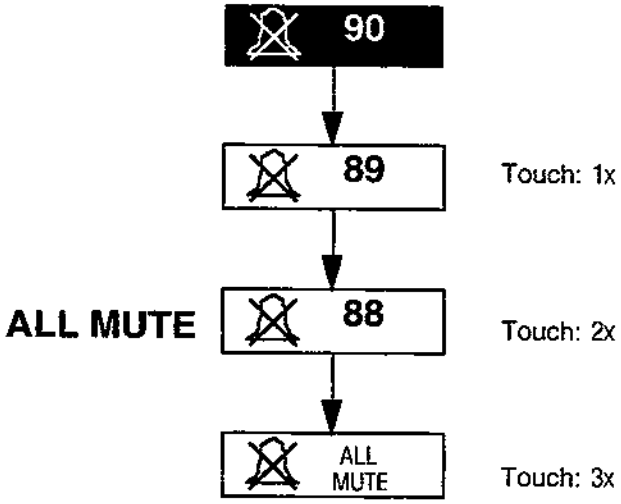


Figure 1-2. Alarm silence

If, **within 2 seconds** you touch alarm silence

- One time: silences alarms for indicated time period (a **new** alarm will sound during the remaining silence time).
- Two times: causes ALL MUTE condition (new alarms will **not** sound during the all-mute period remaining).
- Three times: causes ALL MUTE condition indefinitely, with the exception of the LOW INSPIRED O_2 and LOW CIRCUIT O_2 alarms, which will sound if they occur.

After two seconds, an additional touch resets the alarm.

To change the alarm silence interval, see "Changing the setup" in 2/Operations.

6 Display Release

Press this button to slide the display to the right, at which point you can remove the display and/or attend to the water separator assembly.

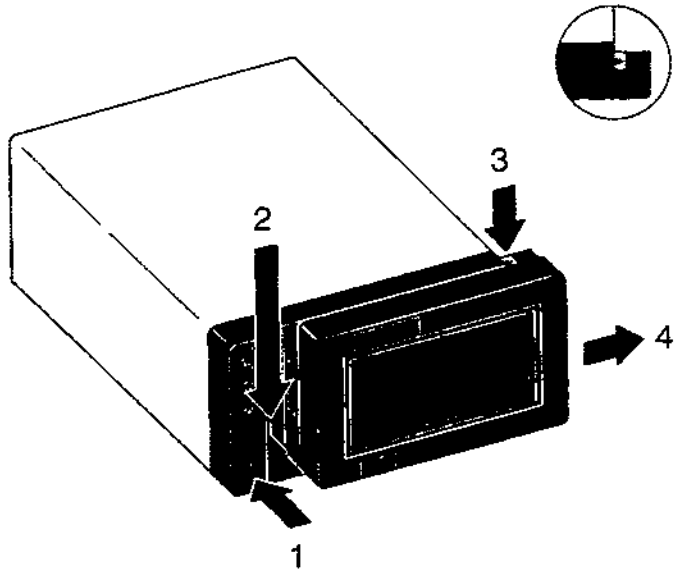


Figure 1-3. Display release

1 Display release button
2 Water separator assembly
3 Alignment indicators
4 Release steps

To remove the display:

1. Press the Display Release button (1) and slide the display to the right (4) until the alignment marks (3) line up as shown above.
2. Gently lift the display straight up, pull the bottom away from the chassis and remove (4).

   Place the display where it is most convenient within the range of the eight-foot extension cord attached to the display.

To attach the display to the RGM:

1. Coil the cord into the cord storage area on the back of the display.
2. Insert the top of the display, matching up the alignment indicators, and gently push the bottom of the display toward the chassis.
3. Slide the display to the left until the latch clicks.

CAUTION: To prevent damage to the display, make sure that both the top and the bottom of the display are fully seated into their slides when attaching the display to the monitor chassis.

7 Power switch

This switch turns AC power to the RGM on (|) or Off (O).

8 SpO_2 connector

Attach the oximeter probe to the RGM at this connector.

WARNING: Patient safety—To prevent patient injury or equipment damage, use only Ohmeda sensors with this monitor. Refer to the instructions that came with the sensor you are using to assure compatibility.

PAW

9 PAW inlet

Attach the pressure-sensing tube from the patient circuit to the RGM here.

10 Sample inlet

This inlet connects the patient circuit to the RGM by way of a small-diameter gas-sampling tube. The connector accepts a male luer lock fitting.

WARNING: Data validity—Use only the Ohmeda 244-cm (96-in.) sample tube assembly supplied with the monitor. Other sample tubes can change the operating characteristics (specifications) of the monitor, such as degrade the response time.

Water separator assembly

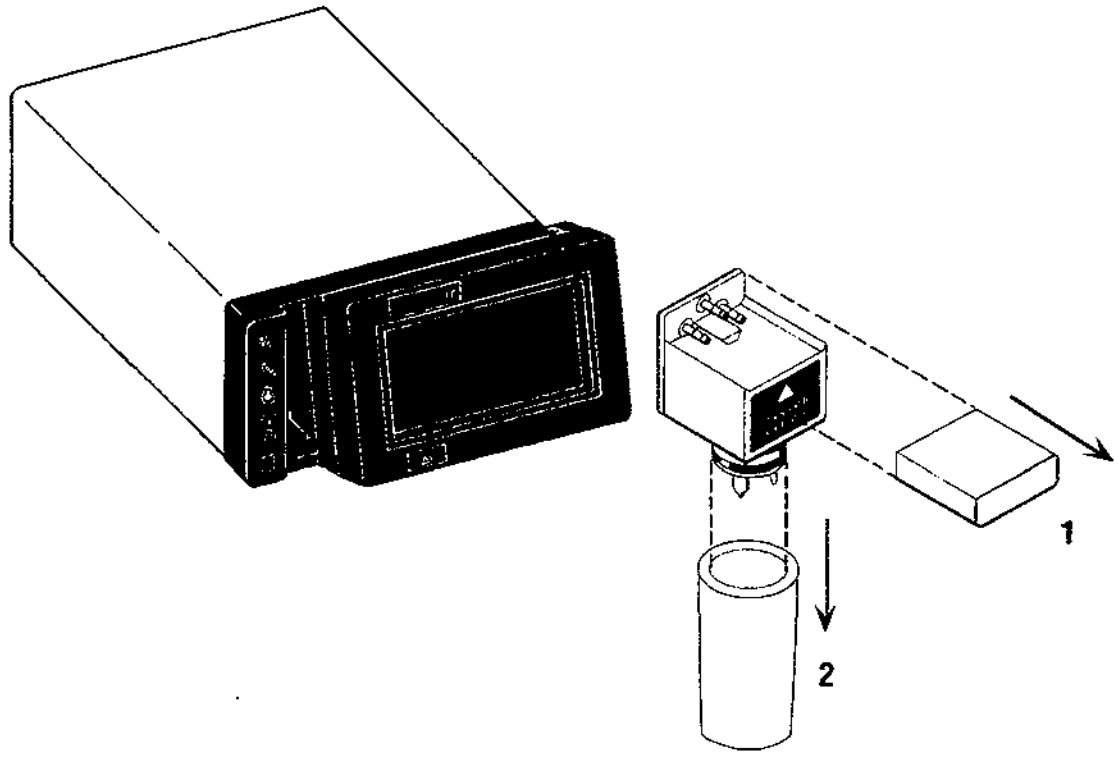


Figure 1-4. Water separator assembly

1 Membrane water separator cartridge
2 Water bottle

This assembly, located behind the removable display, collects fluids separated from the aspirated patient sample. In most RGMs the assembly consists of the membrane water separator cartridge (filter cartridge) and the water bottle.

WARNING: Operator safety—Always wear gloves, mask, and gown when handling any component of the patient circuit that comes in contact with the patient's exhalant gas or fluids.

CAUTION: Always empty the water bottle before each patient, whenever the bottle is more than half full, and before moving the monitor. Failure to empty the bottle may allow fluid to overflow into the monitor and cause malfunction.

For instructions on how to empty the water bottle and when and how to replace the water separator cartridge, see 4/Maintenance, Calibration, and Service.

Back panel

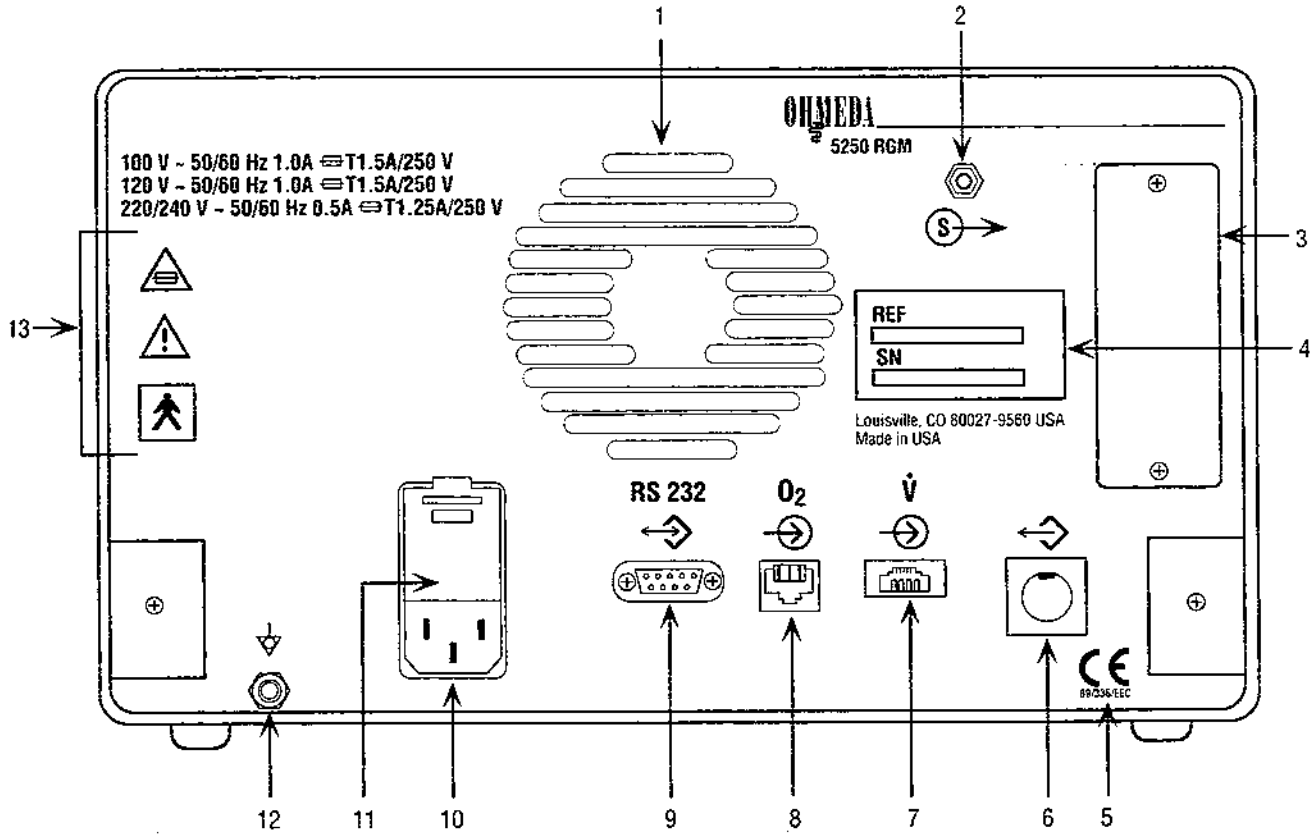


Figure 1-5. Back panel

1 Cooling fan
2 Sample exhaust
3 Software module
4 Reference and serial numbers
5 CE mark
6 Analog output
7 Flow sensor (v) input
8 O_2 sensor input
9 RS-232 connection
10 Power module (with voltage selection drum and fuses)
11 Voltage selection drum and fuses
12 External ground (equipotential) connection
13 Symbols

1 The fan behind this grill provides constant air circulation to protect the monitor's heat-sensitive electronic components.

CAUTION: To prevent damage to the monitor, do not cover or block the cooling fan.

2 Sample exhaust

Connect the sample exhaust line's barbed connector (0.3 cm [⅛ in.]) to a waste gas scavenging system to properly eliminate the gas sample. If a closed circuit is required, return the gas sample to the patient circuit.

3 Software module

The RGM's program is stored in the software module. Contact Ohmeda Customer Service (listed on the back cover of the manual) to obtain the latest software upgrade. For software module replacement, see "Software replacement" in 4/Maintenance, Calibration, and Service.

4 Reference and serial numbers

The RGM's part number and unique serial number for this monitor are found here.

5 CE mark

If you have this mark on your monitor, it means this product conforms with European Council Directive 89/336/EEC relating to electromagnetic compatibility when it is used in accordance with the instructions provided in this manual.

6 Analog output

This eight-pin DIN connector provides 0-to-1 volt full-scale sensitivity with approximately a 100-ohm source impedance. The monitor will output an analog signal proportional to the real-time N_2O waveform, CO_2 waveform, and other values. For more information, see B/Analog Outputs.

CAUTION: To avoid improper loading, which will upset the correspondence between the measured and intended output voltage, connect only a high input impedance device (10K ohm or higher) to the analog output connector.

7 Flow sensor input

Connect the flow sensor here. When attaching the flow sensor, make sure you seat the connector plug into the modular jack until you hear a locking click. Tug gently on the cord to make sure the plug is secure.

Note: The two possible connectors for this input have six or eight pins in the modular jack. Each requires a special cable. For specific information, see "Accessories" in 4/Maintenance, Calibration, and Service.

8 O_2 sensor input

Connect the O_2 sensor here. When attaching the O_2 sensor, make sure you seat the connector plug into the modular jack until you hear a locking click. Tug gently on the cord to make sure the plug is secure.

9 RS-232 connection

This nine-pin, isolated, connector provides interface to a printer, computer, blood pressure monitor, or 78xx ventilator. For more information, see C/RS-232 Communication.

10 Power module

This module contains the power cord receptacle and, behind the covering flap, the voltage selection drum and two fuses.

- Power cord receptacle—use this connector to connect the RGM to the local AC mains power supply.

CAUTION: Use only the power cord supplied with the 5250 RGM. When replacing the power cord, use only the power cord specified for this RGM.

11 Voltage selection drum and fuses

The clear window in the flap shows the voltage selection for this RGM. The voltage shown must match the available local line voltage. Voltage selections include 100, 120, 220-230, and 240 volts.

Two fuses protect the RGM from power failure damage. To check/change the voltage selection or replace fuses, see "Fuse replacement" in 4/Maintenance, Calibration, and Service.

CAUTION: Be sure the selected voltage on the voltage drum agrees with the local voltage available.

12 External ground connection

This connection allows equipotential grounding for the monitor when required.

13 Symbols

This symbol means "attention," you should refer to the documents that accompany the unit before using it.

This symbol means that the monitor conforms to the International Electrotechnical Commission Standard 601-1 (Safety of Medical Electrical Equipment) for patient-isolation type BF devices.

This symbol means you must replace the fuses with fuses of the same type and rating.

Screen displays

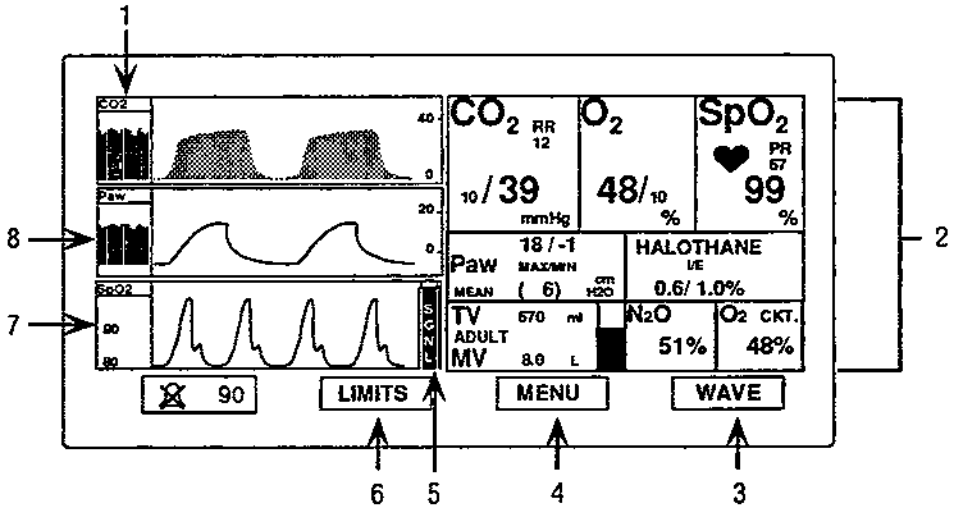


Figure 1-6. Screen display components

1 Waveform area and title
2 Displays—Gas, SpO_2, pressure, and volume
3 Wave/trend selections
4 Setup and calibration selections
5 SpO_2 signal strength indicator
6 Alarm limits selections
7 Plethysmograph scale
8 Trend area

Notes:

- If your unit is not configured for a specific feature, the screens you see may be somewhat different than those shown in the following sections.
- Items labeled 3 through 9 are described in 2/Operations, where setting up and operating the unit are covered. The calibration portion of item 4 is covered in 4/Maintenance, Calibration, and Service.

Parameter and waveform

1 The title of the parameter you have selected and its waveform appear here.

- When the inspired and expired values are transposed (i.e., the expired agent value is higher than the inspired value, or when the inspired CO_2 value is higher than the expired CO_2 value) a dot-patterned trend appears.

Figure 1-7. Transposed inspired and expired trend values

- When the waveform or trend values exceed the upper or lower limits of the scale, the waveform appears with a bar pattern.

Figure 1-8. Indications for out-of-range trend and waveform values

Displays

The digital information that may appear in this area is; CO_2, O_2, pulse oximetry (SpO_2 and pulse rate), airway pressure (PAW), anesthetic agent, tidal and minute volume, flow, N_2O, O_2, and blood pressure.

CO_2

CO_2 digital display

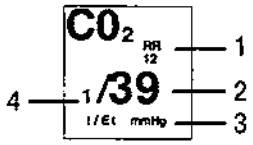


Figure 1-9. CO_2 digital display

1 Respiratory rate
2 Expiratory CO_2
3 Selected unit of measure—mmHg, kPa, or %
4 Inspiratory CO_2

The previous breath's inspired value appears to the left of the slash (/), and the maximum end tidal CO_2 value over the last three breaths appears to the right of the slash (1/ET).

Note: 0 to 15% is approximately in the 0 to 110 mmHg range at sea level. The mmHg and kPa ranges are dependent upon local barometric pressure.

CO_2 waveform and trend display

The capnogram (a graphic representation of the instantaneous concentration of CO_2 in a breath) is displayed with a scale on the right. The minutes, 18 or 70, of end tidal and inspired trend (with one data point drawn every 2 minutes) appear to the left. The trend area shows the average inspired and expired values for each 2-minute period.

The trend time available is:

- 18 minutes if every-breath or 2-hour trend time is selected.
- 70 minutes if 8-hour trend time is selected.
- 8 hours or 2 hours of inspired and expired trend data, with 1 point every 2 minutes, are displayed.

Available display ranges

- mmHg: 0 to 20, 0 to 40 (default), or 0 to 80
- %: 0 to 2.5, 0 to 5, or 0 to 10
- kPa: 0 to 3, 0 to 6, or 0 to 12
- CO_2 breath-by-breath trend

  If you select this option, a 200-breath trend of inspired and expired values is displayed. Tick marks denote 5-minute intervals in this trend.

CO_2 alarms

Message	Default	Range	Type
HIGH Et CO_2	OFF	OFF, 0.1 to 15%	Emergency
LOW Et CO_2	OFF	OFF, 0.1 to 15%	Emergency
CO_2 APNEA	30 sec	20 to 30 sec	Emergency
HIGH Fi CO_2	OFF	OFF, 0.1 to 15%	Emergency

Note: The apnea alarm cannot be disabled.

O_2

O_2 digital display

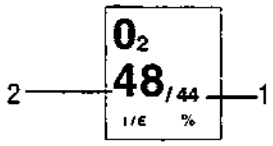


Figure 1-10. O_2 digital display

1 Expiratory O_2
2 Inspiratory O_2

Inspired and expired O_2 are measured from a single galvanic sensor. To obtain a stable O_2 concentration, a microcomputer-controlled switch shunts only inspired gas (based on the CO_2 breath detection) to the sensor for 20 seconds. The inspired gas is then measured for 15 seconds—this value appears to the left of the slash. The expired gas is then supplied to the sensor for 20 seconds and measured for 15 seconds—this value appears to the right of the slash (I/E). This cycle repeats continuously as long as breaths are detected.

O_2 trend

Either 8 hours or 2 hours of inspired and expired O_2 concentration trend data, with 1 point every 2 minutes, are displayed. Available display ranges are 20 to 70% (default) or 20 to 100%.

O_2 breath-by-breath trend

If selected, a 200-breath trend of inspired and expired values appears. Tick marks denote 5-minute intervals on this trend.

O_2 alarms

Message	Default	Range	Type
LOW INSPIRED O_2	18%	18 to 99%	Emergency
HIGH INSPIRED O_2	OFF	OFF, 18 to 99%	Emergency

Note: The LOW INSPIRED O_2 alarm cannot be disabled. The permanent ALL MUTE cannot permanently silence the LOW INSPIRED O_2 alarm.

Pulse oximetry (optional)

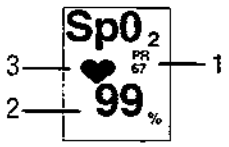


Figure 1-11. Pulse oximetry (optional)

1 Pulse rate
2 SpO_2 % value
3 Pulse indicator

A beating heart symbol (pulse indicator) appears for each detected pulse. An SpO_2 beep tone, with a pitch proportional to the SpO_2 value, occurs with each detected pulse—the higher the pitch, the higher the SpO_2 value, and vice versa.

SpO_2 waveform and trend display

The plethysmograph (used for measuring changes in the size of the arterial bed due to the pulsatile flow of blood) appears to the left of the signal strength indicator (see 5 in Figure 1-6). You may select to display an auto-scaled or fixed-scaled plethysmograph. The minutes, 18 or 70, of SpO_2 trend, with 1 point every 2 minutes, appears with an SpO_2 scale on the left. The available trend time is:

- 18 minutes if every-breath or 2-hour is selected.
- 70 minutes if 8-hour is selected.
- 8 hours or 2 hours of SpO_2 trend appear with one data point every 2 minutes. Available display ranges are 80 to 100% (default) or 50 to 100%.

SpO_2 breath-by-breath

If selected, a 200-breath trend of the SpO_2 value is shown. Tick marks denote 5-minute intervals in this trend.

SpO_2 alarms

Message	Default	Range	Type
LOW SpO_2	90	50 to 100%	Emergency
LOW PULSE RATE	OFF	OFF, 40 to 150 bpm	Warning
HIGH PULSE RATE	OFF	OFF, 80 to 235 bpm	Warning
HIGH SpO_2	OFF	OFF, 70 to 100%	Warning

Airway pressure

Airway pressure digital display

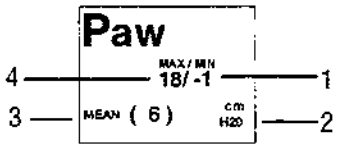


Figure 1-12. PAW digital display

1 Minimum
2 Unit of measure, cm H_2O
3 Mean
4 Maximum

The peak pressure over the previous breath appears to the left of the slash, with the minimum pressure over the previous breath to the right. The mean pressure over the previous breath appears in parentheses beneath the slash.

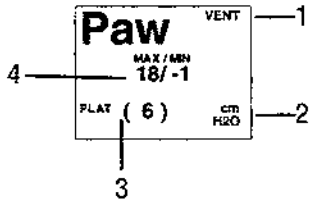


Figure 1-13. PAW with ventilator interface.

1 Indicates the RGM is interfaced to a 78xx ventilator
2 Minimum
3 Plateau
4 Maximum

When interfaced to a 78xx ventilator, you can receive the waveform by connecting a tee into the pressure line (see Figure 2-11).

Airway pressure waveform and trend display

The pressure waveform appears with its scale to the right. The minutes, 18 or 70, of trend, with one data point every 2 minutes, appear on the left. Available trend time is

- 18 minutes if every-breath or 2-hour trend selected.
- 70 minutes if 8-hour trend selected.

Note: The airway pressure waveform will not be in phase with the CO_2 waveform due to CO_2 sample transit time delay.

Airway pressure trend display

Peak pressure is the top value, the gap is the mean or pressure plateau value, and minimum pressure is the bottom value. Either 8 hours or 2 hours of trend with 1 point every 2 minutes appear. Available display ranges are -10 to 20 (default), -25 to 50, and -40 to 80 cm H_2O.

Airway pressure breath-by-breath trend display

If you select this trend on the Setup screen, a 200-breath trend of peak, mean or pressure plateau, and minimum pressure appears. Tick marks show 5-minute intervals in this trend.

Airway pressure alarms

Note: When interfaced to the 78xx ventilator, you can't select pressure alarm limits; these alarms are set on the ventilator.

Alarm message	Default	Range	Type
HIGH SUSTAINED PAW (30 seconds)	30 cm H_2O	OFF, 10 to 30 cm H_2O	Emergency
SUB-ATMOSPHERIC PAW	15 cm H_2O	fixed	Emergency
HIGH PAW	80 CM H_2O	OFF, 1 to 120 cm H_2O	Warning
LOW SUSTAINED PAW (30 seconds)	OFF	OFF -10 to 20 cm H_2O	Warning

Anesthetic agent displays (option)

WARNINGS: Data validity—

- **The 5250 RGM does not have the ability to identify anesthetic agents. If the agent selected on the monitor is not the agent being delivered to the patient circuit, the values will be inaccurate. If a mixture of anesthetic agents is delivered, the monitor may not show accurate values.**
- **In the presence of alcohols, ketones, or other organic hydrocarbon vapors—in the sample line or patient circuit, and ethyl alcohol in the patient's bloodstream—the 5250 RGM may not indicate accurate readings of the anesthetic agent.**
- **If the agent type is changed in the middle of a case, incorrect agent values appear until the patient circuit and the patient have been flushed of the old agent. This flushing process may take 10 minutes or longer, depending on fresh gas flow and the patient.**

Note: In agent RGMs, when monitoring one agent and changing to another, the maximum value of 9.9% may be indicated because of residual agent. This is normal and does not indicate a malfunction.

Anesthetic agent digital display

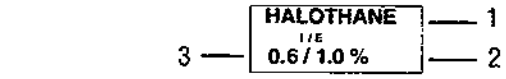


Figure 1-14. Anesthetic agent digital display

1 Selected agent
2 Expiratory agent %
3 Inspiratory agent %

Anesthetic agent trend display

Either 8 hours or 2 hours of inspired and expired values for the selected agent trend, with 1 point every 2 minutes, appear. Available display ranges are 0 to 2% (default), 0 to 3%, 0 to 4%, 0 to 8%, 0 to 12%, or 0 to 16%.

Anesthetic agent breath-by-breath trend display

If you select this option on the Setup screen, a 200-breath trend of inspired and expired values appears. Tick marks show 5-minute intervals in this trend.

Anesthetic agent alarms

Alarm message	Default	Range	Type
LOW INSP AGENT	OFF	OFF, 0.1 to 10%	Emergency
HIGH INSP AGENT	See notes	OFF, 0.1 to 15%	Emergency
LOW EXP AGENT	OFF	OFF, 0.1 to 10%	Emergency
HIGH EXP AGENT	See notes	OFF, 0.1 to 15%	Emergency

Notes:

- High alarm default limits

	High Insp.	High Exp.
Desflurane	16.0%	14.0%
Enflurane	6.5%	4.2%
Halothane	4.5%	3.0%
Isoflurane	5.5%	3.5%
Sevoflurane	8.0%	5.0%

- When you select and change an agent's alarm limit, the limit you set becomes the new value for that agent. Changing an agent's alarm limits affects **only that agent.**

Important: Select the agent type **before** adjusting the desired alarm limit.

- If you selected NO AGENT at the Setup screen, the RGM will alarm if trace agent is detected. The message AGENT DETECTED appears and SET AGENT flashes.
- Certain other agent types are displayed only if the correct version of the software is installed and if the agent photometer has been calibrated for the agent at the manufacturing site.

Tidal and minute volume displays (option)

Tidal and minute volume digital display

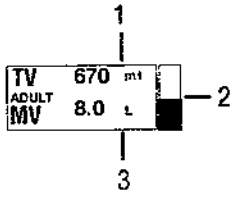


Figure 1-15. Tidal and minute volume digital display

1 Tidal volume/mL
2 Flow volume activity bar
3 Minute volume/L

The tidal volume in milliliters appears to the right of TV. The minute volume in liters appears to the right of MV.

Flow volume activity bar

This bar is a graphical representation of the instantaneous flow in the expiratory limb. Full scale is 100 L/min.

Minute volume trend display

Either 8 hours or 2 hours of minute volume trend, with one point every 2 minutes, appears. Available display ranges are 0 to 10 L (default) or 0 to 20 L.

Minute volume breath-by-breath trend display

If you select this option on the Setup screen, a 200-breath trend of inspired and expired values appears. Tick marks show 5-minute intervals in this trend.

Tidal and minute volume alarms

Note: When interfaced to the 78xx ventilator, you cannot set the tidal/minute volume alarm limits; these alarm limits are set on the ventilator.

Alarm message	Default	Range	Type
LOW TIDAL VOLUME	OFF	OFF, 50 to 1500 mL	Emergency
HIGH TIDAL VOLUME	OFF	OFF, 50 to 1500 mL	Warning
LOW MINUTE VOLUME	OFF	OFF, 0.2 to 50.0 L	Warning
HIGH MINUTE VOLUME	OFF	OFF, 0.2 to 50.0 L	Warning
REVERSE FLOW	OFF	N/A	Warning

Note: You can enable the REVERSE FLOW alarm on the Setup Screen.

O_2 circuit patient displays

Patient circuit O_2 digital display

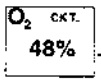


Figure 1-16. Patient circuit O_2 digital display

1 Patient circuit O_2 %

The value shown is the patient circuit O_2 mean over a 5-second interval.

Patient circuit O_2 alarms

Alarm message	Default	Range	Type
LOW CIRCUIT O_2	18%	18 to 99%	Emergency
HIGH CIRCUIT O_2	OFF	Off, 18 to 99%	Warning

Note:

- You can't set the O_2 circuit alarm limits; these limits are set on the ventilator.
- You can't disable the LOW CIRCUIT O_2 alarm unless the Patient Circuit O_2 parameter is disabled on the Setup Screen (where this parameter is enabled).
- Permanent ALL MUTE cannot permanently mute the LOW CIRCUIT O_2 alarm.

Flow (inspiratory and expiratory) waveform display

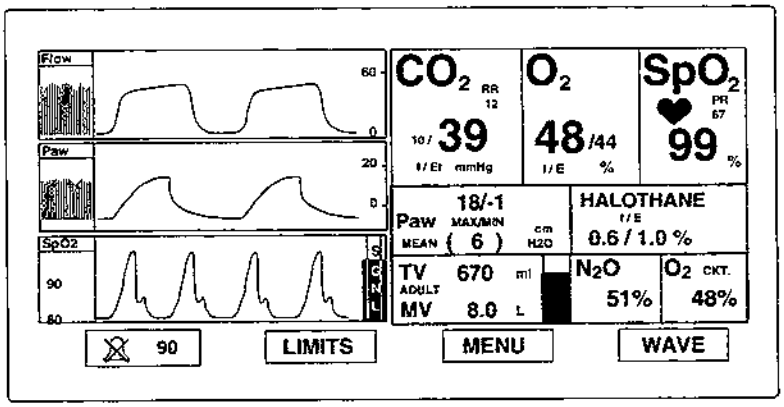


Figure 1-17. Flow waveform display

The flow waveform is available in two scales: 30 L/m and 60 L/m (default). The scaling of the flow bar graph in the tidal volume box corresponds to the scaling selected for the flow waveform.

To setup the flow waveform for display, see "Flow waveform selection" in 2/Operations.

N_2O displays

N_2O digital display

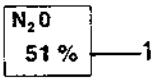


Figure 1-18. N_2O digital display

1 Inspired N_2O %

Inspired N_2O% from the last breath appears.

N_2O trend display

Either 8 hours or 2 hours of inspired and expired N_2O trend, with 1 point every 2 minutes, appear. Display ranges are 0 to 50% (default) or 0 to 80%.

N_2O breath-by breath trend display

If you select this option on the Setup Screen, a 200-breath trend of inspired and expired values appears. Tick marks show 5-minute intervals in this trend.

N_2O alarms

Alarm message	Default	Range	Type
HIGH N_2O	80%	OFF, 1 to 99	Emergency

Blood pressure monitor displays (option)

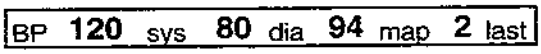


Figure 1-19. Blood pressure display area

The sys(tolic), dia(stolic), mean (map), and last pressure (minute[s] elapsed since last reading) values appear here.

The 5250 RGM, when interfaced with the RS-232 option to one of the blood pressure monitors on the RS-232 option list, shows the blood pressure parameters and graphic trend of the blood pressure changes over time. The trend shows systolic, diastolic, and mean arterial pressure.

Blood pressure trend display

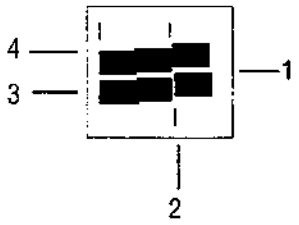


Figure 1-20. Blood pressure trend

1 Mean arterial pressure (map)
2 Five-minute interval marker
3 Diastolic pressure
4 Systolic pressure

Trend data is available with every breath, and in 2-hour and 8-hour trends.

Blood pressure alarms

If there is a failure in the communication link between the RGM and the blood pressure monitor, the message BLOOD PRESSURE COMM FAIL appears over the time and date line; see 3/Messages and Troubleshooting.

To set up the RGM for blood pressure monitoring, see "Blood pressure monitor interface" in 2/Operations.

Precautions

Two types of precautions appear in this manual:

- **WARNINGS** indicate the possibility of injury to the patient or operator.
- **CAUTIONS** indicate a condition that may lead to equipment damage or malfunction.

Read this section carefully before using the 5250 RGM for patient monitoring.

Warnings

Federal US and Canadian laws restrict this device to sale by or on the order of a licensed medical practitioner.

Failure of operation

If the 5250 RGM fails to respond as described in the calibration procedure, do not use that portion of the monitor until the malfunction is corrected.

Perform the "Preoperative checkout procedure" in 2/Operations before using the unit for patient monitoring. If the unit fails any test, remove it from use until it has been repaired and checked for correct operation.

Patient safety

To prevent patient injury or equipment damage, use only Ohmeda sensors with this monitor. Refer to the instructions that came with the sensor you are using to assure compatibility.

Exercise extreme care to assure continued circulation distal to the sensor site after application.

Prolonged monitoring or patient condition may require periodically changing the sensor test site. To reduce the risk of blistering, skin erosion, or ischemic skin necrosis, change the sensor site as specified in the user instructions for the sensor you are using. If any evidence of the above conditions appears before the specified period of time (for example, discoloration or reddening), change the sensor site immediately.

The flow sensor must be correctly oriented in the breathing circuit as indicated by the markings on the sensor clip. The arrows must point away from the patient. If the clip is not mounted correctly, the 5250 RGM will not operate properly.

The circuit O_2 display and alarms operate only if enabled on the Setup Screen and if a calibrated circuit O_2 sensor is installed. The RGM must be calibrated for the currently installed O_2 sensor.

This device is not intended for use in a magnetic resonance imaging (MRI) environment.

The correct use of the oximetry function of this monitor is to measure only arterial oxygen saturation (SpO_2) and pulse rate.

- A pulse oximeter does not measure respiration and under no circumstances should be used as a substitute for an apnea monitor.
- The oximeter must not be used as the primary monitor for infants being monitored for apnea, either in the hospital or in the home setting. It measures SpO_2 and pulse rate, and only in conjunction with other appropriate monitoring techniques.
- A pulse oximeter is often used during sleep studies with adults, but must be used only to gather information regarding SpO_2 and pulse rate during these studies.
- A pulse oximeter is to be used only by or on the order of medically trained personnel.

Data validity

Use only the Ohmeda 244-cm (96-in.) sample tube assembly supplied with the monitor. Other sample tubes can change the operating characteristics (specifications) of the monitor, such as degrade the response time.

The 5250 RGM does not have the ability to identify anesthetic agents. If the agent selected on the monitor is not the agent being delivered to the patient circuit, the values will be inaccurate. If a mixture of anesthetic agents is delivered, the monitor may not show accurate values.

In the presence of alcohols, ketones, or other organic hydrocarbon vapors—in the sample line or patient circuit, and ethyl alcohol in the patient's bloodstream—the 5250 RGM may not indicate accurate readings of the anesthetic agent.

If the agent type is changed in the middle of a case, incorrect agent values appear until the patient circuit and the patient have been flushed of the old agent. This flushing process may take 10 minutes or longer, depending on fresh gas flow and the patient.

Do not operate the 5250 RGM unless it is properly calibrated. Inaccurate patient parameter readings will result.

For the 5250 RGM without agent, use only Ohmeda calibration gas of 6% CO_2, 50% O_2, and 44% N_2O (±0.05 volume % gravimetric standard).

For the 5250 RGM with agent, use only Ohmeda calibration gas of 4% halocarbon-22/freon or equivalent, 6% CO_2, 40% N_2O, and 50% O_2.

Do not place the airway pressure adapter on the expiratory check valve of the absorber. Blockages in the tubing circuit can cause high patient airway pressures and may not be detected by the 5250 RGM.

The oxygen monitoring portion of the 5250 RGM monitor should be calibrated at the same temperature at which it will be used to monitor oxygen delivery in the patient circuit. Operation at temperatures other than those present during calibration may result in readings outside of the stated accuracy for the monitor. When the ambient temperature changes, we recommend recalibrating the monitor for maximum accuracy. Refer to the O_2 sensor information sheet for more details.

The tidal and minute volume alarms are usable only if the TVX flow cartridge is installed in the correct section of the breathing circuit. Operate the 5250 RGM only with the TVX flow cartridge placed in the expiratory limb or common airway of the breathing circuit. If the flow sensor is placed in the inspiratory limb, the monitor will not provide exhaled volume data.

If the 5250 RGM is used with a hanging-bellows-type anesthesia ventilator, the monitor may register volumes in spite of circuit disconnection.

To prevent erroneous tidal and minute volume readings, position the tubing so that water drains away from the TVX flow cartridge. If water accumulates in the TVX flow cartridge, it will restrict the motion of the internal vanes in the cartridge.

Exposure of the sensor clip to a direct beam of light may cause erroneous tidal volume and minute volume readings. Shield the sensor clip with opaque material if the reading is suspect.

Keep the circuit O_2 sensor attached to the monitor to assure accurate O_2 readings. If detached, the sensor must be reattached and stabilized for a length of time equal to the time it was detached (to maximum of 14 hours) before recalibrating.

To prevent inaccurate readings or damage to the RGM, do not block the airflow from the air intake or exhaust vents.

To prevent inaccurate readings or damage to the RGM, do not place the monitor on surfaces with above-ambient temperatures.

Operator safety

Always wear gloves, mask, and gown when handling any component of the patient circuit that comes in contact with the patient's exhalant gas or fluids.

Explosion hazard

Do not use the 5250 RGM in the presence of flammable anesthetics or other flammable substances in combination with air, oxygen-enriched environments, or nitrous oxide.

Electric shock hazard

Do not remove the cover of the 5250 RGM. Refer servicing to qualified service personnel. Service personnel must disconnect the power cord before servicing the RGM.

Always unplug the monitor from AC mains power before cleaning or servicing.

Flammability and electric shock hazard

For continued protection against fire hazard and electric shock, replace only with the same type and rating of fuse as shown on the rear panel of the 5250 RGM. Some RGMs require a different fuse than others.

Handle this equipment with care

Handle the 5250 RGM with care. Damage to the RGM or inaccurate operation may result from improper handling.

Cautions

Over extended periods of exposure, the presence of nebulized agent in the sample gas (such as Mucomyst®) may tend to obstruct internal RGM filters.

To prevent damage to the display, make sure that both the top and the bottom of the display are fully seated into their slides when attaching the display to the monitor chassis.

Always empty the water bottle before each patient, whenever the bottle is more than half full, and before moving the monitor. Failure to empty the bottle may allow fluid to overflow into the monitor and cause malfunction.

Be sure the selected voltage on the voltage drum agrees with the local voltage available.

To prevent damage to the monitor, do not cover or block the cooling fan.

Use only the power cord supplied with the 5250 RGM. When replacing the power cord, use only the power cord specified for this RGM.

To avoid improper loading, which will upset the correspondence between the measured and the intended output voltage, connect only a high-input impedance device (10K ohm or higher) to the analog output connector.

Pressure in excess of 10 psi above atmospheric pressure could damage the PAW inlet or sample inlet to the 5250 RGM.

When placing the TVX flow cartridge on the absorber valve, be certain to obtain a secure fit but do not force the cartridge in place as tightly as possible. Because the sensor cartridge is tapered, you can achieve a secure fit without excessive force.

Avoid storing O_2 sensors outside the temperature range of -20 °C to 50 °C (-4 °F to 122 °F). O_2 sensors must have shorting clips or be connected to the monitor when in storage or not in use.

To reduce moisture buildup on its sensing surface, the circuit O_2 sensor must always be facing downward when in use.

Destroy malfunctioning flow cartridges to prevent their inadvertent use.

To avoid damaging the sensor cartridge, handle it with care.

Cleaning

Do not autoclave, pressure sterilize, or gas sterilize the 5250 RGM.

Do not immerse the monitor in liquid. The electronic circuitry can be short circuited causing permanent damage to the internal components.

Use the cleaning solution sparingly. Do not saturate the RGM. Excessive solution can flow into the RGM and cause damage to its internal components.

Do not use organic-, petroleum-, or acetone-based solutions, or other harsh solvents, to clean the display panel or the unit. These substances attack the device's materials and device failure may result.

To prevent damage to the precision movement, never insert cleaning brushes or other foreign objects through the flow cartridge vanes.

To prevent permanent damage to the internal sensor and void its warranty, do not attempt to clean the sample chamber of an RGM with agent.

In an RGM without agent, do not use a strong alkaline detergent to clean the sample chamber as alkaline detergent may corrode the aluminum casing.

Use the recommended cleaning solution sparingly; do not saturate or immerse the flow sensor clip.

Do not tamper with the set screws in the flow cartridge. Such action will render the cartridge unusable.

Service

Only competent individuals trained in the repair of this equipment should attempt to service it.

Detailed information for more extensive repairs is included in the service manual solely for the convenience of users who have proper knowledge, tools, and test equipment, and for service representatives trained by Ohmeda.

Maximum voltage

No more than 5 volts should appear on any pin of the analog output connector.

Symbols

The symbols and their meanings found on the 5250 RGM and in this manual are as follows:

Warning or Caution—Read the manual and other information that accompanied the monitor.

Flammability and electric shock hazard—For continued protection against fire hazard and electric shock, replace only with the same type and rate of fuse as shown on the rear panel of the RGM.

89/336/EEC

If your monitor has this mark, this product conforms with European Council Directive 89/336/EEC relating to electromagnetic compatibility when it is used in accordance with the instructions provided in this manual.

RS 232

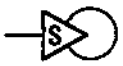
Indicates an RS-232 connector.

Indicates an input connector.

Indicates an output connector.

Indicates the equipotential ground connector.

Indicates the sample exhaust connector.



Indicates the patient sample inlet.

Indicates the monitor has type BF patient isolation.

PAW

Indicates the patient airway pressure inlet.

Indicates the display release button.

Notes

2/Operations

This chapter covers

- The preoperative checkout procedure.
- Changing the setup for the RGM's monitoring parameters.
- Selecting waveforms, trends, and scales.
- Changing alarm limits.
- Making the patient connections necessary for monitoring respiratory gases and anesthetics, pulse oximetry, patient airway pressure, inspiratory and expiratory flow, and circuit O_2.
- The types of alarms the RGM provides.

Preoperative checkout procedure

To use the 5250 RGM effectively:

- Be thoroughly familiar with the RGM's controls, connectors, and screens; see 1/Overview.
- Understand the monitor's alarms and messages; see 3/Messages and Troubleshooting.

Important: Before using the 5250 RGM for the first time, the barometric pressure must be checked and calibrated for local pressure. Make sure this procedure has been performed before monitoring the patient.

The RGM has a software-driven menu control system. The screen has touch-sensitive features that let you control the operation of the RGM by touching an option on the screen to select it.

The main monitoring screen has four options that control the setup and operation of the RGM: alarm silence, LIMITS, MENU, and WAVE.

WARNINGS:

- **Failure of operation—Perform the following procedure before using the unit for patient monitoring. If the unit fails any test, remove it from use until it has been repaired and checked for correct operation.**
- **Data validity—Do not operate the 5250 RGM unless it is properly calibrated. Inaccurate patient parameter readings will result.**

1. Inspect all of the RGM's accessories for damage. Replace any that are broken or damaged with Ohmeda replacement accessories.
2. Inspect the exterior of the monitor for damage. Check all the connectors and controls. Replace any broken or damaged parts with Ohmeda replacement parts.

CAUTION: Use only the power cord supplied with the 5250 RGM. When replacing the power cord, use only the one specified for this RGM.

3. Check that the local voltage matches the voltage selector setting on the rear of the monitor.
4. Connect the power cord to the RGM and to the AC mains power supply.

CAUTION: Empty the water bottle before each patient, when the bottle is more than half full, or before moving the monitor. Failure to empty the bottle may allow fluid to overflow into the monitor and cause malfunction.

5. Press the Display Release button to slide the display panel to the right and, if necessary, empty the water bottle.
6. Make the proper patient and RGM connection; see "Patient connections" later in this chapter.
7. To power on the monitor, press the power switch on the front panel.

   Allow the monitor to warm up for at least ten minutes. During poweron, the RGM performs a self-test procedure. The alarm tone may sound and the red and yellow LEDs will flash. If a problem exists, a message appears on the screen; see 3/Messages and Troubleshooting if a poweron failure occurs and for a description of alarm messages.

   After the warm-up period is over, you'll see the messages Use default limits? and Use previous limits?

   a. If the default limits (described in 1/Overview) or a set of limits that were previously set and in effect when the monitor was powered off are acceptable, touch your preference to select it.
      1) If you select the defaults, you'll be asked to confirm your choice: ARE YOU SURE?
      2) To confirm, touch YES.

   or

   b. Select MENU from the screen to change the limits.
      1) The configuration settings are preselected. To check or change these settings, see "Changing the setup," which follows.
      2) The waveforms, trends, and scale displays are preselected. To change these selections, see "Selecting waveforms, trends, and scales" later in this chapter.
      3) The alarm limits are preselected. To check or change these settings, see "Changing alarm limits" later in this chapter.
8. If you want to clear any data in trend memory,
   a. Select MENU.
   b. Select DIGITAL TREND.
   c. Select TREND CLEAR.
   d. When the message ARE YOU SURE? appears, touch YES to confirm.

Changing the setup

To change one or more of the setup parameters:

1. With the main monitoring display on the screen, select MENU.

   A popup menu appears and the word MENU changes to EXIT in case you change your mind and choose not to select from this popup menu.

2. To continue, select SETUP from the menu.
3. The first "page" of the Setup Screen appears.

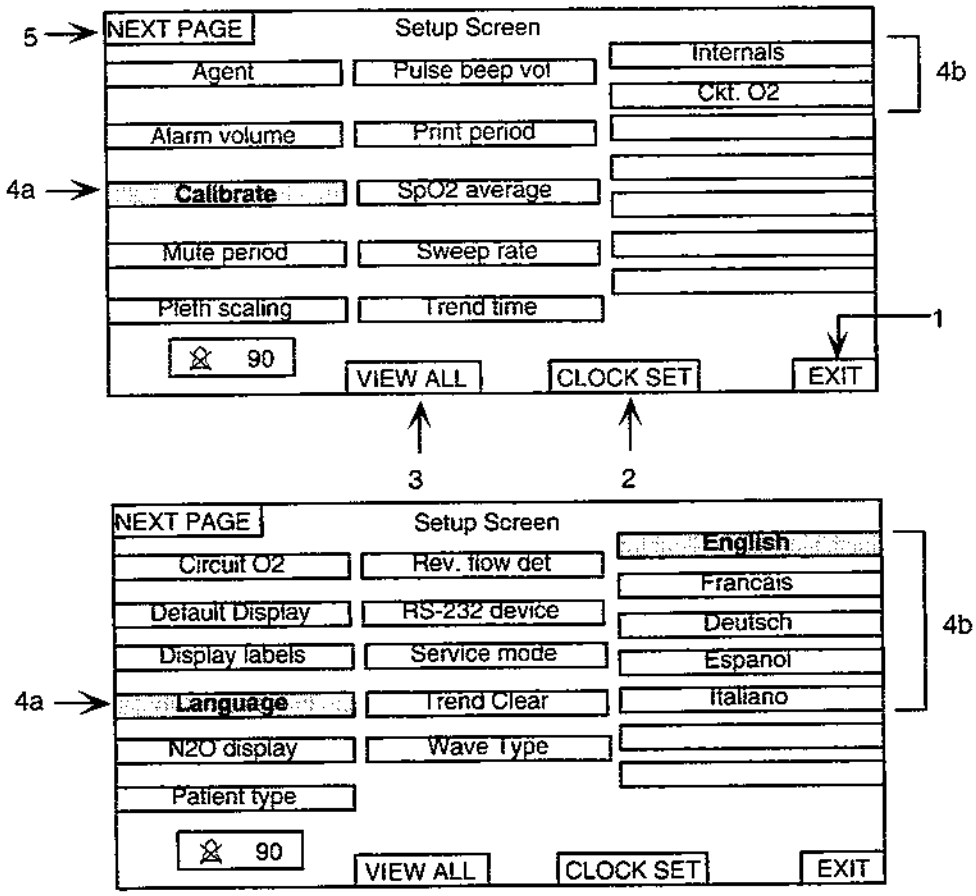


Figure 2-1. Setup Screens

1 EXIT leaves the setup screen(s)
2 CLOCK SET allows you to set the time and date
3 VIEW ALL accesses a screen that shows all the current settings for the parameters
4a Lists the parameters you can change.
4b List the options you can select after you've chosen the parameter you want to change.
5 NEXT PAGE toggles between pages 1 and 2 of the Setup Screen.

4. Select the desired parameter from the left side of the screen (4a).
5. Select the desired option from the right side of the screen (4b).
6. When you have made all the desired changes, select EXIT.

Setup Screen parameters

Agent

At poweron, No Agent is selected. Select the agent being delivered to the patient.

Alarm volume

Select from 1 (lowest) to 5 (highest); the default is 3.

Note: If the alarm volume is 1 when the monitor is powered off, it will be set to volume level 2 at the next poweron.

Calibrate

Selects to calibrate circuit O_2 or internal calibration.

Circuit O_2

Selects to enable or disable the circuit O_2 alarm and display of the circuit O_2 value; the default (off) is disabled.

Default Display

Selects to return to using the default scales and waveforms.

Display labels

Selects to add or delete additional descriptive text for the parameters as shown on the main display; i.e., I/Et, MAX/MIN. Until you are familiar with the parameters, you may choose to display the text. After that, you may choose to turn off the extra labeling for a less-cluttered screen display. The default is OFF.

Language

Selects the language for screen text: English, French (Francais), German (Deutsch), Italian (Italiano), or Spanish (Español). The chosen language is retained after powering off the monitor.

Note: If you accidentally change the language parameter to a language you can't read, the parameter is always found in the third box up from the alarm silence on the left side of Setup Screen, page two. In that box you will see one of the following: Language (English), Langue (French), Sprache (German), Lingua (Italian), or Idioma (Spanish).

Mute period

Selects the length of time for which all alarms will be muted: 30, 60, 90 (default), and 120 seconds

Note: If 78xx is selected for the RS-232 device, the only available mute period is 30 seconds.

N_2O display

Toggles between showing or not showing the display of nitrous oxide. After changing the selection, you must power off the RGM and then power it on again to see the change. The default is On.

Patient type

Select to adjust the scale factors for the flow sensor to the patient type: adult or pediatric. Use the adult setting (the default) for a tidal volume that is greater than 150 mL/breath.

Pleth scaling (with SpO_2 option)

When set to auto (default), this automatically scales the plethysmogram to full scale. When set to non-auto, it fixes the scale at the current value.

Print period

Selects the rate of output for the display of information for the RS-232 port. The choices are to receive one printed line of data every 10 seconds or every 1, 15, or 60 minutes or Off (default). The system test option is used only for manufacturing testing of the monitor.

Pulse beep vol (with SpO_2 option)

Selects the volume for the pulse beep at Off, 1, 2, 3 (default), 4, or 5 (the loudest). Pitch is determined by the patient condition; the higher the SpO_2 value, the higher the pitch.

Rev. flow det (reverse flow detection)

Toggles off (default) and on the reverse flow alarm. This alarm detects reverse flow through the tidal volume sensor. Turn off the alarm when the sensor is placed at the proximal location (in the patient airway). To detect a failed valve, turn on the alarm when the sensor is placed in the distal location (in the expiratory limb).

RS-232 device

Selects the communication parameters for the device that is communicating with the RS-232 port as follows:

- 1200 Odd (default) selects 1200 baud, odd parity, 7 data bits, and 1 stop bit.
- 9600 None selects 9600 baud, no parity, 8 data bits, and 1 stop bit.
- 78xx selects the correct baud rate and parity for communication with a 78xx ventilator.
- Dinamap selects the Dinamap® blood pressure monitor.
- 2300 selects the Ohmeda Finapres® blood pressure monitor.
- 2120 selects the Ohmeda 2120 blood pressure monitor.

Service mode

Selects to display the RGM maintenance screens; for service use only.

SpO_2 average

Selects the averaging interval for the SpO_2 values over 3, 6, or 12 (default) seconds. Longer averaging intervals smooth out the changes in SpO_2 values; shorter intervals track rapid changes in the SpO_2 value.

Sweep rate

Selects the fast (12.5 mm/sec) or slow (default; 6.5 mm/sec) rate of waveform display refreshing.

Trend clear

Provides the option of clearing all trends from memory. You are asked to confirm your selection to erase all trends before that action can occur.

Trend time

Selects the display for the display screen trends for every breath (default), 2 hour or 8 hour.

Wave type

Lets you choose the wave display characteristics that you prefer. Scroll (default) shows the waveform moving across the screen from right to left. The erase bar shows waveforms stationary across the display area. The erase bar, which is to the left of the waveform, precedes the current reading, and erases previous readings.

VIEW ALL Setup Screen

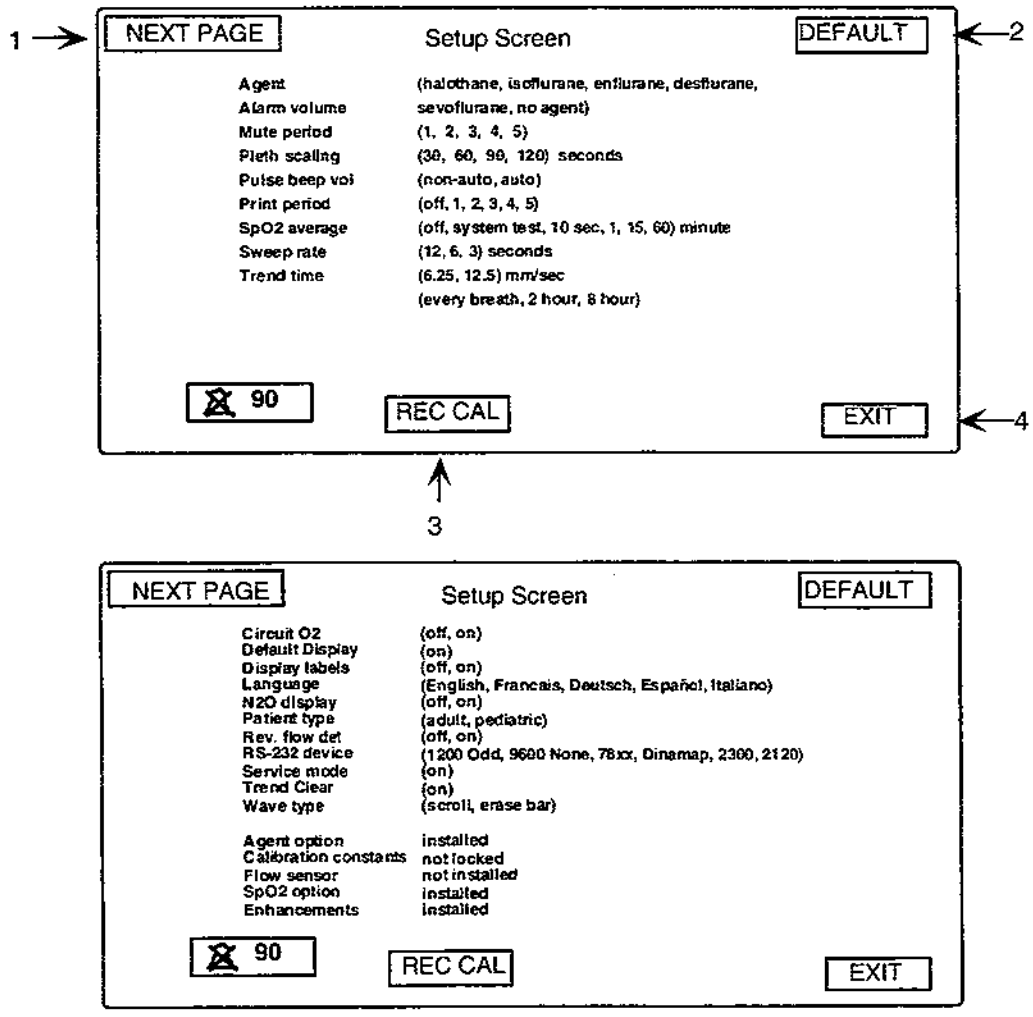


Figure 2-2. View-all setup screen, pages 1 and 2

You can select VIEW ALL to see a summary of the current settings for the above parameters.

Press NEXT PAGE (1) to move to page 2 (or back to page 1).

Press DEFAULT (2) to return all parameters to their factory defaults.

When you select DEFAULT, the default values are activated and highlighted in reverse video on the screen. The alarm silence key in the lower-left corner will continue to display the previous value until you touch that key to refresh it or exit the screen.

Press REC CAL (3) to access the Chart Recorder Calibration/Analog Diagnostic screen. See B/Analog Outputs for instructions on calibrating the chart recorder.

Press EXIT (4) to leave the view-all screens.

Waveform, trend, and scale selection

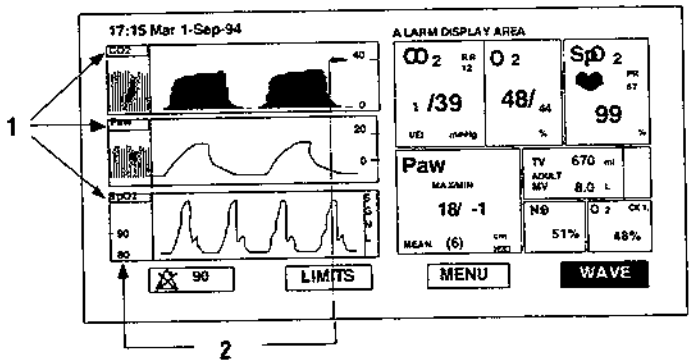


Figure 2-3. Waveform, trend, and scale selection

1. Select one of these places to select the desired waveform/trend.
2. Select the scale number to select available scale options

To change waveforms, trends, or scales:

1. Select WAVE from the display screen.
   The three waveform titles and their scales are highlighted.
2. Select the waveform you wish to change.
   The waveform and trend options appear.

CO2	CO2 TREND
PLETH/SpO2	Sp02 TREND
Paw	Paw TREND
FLOW	MV TREND
O2 I/E TND	AGT TREND
N2O TND	BP TREND

Figure 2-4. Waveform trend options

3. Select the desired waveform or trend from this popup menu.
4. Select the scale number for waveform/trend that you wish to change.

20 mmHg	10 %
40 mmHg	3 kPa
80 mmHg	6 kPa
2.5 %	12 kPa
5 %	

Figure 2-5. Scale options

6. Select the desired scale for the waveform/trend you choose.

   You may change any or all of the waveforms, trends, and scales before exiting the screen.

   Note: If you select the same display for two waveforms, any scale selection made for one of them will change both of them.

7. Select EXIT to return to monitoring.

   Note: Occasionally when changing from the SpO_2 waveform to a different one, a small portion of the scale at the bottom remains on the new waveform. To refresh the display, select SpO_2 and then select the new waveform again.

   To freeze the waveforms:

   1. Select MENU to freeze.
   2. Select EXIT to unfreeze.

Digital trend

The digital trend screen shows the monitored parameters at five-minute intervals for the previous hour of monitoring time. All parameters reflect the data on the screen at the time the data was collected.

To view the digital trend screen:

1. At the monitoring display screen, select MENU.
2. From the popup menu, select DIGITAL TREND.

Digital trend for 06:35

Time	0535	0540	0545	0550	0555	0500	0605	0610	0615	0620	0625	0630
SpO2	97	96	97	95	93	95	94	95	96	97	97	97
PR (SpO2)	85	85	84	79	78	77	79	84	85	84	85	85
EtCO2	48	49	46	45	40	38	37	39	38	39	40	39
FiO2	65	65	59	60	61	59	58	57	56	57	58	59
BP Systolic	130	135	136	138	140	135	130	129	128	127	126	127
BP Diastolic	80	75	76	75	80	75	76	77	76	75	80	79
AxI	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
AxE	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9	.9

TREND CLEAR EXIT

Figure 2-6. Digital trend screen

To clear the digital, breath, and 2-minute trends, select TREND CLEAR.

To retain the trends but leave the screen, select EXIT.

Changing alarm limits

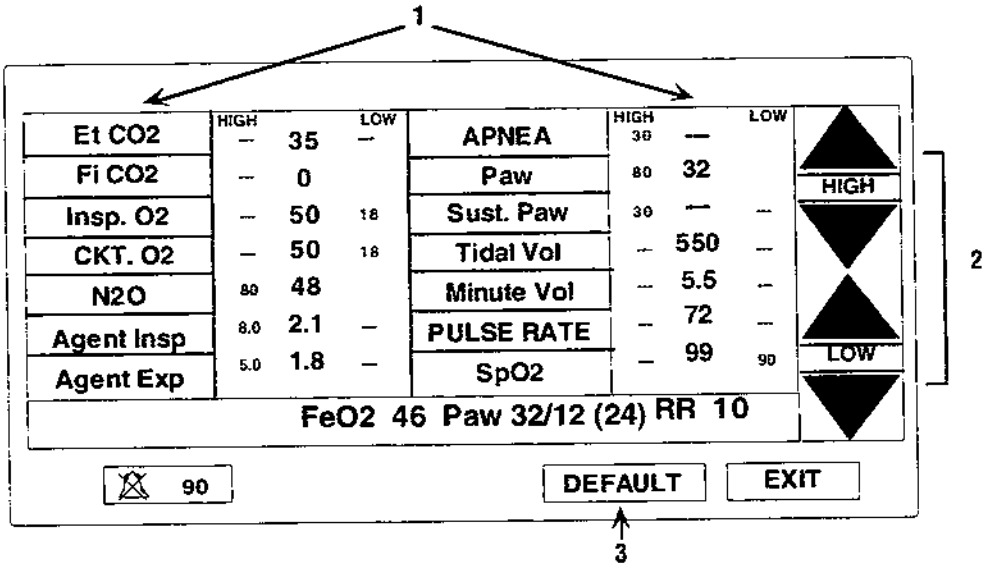


Figure 2-7. Alarm limits screen

You can change all of the limits shown on the screen above. When you change the type of agent being delivered, the alarm limits change to the default limits for the new agent. An advisory message, SET NEW AGENT LIMITS, appears at the top of the screen to remind you that you can choose new limits; otherwise, the default alarm limits are in effect.

To change alarm limits:

1. At the monitoring display screen, select LIMITS.
2. Select the name of the limit you want to change (1).
3. To change a limit for that alarm select the [up] or [down] arrows for the limit you want to change, HIGH or LOW (2).

   Note: To make a large change quickly, hold your finger on the arrow adjustment key. To make a small change, touch the arrow with your finger and remove it, in steps, until you reach the desired alarm limit.
4. After viewing or adjusting the alarm limits, select EXIT to return to the display screen.

   If you want to change all of the alarm limits to their default values, select DEFAULT (3). To confirm your selection, select YES after your see the message ARE YOU SURE?

   All of the default values will appear on the screen.

Alarm types

A complete list of alarm messages you may receive is in 3/Messages and Troubleshooting. The following list describes the types of alarms that may be generated and the results produced on the monitor.

		Indications	
Alarm type	**Meaning**	**Visual**	**Audible**
Emergency. 3-tone repeated	Condition requires immediate action	Flashing red indicator in the lower left area of the display. Alarm message appears in message area. The affected parameter flashes as long as the alarm condition exists.	Three high tones every 5 seconds. Reset automatically when the condition is cleared.
Emergency. 2-tone once	Condition requires immediate action	Flashing red indicator in the lower left area of the display. Alarm message appears in message area. The affected parameter flashes as long as the alarm condition exists.	One high tone and one low tone, only once when the condition occurs. Reset automatically when the condition is cleared.
Warning	Condition requires prompt action.	Flashing yellow indicator in the lower left area of the display. Alarm message appears in message area. The affected parameter flashes as long as the alarm condition exists.	Three low tones every 10 seconds. Reset automatically when the condition is cleared.
Advisory	Condition requires operator awareness but not necessarily action.	Alarm message appears in the message area.	One high tone and one low tone, only once when the condition occurs. Reset automatically when the condition is cleared.
Silent advisory	Condition requires operator awareness but not necessarily action.	Alarm message appears in the message area. Message removed when the condition is cleared.	None.
System failure	Failure within the RGM; remove from operation.	See 3/Messages and Troubleshooting.	Continuous alarm tone.

Patient connections

Follow the instructions for establishing the patient connections that are appropriate for the patient and for the RGM you are using.

- CO_2, N_2O, O_2, and anesthetic agent connections
- SpO_2 connections
- Airway pressure connection
- Flow sensor connection
- Circuit O_2 connection

CO_2, N_2O, O_2, and anesthetic agent connections

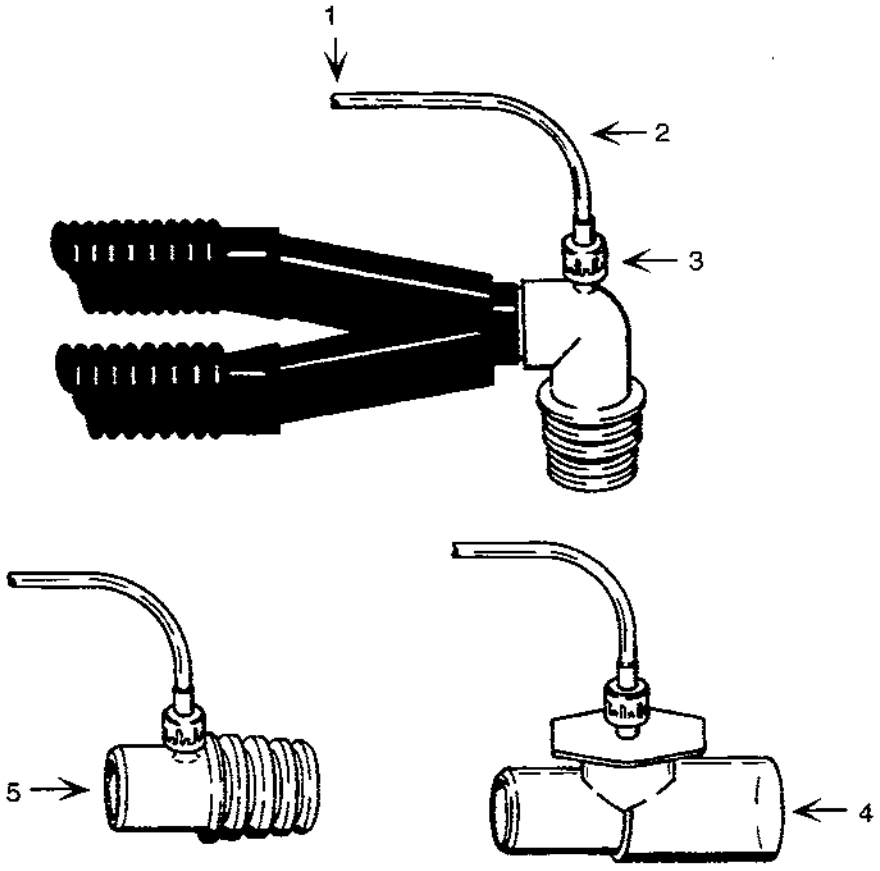


Figure 2-8. Patient circuit adapters (proximal)

1 End of the sample tube that attaches to the RGM sample inlet
2 Sample tube
3 Right angle adapter
4 Straight adapter
5 Critical care adapter

Use the right-angle adapter (3) or the straight adapter (4) for monitoring environments when little or no mucus is present in the patient breathing circuit. High humidity and light fluids, such as water, will be separated by the membrane water separator and collected in the fluid bottle. Heavy mucus may, however, clog the separator. If the patient is likely to aspirate heavy mucus, use the critical care adapter (5) with a replaceable filter. If the critical care adapter filter becomes occluded, replace it.

1. Check that the sample tube assembly is in good condition. If it is not, replace it. Some purging may occur if the sample tube assembly is changed while the monitor is in operation.
2. Connect one end of the sample tube securely to the luer connector on the sample inlet on the front of the monitor.
3. Attach the other end of the sample tube securely into the luer fitting on the patient circuit adapter.
4. Place the patient circuit adapter at the proximal end of the patient circuit.
5. Make sure that the sample exhaust (on the rear panel) is connected to the gas scavenging system or, if necessary, returned to the patient circuit.

SpO_2 connections

WARNINGS: Patient safety—

- **To prevent patient injury or equipment damage, use only Ohmeda sensors with this monitor. Refer to the instructions that came with the sensor you are using to assure compatibility.**
- **Exercise extreme care to assure continued circulation distal to the sensor site after application.**
- **Prolonged monitoring or patient condition may require periodically changing the sensor test site. To reduce the risk of blistering, skin erosion, or ischemic skin necrosis, change the sensor site as specified in the user instructions for the sensor you are using. If any evidence of the above conditions appears before the specified period of time (for example, discoloration or reddening), change the sensor site immediately.**
- **The correct use of the oximetry function of this monitor is to measure only arterial oxygen saturation (SpO_2) and pulse rate.**
  - **A pulse oximeter does not measure respiration and under no circumstances should be used as a substitute for an apnea monitor.**
  - **The oximeter must not be used as the primary monitor for infants being monitored for apnea, either in the hospital or in the home setting. It measures SpO_2 and pulse rate, and only in conjunction with other appropriate monitoring techniques.**
  - **A pulse oximeter is often used during sleep studies with adults, but must be used only to gather information regarding SpO_2 and pulse rate during these studies.**
  - **A pulse oximeter is to be used only by or on the order of medically trained personnel.**

Connect the cable end of the sensor to the SpO_2 connector on the front of the monitor. For specific application of the sensor to the patient, see the instructions shipped with the sensor you are using.

Signal and data validity

Use the all of the following oximeter indicators to determine that the sensor is correctly attached to the patient and that the data are verifiable.

- The heart rate indicator is active.
- The signal strength bar graph shows a strong signal from the SpO_2 sensor.
- The plethysmographic waveform is strong.
- The SpO_2 numeric display is stable.
- The SpO_2 beep sounds with every heart beat.

Signal strength

A LOW QUALITY SpO_2 SIGNAL appears in the message area when the signal is questionable. To remedy the situation,

- Make sure the sensor is properly attached to the patient.
- Perfuse the sensor site and reapply the sensor.
- Select an alternate test site, one with less distance between the emitter and the detector or possibly one with less pigmentation.

See 3/Messages and Troubleshooting for additional causes and recommendations.

Plethysmographic (pleth) waveform

Three complete passes of a valid pleth waveform should be easily identified. Although the waveform shape may vary from patient to patient, under normal conditions it corresponds to the arterial pressure waveform.

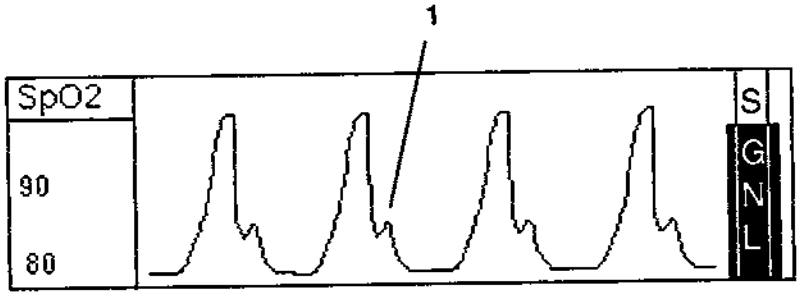


Figure 2-9. Typical adult pleth waveform

1 Dicrotic notch

If you see noise on the waveform, the detector may not be flush with the test site. Make sure the sensor is secure and that the tissue sample is not too thick.

Pulse rate, determined from the pleth waveform, can be disrupted by a cough or other hemodynamic pressure disturbances. Motion at the test site may produce noise spikes in the waveform.

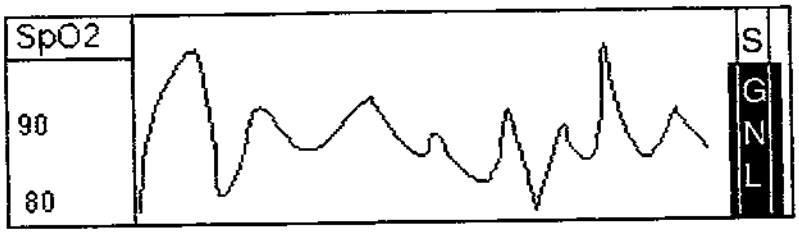


Figure 2-10. Noisy pleth waveform

If three good passes of the waveform do not occur, check the patient and the oximeter setup.

SpO_2 numeric display

You can use the stability of the $Sp\,O_2$ reading as an indicator of signal validity. With practice, you can get a good feeling for changes in the signal that are artifactual or physiological and the speed of each.

The stability of the reading over time is also affected by the SpO_2 averaging interval. In the slower modes, the readings have a tendency to be more stable because the signal averaging is done over a longer interval. To change the averaging interval (SpO_2 average), see "Changing the setup" earlier in this chapter.

SpO_2 beep

The pulse beep tone, with the pitch proportional to the SpO_2 value, occurs with each beat of the heart; the higher the value the high the pitch of the beep and vice versa.

Important: If the pulse rate drops to 40 bpm or less, both SpO_2 and pulse rate are dashed on the screen. If a low pulse rate alarm is enabled, a warning alarm tone (three low tones) sounds, the red alarm light flashes, and the LOW PULSE RATE alarm and the pulse rate flash on the numeric display. If the low pulse rate alarm is not enabled, the alarm will not be activated.

Airway pressure connection

WARNING: Data validity—Do not place the airway pressure adapter on the expiratory check valve of the absorber. Blockages in the tubing circuit can cause high patient airway pressures that may not be detected by the 5250 RGM.

CAUTION: Pressure in excess of 10 psi above atmospheric pressure could damage the P_{AW} inlet or sample inlet to the 5250 RGM.

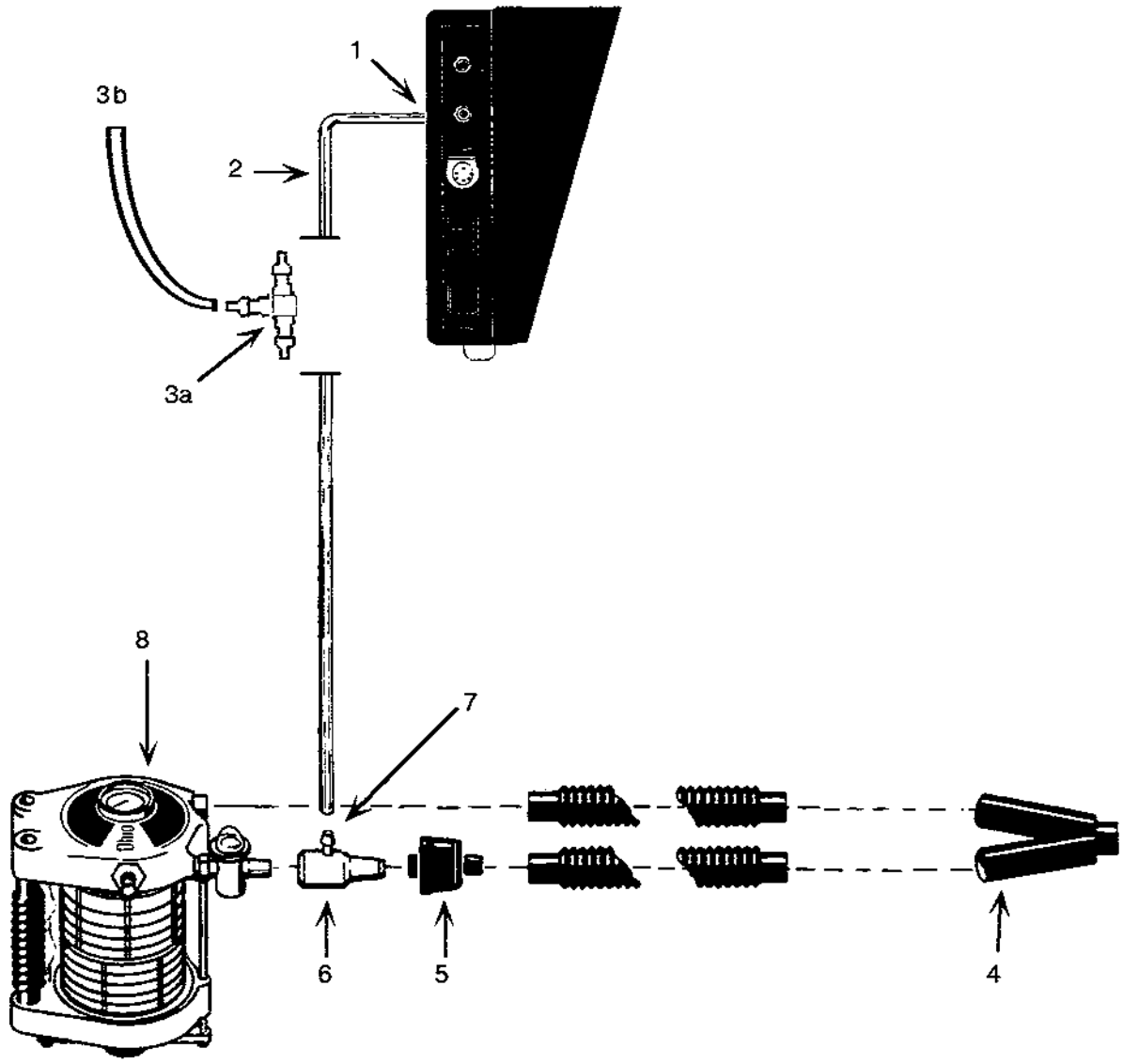


Figure 2-11. Patient circuit adapter connections

1 P_{AW} inlet connection
2 Sensing tube, ⅛ ID
3a 0.32-cm (⅛-in.) tee–78xx ventilator connection
3b To 78xx ventilator
4 Inspiratory limb
5 Bacterial filter
6 Patient circuit adapter
7 Pressure outlet connection
8 Absorber

A built-in transducer senses the patient airway pressure by way of a pressure-sensing tube connected to the breathing circuit. Use one of the following options to sense the airway pressure:

- From the PAW inlet on the RGM to a pressure-sensing tube to the 78xx ventilator.

  Note: In many instances, a pressure sense line is attached by way of an 1/8-in. tubing from the patient circuit to the ventilator. This tubing can be cut at a convenient location, and the 1/8-in. tee (specified in 4/Maintenance, Calibration, and Service) can be inserted. (See Figure 2-11.) Run a piece of tubing from this tee to the RGM.

- From the PAW inlet on the RGM to a patient circuit adapter tee to the inspiratory limb.

78xx ventilator connection

In many instances pressure-sensing tubing is attached by way of a tee from the patient circuit to the ventilator.

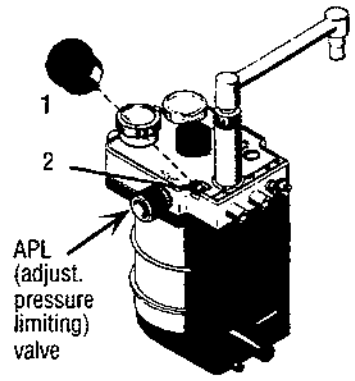
1. Cut the tubing at a convenient location.
2. Insert the tee
3. Use a second length of tubing from the tee to the PAW inlet on the RGM.

Patient circuit adapter connection

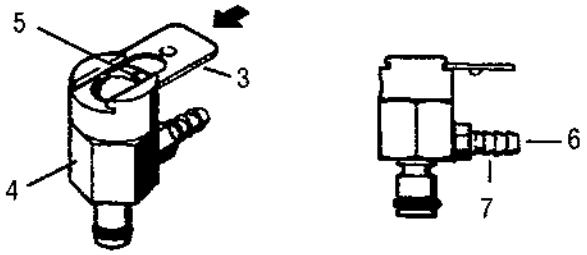
1. Place the circuit adapter in the inspiratory limb.
2. Mount the adapter with the pressure outlet pointing up.

GMS absorber connection

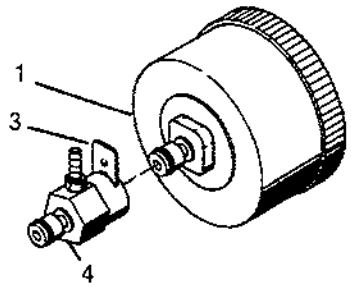
The pressure-sensing tube can also be connected to the GMS absorber in a position beneath the pressure gauge as follows:



1. Remove the pressure gauge (1) from the GMS absorber by pressing the latch (2).

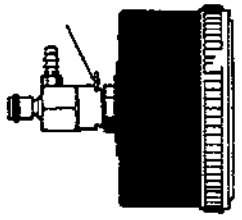


2. Partially insert the retaining clip (3) into the coupling (4) from the side of the coupling with the hole (5). Be sure the raised point (6) on the clip is facing inward toward the pressure outlet (7).

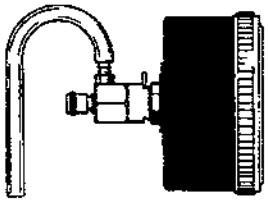


3. Fully insert the pressure gauge (1) into the coupling (4). The retaining clip (3) can be easily pushed in until the raised point touches the coupling.

4. Use pliers or a similar tool to squeeze the retaining clip into the coupling until the raised spot snaps into the hole on the coupling. The clip will stay in the coupling and extend out about 0.48 cm (3/16 in.).



5. Replace the pressure gauge, with the coupling attached, in the absorber.



6. Slip one end of the tubing over the pressure outlet on the coupling and attached the other end to the PAW inlet on the RGM.

Figure 2-12. GMS pressure gauge coupling installation

Flow sensor connection

WARNINGS: Data validity—

- **The tidal and minute volume alarms are usable only if the TVX flow cartridge is installed in the correct section of the breathing circuit. Operate the 5250 RGM only with the TVX flow cartridge placed in the expiratory limb or common airway of the breathing circuit. If the flow sensor is placed in the inspiratory limb, the monitor will not provide exhaled volume data.**
- **If the 5250 RGM is used with a hanging-bellows type of anesthesia ventilator, the monitor may register volumes in spite of circuit disconnection.**
- **To prevent erroneous tidal and minute volume readings, position the tubing so that water drains away from the TVX flow cartridge. If water accumulates in the TVX flow cartridge, it will restrict the motion of the internal vanes in the cartridge.**
- **Exposure of the sensor clip to a direct beam of light may cause erroneous tidal volume and minute volume readings. Shield the TVX flowsensor clip with opaque material if the reading is suspect.**

Proximal sensor mounting

The flow sensor performs well when the sensor is mounted distally. Accuracy is optimized, however, when the sensor is mounted proximally to the patient.

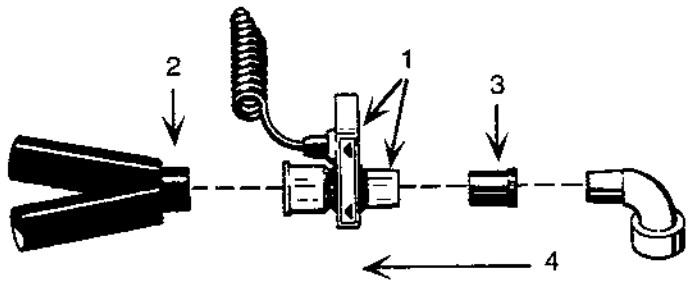


Figure 2-13. Proximal flow sensor connection

1 TVX flow sensor with cartridge
2 Inhaler "Y" connection
3 Endotracheal tube adapter
4 Direction of expiratory flow from patient

1. Install the cartridge with the sensor clip (1) attached between the inhaler "Y" connection (2) and the endotracheal tube adapter (3).

WARNING: Patient safety—The flow sensor must be correctly oriented in the breathing circuit as indicated by the markings on the sensor clip. The arrows must point away from the patient. If the clip is not mounted correctly, the RGM will not operate properly.

2. Check the orientation of the sensor clip on the cartridge. The clip is marked with arrows to indicated the proper air flow direction through the cartridge. When correctly installed, the arrows on the clip point **away** from the patient and toward the inhaler "Y" connection.

   To minimize interference from cords and tubes, disconnect the sensor clip from the transducer cartridge during intubation of a patient. The clip (1), with its attached cord, can be unsnapped from the cartridge (2) and placed out of the way. When you are ready, snap the clip back onto the cartridge to resume monitoring.

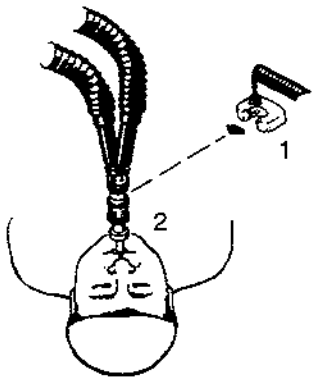


Figure 2-14. Sensor clip replacement after intubation

Distal sensor mounting

Distal placement of the sensor allows the RGM to detect reverse flows through the exhalation check valve and makes it less likely that the sensor will come in contact with patient mucus. The data from distal placement, however, is less precise than that of proximal mounting because of breathing circuit compliance.

CAUTION: When placing the TVX flow cartridge on the absorber valve, be certain to obtain a secure fit but do not force the cartridge in place as tightly as possible. Because the sensor cartridge is tapered, you can achieve a secure fit without excessive force.

A properly placed cartridge is removable by hand but keep a tool (pliers or channel-lock pliers) available to remove the cartridge in case it has been jammed on too tightly.

Before every use, make sure that TVX flow cartridge is operational and easily removable.

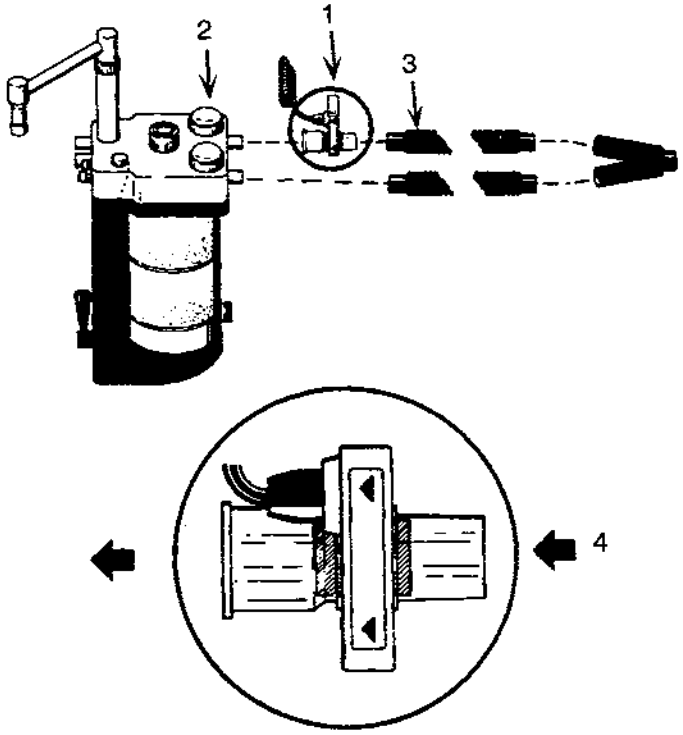


Figure 2-15. Proper sensor and clip positioning in distal mounting

1 TVX flow sensor clip with cartridge
2 Exhalation check valve
3 Expiratory limb from the inhaler "Y" connection
4 Direction of flow from patient

1. Install the cartridge (1) with the sensor clip attached between the exhalation check valve (2) and expiratory limb (3) from the inhaler "Y" connection.

WARNING: Patient safety—The flow sensor must be correctly oriented in the breathing circuit as indicated by the markings on the sensor clip. The arrows must point away from the patient. If the clip is not mounted correctly, the 5250 RGM will not operate properly.

2. The sensor clip is marked with arrows to indicate the correct airflow direction through the cartridge. Be sure the clip is correctly installed with the arrows pointing **toward** the exhalation check valve and **away** from the patient (4).

Circuit O_2 sensor connection

WARNINGS:

- **Patient safety—The circuit O_2 display and alarms operate only if enabled on the Setup Screen and if a calibrated circuit O_2 sensor is installed. The RGM must be calibrated for the currently installed O_2 sensor.**
- **Data validity—Keep the circuit O_2 sensor attached to the monitor to assure accurate O_2 readings. If detached, the sensor must be reattached and stabilized for a length of time equal to the time it was detached (up to a maximum of 14 hours) before recalibrating.**
- **Data validity—The oxygen monitoring portion of the 5250 RGM monitor should be calibrated at the same temperature at which it will be used to monitor oxygen delivery in the patient circuit. Operation at temperatures other than those present during calibration may result in readings outside of the stated accuracy for the monitor. When the ambient temperature changes, we recommend that you recalibrate the monitor for maximum accuracy. Refer to the O_2 sensor information sheet for more details.**

CAUTION: Avoid storing O_2 sensors outside the temperature range of -20 °C to 50 °C (-4 °F to 122 °F). O_2 sensors must have shorting clips or be connected to the monitor when in storage or not in use.

You can insert the circuit O_2 sensor assembly into the gas stream you want monitored one of two ways:

- Directly into the manifold of a GMS absorber, into the inspiratory limb of the patient circuit using the 22-mm tee manifold supplied with the monitor.
- Using the Dome Adapter Kit for the inhalation check valve on an Ohmeda (Ohio) absorber.

To mount the circuit O_2 sensor in the inspiratory limb:

1. Insert the adapter between the patient circuit and the outlet of the absorber.
2. Insert the O_2 sensor into the 15-mm port, mounting the sensor vertically with the sensor opening facing down and the cord end facing up.

CAUTION: To reduce moisture buildup on its sensing surface, the circuit O_2 sensor must always be facing downward when in use.

3. Insert the O_2 sensor plug in the O_2 connector on the rear panel of the monitor.
4. Switch on the monitor and allow it to warm up for at least ten minutes.
5. The alarm limits are preset. If you want to change the settings, see "Changing alarm limits" earlier in this chapter.
6. Calibrate the patient circuit O_2 sensor; see 4/Maintenance, Calibration, and Service.

Application notes:

- When the O_2 sensor is used in the patient circuit of a ventilator or anesthesia gas machine, water vapor will condense on the surface of the sensor if the sensor's temperature is lower than or equal to the dew point temperature of the breathing gas. The condensate acts as an additional diffusion resistance and may result in a lower than actual O_2 concentration display because of slower response times.
- In the patient circuit of a ventilator, place the O_2 sensor ahead of the breathing gas humidifier.
- Continuous exposure of the O_2 sensor to CO_2 gas mixture can reduce the service life of the sensor; **it will not affect the accuracy of the readings**. The service life of the sensor is 5,000 percent hours/C O_2. Using the sensor in a gas mixture containing 1% CO_2 for 5 hours would reduce the service life of the sensor by 0.1%. However, since the sensor should preferably be located in the inspiratory section of the patient circuit, service life reduction as a result of CO_2 is minimal.
- The O_2 sensor provides information about the presence of O_2 at the point of sensing. This is not necessarily the same percentage that is present throughout the patient circuit.

Notes

3/Messages and Troubleshooting

This chapter is divided into two sections:

- Listed alphabetically, the messages, including alarms, that may appear in the message area of the display.
- Monitor conditions and/or symptoms that may occur.

Both sections contain the possible causes and recommended actions to correct the problem.

There are no user-serviceable parts in the 5250 RGM except the O_2 sensor and the autozero scrubber. Several components, however, can be accessed without removing the cover from the monitor. Replacing a defective component or making a suggested adjustment may restore a malfunctioning monitor.

If the recommended action is to **replace a component or to calibrate** some portion of the RGM, the instructions are found in 4/Maintenance, Calibration, and Service.

If the recommended action is to remove the monitor from use because it requires service, see "Service" in 4/Maintenance, Calibration, and Service.

Messages

Message	Cause(s)	Recommended action(s)
ACX DECODE TASK FAIL	System failure	Unit requires service.
ACX XMIT TASK FAIL	System failure	Unit requires service.
AGENT DETECTED (1-tone emergency)	Photometer detects an agent	Select agent being delivered.
ANALOG FAIL	System failure	Unit requires service.
AUTO ZERO IN PROGRESS (silent advisory)	Autozero calibration is in progress.	No action required.
BLOOD PRESSURE COMM FAIL (silent advisory)	System failure	Activate RS-232 device for blood pressure connection.
	Blood pressure monitor is not connected.	Check connections.
CALIBRATE TASK FAIL	System failure	Unit requires service.

Message	Cause(s)	Recommended action(s)
CO_2 APNEA (silent emergency)	Lapse in CO_2 detection	Check patient/ventilator for respiration. Check for any disconnections.
COMMUNICATIONS FAIL	System failure	Unit requires service.
DEVICE OVERHEATED (advisory)	Cooling fan ventilation holes are blocked.	Make sure there is adequate circulation for the cooling fan and that nothing is blocking the holes.
	Cooling fan failure	If condition persists, unit requires service.
DISPLAY CPU FAIL	System failure	Unit requires service.
DISPLAY DECODE TASK FAIL	System failure	Unit requires service.
DISPLAY DIAG TASK FAIL	System failure	Unit requires service.
DISPLAY RAM FAIL	System failure	Unit requires service.
DISPLAY ROM CHECKSUM FAIL	System failure	Unit requires service.
DISPLAY TASK FAIL	System failure	Unit requires service.
DISPLAY TOUCH PANEL FAIL	System failure	Unit requires service.
DISPLAY TREND TASK FAIL	System failure	Unit requires service.
DISPLAY VIDEO RAM FAIL	System failure	Unit requires service.
DISPLAY XMIT TASK FAIL	System failure	Unit requires service.
EVENT TASK FAIL	System failure	Unit requires service.
GAS ANALYZER INOPERATIVE (advisory)	Photometer measured greater than 15% CO_2.	Remove sample line until the message goes away.
	Intermittent (fewer than two occurrences per day).	No problem, normal operation.
	If more often, install ACX-100 RAM upgrade kit.	Unit requires service. See "Upgrade Options" in 4/Maintenance, Calibration, and Service."
GAS ANALYZER SATURATED (warning)	Moisture in the measurement chamber.	Unit requires service.
	Gas analyzer calibration incorrect.	Recalibrate internals.
GAS ANALYZER WARM-UP (silent advisory)	Gas analyzer is warming up; not yet ready to monitor.	No action required.
HIGH CIRCUIT O_2 (warning)	High Alarm Limit violated	Check High Alarm Limit setting. Check O_2 setting.
HIGH Et CO_2 (emergency)	High Alarm Limit violated	Check patient. Check High Alarm Limit setting. Check ventilator settings. Check breathing circuit.

Message	Cause(s)	Recommended action(s)
HIGH EXPIRED AGENT (emergency)	High Alarm Limit violated	Check vaporizer setting, check that vaporizer selected is the agent the RGM should be monitoring.
HIGH EXPIRED O_2 (emergency)	High Alarm Limit violated	Check High Alarm Limit setting. Check O_2 setting.
HIGH Fi CO_2 (emergency)	High Alarm Limit violated	Check patient. Check breathing circuit. Check alarm limit setting. Unit requires service.
HIGH INSPIRED AGENT (emergency)	See High Expired Agent message	See High Expired Agent message.
HIGH INSPIRED O_2 (emergency)	High Alarm Limit violated	Check High Alarm Limit setting. Check O_2 setting.
HIGH MINUTE VOLUME (warning)	High Alarm Limit violated	Check ventilator settings. Check alarm limit setting.
HIGH N_2O (emergency)	High Alarm limit violated	Check N_2O flowmeter setting. Unit requires service.
HIGH Paw (warning)	High Alarm Limit violated	Check ventilator settings. Check APL valve.
HIGH PULSE RATE (warning)	High Alarm Limit violated	Check patient. Check ECG. Check alarm limit setting.
HIGH Sp O_2 (warning)	High Alarm Limit violated	Check O_2 setting, check alarm limits setting.
HIGH SUSTAINED Paw (emergency)	High Alarm Limit violated	Check breathing circuit. Check alarm limit settings.
HIGH TIDAL VOLUME (warning)	High Alarm Limit violated	Check ventilator settings. Check alarm limit setting.
INTERFERENCE ON Sp O_2 (advisory)	Artifact (interference) detected	Check for motion, electromagnetic interference, ambient light.
INVALID AGT SPAN or INVALID AGT ZERO	Leak in calibration sampling system.	Check sample tube connections, be sure the calibration canister is not empty, and make sure the calibration gas reservoir bag has no leaks. See "Respiratory gas calibration."
	Wrong calibration gas.	Check for correct calibration gas mixture. See "Zero and span calibration" in 4/Maintenance, Service, and Calibration.
	Invalid data reading.	Retry zero or span calibration.

Message	Cause(s)	Recommended action(s)
CKT O_2 ZERO ERR or CKT O_2 SPAN ERR (calibration result)	Circuit O_2 sensor or cable may not be installed, or O_2 sensor may be at end of life cycle.	Check that the circuit O_2 cable is plugged into the correct jack on the rear panel. Check the O_2 sensor. Replace O_2 sensor if necessary.
	Span calibration attempted before zero calibration.	Calibrate at 21% first.
INVALID CO_2 SPAN or INVALID CO_2 ZERO	Leak in calibration sampling system.	Check sample tube connections, be sure the calibration canister is not empty, and make sure the calibration gas reservoir bag has no leaks. See "Respiratory gas calibration."
	Wrong calibration gas.	Check for correct calibration gas mixture. See "Zero and span calibration" in 4/Maintenance, Calibration, and Service.
	Invalid data reading.	Retry zero or span calibration.
INVALID N_2O SPAN or INVALID N_2O ZERO	Leak in calibration sampling system.	Check sample tube connections, be sure the calibration canister is not empty, and make sure the calibration gas reservoir bag has no leaks. See "Respiratory gas calibration."
	Wrong calibration gas.	Check for correct calibration gas mixture. See "Zero and span calibration" in 4/Maintenance, Calibration, and Service.
	Invalid data reading.	Retry zero or span calibration.
INVALID O_2 ZERO or INVALID O_2 SPAN (result of circuit sensor calibration)	Leak in O_2 sensor housing. O_2 sensor not installed or O_2 sensor reaching end of life cycle.	Tighten the O_2 sensor housing. If condition persists, replace O_2 sensor.
INVALID SPAN	No gas applied within 10 seconds or pneumatics blocked.	If continuous, remove monitor from use; requires service. If less than once per day, ignore.
INVALID ZERO or INVALID AUTO ZERO (advisory)	Pneumatic error. Auto zero valve, purge valve, or autoscrubber failure.	Unit requires service. **Note:** An occasional (less than twice a day) N_2O, CO_2, or agent error is normal.
	No sensor hooked up to monitor.	Make sure sensor is attached to SpO_2 connector on front panel.

Message	Cause(s)	Recommended action(s)
LOW CIRCUIT O_2 (emergency)	Low Alarm Limit violated	Check High Alarm Limit setting. Check O_2 setting.
LOW CIRCUIT O_2 (continuous alarm)	Circuit O_2 sensor or cable may not be installed, or O_2 sensor may be at end of life cycle.	Make sure the circuit O_2 cable is plugged into the correct jack on the rear panel. Check the O_2 sensor and replace it, if necessary.
LOW EtCO_2 (emergency)	Low Alarm Limit violated	Check patient. Check High Alarm Limit setting. Check ventilator settings. Check breathing circuit.
LOW EXPIRED AGENT (emergency)	Low Alarm Limit violated	Check vaporizer setting, check vaporizer agent level.
LOW INSPIRED AGENT (emergency)	Low Alarm Limit violated	Check vaporizer setting, check vaporizer agent level.
LOW INSPIRED O_2 (emergency)	Low Alarm Limit violated	Check O_2 setting. Check O_2 supply/pressure gauge.
LOW INSPIRED O_2 (continuous alarms)	O_2 sensor is not installed or O_2 sensor reaching end of life cycle	Install O_2 sensor, if necessary. Replace O_2 sensor.
LOW MINUTE VOLUME (warning)	Low Alarm Limit violated	Check for ventilator settings. Check for disconnections.
LOW PULSE RATE (warning)	Low Alarm Limit violated	Check ECG. Check patient.
LOW QUALITY SpO_2 SIGNAL (silent advisory)	Sensor may not be in an optimal location	Check sensor site at patient. See the user instructions for the sensor you are using.
LOW Sp O_2 (emergency)	Low Alarm Limit violated	Check patient. Check FiO_2.
LOW SUSTAINED Paw (warning)	Low Alarm Limit violated	Check for disconnections. Check ventilator settings.
LOW TIDAL VOLUME (emergency)	Low Alarm Limit violated	Check for disconnections. Check ventilator settings.
NO BREATH DATA	System failure	Unit requires service.
NO FLOW (advisory)	Sample pump failure.	Unit requires service.
	Sample flow calibration incorrect.	Calibrate sample flow.
NO Sp O_2 PROBE (silent advisory)	No sensor is connected to monitor	Connect sensor to monitor.
NO VACUUM (advisory)	Significant internal pneumatics leak or pump failure.	Unit requires service.
	Barometric pressure calibration incorrect.	Unit requires service.
PNEUMATIC TASK FAIL	System failure	Unit requires service.

Message	Cause(s)	Recommended action(s)
PURGING (advisory)	System is clearing moisture from the sample tube assembly.	No action required, normal operation.
	If the purging is occurring frequently, the sample line may be occluded.	Check sample line for sharp bends or for a kinked line. If sample line needs replacing, see the respiratory gas connection section in 2/Operations.
PURGING (followed by SAMPLE LINE/FILTER BLOCK)	Purging system cannot clear blocked line	Replace sample tube assembly and reset monitor; see the respiratory gas connection section in 2/Operations. Replace the sample filter cartridge. If condition persists, unit requires service.
RECALIBRATE GAS ANALYZER, RECALIBRATE BAROMETER, RECALIBRATE Paw, or RECALIBRATE CIRCUIT O_2 (when powered on, constant recurrence) (advisory)	Calibration required	Unit requires service. See *5250 RGM Service Manual.*
REVERSE FLOW (warning)	Clip could be reversed. Exhalation valve may be stuck open.	Check that flow sensor clip is installed correctly. Unit requires service.
SAMPLE FILTER BLOCKED (advisory)	Sample filter cartridge occluded.	Replace sample filter cartridge.
SAMPLE LINE/FILTER BLOCK (warning)	Purging system cannot clear blocked line or filter	Replace sample tube assembly and reset monitor as detailed in the respiratory gas connection section in 2/Operations.
SERIAL DEVICE ERROR (advisory)	Incorrect baud rate or data frame length/parity mismatch on RS-232 communication port.	See "Serial communications" in C/RS-232 Communications for details on setting baud and parity for external device communications.
	Serial chip may have failed.	Turn off the serial device (you can continue to use the RGM). The signal processor board may need to be replaced; requires service.
SERIAL TASK FAIL	System failure	Unit requires service.
SERVICE TASK FAIL	System failure	Unit requires service.
SET NEW AGENT LIMITS (advisory)	You have changed agents. System automatically changes to default settings for the new agent.	If you want to use the default settings, no action is required. To change the settings, see "Changing alarm limits" in 2/Operations.

Message	Cause(s)	Recommended action(s)
SIGNAL CPU FAIL	System failure	Unit requires service.
SIGNAL DECODE TASK FAIL	System failure	Unit requires service.
SIGNAL DIAG TASK FAIL	System failure	Unit requires service.
SIGNAL RAM FAIL	System failure	Unit requires service.
SIGNAL ROM CHECKSUM FAIL	System failure	Unit requires service.
SIGNAL TREND TASK FAIL	System failure	Unit requires service.
SpO_2 INOPERATIVE (advisory)	System failure	Unit requires service.
SpO_2 INSUF LIGHT DETECTED (silent advisory)	Sensor failure	Check sensor/sensor site. Replace if necessary. See the user instructions for the sensor you are using.
SpO_2 PROBE FAIL (advisory)	Sensor failure	Replace sensor.
SpO_2 PROBE ID ERROR (advisory)	Unit cannot recognize sensor.	Check that sensor is an Ohmeda sensor.
SpO_2 PROBE OFF PATIENT (emergency)	Sensor is off patient.	Reconnect patient to sensor. See the user instructions for the sensor you are using.
SUB-ATMOSPHERIC Paw (emergency)	Negative pressure in breathing circuit	Check patient. Check scavenging system.
TARGET CHECK TASK FAIL	System failure	Unit requires service.
VENT-CHECK GAS SUPPLY (advisory)	O_2 supply may be low.	Check O_2 supply.
VENT-CHECK O_2 PROBE (advisory)	O_2 sensor may be failing	Calibrate O_2 sensor. Replace if necessary.
VENT-HIGH CIRCUIT O_2 (emergency)	O_2 concentration ≥ to set limit.	Check O_2 setting. Check alarm limit on ventilator.
VENT-HIGH Paw (emergency)	PAW ≥ to set limit.	Check ventilator settings. Check alarm limit setting on ventilator.
VENT-HIGH SUSTAINED Paw (emergency)	Sustained PAW ≥ to set limit.	Check breathing circuit. Check alarm limit setting on ventilator.
VENT-LOW CIRCUIT O_2 (emergency)	O_2 concentration ≤ to set limit.	Check O_2 supply.
VENT-LOW MINUTE VOLUME (warning)	Minute Volume ≤ to set limit.	Check ventilator settings/limits. Check breathing circuit.
VENT-LOW Paw (emergency)	PAW ≤ to set limit.	Check breathing circuit. Check ventilator settings/limits.
VENT-REVERSE FLOW (warning)	Flow of gas in opposite direction detected.	Check breathing circuit. Check patient.
VENT-SUBATMOSPHERIC PAW (emergency)	PAW ≤ 10-cm H_2O.	Check patient. Check breathing circuit scavenging system.
VENT-TIDAL VOLUME APNEA (silent emergency)	Insufficient volume detected for 30 seconds.	Check ventilator. Check breathing circuit.

Message	Cause(s)	Recommended action(s)
VENT-TV APNEA ALARM OFF (advisory)	Tidal volume set < 300 mL and mechanical ventilation set to "off"	Set tidal volume to > 300 mL to activate alarm.
VENT-VOL MONITOR STANDBY (advisory)	System waiting for first breath to activate volume monitoring and apnea timer.	No action required
VENT-VOLUME SENSOR FAIL (advisory)	Volume sensor inoperative	Check TVX cartridge. Check volume sensor.
VENTILATOR COMM FAIL (silent advisory)	RS-232 connection to ventilator not working.	Check RS-232 connections.
WATER TRAP FULL, PUMP OFF (warning)	Water bottle is full.	Empty the water bottle; see "Water bottle removal."

Symptoms and conditions

Symptom/condition	Cause(s)	Recommended action(s)
RGM fails to respond when power is turned on.	No power to the monitor.	Make sure the power cord is securely connected to both the RGM and the AC mains power supply.
	Fuses may have blown.	Replace fuses; see "Fuse replacement" in 4/Maintenance, Calibration, and Service.
Display blank, the yellow alarm indicator is lit, and/or the audible alarm sounds continuously.	System failure	Unit requires service.
CO_2 or N_2O values are higher than expected.	Gas calibration incorrect	Perform gas calibration.
	Wrong calibration gas used	Verify gas concentration is correct for agent or non-agent monitor. See warning in zero and span calibration procedure.
Values for any of the gases are lower than expected.	Gas calibration incorrect	Perform gas calibration.
	Leak in pneumatics	Unit requires service.
	Wrong agent selected	Select correct agent.
	Wrong calibration gas used	Verify gas concentration is correct for agent or non-agent monitor. See warning in zero and span calibration procedure.

Message	Cause(s)	Recommended action(s)
Values for agent are higher than expected.	Gas calibration incorrect	Perform gas calibration.
	Traces of isopropyl alcohol used to clean breathing circuits	Flush the circuit.
	Wrong agent selected	Select correct agent.
	Patient has high concentration of alcohol in blood stream	Ignore high reading.
	Measurement chamber contaminated	Unit requires service.
	Vaporizor output incorrect	Check vaporizer output.
	Wrong calibration gas used	Verify gas concentration is correct for agent or non-agent monitor. See warning in zero and span calibration procedure.
CO_2 reads correctly in % but not in mmHg.	Wrong barometric pressure used for conversion	Unit requires service.
Spiking on agent or CO_2 channel (agent monitor [with ACX-100 photometer] only)	Measurement board software revision 0.53 or 0.60 installed	Unit requires installation of ACX ROM upgrade, requires service.
SpO_2 is inoperative.	SpO_2 software is incompatible with RGM software.	Unit requires service.
1% to 2% N_2O reading appears when no N_2O is present.	An interaction between the anesthetic agent and N_2O absorption wave lengths in the gas analyzer may infrequently produce this phenomena. It is most likely to be seen with isoflurane and is clinically insignificant.	No action required.
Zero readings in calibrate mode drift and require frequent adjustment.	The measurement chamber is contaminated or may be saturated with water.	Unit requires service.

Notes

4/Maintenance, Calibration, and Service

This chapter contains

- A recommended maintenance and calibration schedule.
- Safety procedures to follow when working with the RGM.
- Cleaning procedures
  - Monitor
  - Patient circuit O_2 sensor
  - Patient flow sensor
  - Expendable items
- Calibration procedures
  - Respiratory gas; zero and span
  - Patient circuit O_2 sensor
  - Airway pressure
  - Barometric pressure check and calibration, and airway pressure and sample flow calibration
- Replacement procedures
  - Sample filter cartridge
  - Auto zero scrubber (agent RGMs only)
  - Fuses
  - Internal O_2 sensor
  - Patient circuit O_2 sensor
  - Software
  - Transducer flow sensor cartridge and clip
- Accessories
  - Standard
  - Optional

Maintenance and calibration schedule

Weekly	Clean monitor.
Monthly	Perform O_2 sensor linearity check.
Thirty days	Replace transducer cartridge and/or flow transducer clip.
Yearly	Agent RGMs only—Replace auto-zero scrubber.
As necessary	Clean patient circuit O_2 sensor.
	Clean O_2 sensor cartridge.
	Clean patient flow sensor.
	Perform a zero and span calibration (when accuracy is suspect or after RGM has been returned after service).
	Calibrate the patient circuit O_2 sensor (after installation of a new O_2 sensor or after ambient temperature changes).
	Replace the sample filter cartridge.

Safety procedures

When handling any component of the 5250 RGM that may have come in contact with patient exhalant or fluids, always wear

- Safety eye glasses.
- Disposable waterproof gloves.
- Mask and gown.

Cleaning procedures

Monitor

WARNING: Electric shock hazard—Always unplug the monitor from AC mains power before cleaning or servicing.

CAUTIONS:

- Do not autoclave, pressure sterilize, or gas sterilize the 5250 RGM.
- Do not immerse the monitor in liquid. The electronic circuitry can be short circuited, causing permanent damag to internal components.
- Do not use organic-, petroleum-, or acetone-based solutions, or other harsh solvents, to clean the display panel or the unit. These substances attack the device's materials and device failure may result.
- Use the cleaning solution sparingly. Do not saturate the RGM. Excessive solution can flow into the unit and cause damage to its internal components.

Clean the monitor weekly, or more frequently if necessary.

1. You must, at all times,
   - Wear safety eyeglasses.
   - Wear disposable waterproof gloves.
2. If they have been used, remove and disgard the sample filter line and water separator cartridge in a receptacle designated for patient wastes.
3. If necessary, empty the water bottle and rinse clean.
4. Clean the outside surface of the RGM with a soft cloth dampened with a mild soap and water solution or with isopropyl alcohol (70%).
5. Discard the cloth.
6. Clean the display with a cotton swab dampened with 70% isopropyl alcohol and gently wipe the panel. Do not touch, press, or rub the display panel with abrasive cleaning compounds, instruments, brushes, rough surface materials, or anything that can scratch the panel. Do not use organic solvents to clean the display panel.
7. Discard the cotton swab.
8. Wait for the monitor surface to dry completely before handling.
9. Insert new water separator cartridge and replace the water bottle.
10. Remove gloves and discard.
11. Wash hands.

Note: You must allow the monitor to dry thoroughly before returning it to use.

Patient circuit O_2 sensor

O_2 sensor assembly (without cartridge) and tee manifold

Clean the sensor assembly and the sensor cartridge separately. The sensor's front housing and the sensor cartridge (screened surface) are the only parts of the sensor assembly that are exposed to the patient circuit. To remove the sensor cartridge, follow the instructions in "Patient circuit O_2 sensor replacement" later in this chapter.

Sensor house, rear half and cable assembly: The electrical contacts in this housing do not require cleaning under normal use. If required, the rear housing and cable assembly can be wiped with a cloth moistened in disinfectant.

CAUTION: Do not immerse the rear half of the housing in cleaning solution.

Sensor housing, front half and tee manifold: These components can be gas sterilized using an ethylene oxide mixture (low temperature methods only).

O_2 sensor cartridge

Do not clean the sensor cartridge routinely. However, if it is necessary to do so, follow these recommendations.

CAUTION: To avoid damaging the sensor cartridge, handle it with care.

1. Remove salt deposits and dirt accumulation from the sensor with a cloth moistened in distilled water. Do not saturate the sensing membrane with liquid.
2. If required, isopropyl alcohol can be used in place of water.
   - Do NOT autoclave the sensor cartridge.
   - Do NOT cold sterilize (disinfect) the sensor cartridge.
   - Do NOT use solvents or cleaning agents other than water or isopropyl alcohol.
3. To avoid inaccurate readings, allow the sensor to dry completely before use (approximately 24 hours).

Patient flow sensor

The transducer cartridge MUST be snapped out of the sensor clip for cleaning.

The transducer cartridge is a precision device containing jeweled bearings and is assembled to close tolerances.

- Do not drop the cartridge.
- Do not allow any contaminants (such as hair) to enter the cartridge.

CAUTION: To prevent damage to the precision movement, never insert cleaning brushes or other foreign objects through the flow cartridge vanes.

Replace the cartridge if it becomes clogged or obstructed.

If the cartridge is disinfected with liquid agents, it must be completely dry before use. Once dry, the cartridge is ready for use; it does not require lubrication.

Clean the sensor clip with a cloth moistened in a mild liquid detergent solution (wetting agent). Isopropyl alcohol can be used if further cleaning is required.

CAUTION: Use the recommended cleaning solution sparingly; do not saturate or immerse the flow sensor clip.

Expendable items

Sample tube assembly

The sample tube assembly and optional and standard patient circuit adapters are expendable items. Cleaning these items is **not** recommended. However, if required, the sample tube can be disinfected by following standard hospital procedures.

Internal filters

CAUTION: Over extended periods of exposure, the presence of nebulized agent in the sample gas (such as Mucomyst®) may tend to obstruct internal RGM filters.

The monitor contains several filters that do not require regular maintenance. If, however, a clogged or contaminated filter is indicated (reduced flow), the unit requires service.

Calibration procedures

Respiratory gas calibration

WARNINGS:

- **Handle this equipment with care—Handle the 5250 RGM with care. Damage to the RGM or inaccurate operation may result from improper handling.**
- **Data validity—Do not operate the 5250 RGM unless it is properly calibrated. Inaccurate patient parameter readings will result.**
- **Failure of operation—If the 5250 RGM fails to respond as described in the calibration procedure, do not use that portion of the monitor until the malfunction is corrected.**

Note: The RGM must be calibrated in the calibrate mode detailed below. Do not use a pressurized calibration gas to check the readings in the monitoring mode. In the monitoring mode the RGM records peak values, and if the gas is supplied under pressure, the readings may be slightly higher than the actual gas value.

To ensure that the gas monitoring portion of the RGM is working properly, a periodic calibration is required. Perform the following calibration checks

- Whenever the accuracy of the RGM is suspect,
- Whenever the RGM is returned to use after service.

Two forms of calibration are involved: zero (baseline) calibration and span calibration, which requires a calibration gas.

Note: To ensure adequate pressure, make sure the calibration gas is at room temperature before use (for up to eight hours).

Zero calibration

The RGM automatically zeros after five minutes, then every hour. The RGM should be manually zeroed prior to span calibration, as detailed in the calibration procedure. Since the RGM aspirates the patient sample, contaminants that may be present can accumulate in the gas optical detector. More contaminants accumulate in a high-humidity and high-patient-secretion environment (such as an ICU) than in a dryer environment (such as an OR).

Contaminants in the optical detector offset the zero baseline. The RGM's auto zero controls are used to compensate for the zero offset.

Non-agent RGM only: When the offset due to contaminants becomes too large to be calibrated out, the measurement chamber of the photometer must be cleaned and the zero calibrated; the unit requires service.

Span calibration

In a clean environment, the span calibration drift is less than 1.5 mmHg for CO_2, 2% for N_2O, and 3 mmHg for agent, within a 24-hour period of operation. Although the monitor remains in calibration over long periods, span calibrate the monitor periodically.

Zero and span calibration procedure

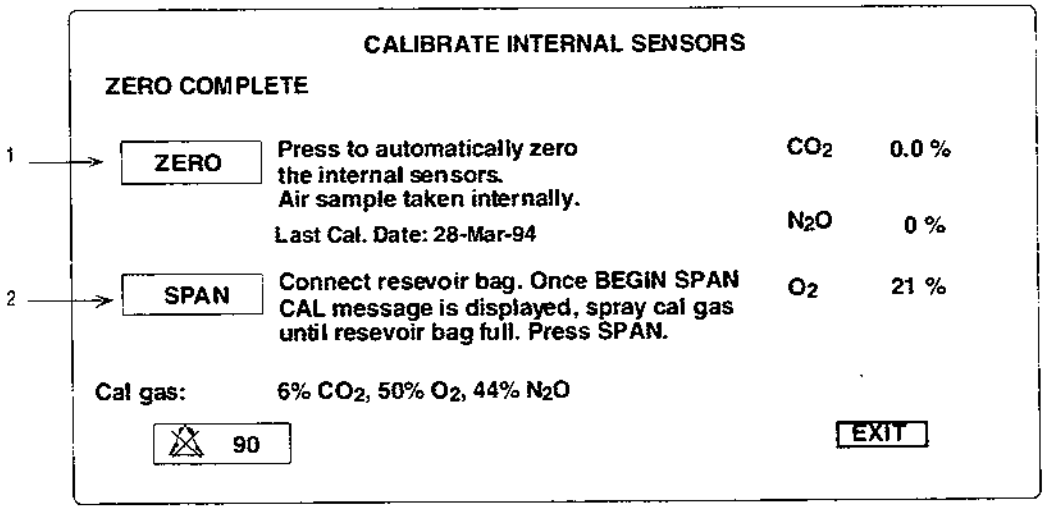


Figure 4-1. Calibration screen

1. Connect a sample tube to the sample inlet. Check that all connections are properly made and secure.
2. Switch on the monitor and allow it to warm up for at least 10 minutes.
3. Select MENU from the display screen.
4. Select SETUP.
5. Select Calibrate.
6. From the menu, select Internals.
7. From the Calibrate screen, select ZERO (1).

The word ZEROING appears on the screen. After about 55 seconds, ZERO COMPLETE appears. If an error message appears, see 3/Messages and Troubleshooting.

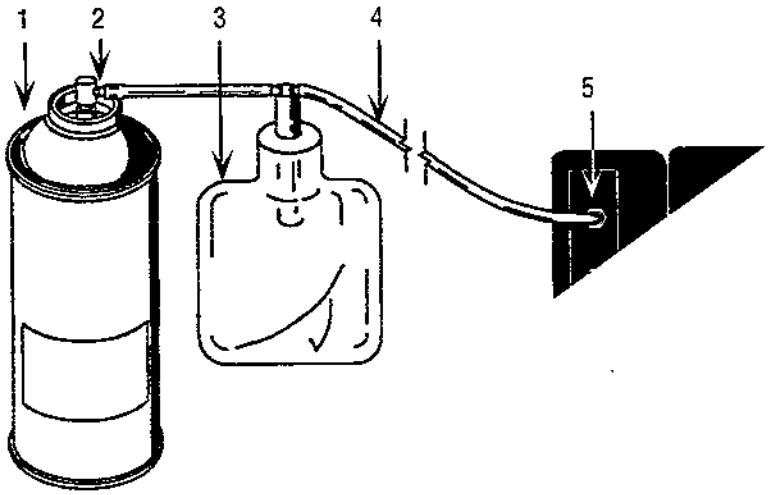


Figure 4-2. Calibration gas connection

1 Calibration gas
2 Brass restrictor
3 Calibration bag
4 Sample line
5 Sample inlet

WARNINGS: Data validity—

- **5250 RGM WITHOUT AGENT: Use only Ohmeda calibration gas of 6% CO_2, 50% O_2, and 44% N_2O (±0.05 volume % gravimetric standard).**
- **5250 RGM WITH AGENT: Use only Ohmeda calibration gas of 4% halocarbon-22/ freon or equivalent, 6% CO_2, 40% N_2O, and 50% O_2.**

8. Connect the required Ohmeda calibration gas (as indicated on the screen) to the sample inlet (5).
   a. Connect the free end of the sample tube (4) to the female luer connector on the calibration bag (3).
   b. Connect the tubing from the other end of the bag to the calibration gas can (1) through the brass restrictor (2).
9. Once the pumping action of the monitor has automatically evacuated the bag, the RGM automatically generates one high tone and one low tone, and the message BEGIN SPAN CALIBRATION appears.
10. Press down on the calibration gas canister's valve stem until the bag fills but is not pressurized.
11. Select SPAN (see [2] in Figure 4-1).

Notes:

- Do not overinflate the bag. Do not attempt the calibration process if there are any leaks in the bag or tubing. Prevent the bag from emptying before the span is complete by adding more gas to the bag.
- If the bag does not fill up, the gas canister is empty, the bag is leaky, or the brass restrictor is blocked.

12. After about 20 seconds, SPAN COMPLETE appears and the process is finished.
13. Verify that the values displayed on the screen are the same as those on the calibration gas canister, within the following tolerances:

    CO_2 ±0.1%, N_2O ±1%, O_2 ±1%, and halocarbon-22/freon or equivalent ±0.1% (5250 RGM with agent calibration gas only).

    If INVALID SPAN appears on the screen, repeat the span calibration; see 3/Messages and Troubleshooting.
14. Disconnect the calibration gas from the sample inlet.
15. To return to the monitoring display screen, select EXIT.
16. Store the calibration gas bag in a location where it will be safe from puncture.

Patient circuit O_2 sensor calibration

Note: Before calibrating the patient O_2 sensor, allow the currently installed sensor cartridge to come to current room temperature (1 hour).

When a new sensor cartridge has been installed, the 1-hour stabilization period assumes that the cartridge was removed from its sealed, protective packaging just before calibration, and that the shorting foil or clip was in place. If the cartridge is not packaged with a shorting foil or clip, it must be shorted or installed on the monitor for as long as 14 hours before the sensor will meet specifications.

WARNING: Data validity—The oxygen monitoring portion of the 5250 RGM monitor should be calibrated at the same temperature at which it will be used to monitor oxygen delivery in the patient circuit. Operation at temperatures other than those present during calibration may result in readings outside of the stated accuracy for the monitor. When the ambient temperature changes, we recommend that you recalibrate the monitor for maximum accuracy. Refer to the O_2 sensor information sheet for more details.

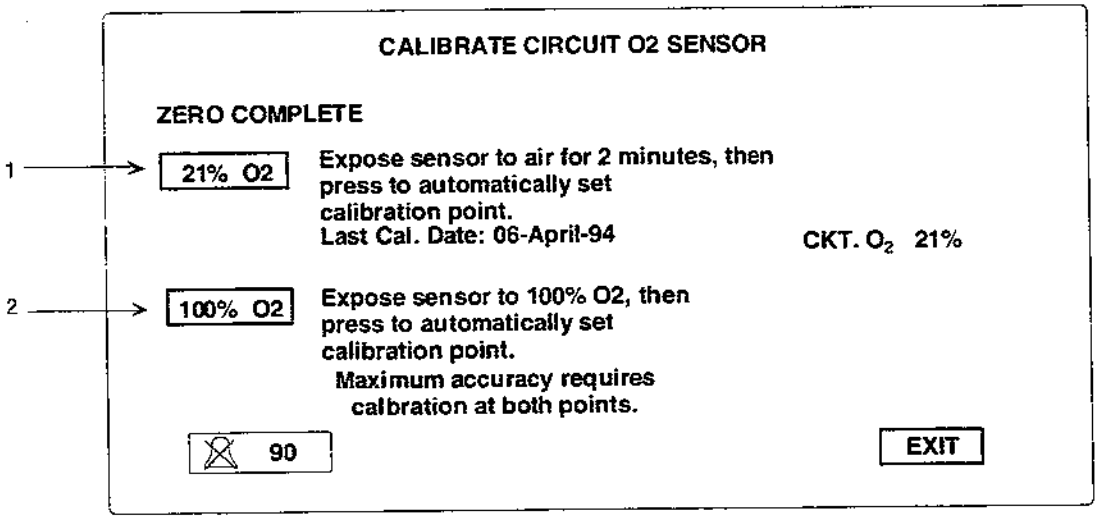


Figure 4-3. Patient circuit O_2 sensor calibration

1 Room air calibration
2 100% O_2 calibration

1. Turn on the the RGM and allow it to warm up for 10 minutes.
2. Select MENU from the display screen, select SETUP, then select CALIBRATE.
3. Select CKT O_2 on the menu. The CALIBRATE CIRCUIT O2 SENSOR screen appears.
4. Expose the sensor to room air for a minimum of 2 minutes.
5. Press 21% O_2. Wait approximately 25 seconds until the ZERO COMPLETE message appears.

IMPORTANT: For maximum protection against a potentially hypoxic mixture, expose sensor to room air and calibrate the monitor to display 21%.

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6. Apply 100% O_2 to the circuit O_2 sensor to flush the room air from the sensor housing.

7. While continuing to apply 100% O_2 to the sensor, press 100% O_2. The message SPAN CALIBRATING appears for approximately 25 seconds. Wait for the message SPAN COMPLETE to appear.
8. CKT O_2 should read 100% O_2 within ±1% at the completion of the span.
9. Select EXIT from the CALIBRATE CIRCUIT O2 SENSOR screen, to return to the display screen.

Note: Temperature variation can affect O_2 reading. To ensure maximum accuracy, we recommend recalibrating the the RGM if the ambient temperature changes. A typical % display change at 21% O_2 is 0.3% O_2 per degree Celsius, and at 100% O_2 is 1.8% per degree Celsius.

O_2 sensor monthly linearity check

1. Apply 100% O_2 to the sensor area to flush the room air from the sensor housing.
2. Allow the display readings to stabilize.
3. Adjust the Calibration Control until the display indicates 99% O_2.
4. Discontinue applying 100% O_2 to the sensor area.
5. Expose sensor area to room air.
6. The display should indicate 21% ±3% within 3 minutes

Barometric pressure check and calibration, and airway pressure and sample flow calibration

CAUTION: Detailed information for more extensive repairs is included in the service manual solely for the convenience of users who have proper knowledge, tools, and test equipment, and for service representatives trained by Ohmeda.

Instructions on checking and calibrating the barometric pressure, and calibrating airway pressure and sample flow are service procedures; send the unit for service.

Replacement procedures

Water bottle removal

To empty the water bottle:

1. Pull the bottle straight down.
2. Dispose of the contents in a receptacle designated for patient waste.
3. If necessary, lubricate the O-rings with VacKote™, Krytox®, or Cello Seal™, which are specified safe for use in an oxygen-enriched environment.
4. To replace the bottle, push it straight up into position.

Sample filter cartridge replacement

Some monitors have a sample filter cartridge located above the fluid bottle. Replace this filter cartridge when the advisory message SAMPLE FILTER BLOCKED appears in the alarm display area or when the CO_2 waveform response time is degraded.

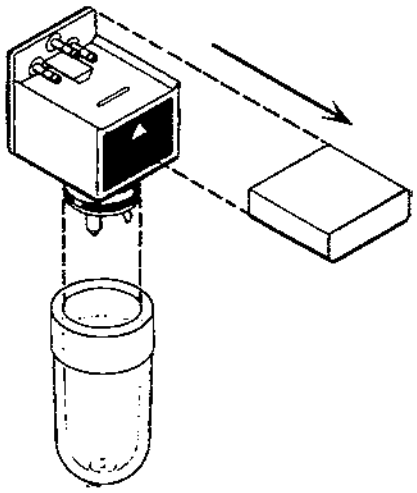


Figure 4-4. Sample filter cartridge replacement

To replace the filter cartridge:

1. Slide the display panel to the right.

WARNING: Operator safety—Always wear gloves, mask, and gown when handling any component of the patient circuit that comes in contact with the patient's exhalant gas or fluids.

2. Pull the cartridge straight out from the sample cartridge assembly and dispose of it in a receptacle designated for patient waste.
3. Place the new cartridge in position and slide it in until it seats properly.
4. Check for leaks by occluding the sample inlet and noting that the unit purges within 5 seconds.
5. Slide the display panel to the left until it latches.

Auto zero scrubber replacement (for agent RGMs only)

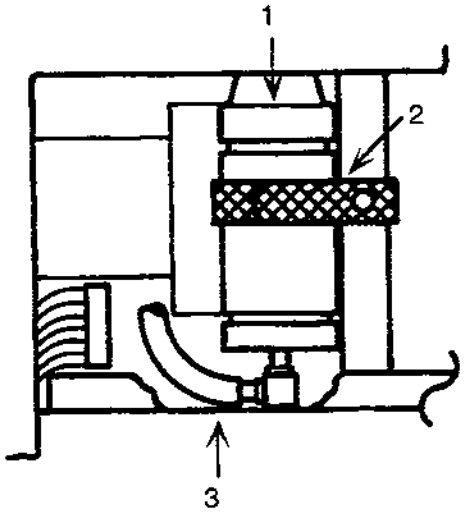


Figure 4-5. Auto zero scrubber replacement (agent version only)

1 Auto zero scrubber
2 Hook-and-loop strap
3 Zero inlet tubing

The auto zero scrubber removes traces of CO_2 from room air used to zero the optical sensor. The scrubber, which uses soda lime, must be replaced at about 1-year intervals.

To replace the scrubber:

1. Remove the display panel.
2. Remove the access panel.
3. Pull the hook-and-loop tape strap to release the scrubber.
4. Lift the scrubber out and disconnect the zero inlet tubing.
5. Install the new scrubber assembly, reconnect the zero inlet tubing, and secure the scrubber in place with the hook-and-loop tape strap.
6. Replace the access panel.
7. Replace the display panel.

Fuse replacement

Both lines of the monitor's AC power are fused. The fuses are inside the power input module, located on the back panel of the monitor. The power input module includes the power cord receptacle and the voltage selection drum.

WARNING: Flammability and electric shock hazard—For continued protection against fire hazard and electric shock, replace only with the same type and rating of fuse as shown on the rear panel of the 5250 RGM. Some RGMs require a different fuse than others.

To replace a fuse:

1. Switch off the RGM and unplug the power cord from the monitor's power receptacle.
2. Note the voltage marking to the right of the receptacle. This marking should match the voltage available at the wall receptacle (220 V used for 220 or 230 V).
3. Using a small straight-blade screwdriver, pry open the cover of the power input module.

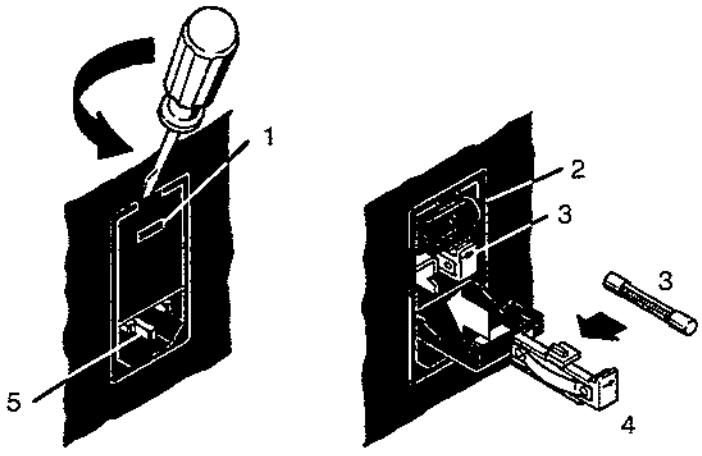


Figure 4-6. Fuse replacement

1 Voltage rating
2 Voltage selection drum
3 Fuse
4 Fuse holder
5 Line power input module

4. Do not disturb the voltage selection drum. If it slips out of position, replace it so that the marked voltage noted in step 2 will be displayed through the cover when it is closed.
5. Note the direction of the arrow on the ends of the fuse holders (down). Slip the blade of the screwdriver behind the arrow and pull the fuse holder forward. Remove both fuse holders.
6. Remove the blown fuses and replace with same type and rating of fuse.
7. Orient the fuse holder with the arrow facing down and slip it back into the power input module.
8. Ensure that the voltage selection drum is properly seated in the module.
9. Close the cover of the module and snap it in place. Verify that the voltage marking matches the voltage available at the wall receptacle as noted in step 2.
10. Replace the power cord and test the monitor for proper operation.

Internal O_2 sensor replacement

WARNING: Data validity—The oxygen monitoring portion of the 5250 RGM monitor should be calibrated at the same temperature at which it will be used to monitor oxygen delivery in the patient circuit. Operation at temperatures other than those present during calibration may result in readings outside of the stated accuracy for the monitor. When the ambient temperature changes, we recommend that you recalibrate the monitor for maximum accuracy. Refer to the O_2 sensor information sheet for more details.

1. Turn off the monitor and disconnect the power cord from the monitor.
2. Remove the display panel.
3. Remove the two mounting screws from the front access panel.
4. Disconnect the cable from the front of the O_2 sensor housing.
5. Turn the O_2 sensor housing counterclockwise and remove it.
6. Insert a new sensor in the housing with the circular copper conductors facing the front of the chassis.
7. Turn the cover housing clockwise until the cover is snug.
8. Reattach the O_2 sensor cable.
9. Remount the access door with the mounting screws.

IMPORTANT: After replacing the internal O_2 sensor, perform the calibration procedure in this chapter to verify the RGM is working properly. Allow at least 1 hour for the sensor to stabilize before calibrating.

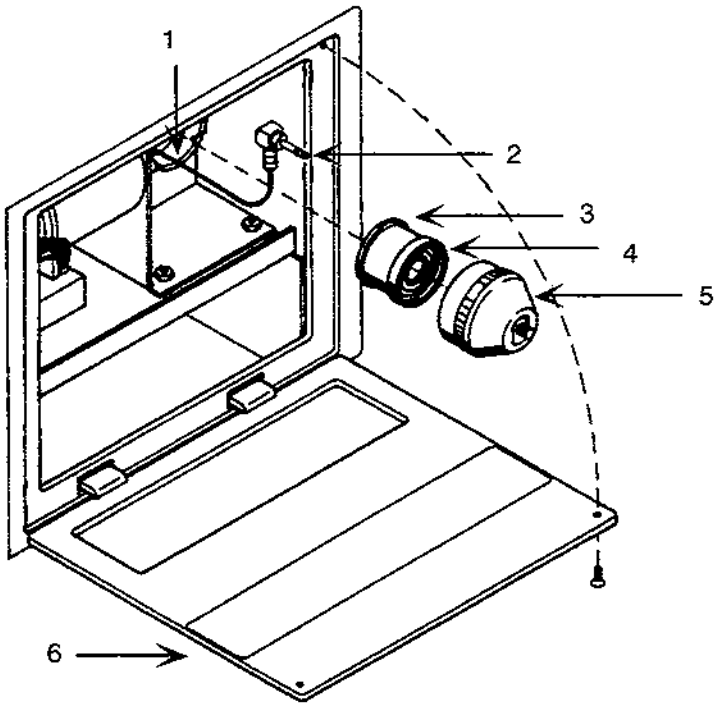


Figure 4-7. Internal O_2 sensor replacement

1 O_2 sensor housing
2 Sensor housing cable connector
3 O_2 sensor
4 Copper conductors
5 Sensor housing cap
6 Front access panel

Patient circuit O_2 sensor replacement

Sensor assembly replacement

Note: The sensor assembly consists of the housing for the O_2 sensor cartridge, the coiled cable, and the connector that joins the sensor assembly to the monitor through a modular jack. The sensor cartridge is not included in the replacement sensor assembly. It must be transferred from the old assembly, or a new cartridge must be installed.

WARNING: Data validity—The oxygen monitoring portion of the 5250 RGM monitor should be calibrated at the same temperature at which it will be used to monitor oxygen delivery in the patient circuit. Operation at temperatures other than those present during calibration may result in readings outside of the stated accuracy for the monitor. When the ambient temperature changes, we recommend that you recalibrate the monitor for maximum accuracy. Refer to the O_2 sensor information sheet for more details.

To disconnect the sensor assembly, push the release tab toward the cable and gently pull the connector (cable) from the monitor.

To connect the sensor assembly:

1. Align the cable connector with the modular jack (release tab down).
2. Gently push the connector into the jack. The release tab should snap into place.

3. Gently pull on the cable to verify a secure connection.

IMPORTANT: After replacing the circuit O_2 sensor or sensor cartridge assembly, perform the calibration procedure in this chapter to verify that the RGM is working properly. Allow at least 10 minutes for the sensor to stabilize before calibrating.

Sensor cartridge replacement

The O_2 sensor cartridge is located inside the sensor housing. Tools are not required to replace the sensor.

WARNING: Data validity—The oxygen monitoring portion of the 5250 RGM monitor should be calibrated at the same temperature at which it will be used to monitor oxygen delivery in the patient circuit. Operation at temperatures other than those present during calibration may result in readings outside of the stated accuracy for the monitor. When the ambient temperature changes, we recommend that you recalibrate the monitor for maximum accuracy. Refer to the O_2 sensor information sheet for more details.

Note: To avoid damaging the sensor cartridge, handle it with care. Keep it packaged until installation.

To remove the sensor cartridge:

1. Hold each half of the probe assembly at the knurled surfaces.
2. Unscrew the front housing half (the one without the cable attached) in a counterclockwise direction to open the housing.

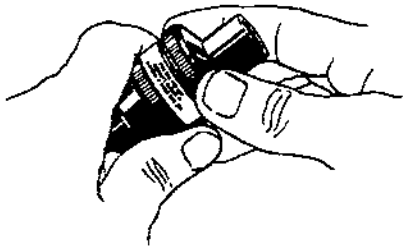


Figure 4-8. Opening the front housing

3. Hold the rear housing with the cable connection down and spin off the front housing.
4. Note the appearance of the forward surface of the sensor (screened). This is the portion of the sensor that analyzes the oxygen concentration.

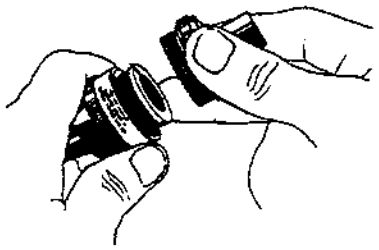


Figure 4-9. Sensor cartridge area for O_2 concentration analyzation

5. Lift the sensor out of the rear housing.

To replace the sensor module:

1. Hold the rear housing with the cable connection down.
2. Note the three gold-colored terminals in the rear housing. The sensor mates to these terminals through three concentric rings (1).

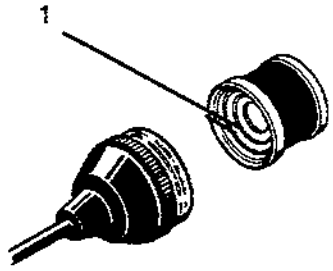


Figure 4-10. O_2 sensor cartridge mates through three concentric rings in the rear housing

3. Remove the sensor from the protective package and remove the foil shorting clip.
4. Place the sensor into the rear housing. The rings must face into the housing to form an electrical contact with the terminals. The screened surface must face out to be exposed to the sample gas.
5. Thread the front housing into the rear housing to capture the sensor and hold it in place.
6. Turn the front housing clockwise until you feel resistance.

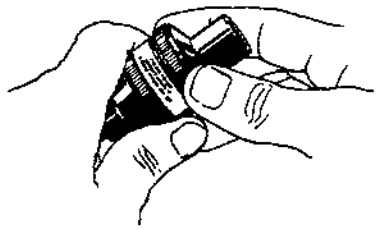


Figure 4-11. Replacing the front housing of the O_2 sensor cartridge

7. Twist the housing halves further (finger tight) to compress the O-rings (1) and to form a mechanical and gas tight seal.

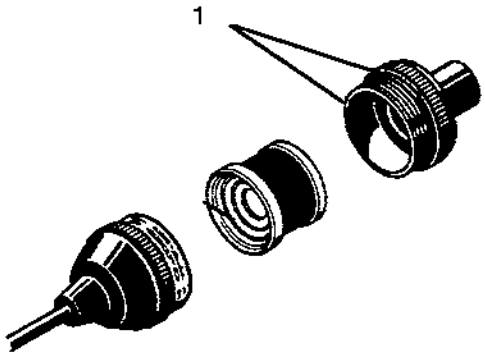


Figure 4-12. Connecting the front and rear housing of the O_2 sensor cartridge

IMPORTANT: After replacing the circuit O_2 sensor or sensor cartridge assembly, perform the calibration procedure in this chapter to verify that the 5250 RGM is working properly. Allow at least 1 hour for the sensor to stabilize before calibrating.

Software replacement

A software upgrade may require other upgrades. See the kit instructions. Always replace both the display and signal processing software cartridges as a set.

Signal processing software replacement

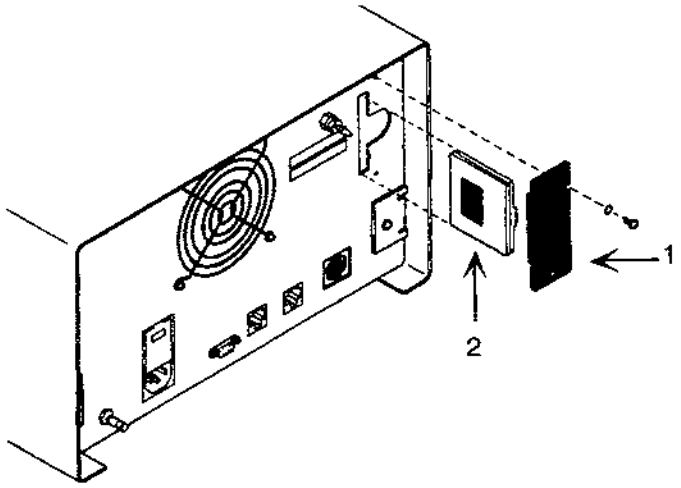


Figure 4-13. Signal processing software replacement

1. Switch off the RGM and disconnect the power cord from the rear of the monitor.
2. Remove the two screws and the cover from the rear panel (1).
3. Grasp the installed software cartridge and pull away from the chassis (2).
4. Install the new software cartridge and replace the cover plate and mounting screws. Software cartridges are keyed to install only in one direction.

Display processing software replacement

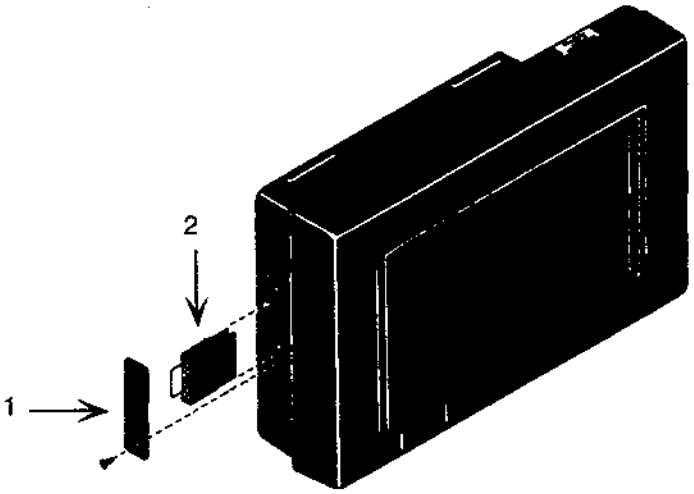


Figure 4-14. Display processing software replacement

1. Switch off the RGM and disconnect the power cord from the rear of the monitor.
2. Remove the two screws and the cover (1) from the left side of the display.
3. Grasp the installed software cartridge (2) and pull away from the display.
4. Install the new software cartridge, replace the cover plate and mounting screws.

Flow sensor maintenance

Transducer cartridge replacement

When used regularly, replace the transducer cartridge at least every 30 days. Also, replace it if it becomes clogged or obstructed.

WARNING: Patient safety—The flow sensor must be correctly oriented in the breathing circuit as indicated by the markings on the sensor clip. The arrows must point away from the patient. If the clip is not mounted correctly, the 5250 RGM will not operate properly.

CAUTION: Do not tamper with the set screws in the flow cartridge. Such action will render the cartridge unusable.

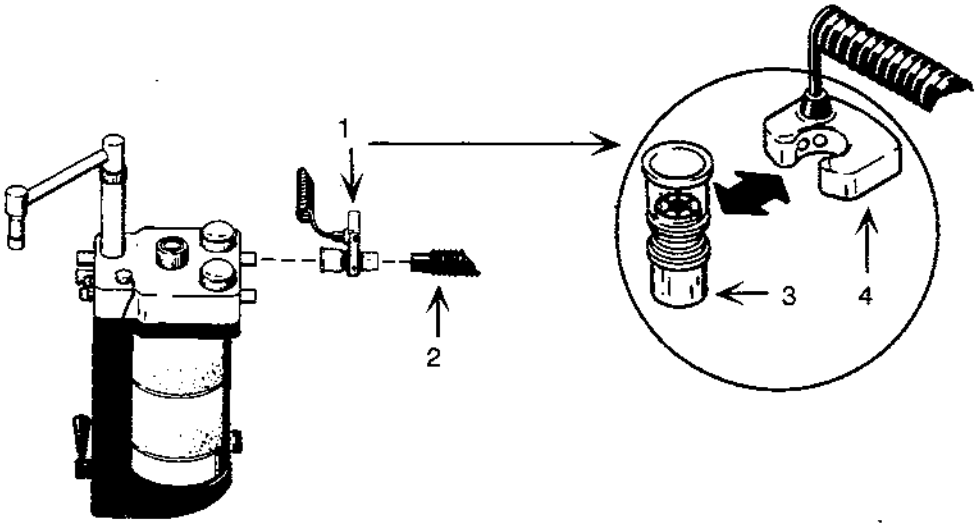


Figure 4-15. Transducer cartridge replacement

1. Disconnect the sensor assembly (1) if it is installed in a patient breathing circuit (2).
2. Remove the used cartridge (3) from the sensor clip (4) and destroy it.
3. Snap the sensor clip onto the replacement cartridge.
4. Replace the sensor assembly into the patient breathing circuit.

The sensor clip arrows must point away from the patient end of the breathing circuit.

CAUTION: Destroy malfunctioning flow cartridges to prevent their inadvertent use.

Sensor clip replacement

If the flow sensor portion of the RGM does not provide the desired results and replacing the cartridge does not rectify the problem, try replacing the sensor clip. The sensor clip is a sealed unit. Do not open it for repair or cleaning; replace it as a unit.

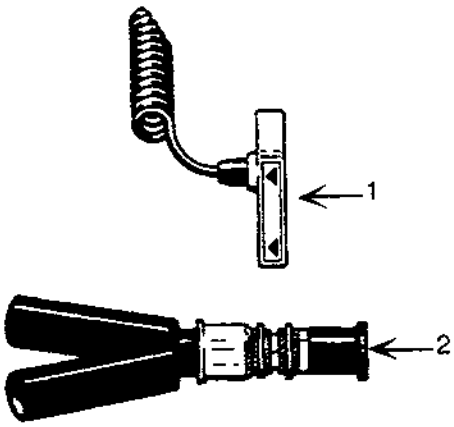


Figure 4-16. Sensor clip removal from the breathing circuit

1. Unsnap the sensor clip (1), from the transducer cartridge (2). It is unnecessary to remove the cartridge from the breathing circuit.
2. Unplug the sensor clip's electrical connector from the RGM.
3. Snap the new sensor clip into position on the cartridge. Be sure to orient the sensor clip in the correct direction for gas flow as indicated by the arrow direction. The sensor clip arrows must point away from the patient end of the breathing circuit.
4. Plug the sensor clip's electrical connector back into the RGM.

WARNING: Patient safety—The flow sensor must be correctly oriented in the breathing circuit as indicated by the markings on the sensor clip. The arrows must point away from the patient. If the clip is not mounted correctly, the 5250 RGM will not operate properly.

Repair policy

Warranty repair and service must be performed by an Ohmeda Service Representative or at the Ohmeda Service and Distribution Center at the address listed in this section. To contact an Ohmeda Service Representative, call the nearest Ohmeda Service Office listed on the back cover of this manual.

Do not use malfunctioning equipment. Make all necessary repairs or have the equipment repaired by an Ohmeda Service Representative. Parts listed in the *5250 RGM Service Manual* for this product may be repaired or replaced by a competent, trained person who has experience in repairing devices of this nature.

After repair, perform the preoperative checkout procedure (2/Operations) to ensure the unit is functioning properly, in accordance to the manufacturer's published specifications.

WARNING: Electric shock hazard—Do not remove the cover of the 5250 RGM. Refer servicing to qualified service personnel. Service personnel must disconnect the power cord before servicing the RGM.

CAUTIONS:

- Only competent individuals trained in the repair of this equipment should attempt to service it.
- Detailed information for more extensive repairs is included in the service manual solely for the convenience of users who have the proper knowledge, tools, and test equipment, and for service representatives trained by Ohmeda.

Authorized service

Obtaining service

USA and Canada: Contact Technical Service at the telephone listed on the back cover of this manual.

All others: Contact the nearest service office listed on the back cover for assistance.

Packaging and return procedure

If returning the equipment to Ohmeda:

Everyone: Please clean and properly decontaminate the equipment as described in the cleaning procedures for this manual. The unit must be thoroughly dry before you pack it for shipment.

Package the monitor securely for protection, in the original carton if possible, and ship it prepaid. Enclose the following items:

1. A letter describing in detail any difficulties experienced with the monitor.
2. Warranty information—a copy of the invoice or other applicable documentation must be included.
3. Purchase order number to cover repair of a monitor (required if out of warranty) or for tracking purposes when in warranty.
4. "Ship to" and "bill to" information.
5. Person (name and telephone/Telex/Fax number and country) to contact for questions about necessary repairs.

In all cases, other than where Ohmeda's warranty is applicable, repairs will be made at Ohmeda's current list price for replacement part(s) plus a reasonable labor charge.

USA

First call OSDC for instructions on your specific product, then ship it prepaid to the following address:

Ohmeda Service and Distribution Center

7750 The Bluffs NW

Austell, GA 30001

All others

Send to your local authorized service office as shown on the back cover of this manual.

Accessories

Standard accessories (all configurations)

	Accessory	Part number
	Power cord, US/Canada/Latin America/Japan(1)	0208-0943-300
	Power cord, Italian	6030-0000-002
	Power cord, Cont. European	6030-0000-004
	Power cord, Australian	6030-0000-001
	Power cord, British	6030-0000-003
	Sample lines (package of 10) 8 ft long	6026-0000-009
*	ET tube adapters, straight-T (package of 10)	6027-0000-019
*	ET tube adapters, elbow (package of 10)	6027-0000-020
	Pressure sensor line tee with ⅛-in. barbs	6027-0000-005
	Pressure-sensing tee adapter	6050-0000-456
	Tubing ⅛-in. ID x 8 ft	6026-0000-014
	Scavenger adapter kit, 19-mm tee M/F with ⅛-in. barb and 10-ft ⅛-in. tubing	0237-2124-870
*	Calibration gas canister kit, (non-agent calibration gas canister with calibration bag)	6050-0001-386
*	Calibration gas canister kit, (agent calibration gas canister with calibration bag)	6050-0001-380
	Cartridge, Filter (package of 5)	6050-0001-379
	5250 RGM Service Manual	6050-0004-022
	5250 RGM Operation and Maintenance Manual, English	6050-0004-020

* Not shipped with International monitors.

Optional accessories (all configurations)

Gas sampling	Part number
Sample lines (package of 100)	6026-0000-037
ET tube adapter, straight-T metal ISO (one per package)	6050-0000-478
ET tube adapters, straight-T (package of 100)	6027-0000-073
ET tube adapters, elbow (package of 100)	6027-0000-072
Critical care adapters	
Package of 5	6027-0000-070
Package of 10	6027-0000-059
Package of 100	6027-0000-071
Pediatric/neonatal adapters 3.0 mm (package of 10)	6027-0000-065
Replacement filters for critical care adapters (10-pack)	6027-0000-060
Water separator cartridge	
Package of 25	6050-0001-772
Package of 50	6050-0001-669
Nasal cannula CO_2 sampling line (package of 10)	6002-0000-046
Return adapter kit, sample exhaust to patient circuit tee, 22 mm M/F with ⅛-in. barb	6050-0000-002

Pressure sampling	Part number
Pressure sensing installation kit for GMS absorber	0236-6152-870

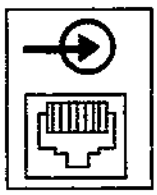
O_2 measurement	Part number
Patient circuit O_2 sensor kit (cartridge not included)	0237-2030-700
O_2 in-airway tee adapter, 22 mm	6050-0001-222
O_2 tee adapter, 22 mm	0212-0763-100
Dome adapter kit	0236-0035-800
O_2 sensor cartridge	0237-2034-700

Volume measurement	Part number
Flow transducer cartridge (package of 10)	0237-2228-870

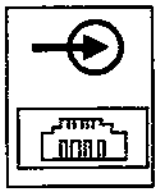
Refer to figure below to order the correct flow sensor assembly for your RGM.

Flow sensor clip assembly	
8-ft (Pre-TUV)	0237-2226-700
16-ft (Pre-TUV)	6050-0000-400
Flow sensor extension cord kit	
8-ft (Pre-TUV)	0237-2041-880
6-ft (Pre-TUV)	0237-2040-880
TUV flow sensor clip assembly	
8-ft	6050-0001-853
16-ft	6050-0002-206

Note: TUV, the German regulatory agency, stipulates certain electrical requirements set forth in IEC-601. Serial numbers of monitors that include the TUV changes begin with FARU or later (for example, FARV will follow FARU).



Pre-TUV
V
Connector



TUV
V
Connector

Calibration gases	Part number
Non-agent calibration gas canister with calibration bag	6050-0001-386
Non-agent calibration gas canister: 6% CO_2, 50% O_2, 44% N_2O	6016-0000-053
Agent calibration gas canister with calibration bag	6050-0001-380
Agent calibration gas canister: 6% C O_2, 4% halocarbon-22, 50% O_2, 40% N_2O	6016-0000-045
Calibration gas kits, bulk (6-pack non-agent calibration gas kits) with bag	6050-0001-646
Calibration gas kits, bulk (6-pack agent calibration gas kits) with bag	6050-0001-638
Calibration gas bag only	6050-0000-226

Misc., brackets, fuse kits, etc.	Part number
Cable management clips	6032-0000-053
Display mounting bracket kit,	
Dovetail style, for Modulus II® Plus, and Excel	6050-0001-450
Pole style, ¾ in. to 1⅛ in. diameter range	6050-0001-642
Fuse kit, 100/120 V and 220/240 V	6050-0001-059
Auto zero sample scrubber (agent only)	6050-0001-387
Water trap bottle with/label	6050-0000-847
Water trap O-rings	6016-0000-032
Cable, RS-232 interface, 2 m (6 ft)	6050-0001-629
Connector, Analog output	6006-0000-184

Upgrade options

Fuses	Part number
International Fuse Upgrade Kit:	6050-0002-064

Needed only for international monitors with fuse ratings (noted on rear panel) lower than 1.6 A that are operating at 220/240 Vac, 50 Hz. The kit provides 1.6 A primary fuses to RGMs originally specified with 1.00 A for 220/240 V ac operation. This higher fuse value significantly reduces the likelihood of blowing primary fuses during poweron.

Note: The international fuse kit is not needed for RGMs with fuses rated 1.25 A/250 V on the rear panel

Software	Part number
Software Upgrade, Revisions 3.0 or higher:	6050-0001-460

Provides an improved user interface for changing all alarm limits on one screen, which includes automatically saving the alarm limits that were in effect when the RGM was powered off. The software upgrade also provides the following:

- Interface to the Ohmeda 2120, Ohmeda Finapres, and Dinamap blood pressure monitors
- Selectable flow waveform display
- The last calibration date
- A trend clear function to clear all trend information from memory
- Digital trend data every 5 minutes for the last hour.

Desflurane Software Upgrade: 6050-0002-408

Provides the additional capability for monitoring desflurane, Suprane®. Use this kit only with RGMs 6051-0000-026 and 6051-0000-027, which have the ACX-200 photometer.

Five-Agent Software Upgrade: 6050-0002-957

Provides the additional capability for monitoring sevoflurane and desflurane. Use this kit only with RGMs 6051-0000-026 and 6051-0000-027, which have the ACX-200 photometer.

Notes

A/Specifications

Note: All specifications are nominal and are based at sea level. They are subject to change without notice. See 4/Maintenance, Calibration, and Service for specific information.

Warm-up time: 10 minutes for the stated accuracies.

Electromagnetic compatibility (EMC)

Electromagnetic effects

Indications that the system is experiencing electromagnetic interference include variations in the display (plethysmograph or waveforms do not correlate to physiological signals), instability of readings, error messages indicating a patient or system problem that cannot be resolved by the instructions found in the Operator's Manual, or dashed readings when a valid physiological signal is present. This interference may be intermittent and careful correlation between the effect and its possible source is important. The system will not display any of these indications if it is used within its intended electromagnetic environment.

Environment

Suitable for use in the environment described in IEC 601-1-2.

EMC performance

The monitor complies with the requirements of IEC 601-1-2 when tested at 230 V/ 50 Hz (Electromagnetic compatibility - Requirements and tests). The following basic EMC standards were applied to verify conformance. The IEC 1000 series replaces the IEC 801 series referenced in IEC 601-1-2.

Emissions: CISPR 11 Group 1, Class B

Immunity: IEC 1000-4-2, 8 kV air, 3 kV contact
IEC 1000-4-3, 3 V/m
IEC 1000-4-4, 1 kV power, 500 V I/O
IEC 1000-4-5, 2 kV line to earth, 1 kV line to line

CO_2

RGM	Measured parameter	Range	Accuracy	*Response time
Non-agent	CO_2	0 to 9.9%	±0.3% CO_2	≤200 msec
		10 to 15%	±1.0% CO_2	
	Temperature gain stability		±0.2% CO_2 /10 °C	
Agent	CO_2	0 to 8% 8.1 to 15%	±0.3% CO_2 unspecified	≤400 msec
	Temperature gain stability		±0.2% CO_2/10 °C	

N_2O

RGM	Measured parameter	Range	Accuracy	*Response time
Non-agent	N_2O	0 to 59% 60 to 80%	±2% N_2O ±5% N_2O	≤550 msec
	Temperature gain stability		±2% N_2O/10 °C	
	N_2O	0 to 59%	±2% N_2O	≤400 msec
Agent		60 to 80%	±5% N_2O	
	Temperature gain stability		±3% N_2O/10°C	

Agent

RGM	Measured parameter	Range	Accuracy	*Response time
Agent	Halothane, Enflurane, Isoflurane,	0 to 5% 5.1 to 15%	±0.2% agent unspecified	≤500 msec
	Sevoflurane	0 to 8% **Extended range:** 8.1 to 15%	±0.2% sevoflurane Unspecified	≤500 msec
	Desflurane	0 to 5% 5.1 to 10% 10.1 to 18% **Extended range:** 18.1 to 30%	±0.2% desflurane ±0.5% desflurane ±1.0% desflurane Unspecified	≤500 msec
	Temperature gain stability		±0.4% agent/10 °C	

* Response time is defined as 10 to 90% change in the signal @ 200 mL/min sample flow rate. Does not include transit time of sample gas through the patient sample line.

O_2–internal and circuit

Measured parameter	Range	Accuracy	Response time
O_2	0 to 59%* 60 to 100%*	±3% O_2 ±5% O_2	20-second circuit and 60-second internal
O_2 zero stability		±3% O_2/24 hours	
O_2 gain stability		±2% O_2/6 months	

* Refer to O_2 sensor information sheet

SpO_2

Measured parameter	Range	Accuracy (±1 standard deviation)
SpO_2	90 to 100% 80 to 89.9% Below 79.9%	±1.5% ±2.1% unspecified
Pulse rate	40 to 235 bpm	±1.75% of reading

Volume

Measured parameter	Range	Accuracy (±1 standard deviation)	Response time
Tidal volume	**Pediatric**: 50 to 200 mL	±20 mL or ±15% of reading, whichever is greater.	May take up to 1 minute to adjust to new patient then every breath
	Adult: 150 to 1500 mL	±40 mL or ±8% of reading, whichever is greater.	
Minimum flow rate to detect a breath is 8 LPM. All accuracies are specified for the TVX sensor located proximal to the patient.			
Minute volume	0 to 50 L	Sum of tidal volumes for last minute	5 seconds or end of breath

Pressure

Measured parameter	Range	Accuracy	Response time
Airway pressure	-20 to 120 cm H_2O	±5 cm H_2O	≤50 msec

Compensation

CO_2, N_2O, and internal O_2 for barometric pressure

CO_2 for O_2, and N_2O

Sample flow rate

200 ±50 mL/min

Environmental characteristics

Operating

Temperature	15 °C to 40 °C
Humidity	0 to 95% RH, noncondensing
Pressure	500 to 800 torr

Storage

Temperature	-30 °C to +60 °C
	(-20 °C to +50 °C for O_2 sensors)
Humidity	0 to 95% RH, noncondensing
Pressure	5 to 20 psia

Physical characteristics

Main chassis

Size

32 cm wide x 19 cm high x 41 cm long
(12.4 in. wide x 7.5 in. high x 16 in. long)

Weight

Less than 11.3 kg (25 lbs)

Power-fuse rating

100 V ac 50/60 Hz 1.0A ⎓ T1.5A/250 V

120 V ac 50/60 Hz 1.0A ⎓ T1.5A/250 V

220/240 V ac 50/60 Hz 0.5A ⎓ T1.0A/250 V

Voltage tolerance

+10% to -15%

Power consumption

100 watts

50/60 Hz

International Electrotechnical Commission Classifications

Type of protection against electric shock: Class I
Degree of protection against electric shock: Type BF
Degree of protection against ingress of liquids: Ordinary
Mode of operation: Continuous
Recommended methods of sterilization or disinfection: See "Cleaning" in 4/Maintenance, Calibration, and Service of this manual for recommended safety procedures when cleaning this equipment.
Degree of safety of application in the presence of a flammable anesthetic mixed with air or with oxygen or nitrous oxide: Equipment not suitable for use in the presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide.

B/Analog Outputs

Channel assignments

CAUTION: Maximum voltage—No more than 5 volts should appear on any pin of the analog output connector.

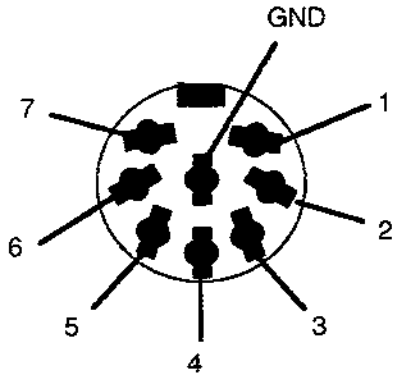


Figure B-1. Connector pinouts

Channel	Scale
1 CO_2 waveform	66.6 mV/%
2 N_2O waveform	10 mV/%
3 PAW waveform	(V x 140)-20 = cm H_2O
4 Flow waveform	10 mV –1 L/min
5 Agent waveform	66.6 mV/%
Prior to software revision 6.0	
Non-agent unit–SpO_2 digital value	10 mV/%
Agent unit–agent waveform	66.6 mV/% (Desflurane: 33.3 mV/%)
Software revision 6.0 or higher	
Non-agent unit	No data
Agent unit–agent waveform	66.6 mV/% (Desflurane: 33.3 mV/%)
6 O_2 inspired/expired	10 mV/%
7 **Prior to software revision 6.0**	
CO_2 expired	66.6 mV/%
Software revision 6.0 or higher	
Plethysmograph	0-0.5V with 16.1mV resolution

The analog output accuracy is ±3.5% (absolute), linearity ±0.5%, with an update rate of 10 milliseconds and a resolution of 3.9 mV.

Note: Output source impedance is 100 ohms.

Strip chart calibration

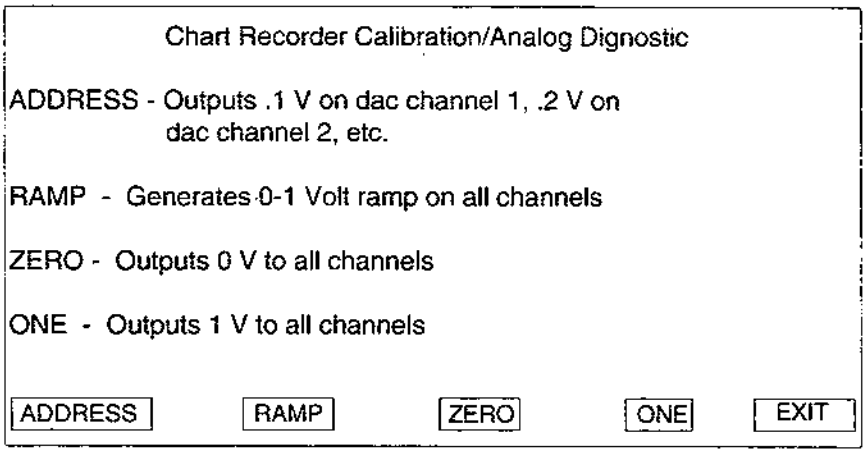


Figure B-2. Chart Recorder Calibration/Analog Dianostic screen

1. Select MENU, SETUP, VIEW ALL, and REC CAL.
2. Connect the strip chart recorder to the analog output connector.
3. Select ZERO. All channels will be set to zero volts. Adjust the strip chart recorder.
4. Select ONE. All channels will be set to one volt (full scale). Adjust the strip chart recorder.
5. Press EXIT three times to return to the display screen.

C/RS-232 Serial Communications

Serial connections

Use a cable assembly (part number 6050-0001-629) for connection to the printer or computer.

The printer protocol outputs a form feed at the beginning of each page. This implies that the printer must be able to know the size of the form, and the form must be able to print 60 lines per page. To align the paper simply press the form feed button on the printer and then manually align the paper.

On the Setup Screen, the following selections are available:

RS-232 device		
Parameter	1200 odd	9600 none
Baud rate	1200	9600
Data bits	7	8
Parity	odd	none
Stop bits	1	1

The following data is output to the RS-232 port at the configured time interval. At the top of each page the following title will be output with 58 lines of data formatted under each column.

<ff>

		CO_2			O_2		Paw			Flow			CKT	Bar	Sp		Agent X		<cr>
:RG*	I	E	RR	I	E	I	E	M	TV	MV	N_2O	O_2	Pre	O_2	PR	I	E	<cr>
:RG	xx.x	xx.x	xxx	xxx	xxx	xxx	xxx	xxx	xxxx	xxx	xxx	xxx	xxx	xxx	xxx	xx.x	xx.x	<date/time><cr>
Value indexes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

*These header labels are printed at the top of each page or when a new agent is selected (software revision 6.0 or higher).

Note: The title line has an asterisk after the :RG and data lines have a space after :RG to allow easy parsing.

1. CO_2 inspired in % (See item 13 for mmHg.)
2. CO_2 expired in %
3. CO_2 respiratory rate in breaths per minute
4. O_2 inspired in %
5. O_2 expired in %
6. Paw inspired in cm H_2O

7. PAW expired in cm H_2O
8. PAW mean in cm H_2O
9. Tidal volume in milliliters
10. Minute volume in liters
11. N_2O in %
12. Patient circuit O_2 in %
13. Barometric pressure in torr in sample chamber. Can be used to convert CO_2 to mmHg if desired. CO_2 mmHg = CO_2 % x barometric pressure divided by 100. CO_2 kPa = CO_2 mmHg /7.5
14. SpO_2%. Output only if option is installed.
15. SpO_2 pulse rate in beats per minute from SpO_2 board. Output only if option is installed.
16. Agent inspired in %. Title line changes to indicate type of agent configured. "H" indicates halothane, "I" indicates isoflurane, "E" indicates enflurane, "S" indicates sevoflurane, "D" indicates desflurane, and "N" indicates no agent. Output only if agent option is installed.
17. Agent expired in (%). Output only if agent option is installed.
18. <date/time> is in the format "hh:mm www dd-mmm-yy" in a 21-character string. The day of the week "www" and month of the year "mmm" vary in length depending on the language selected.

Printer data response intervals are selectable from the "Print Period" icon on the Setup Screen. You may select print periods of 10 sec, 1 min, 15 min, and 60 min. Set print period for desired update rate.

Connector pinout, type DB-9

Pin	Function
2	Transmitted data from monitor
3	Received data into monitor
7	Ground
9	Used for factory test

All other pins are unused.

Cable wiring for connecting RGM to computer

RGM 9-pin		AT computer 9-pin	RGM 9-pin		XT computer 5-pin
2	--------	2	2	----------	3
3	--------	3	3	----------	2
7	--------	5	7	----------	7
		7			5
		8			4

Hardware flow control. CTS, RTS, and other control signals are not required for the RGM serial interface to operate. The host computer or the application software running on the host computer may sometimes require these signals. Review your manuals and documentation for your computer and computer application to determine if these signals are used. If so, it may be necessary to wire the CTS to RTS on the connector that the user plugs into the computer. (For an IBM PC®, wire pin 4 to pin 5 on the DB-25S connector. For the IBM AT®, wire pin 7 to pin 8 on the DE-9S connector.)

Interface program

When run on a personal computer, this program collects data from the RS-232 port and stores it in a file. Set RS-232 device to "1200 ODD" for this program.

For 9600 baud operation, change program line 70 as follows and set RS-232 device to "9600 NONE" on the setup screen.

```
70 OPEN "com1:9600,n ,8,1,cs0,ds0" AS #1
```

```
10 PRINT "RGM terminal emulator to save a case to a file"
20 PRINT "please enter filename to store case xxx.prn?"
30 LINE INPUT FI$
40 OPEN "O",3,FI$
50 PRINT "Type # to stop"
60 OPEN "O",2,"temp.xxx"
70 OPEN "com1:1200,o,7,1,cs0,ds0" AS #1
80 A$=INKEY$: IF A$ <> "" THEN PRINT A$;:PRINT #1,A$;:IF A$="#" THEN 140
90 IF EOF(1) THEN 80
100 A$=INPUT$(LOC(1),1)
110 PRINT A$;
120 PRINT #2,A$;
130 GOTO 80
140 PRINT "stripping file of header lines"
150 CLOSE 1:CLOSE 2
160 OPEN "I",1,"temp.xxx"
170 IF EOF(1) THEN CLOSE:SYSTEM
180 LINE INPUT #1,A$
190 IF LEFT$(A$,4) = ":RG*" THEN 170
200 PRINT #3,RIGHT$(A$,LEN(A$)-4)
210 GOTO 170
```

Standard RS-232 25-pin pinout		Standard PC/AT RS-232 9-pin pinout	
Transmitted data	2	Carrier detect	1
Received data	3	Received data	2
Request to send	4	Transmitted data	3
Clear to send	5	Data terminal ready	4
Data set ready	6	Signal ground	5
Signal ground	7	Data set ready	6
Received line signal detector/carrier det.	8	Request to send	7
Data terminal ready	20	Clear to send	8
Ring indicator	22	Ring indicator	9
All other pins are unused.			

Serial communications protocol interface

Commands sent to the RGM

Definitions

<ff> is form feed character 12.

<cr> is carriage return character 13.

<esc> is escape character 27.

<checksum> is the negative of the 7-bit sum of all characters in the message except the <cr> character at the end. On decode this means that the sum of all characters including the checksum is zero. If checksum is not enabled a space must be inserted.

Unless otherwise specified, all numbers are in ASCII decimal format.

Wake up command

This command must be sent before any other Ohmeda serial protocol command. This command places the monitor in auto mode with printer format.

<esc>!<cr>

Responds with Y frame

Mode selection commands

Auto mode (default mode after the wakeup command)
<esc>RGX<checksum><cr> Select auto

This command also selects printer data format. Responds with Y frame.

Slave mode
<esc>RGS<checksum><cr> Select slave

This command also selects compressed data format. Responds with Y frame.

Note: Slave printer and slave compressed modes are identical.

Configurations
Four configurations to the serial protocol are selected by the X, S, P, and Q commands.

Mode = auto, Format = printer (default mode)
<esc>!<cr> or <esc>RGX <cr>

Data transmission timing is controlled by the selection of print period on the setup menu. Frames "*" and " " are sent in this mode.

Additional data frames may be requested in this mode after the serial protocol is enabled.

Mode = auto, Format = compressed
<esc>!<cr>, <esc>RGQ <cr>

Optimal mode for computer collection of data as it is generated. Frames A, B, C, E, H, K, and P are sent in this mode. See Responses received from RGM in this appendix for timing information. Additional data frames may be requested in this mode.

Mode = slave, Format = compressed
<esc>!<cr>, <esc>RGS <cr>

Data only sent on request.

Mode = slave, Format = printer
<esc>!<cr>, <esc>RGS <cr>, <esc>RGP <cr>

Data only sent on request. This mode is identical to mode "slave" format "compressed".

Data format mode selection commands

Select printer (default data format after the wakeup command)
<esc>RGP<checksum><cr> Select printer

Responds with Y frame.

Select compressed
<esc>RGQ<checksum><cr> Select compressed

Responds with Y frame. In compressed auto format, the RGM sends data to the RS-232 port as it is generated.

Enable checksum on input and output
<esc>RGE<checksum><cr> Enable checksum

Responds with Y frame.

Disable checksum on input and output (default after the wakeup command)
<esc>RGD<space><cr> Disable checksum

No checksum is required for this command. Responds with Y frame.

Send data commands

These commands are designed to be used in slave compressed mode but may be sent in auto mode if desired.

Send all
<esc>RG?<checksum><cr> Send all data

The A, B, C, E, H, P, and Q data frames are sent.

Send
<esc>RGVx<checksum><cr> Send data

If x is: A send 5-second data frame
B send breath-data frame
C send SpO_2-data frame
D send config-data frame
E send alarm-status frame (same as RGT)
H send tidal-volume frame
P send PAW-data frame
Q send alarm-limit frame
V send version frame

Send alarm limit
<esc>RGA<checksum><cr> Send alarm limit data

Responds with E and Q frame

<esc>RGT<checksum><cr> Send status data

Responds with E frame

Note: RGVE can also be used. Either command is acceptable, because there is no difference.

Send trend data
<esc>RGRabccddd<checksum><cr> Send trend data

Responds with R frame (see Two-minute trend response—R frame in this appendix)

a = parameter index

0 = CO_2 trend (exp, insp values) LSB = 0.1%

1 = SpO_2 trend (SpO_2 value)LSB = 1%

2 = PAW trend (max, min, mean values) LSB = 0.1 cmH_2O
(Note: 20 cmH_2O added to each value)

3 = O_2 trend (exp, insp values) LSB = 1%

4 = MV trend (minute volume value) LSB = 1L

5 = N_2O trend (exp, insp values) LSB = 1%

6 = Agent trend (exp, insp values) LSB = 0.1% (max value 25.3%)

7 = BP trend (systolic, diastolic, mean) LSB = 2mmHg

b = should be set to 1 to indicate this is the first request of multiple requests for the whole trend buffer. This tells the RGM to save off the latest breath trend point pointer and use that as trend point 0 pointer for full trend requests until the new request bit is seen again. This will prevent the point 0 reference from being updated by the 2-minute update, yet allow the 2-minute update to occur. Set to 0 if reading subsequent values.

ccc= number 0 to 217 start value number to retrieve. Value 0 is newest. Values are the 2-minute average of the data (except minute volume which is a 1-minute average). If multiple points exist for a trend, they are sent in order (value 0 point 1, value 0 point 2, value 1 point 1, value 1 point 2, value 2 point 1, value 2 point 2, ...) The ccc parameter controls the start index, which is the index in time back from the current time. At most, there are 218 data sets to retrieve or (218 * 2 minutes/ 60 = 7.26 hours of data). The start index must be in the range of 0 to 217.

ddd= number 1 to CO_2 = 61, SpO_2 = 122, PAW = 40, O_2 = 61, MV = 122, N_2O = 61, Agent = 61, BP = 40. Maximum request size number of trend values to retrieve. Buffer size limited to 255 bytes. There are 11 bytes of overhead per response. With 2 characters per value, that allows up to 122 values maximum per response frame. The number of values sent is ddd * (the number of values collected for the trend). Since different parameters (CO_2, SpO_2, etc.) may have 1 to 3 values for each 2-minute trend interval and since the maximum buffer size is limited to 255 bytes, the maximum number of trend times retrievable varies with different parameters. For example, CO_2 maximum size is 61, and SpO_2 is 122.

The trend buffer is maintained as a wrap-around buffer with the oldest data being replaced with the newest data every 2 minutes. You must retrieve the oldest values first in order not to have them replaced while you are retrieving the trend values.

There is no "send all trend frames" request. Instead, you request the individual parts, one frame at a time.

Example: Commands to request all CO_2 trend data in 111 byte buffers.

<esc>RGR01200025<checksum><cr> <esc>RGR00175025<checksum><cr>
<esc>RGR00150025<checksum><cr>

...

<esc>RGR00000025<checksum><cr>

As you retrieve the data, put it into an array with the proper base index for the message. After you retrieve all the data, send the entire array into a plot package for plotting.

If you want to cross correlate two trends; e.g. CO_2 and PAW, then retrieve them with the following sequence of commands:

<esc>RGR01200025<checksum><cr> get oldest CO_2 data freeze pointer

<esc>RGR20200025<checksum><cr> get oldest PAW data

<esc>RGR00175025<checksum><cr> get next oldest CO_2 data

<esc>RGR20175025<checksum><cr> get next oldest PAW data

<esc>RGR00150025<checksum><cr> get next oldest CO_2 data

<esc>RGR20150025<checksum><cr> get next oldest PAW data

...

<esc>RGR00000025<checksum><cr> get newest CO_2 data

<esc>RGR20000025<checksum><cr> get newest PAW data

As you retrieve the data, put it into two 218-byte arrays. The following "C" program segment illustrates command generation and decoding to retrieve trends in slave mode. All error checking has been eliminated for clarity.

```
unsigned char co2_data[218][2],paw_data[218][3],cmd[80],resp[255];
int i,len,p1,p2,p3,index,first_time;
first_time = 1;  /* set flag to freeze data on first request */ for(index=200; index
> -1; index -=25)/* loop through each start point */
    {
    /* create a command to send to RGM to get CO2 trend data */
    sprintf(cmd,"\0x1bRGR0%d%3d025 \r",first_time,index);
    first_time = 0;
    send_cmd(cmd);  /* send command to RGM */
    receive_resp(resp);  /* receive response from RGM up to 111 bytes */
    sscanf(&resp[8],"%3d",&len); /* number of data points in response */ for
    (i=0; i < len; i++) /* loop through each data point */
        {
        /* decode data values for co2 inspired and expired value */
        sscanf(&resp[11+i*4],"%2x%2x",p1,p2);
        co2_data[index+i][0] = p1; /* get expired value from response */
        co2_data[index+i][1] = p2; /* get inspired value from response */
        }
    /* create command to send to RGM to get PAW trend data */
    sprintf(cmd,"\0x1bRGR20%3d025 \r",index);
    send_cmd(cmd); /* send command to RGM */
```

```
receive_resp(resp); /* receive response up to 161 bytes */
sscanf(&resp[10],"%3d",&len); /* get number of data points in response */
for(i=0; i < len; i++) /* loop through each data point */
    {
    /* decode data values for paw (max, min, and mean) values */
    sscanf(&resp[11+i*6],"%2x%2x%2x",p1,p2,p3);
    paw_data[index+i][0] = p1-20; /* max value -20 for value offset */
    paw_data[index+i][1] = p2-20; /* min value */
    paw_data[index+i][2] = p3-20; /* mean value */
    }
}
```

Each element index will represent the same time period with index 0 being the newest value and index 1 being two minutes older. The time of index 0 will correspond with the time the freeze command (b=1) is sent.

Front panel commands

Alarm silence

<esc>RGCA<checksum><cr> Alarm silence

Resets alarm silence time to maximum value selected on Setup Screen for mute period and enable silence.

Responses received from RGM

In compressed auto format, data is sent to the interface as it is generated. In printer auto format, data is sent to RS-232 at the interval selected by print period in the same format as described in C/ RS-232 Communications.

Five-second data—A frame

:RGAaaabbbcccdddeeeefffgggghhhiiijjj<checksum><terminator>

One output every five seconds in auto compressed mode or on request.

<parameters> are:

aaa	=	unused
bbb	=	Inspired O_2, 3 byte ascii, lsb = 1%
ccc	=	Unused
ddd	=	Unused (may contain a value)
eeee	=	Unused
fff	=	Unused
ggg	=	Barometric pressure, 3 byte ascii, lsb = 1 mmHg
hhh	=	Circuit O_2, 3 byte ascii, lsb = 1%
iii	=	Unused
jjj	=	Expired O_2, 3 byte ascii, lsb = 1%

If a parameter is unused, dashes (2DH) fill the field.

Note: Ignore the inspired/expired O_2 values if any of the following alarms are active:

Sample line/filter block
Sample filter blocked
Water trap full
Signal RAM fail
Signal CPU fail
Analog fail
No vacuum
No flow
Recalibrate gas analyzer

Breath data—B frame

:RGBaaabbbcccdddeeefffgggghhhiii<checksum><cr>

On every valid CO_2 breath's medium to low transition (or if no breath, minimum/maximum over last ten seconds every ten seconds) in auto compressed or on request.

<parameters> are:

aaa = resp. rate(CO_2), 3 byte ASCII, lsb = 1 bpm
bbb = EtCO_2, 3 byte ASCII, lsb = 0.1%
ccc = FiCO_2, 3 byte ASCII, lsb = 0.1%
ddd = FeAx, 3 byte ASCII, lsb = 0.1%
eee = FiAx, 3 byte ASCII, lsb = 0.1%
fff = FeN_2O, 3 byte ASCII, lsb = 1%
ggg = FiN_2O, 3 byte ASCII, lsb = 1%
hhh = unused
iii = unused

If a parameter is unused, dashes (2DH) fill the field.

Note: All values in this frame should be ignored by the user if any of the following alarms are active:

Sample line/filter block
Sample filter blocked
Water trap full
Gas analyzer saturated
Gas analyzer inoperative
Gas analyzer warmup
Signal RAM fail
Signal CPU fail
Analog fail
No vacuum
No flow
Recalibrate gas analyzer

SpO_2 data—C frame

:RGCaabbbcccdd<checksum><cr>

Sent every two seconds if SpO_2 option is installed and working in auto compressed or on request.

<parameters> are:

aa = SpO_2 signal_strength (0-31)
bbb = SpO_2value, 3 byte ASCII, lsb = 1%
ccc = pulse rate, 3 byte ASCII, lsb = 1 bpm
dd = SpO_2 error code, 2 byte ASCII (These are the same as 75 to 81 in Alarm status—E frame in this appendix)

Error codes

0 = Normal SpO_2 status
4 = SpO_2 probe fail
6 = No SpO_2probe
8 = Interference on SpO_2
10 = SpO_2 probe off patient
12 = SpO_2 insufficient light detected
13 = SpO_2 probe ID error
14 = Low quality SpO_2 signal
50 = Illegal status

Note: SpO_2value and pulse rate will be dashed if invalid.

Configuration data—D frame

:RGDaaabbbccc ... zzzAAABBB<checksum><cr>

Current configuration sent only on request.

<parameters> are:

aaa = agent_type (0 = halothane),
1 = isoflurane,
2 = enflurane,
3 = no agent,
4 = reserved,
5 = desflurane
6 = sevoflurane

bbb = unused
ccc = mute period (30, 60, 90, 120) seconds
ddd = alarm volume (1 - 5; 1 = min, 5 = max)
eee = agent ready bits
bit 0 1 = ACX-200 analyzer available,
bit 1 1 = sevoflurane available, (reserved for future use)
bit 2 1 = desflurane available (reserved for future use)
fff = display units (0 = units off, 1= units on)
ggg = circuit O_2 (0 = off, 1 = on)
hhh = enhancements enabled bits

Bit Description

0 Enhanced features are available (flow waveform, BP interface, & digital trend).

1 Desflurane display enabled.

2 Sevoflurane display enabled.

iii = language (0=English, 1=French, 2=German, 3=Spanish, 4= Italian)

jjj = SpO_2 average (0 = 12 sec , 1 = 6 sec, 2 = 3 sec)

kkk = SpO_2 scale (0 = non auto, 1 = auto)

lll = Pulse beep vol (0 - 5; 0 = off, 1 = min, 5 = max)

mmm = N_2O display (0 = off, 1 = on)

nnn = options (binary of dip switches 0-255)

agent installed 0x80

unused 0x40

unused 0x20

TV clip installed 0x10

calibration constants locked 4

unused 2

SpO_2 installed 1

ooo = patient_type (0 = adult, 1 = pediatric)

ppp = rs_232_device

0 = 1200 Odd

1 = 9600 None

2 = 78xx

3 = Dinamap

4 = 2300

5 = 2120

qqq = print period

0 = off

1 = system test

2 = 10 seconds

3 = 1 minute

4 = 15 min

5 = 60 minutes

rrr = unused

sss = unused

ttt = unused

uuu = unused

vvv = unused

www = unused

xxx = sweep_rate (0 = 6.25, 1 = 12.5 mm/sec)

yyy = unused

zzz = trend_interval (0 = breath trend, 1 = 2 hour, 3 = 8 hour)

AAA = Rev flow det (0 = alarm off, 1 = alarm on)

BBB = wave_type (0 = scroll, 1 = erase bar) Unused entries are zero filled.

Alarm status—E frame

:RGEaaabbb ... <checksum><CR>

Sent on status change in auto compressed or on request. Variable length response depending on the number of active alarms. Each three-digit number represents the code of the active alarm. See the following table. Message numbers appear in increasing numerical order. In slave mode, alarms that occurred since the last request will appear. In slave mode, alarms are latched. Requesting the alarm frame clears the latched alarms. In order to display the current alarms, request the alarm frame once to clear the latched alarms, and request it a second time to get the currrent alarms.

<parameters> are message codes

HIGH Et CO_2	0
LOW Et CO_2	1
CO_2 APNEA	2
LOW INSPIRED O_2	3
LOW TIDAL VOLUME	4
HIGH SUSTAINED PAW	5
SUB-ATMOSPHERIC PAW	6
HIGH N_2O	7
HIGH INSPIRED O_2	8
LOW SpO_2	9
LOW INSPIRED AGENT	10
HIGH INSPIRED AGENT	11
LOW CIRCUIT O_2	12
HIGH $FiCO_2$	13
LOW EXPIRED AGENT	14
HIGH EXPIRED AGENT	15
AGENT DETECTED (detected by CPU in the display submodule)	16
HIGH TIDAL VOLUME	17
HIGH MINUTE VOLUME	18
LOW MINUTE VOLUME	19
HIGH PAW	20
LOW SUSTAINED PAW	21
SAMPLE LINE/FILTER BLOCK	22
REVERSE FLOW	23

WATER TRAP FULL, PUMP OFF	24
GAS ANALYZER SATURATED	25
LOW PULSE RATE	26
HIGH PULSE RATE	27
HIGH SpO_2	28
HIGH CIRCUIT O_2	29
SIGNAL ROM CHECKSUM FAIL	30
SIGNAL RAM FAIL	31
SIGNAL CPU FAIL	32
ANALOG FAIL	33
SpO_2 INOPERATIVE	34
NO VACUUM	35
NO FLOW	36
DEVICE OVERHEATED	37
SIGNAL DIAG TASK FAIL	38
SERVICE TASK FAIL	39
SIGNAL TREND TASK FAIL	40
PNEUMATIC TASK FAIL	41
CALIBRATE TASK FAIL	42
ACX XMIT TASK FAIL	43
EVENT TASK FAIL	44
ACX DECODE TASK FAIL	45
COMMUNICATIONS FAIL (detected by CPU in the display submodule)	46
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Tidal volume data—H frame

:RGHaaaabbbb<checksum><cr>

Tidal/Minute message sent per flow breath or every 5 seconds in auto compressed or on request. Tidal volume values will be zeroed if no breaths are being detected.

<parameters> are:

aaaa = minute volume LSB = 0.1 L

bbbb = tidal volume LSB = 1 mL

Pulse detect frame—K frame

:RGK<checksum><cr>

SpO_2 Pulse Event Detected sent only in auto compressed mode.

Negative acknowledge frame—N frame

:RGNa<checksum><cr>

Sent upon receipt of an invalid command.

a = 0 Invalid command
1 Invalid parameter
2 Invalid checksum
3 Data received with no <esc>RG header
4 Missing terminator
5 Unable to perform request at this time.

PAW data—P frame

:RGPaaabbbccc<checksum><cr>

For airway pressure values, PAW data is offset so that the number 20 represents the zero baseline of zero cm H_2O. This allows transmittal of negative pressures to -20 cm H_2O. Sent every PAW breath detected or every 10 seconds if no breaths are seen in auto compressed or on request.

<parameters> are:

aaa = inspired pressure = LSB = 1cmH_2O

bbb = expired pressure = LSB = 1cmH_2O

ccc = mean pressure = LSB = 1cmH_2O

Alarm limit—Q frame

:RGQaaabbbcccdddeeefffgggghhhiiijjjkkklllmmmnnnoooppppqqq
rrrssstttuuuvvvwwwxxx<checksum><cr>

Sent only on request.

<parameters> are:

aaa = high $EtCO_2$, 3 byte ASCII, lsb = 0.1%

bbb = low $EtCO_2$ 3 byte ASCII, lsb = 0.1%

ccc = high inspired agent, 3 byte ASCII, lsb = 0.1%

ddd = low inspired agent, 3 byte ASCII, lsb = 0.1%

eee = high SpO_2 3 byte ASCII, lsb = 1%

fff = low SpO_2 3 byte ASCII, lsb = 1%

ggg = high pulse rate, 3 byte ASCII, lsb = 1 bpm

hhh = low pulse rate, 3 byte ASCII, lsb = 1 bpm

iii = apnea time, 3 byte ASCII, lsb = 0.1 sec.

jjj = high tidal volume, 3 byte ASCII, lsb = 0.01 l

kkk = low tidal volume, 3 byte ASCII, lsb = 0.01 l

lll = high sustained PAW, 3 byte ASCII, lsb = 1 cmH_2O

mmm = low sustained PAW, 3 byte ASCII, lsb = 1 cmH_2O

nnn = high PAW, 3 byte ASCII, lsb = 1 cmH_2O

ooo = high N_2O, 3 byte ASCII, lsb = 1%

ppp = high minute volume, lsb = 0.1 l

qqq = low minute volume, lsb = 0.1 l

rrr = high circuit O_2 3 byte ASCII, lsb = 1%

sss = low circuit O_2, 3 byte ASCII, lsb = 1%

ttt = high insp O_2, 3 byte ASCII, lsb = 1%

uuu = low insp O_2 3 byte ASCII, lsb = 1%

vvv = high insp CO_2 3 byte ASCII, lsb = 0.1%

www = high expired agent, 3 byte ASCII, lsb = 0.1%

xxx = low expired agent, 3 byte ASCII, lsb = 0.1%

If alarm is off or parameter is unavailable, dashes (2DH) fill the field.

Two-minute trend response—R frame

:RGRabbbccc<value>...<value><checksum><cr>

Sent only on request

<parameters> are:

a = parameter index

- 0 = CO_2% trend (pair), lsb = 0.1%
- 1 = SpO_2 trend (value), lsb = 1%
- 2 = PAW trend (set of three), lsb = 1 cm H_2O (Note: 20 cm H_2O is added to each value.)
- 3 = O_2 trend (pair), lsb = 1%
- 4 = MV trend (value), lsb = 1L
- 5 = N_2O trend (pair), lsb = 1%
- 6 = Agent trend (pair), lsb = 0.1% (max value 25.3%)
- 7 = BP trend (set of three), lsb = 2mmHg

bbb = trend point (or pair or set of three) start offset

ccc = number of trend points (or pairs or sets of three) in this specific frame. This will be less than or equal to the maximum points requested and may be zero. Zero indicates no data exists for data requested.

<value> is 2 ASCII hex digits per value. Value of 0FEH (hex) indicates invalid, null, or no data available. No delimiters between values.

Version frame

:RGVaaaaabbbbbccccdddd<checksum><terminator>

Sent only on request.

<parameters> are:

aaaaa = Display version xx.xxx

bbbbb = Signal version xx.xxx

ccccc = ACX version xxx.xx

ddd = SpO_2 version implemented as an ASCII string padded with trailing spaces.

Acknowledge Y frame

:RGY<checksum><cr>

Sent as response to commands that do not have a response.

Auto printer format header * frame

```
<ff> :RG*      CO2    | O2| PAW |  FLOW  |      | CKT | Bar| Sp     | AGENT  X<cr>
     :RG* I     E RR  | I E | I E M| TV MV | N2O |  O2  | Pre| O2 PR |   I    E  <cr>
```

(X is H, I, E, N, D, S representing halothane, isoflurane, enflurane, no agent, desflurane, sevoflurane.)

This header is sent at the top of each page of printer output.

Auto printer format header ' ' data frame

This frame is sent to the serial port either on request or according to the time period selected on the Setup Screen. SpO_2 and pulse rate data are only included if RGM is configured with SpO_2 option. Agent data are only sent if monitor is configured with the agent option. After the data line, the date and time are appended.

D/78xx Ventilator Interface

The 78xx ventilator performs all calculations for TV, MV, PAW, and circuit O_2 values. An RS-232 cable is used to transmit these values to the RGM, which displays the values received from the 78xx ventilator. The PAW waveform is obtained from the RGM PAW inlet with a tee (see Figure 2-11). The calculations for PAW values by the ventilator differ from those of the RGM. Mean as calculated by the RGM is changed to PLAT as calculated by the 78xx ventilator. An algorithm similar to the one used by the RGM is used by the 78xx ventilator for MAX and MIN PAW values.

If an alarm associated with a value on the screen flashes, press alarm silence on the RGM to silence the alarm. If the ventilator is interfaced, the alarm silence period is 30 seconds.

Alarm limit settings and the display for TV, MV, PAW, and circuit O_2 values are set on the ventilator.

Note: The minimum software revision level for ventilators is 1.10 for the 7800 and 3.2 for the 7810.

To interface the RGM to a 78xx ventilator:

1. Obtain the cable assembly RS-232 (see "Accessories" in 4/Maintenance, Service, and Calibration). (RGM to HP Thinkjet™ or 78xx ventilator).
2. Connect one end of the cable to the ventilator and the other to the RGM.
3. On the Setup Screen, select RS-232 device and select 78xx VENT.

The RGM will immediately dash (---) PAW, TV, MV, and O_2 vent values until communication with the ventilator is established.

If the cable is disconnected or the ventilator is powered off, the RGM will dash (---) the PAW, TV, MV, and O_2 vent values after 12 seconds and the VENTILATOR COMM FAIL message appears in the alarm window on the RGM.

The RGM will show and sound ventilator parameter alarms for TV, MV, PAW, and circuit O_2. Other patient safety alarms sound only on the ventilator.

Notes