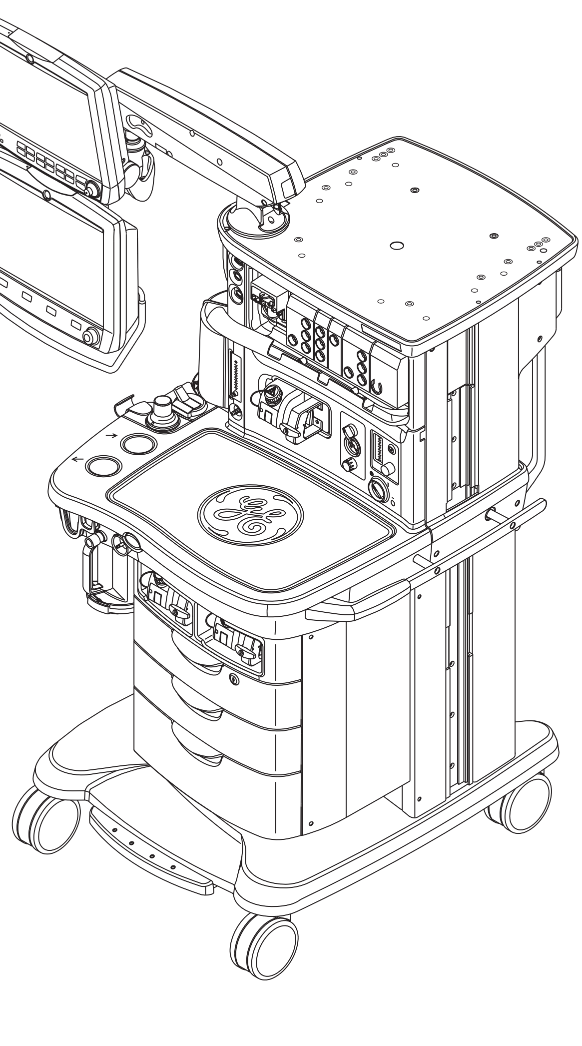
Aisys CS² Anesthesia Machine
Technical Reference Manual



Datex-Ohmeda, Inc., a General Electric Company, doing business as GE Healthcare.

Datex-Ohmeda products have unit serial numbers with coded logic which indicates a product group code, the year of manufacture, and a sequential unit number for identification. The serial number can be in one of two formats.

AAA**X**11111	AAA**XX**111111AA
The **X** represents an alpha character indicating the year the product was manufactured; **H** = 2004, **J** = 2005, etc. **I** and **O** are not used.	The **XX** represents a number indicating the year the product was manufactured; **04** = 2004, **05** = 2005, etc.

Technical Competence

The procedures described in this Technical Reference manual should be performed by trained and authorized personnel only. Maintenance should only be undertaken by competent individuals who have a general knowledge of and experience with devices of this nature. No repairs should ever be undertaken or attempted by anyone not having such qualifications.

Replace damaged parts with components manufactured or sold by GE Healthcare. Then test the unit to ascertain that it complies with the manufacturers's published specifications.

Read completely through each step in every procedure before starting the procedure; any exceptions may result in a failure to properly and safely complete the attempted procedure.

Aisys CS2 Anesthesia Machine

Important

The information contained in this Technical Reference manual pertains only to those models of products which are marketed by Datex-Ohmeda as of the effective date of this manual or the latest revision thereof. This Technical Reference manual was prepared for exclusive use by Datex-Ohmeda service personnel in light of their training and experience as well as the availability to them of parts, proper tools and test equipment. Consequently, Datex-Ohmeda provides this Technical Reference manual to its customers purely as a business convenience and for the customer's general information only without warranty of the results with respect to any application of such information. Furthermore, because of the wide variety of circumstances under which maintenance and repair activities may be performed and the unique nature of each individual's own experience, capacity, and qualifications, the fact that customer has received such information from Datex-Ohmeda does not imply in any way that Datex-Ohmeda deems said individual to be qualified to perform any such maintenance or repair service. Moreover, it should not be assumed that every acceptable test and safety procedure or method, precaution, tool, equipment or device is referred to within, or that abnormal or unusual circumstances, may not warrant or suggest different or additional procedures or requirements.

This manual is subject to periodic review, update and revision. Customers are cautioned to obtain and consult the latest revision before undertaking any service of the equipment. Comments and suggestions on this manual are invited from our customers. Send your comments and suggestions to the Manager of Technical Communications, Datex-Ohmeda, Ohmeda Drive, PO Box 7550, Madison, Wisconsin 53707.

⚠ CAUTION Servicing of this product in accordance with this Technical Reference manual should never be undertaken in the absence of proper tools, test equipment and the most recent revision to this service manual which is clearly and thoroughly understood.

⚠ WARNING Do not modify this equipment without authorization from the manufacturer. Unauthorized modifications could result in damage to the equipment and/or cause patient injury.

Changes or modification to this equipment not expressly approved by the manufacturer could cause EMC issues with this or other equipment. Contact the manufacturer for assistance. This device is designed and tested to comply with applicable regulations regarding EMC as follows:

- Use of portable phones or other radio frequency (RF) emitting equipment (that exceed electromagnetic interference levels specified in IEC 60601-1-2) near the system may cause unexpected or adverse operation. Monitor operation when RF emitters are in the vicinity.
- Use of other electrical equipment adjacent to or stacked with this system may cause interference. Verify normal operation of equipment in the system before use on patients.

1 Introduction

2 Theory of Operation

3 Checkout Procedure

4 Installation and Service Menus

5 Calibration

6 Installation and Functional Checks

7 Troubleshooting

8 Software Download

9 Repair Procedures

10 Illustrated Parts

12 Service Application

13 Maintenance Procedures

Notes

1 Introduction

In this section

This section provides a general overview of the Aisys CS2 anesthesia machine.

1.1 What this manual includes

This manual covers the service information for the Aisys CS2 line of anesthesia machines. It covers the following components:

- Display Unit
- Integral electronics
- Gas delivery components
- Electronic vaporization
- Breathing system components
- Frame component
- Auxiliary O_2 flowmeter
- Optional suction regulator

Other equipment

Other equipment may be attached to the system on a display mount, the top shelf, or on the side dovetail rails. Consult separate documentation relative to these items for details.

1.2 Respiratory Gas Modules

The Aisys CS2 anesthesia machine may be configured for use with a GEHC Respiratory Gas Module. When the GEHC Respiratory Gas Module is configured with the Aisys CS2 anesthesia system, reference the appropriate GEHC Respiratory Gas Module Technical Reference Manual for relevant information regarding Theory of Operation, Installation procedures, Maintenance and Checkout, Calibration and Adjustments, Troubleshooting, Disassembly and Reassembly, and Service Parts.

1.3 User's Reference manuals

Some sections of this manual refer you to the User's Reference manual for the Aisys CS2 anesthesia system. To expedite repairs, you must have, and be familiar with, the User's Reference manuals for this product.

1.4 Overview

The Aisys CS2 anesthesia system is a scalable, flexible, and functionally integrated system, featuring advanced design ventilation, respiratory monitoring, and breathing system.

Module bays allow for the integration of Datex-Ohmeda patient monitors. Optionally, the open architecture design supports mounting of non-Datex Ohmeda patient monitors, record keeping, and connections to the hospital information system.

Optional gas monitoring is available with the following Airway Modules:

- E-series: E-CAiO, E-CAiOV, E-CAiOVX (software version 4.5 and above)
- M-series: M-CAiO, M-CAiOV, M-CAiOVX (software version 3.2 and above)
- CARESCAPE series: E-sCAiO, E-sCAiOV

Airway module requirements for Et Control mode:

- E-series: E-CAiO, E-CAiOV, E-CAiOVX (software version 4.5 and above)
- M-series: M-CAiO, M-CAiOV, M-CAiOVX (software version 4.5 and above)
- CARESCAPE series: E-sCAiOE, E-sCAiOVE

The Aisys CS2 anesthesia system uses SmartVent ventilation technology offering Volume Control Ventilation with tidal volume compensation and electronic PEEP. The proven SmartVent also features optional Pressure Control Ventilation (PCV), Pressure Support Ventilation with an Apnea Backup (PSVPro) that is used for spontaneously breathing patients, Synchronized Intermittent Mandatory Ventilation (SIMV) modes, Pressure Control Ventilation-Volume Guarantee (PCV-VG), Continuous Positive Airway Pressure/Pressure Support Ventilation (CPAP+PSV), and VCV cardiac bypass.

Note

The Aisys CS2anesthesia system is not suitable for use in a MRI environment.

Configurations available for this product depend on local market and standards requirements. Illustrations in this manual may not represent all configurations of the product.

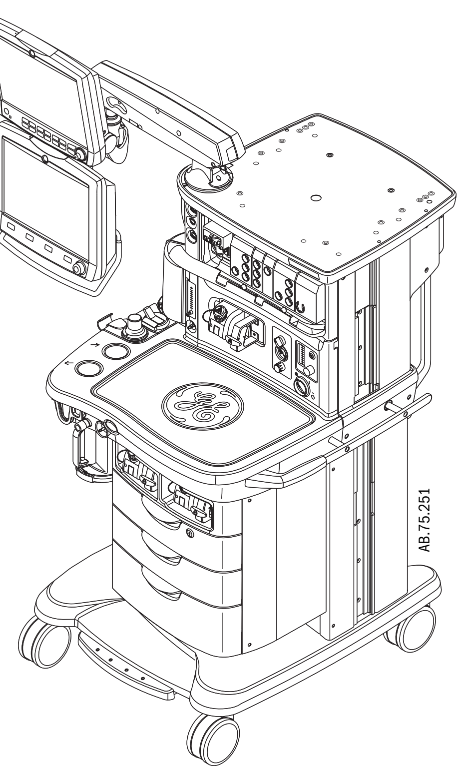
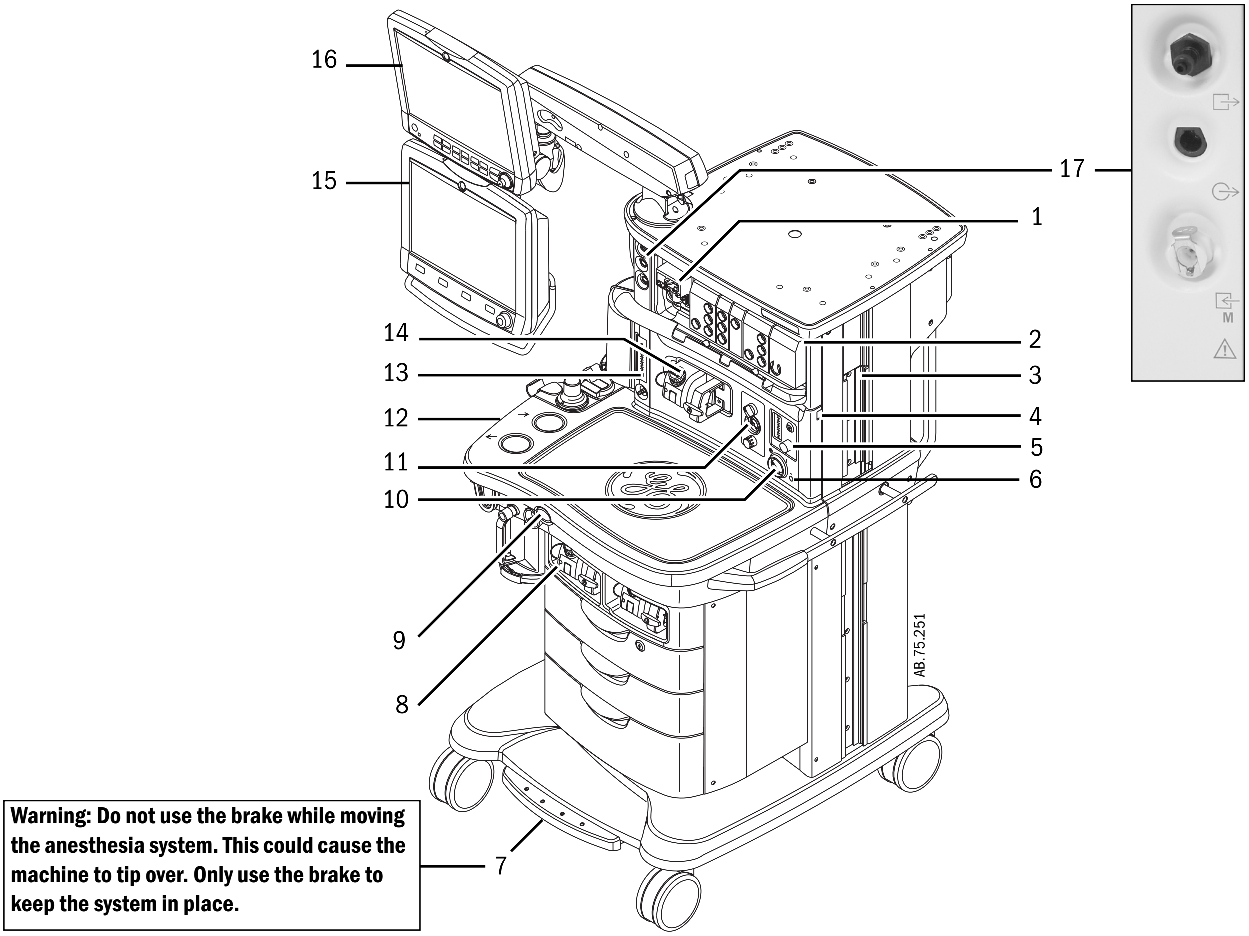


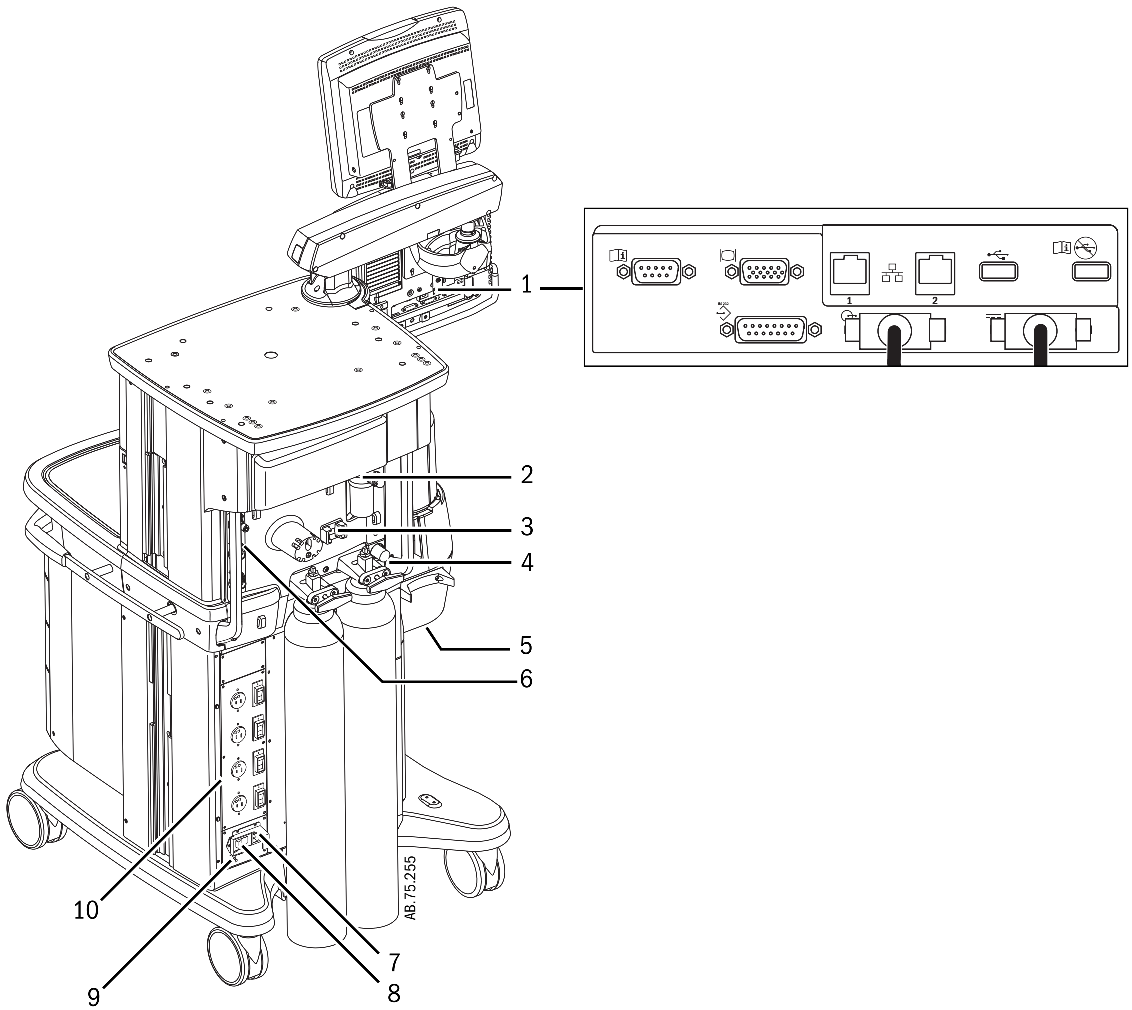
Figure 1-1 • *Aisys CS2* anesthesia system

1.5 Anesthesia system components



1. Airway module
2. Patient monitoring modules
3. Dovetail rails
4. Light switch
5. Alternate O_2 control
6. Mains indicator
7. Brake
8. Aladin cassette storage bay
9. O_2 flush button
10. System switch
11. Integrated suction (optional)
12. Advanced breathing system
13. Auxiliary O_2 flow control
14. Aladin cassette and active bay
15. Anesthesia display
16. Patient monitoring display
17. Et Control

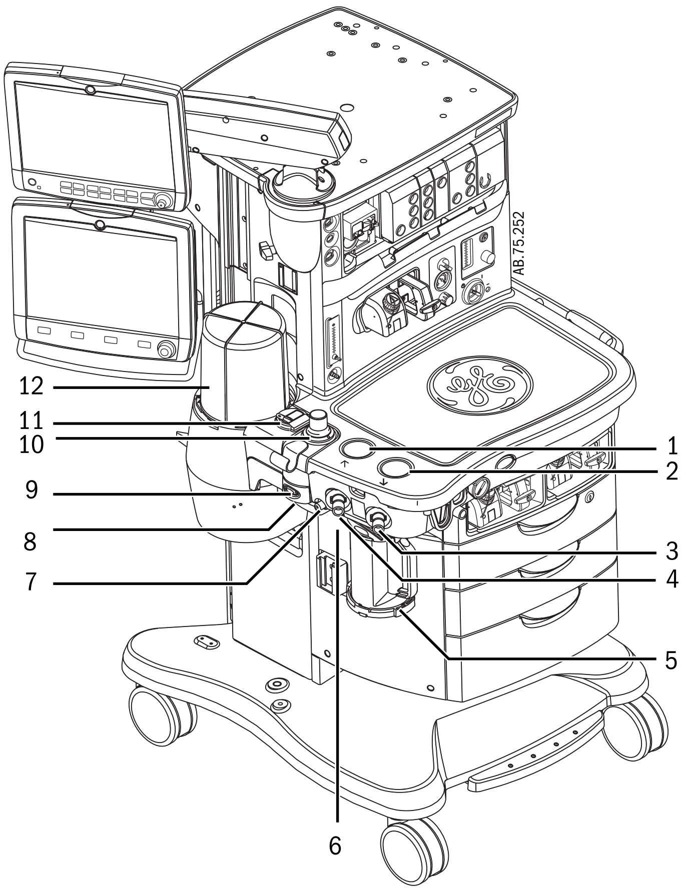
Figure 1-2 • Front view



1. Display Unit system interface connections (refer to Section 2.5.1)
2. Collection bottle connection
3. Cylinder wrench (key) storage
4. Cylinder yoke
5. Anesthesia Gas Scavenging System
6. Pipeline connections
7. Mains inlet
8. System circuit breaker
9. Equipotential stud
10. Isolated electrical outlet

Figure 1-3 • Rear view

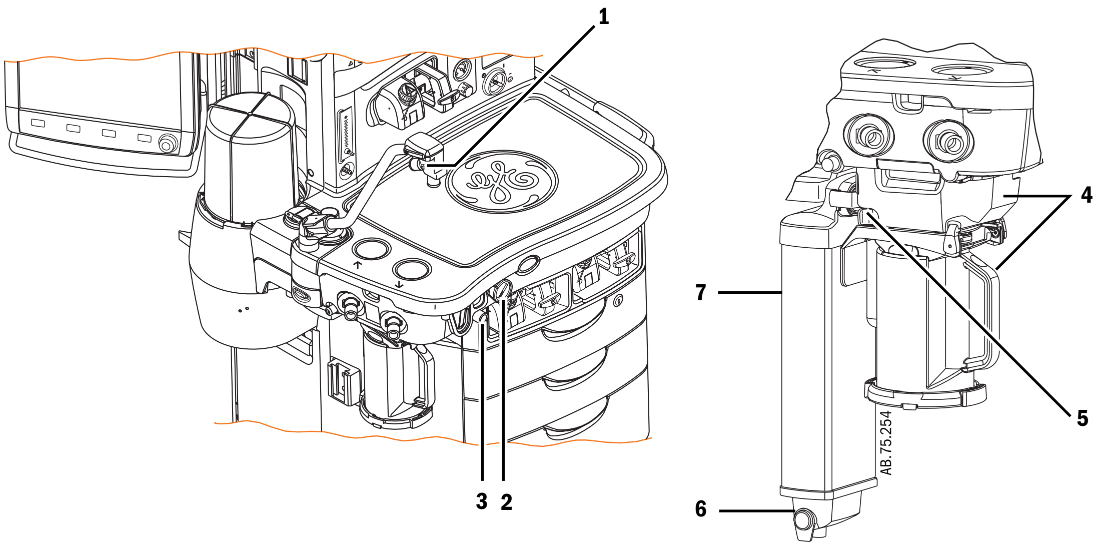
1.6 Breathing system components



1. **Expiratory check valve**
2. **Inspiratory check valve**
3. **Inspiratory flow sensor**
4. **Expiratory flow sensor**
5. **Absorber canister**
6. **Absorber canister release**
7. **Leak test plug**
8. **Manual bag port**
9. **Breathing system release**
10. **Adjustable pressure-limiting (APL) valve**
11. **Bag/Vent switch**
12. **Bellows assembly**

Figure 1-4 • Advanced breathing system

1.6.1 Optional system components

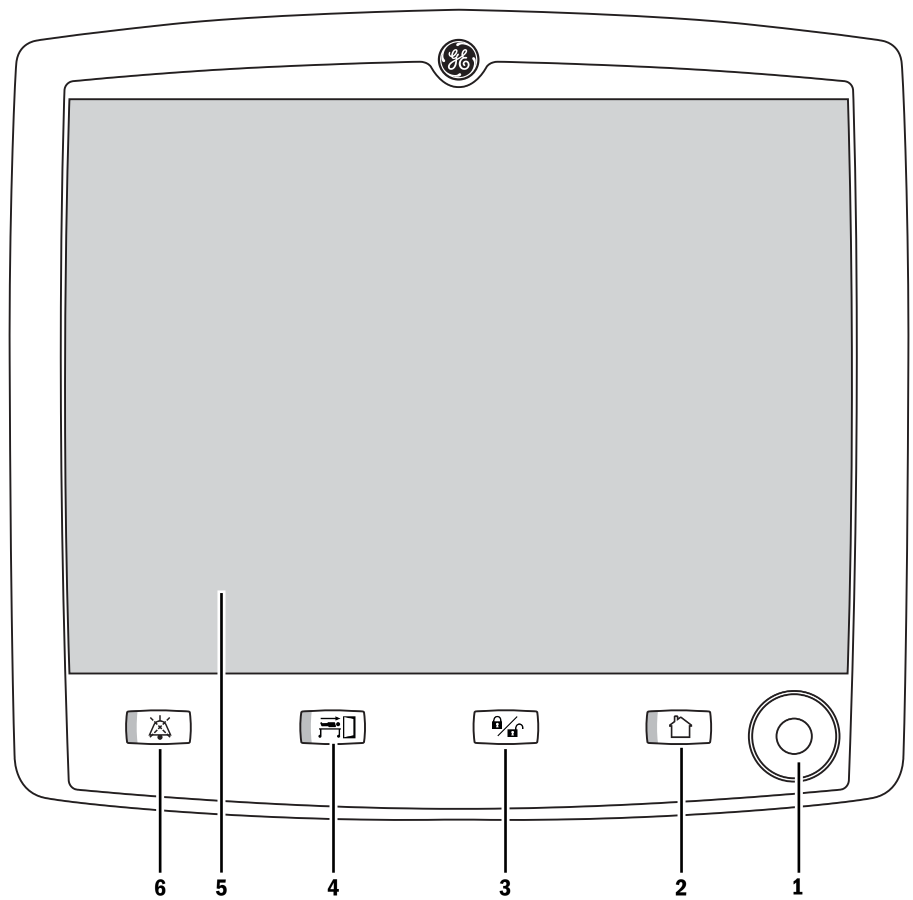


1. **Bag support arm**
2. **Auxiliary Common Gas Outlet (ACGO) switch**
3. **ACGO port**
4. **EZchange Canister system (CO_2 bypass)**
5. **EZchange Canister release**
6. **Condenser drain button**
7. **Condenser**

Figure 1-5 • Breathing system options

1.7 Display controls

The system uses touchscreen technology, hard keys, and a ComWheel to access system functions, menus, and settings.



1.	ComWheel	Selects a menu item or confirms a setting. Turn clockwise or counterclockwise to scroll through menu items or change settings.
2.	Home key	Removes all menus from the screen.
3.	Screen Lock/Unlock key	Locks the touchscreen. Toggles between lock and unlock functions.
4.	Start/End Case key	Initiates Start or End Case function.
5.	Touchscreen	Activates functions when touch areas on the screen are selected.
6.	Audio Pause key	Stops audio for 120 seconds for any active, eligible high and medium priority alarms. Prevents audio (audio off) for 90 seconds when no medium or high priority alarms are active. Allows the operator to acknowledge any non-active medium or high priority latched alarms.

Figure 1-6 • Display controls

1.7.1 Touch points

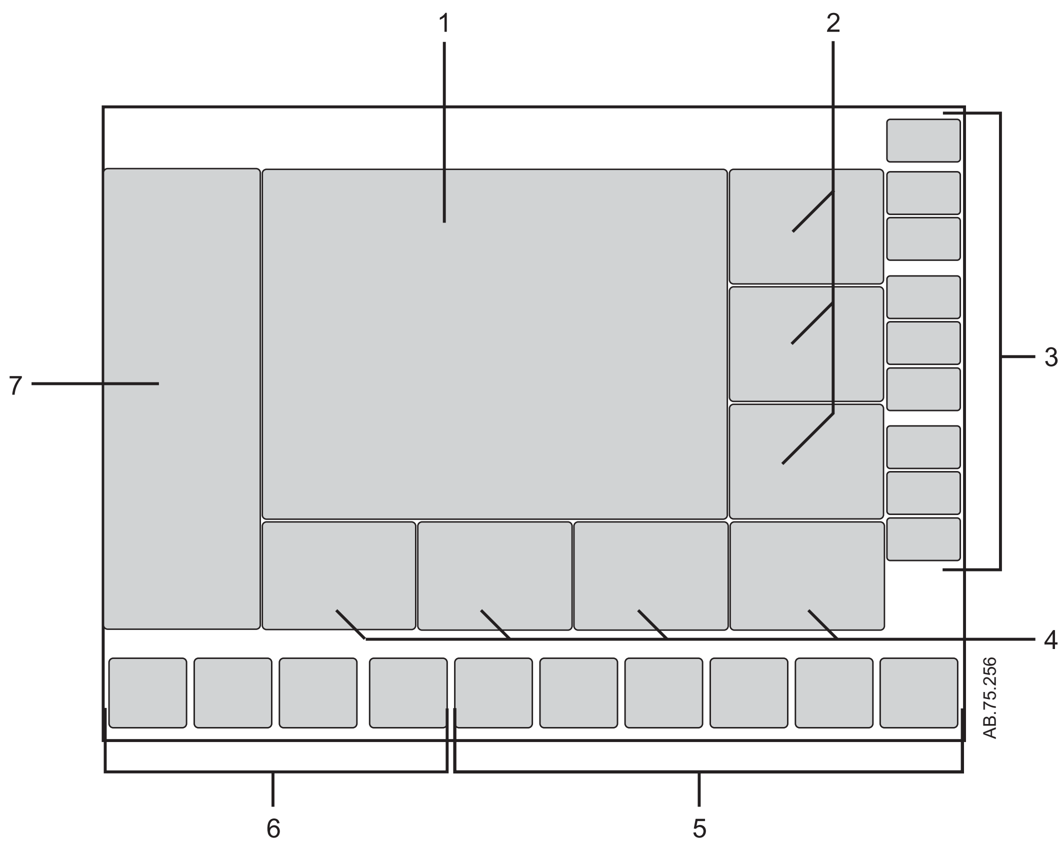
The touchscreen has numerous touch point areas that make accessing menus and settings quick and easy.

- The function keys (**3**) on the right side of the screen provide direct access to commonly used functions.
- The ventilation quick keys (**5**) enable setup of ventilation modes.
- The gas control quick keys (**6**) provide a method to set up the gas used for a case.

Touch only one touch point at a time to ensure the correct selection is made.

WARNING Liquids on the display may degrade the performance of the touchscreen. If liquids come in contact with the display, lock the touchscreen and clean the display. Unlock the touchscreen once the display has been cleaned to resume use of the touchscreen.

CAUTION Do not apply excessive force to the touchscreen as damage may occur.



1. Wave fields
2. Measured values
3. Function keys
4. Digit fields
5. Ventilation quick keys
6. Gas control quick keys
7. Split screen values

Figure 1-7 • Normal/Full screen view with shaded touch point areas

Measured value touch points

Touching measured values provides access to the ***Alarm Setup*** menu and alarm limits.

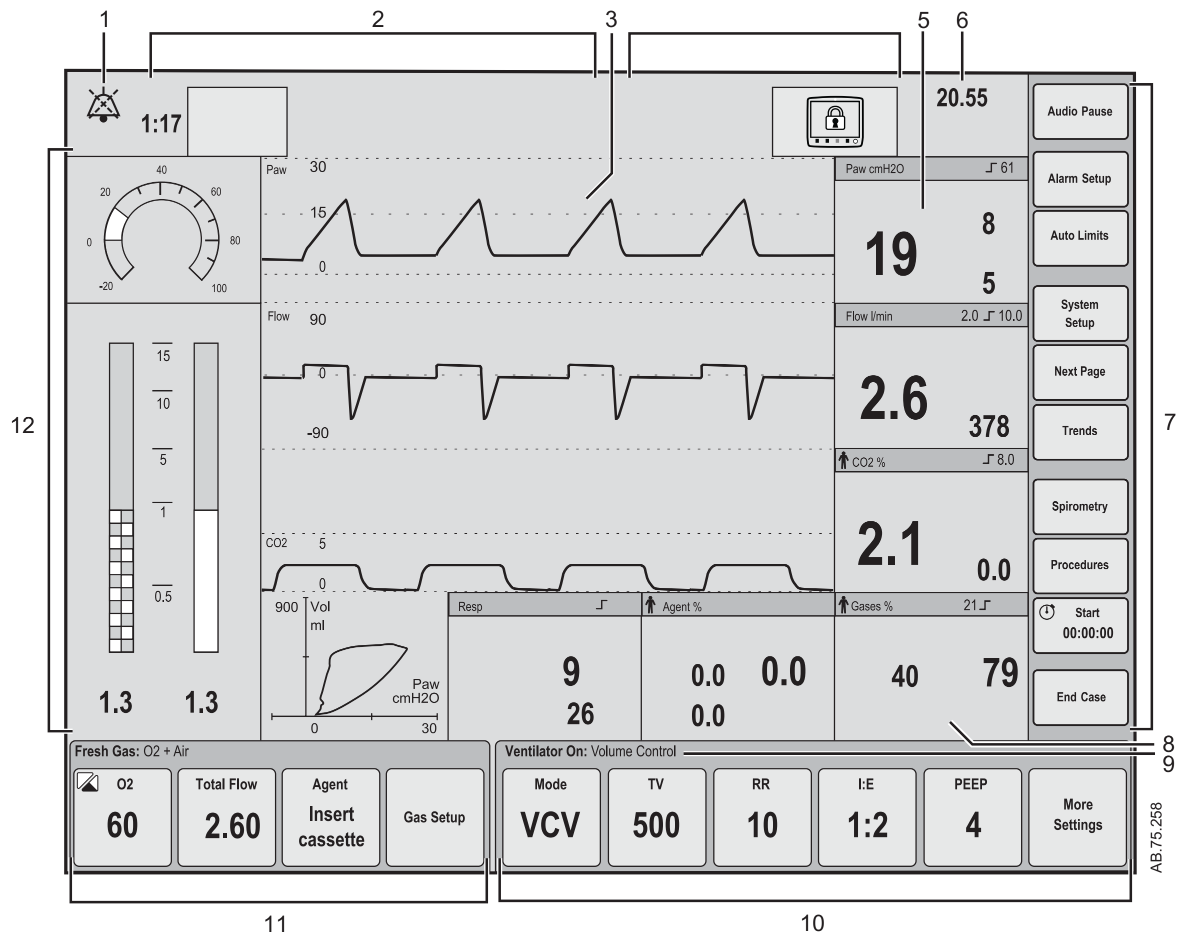
1. Touch the measured value to access the ***Alarm Setup*** menu.
2. The ***Alarm Setup*** menu displays.
3. Select the alarm limit and set it to the correct value. Touch the value on the touchscreen or push the ComWheel to confirm the desired setting.
4. Push the Home key, touch the waveform area of the display, or select ***Close*** to close the menu.

Active alarm touch points

When an alarm sounds the alarm message is displayed at the top of the screen and, if applicable, the alarming numeric field and digit field flashes. The Alarm messages at the top of the screen are message alerts only and not active touch points.

1. Touch the flashing numeric field to access the ***Alarm Setup*** menu and alarm limits for the active alarm.
2. The ***Alarm Setup*** menu displays with the active alarm limit highlighted. For example: If the 'Ppeak high' alarm activates, the high alarm limit setting for Ppeak displays with the highlight.
3. Select the active alarm limit and change it to the desired setting.

1.8 Anesthesia system display



1.	Audio pause symbol and countdown clock	Indicates when alarm audio is paused and the countdown clock until audio is on.
2.	Alarm message fields	Displays the active alarms.
3.	Waveform fields	Displays the waveforms of measured values. For example: Paw, Flow, and CO2.
4.	General message fields or lock touchscreen indicator	Displays general messages and the touchscreen lock indicator.
5.	Measured values fields	Displays the measured values. For example: Paw, Flow, and CO2.
6.	Clock	Displays the current time.
7.	Function keys	Functions available are: Audio Pause, Alarm Setup, Auto Limits, System Setup, Next Page, Trends, Spirometry, Procedures, Timer, Start, and End Case.
8.	Digit fields	Contains information for Spirometry, Resp, Agent, and Gases.
9.	Ventilation mode	Displays the selected ventilation mode. For example: Ventilator On, and Volume Control.
10.	Ventilator quick keys	Displays Mode, associated ventilation parameters, and More Settings. For example: Mode, TV, RR, I:E, Tpause, PEEP, and Pmax.
11.	Gas quick keys	Displays O2, Total Flow, and Gas Setup.
12.	Split screen	Contains airway pressure, gas flow values, compliance, trends, and optional ecoFLOW information.

Figure 1-8 • Normal/Full view

Digit field

The digit field can be set to show specific information such as gas types, gas supply, flow, agent, respiration, and spirometry loops. If the digit field is set to show agent and no airway module is inserted, the area is blank.

Paw, O_2, and either TVexp or CO_2 must show on the display during a case. If any of these parameters are not selected to show on the display, the digit field information is replaced with the missing parameter.

See the User's Reference Manual for more information.

Waveform fields

Up to three waveforms can be shown on the normal screen view. Each waveform can be set to show specific Paw, agent, flow, or CO2 data. The corresponding numeric information shows in the measured values field to the right of the waveform. If the waveform is set to show the agent and no airway module is inserted, that waveform and numeric areas are blank.

When one waveform is turned off, that waveform and the corresponding numerics information are removed from the normal screen view. The remaining waveforms and numerics increase in size to fill the waveform area. When two waveforms are turned off, those waveforms and the corresponding numerics information are removed from the normal screen view. The remaining waveform increases in size and is centered in the waveform area.

See the User's Reference Manual for more information.

Split screen field

The split screen field can be set to show gas and agent delivery, trends, spirometry loops, Paw gauge, airway compliance, and optional ecoFLOW information. If None is selected, the waveforms expand to fill the split screen area.

The split screen consists of an upper and lower portion. The upper portion typically shows graphical information for the selected parameter and the lower portion typically shows a representation of measured gas flow.

See the User's Reference Manual for more information.

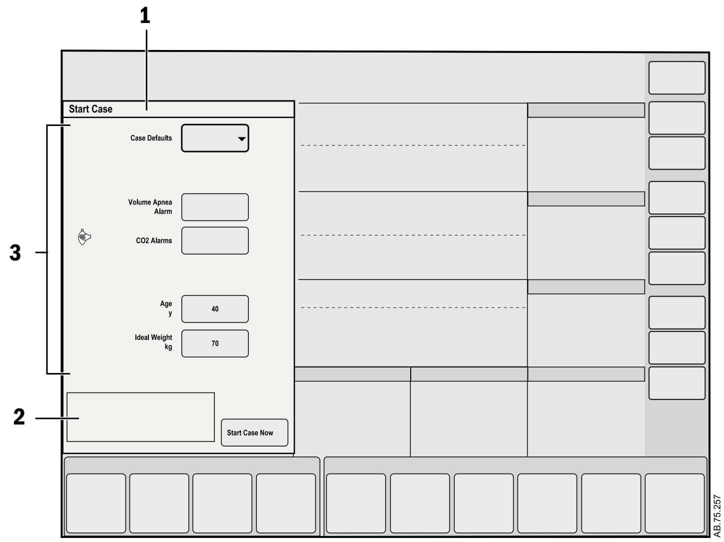
1.9 Display navigation

Use the touchscreen and ComWheel to navigate the display.

Using menus

Use the function keys to access the corresponding menus. When a menu is selected, the menu field overlays the normal view and the waveform fields start at the right edge of the menu.

1. Select the menu key to access the corresponding menu.
2. Select a menu item to select the item, or turn the ComWheel left or right to highlight a menu item and then push to confirm.
3. If the menu item selected is an adjustment, turn the ComWheel left or right to make the setting and then push to confirm.
4. Select ***Close***, touch the waveform area, or push the Home key to exit the menu.



1. Menu — Displays the title of the open menu. For example: Start Case.
2. Instructions or help information — This shows any additional instructions or help messages.
3. Menu items — Shows Case Defaults, Volume Apnea Alarm, O2 Alarms, Age, Ideal Weight, and Start Case Now.

Figure 1-9 • Menu view and menu example

Using the ComWheel

Use the ComWheel to scroll through the quick key settings and function keys, make selections, change settings, and confirm settings.

1. Push the ComWheel to make a selection.
2. Turn the ComWheel to the right.
   - For menu items, the highlight moves down.
   - For quick keys, the highlight moves to the next key on the right.
   - For settings, the value changes to the next available setting.
   - For pull-down selections, the highlight moves to the next available selection.
3. Turn the ComWheel to the left.
   - For menu items, the highlight moves up.
   - For quick keys, the highlight moves to the next key on the left.
   - For settings, the setting changes to the next available setting.
   - For pull-down selections, the highlight moves to the previous available selection.
4. Push the ComWheel to confirm a setting.

Using quick keys

The gas settings and the main ventilator settings for each ventilation mode can be changed using the quick keys.

1. Select a quick key to open the menu or select a parameter.
2. If Gas Setup, Mode, or More Settings is selected, a menu displays. Select the desired value on the menu by touching the value.

   If any other quick key is selected, the value displays with a highlight. Turn the ComWheel left or right to set the desired value
3. Push the ComWheel or select the quick key to confirm the change.

1.10 System Information

1.10.1 System classification

This system is classified as follows:

- Class I Equipment.
- Type B Equipment.
- Type BF Equipment (airway modules).
- Ordinary Equipment.
- Not for use with flammable anesthetics.
- Continuous operation.

1.10.2 Device standards IEC 60601-1:2005

Devices used with this anesthesia system shall comply with the following standards where applicable:

- Breathing system and breathing system components ISO 80601-2-13.
- Anesthetic gas scavenging systems ISO 80601-2-13.
- Anesthetic vapor delivery devices ISO 80601-2-13.
- Anesthetic agent monitors ISO 80601-2-55.
- Oxygen monitors ISO 80601-2-55.
- Carbon dioxide monitors ISO 80601-2-55.
- Exhaled volume monitors ISO 80601-2-13.

1.10.3 Device standards IEC 60601-1:1988

Devices used with this anesthesia system shall comply with the following standards where applicable:

- Breathing system and breathing system components ISO 8835-2.
- Anesthetic gas scavenging systems ISO 8835-3.
- Anesthetic vapor delivery devices ISO 8835-4.
- Anesthetic agent monitors ISO 21647.
- Oxygen monitors ISO 21647.
- Carbon dioxide monitors ISO 21647.
- Exhaled volume monitors IEC 60601-2-13.

1.10.4 Environmental requirements

	Operation	Storage and Transport
Temperature	10 to 35˚C Oxygen cell 10 to 40˚C	-25 to 60˚C Oxygen cell storage is -15 to 50˚C, 10 to 95% RH, 500 to 800 mmHg Aladin cassette storage -25 to 50˚C
Humidity	15 to 95% RH, non-condensing	15 to 95%, non-condensing
Altitude	537 to 800 mmHg (3000 to -440 meters)	425 to 800 mmHg (4880 to -440 meters)

1.10.5 Physical specifications

All specifications are approximate values and can change without notice.

CAUTION Do not subject the system to excessive shock and vibration.

Do not place excessive weight on flat surfaces or drawers.

WARNING Maintain system balance. When using rails or dovetails, distribute equipment on each side of the system. Uneven system balance could cause the system to tip.

System	Height	151 cm
	Width	80 cm
	Depth	89 cm
	Nominally configured mass (including three cassettes)	190 kg
	Maximum configured mass (includes external cylinders and maximum loads on all mounting and storage locations)	500 kg
	Top of machine weight limit	45 kg
	Optional top shelf weight limit, includes top of machine weight	45 kg
	Machine drawer weight limit	8 kg
Casters	13 cm	
LCD and touchscreen display	304 x 228 mm (38 cm diagonal)	

System loading

Lower rail loading

Maximum allowable lower dovetail loading is 22.7 kg and 16.2 Nm.

See “Figure 1-2 • Front view” for the location of the lower dovetail.

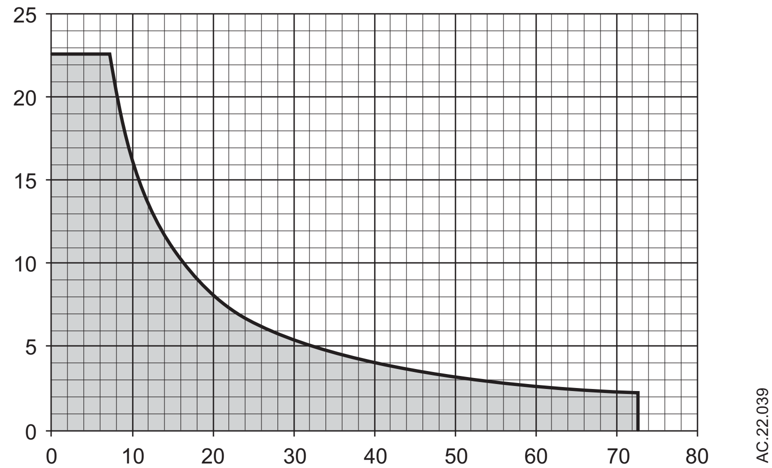


Figure 1-10 • Lower rail load in kg (vertical) versus load distance from the lower rail in cm (horizontal).

Upper dovetail loading

Maximum allowable upper dovetail loading is 11.3 kg and 54 Nm.

See “Figure 1-2 • Front view” for the location of the upper dovetail.

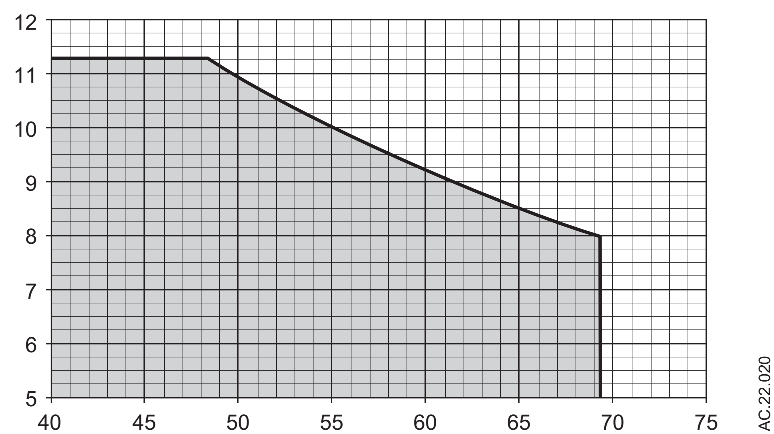


Figure 1-11 • Upper dovetail load in kg (vertical) versus load distance from the upper dovetail in cm (horizontal).

1.10.6 Communication with OEM devices by Network/Data coupling

The RS 232 connection on the display unit may be used to output data to OEM equipment. In order to share information from an Aisys CS2 system, the receiving system must be compatible with Datex-Ohmeda Com 1.2 Serial Protocol. Information on the Datex-Ohmeda Com 1.2 Serial Protocol is available by contacting Technical Support.

Caution Failure to meet the requirements of the Datex-Ohmeda Com 1.2 Serial Protocol will not allow the transfer of data from the Aisys CS2 system to the receiving system.

Caution Connection of the Aisys CS2 system to other equipment may result in previously unidentified risks to patients, operators, or third parties. The responsible organization should identify, analyze, evaluate and control these risks. Subsequent changes to the network/data coupling may introduce new risks and require additional analysis. Possible subsequent changes include:

- changes in network/data coupling configuration.
- connection of additional items to the network/data coupling.
- disconnecting items from the network/data coupling.
- update of equipment connected to the network/data coupling.
- upgrade of equipment connected to the network/data coupling.

1.11 Symbols used in the manual or on the equipment

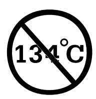
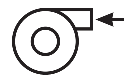
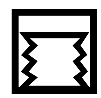
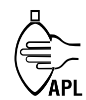
Symbols replace words on the equipment, on the display, or in Datex-Ohmeda manuals. No one device or manual uses all of the symbols.

Warnings and Cautions tell you about dangerous conditions that can occur if you do not follow all instructions in this manual:

- Warnings tell about a condition that can cause injury to the operator or the patient.
- Cautions tell about a condition that can cause damage to the equipment.

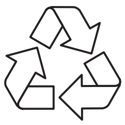
Read and follow all warnings and cautions.

|	On (power)		Standby
O	Off (power)		Lamp, lighting, illumination
	Type B equipment		Type BF equipment
	General warning (yellow background)		Caution
	Direct current		Dangerous voltage
∼	Alternating current		Electrical input/output
	Protective earth ground		Variability
	Earth ground		Variability in steps
	Frame or chassis ground		Pneumatic inlet
	Equipotential		Pneumatic outlet
+	Plus, positive polarity	→	Movement in one direction
-	Minus, negative polarity	↔	Movement in two directions
Air	Air	**AIR**	Air

	Read to center of float
	This way up
	Lock
	Unlock
	Not autoclavable
134°C	Autoclavable
≃ cmH_2O	APL settings are approximate
≃ V_T (mL)	Bellows volumes are approximate
VACUUM	Vacuum
	Inspiratory flow
AGSS	Anesthetic Gas Scavenging System
	Operating instructions
REF	Stock Number
SN	Serial Number
	Vacuum inlet
	Suction bottle outlet
	Low pressure leak test
	Open drain (remove liquid)
	Mechanical ventilation
	Bag position/ manual ventilation
O_2+	O_2 Flush button
O_2%	O_2 cell connection
EXHAUST	Exhaust
	Expiratory flow
	EZchange Canister (CO_2 bypass)
	Refer to instruction manual or booklet (blue background)
MAX	Maximum
℞ ONLY	Caution: federal law prohibits dispensing without prescription.

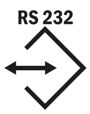
Authorized representative in the European Community

Manufacturer

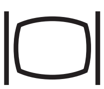


Recyclable material

Single use device



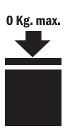
Serial connection



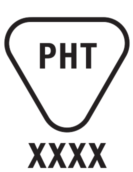
VGA connection

USB port

Pinch hazard



Stacking limit by mass

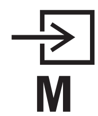


Device contains phthalates.
XXXX indicates phthalate.
Possible phthalates include:
DBP: Di-n-butyl phthalate
DNPP: 1,2-Benzenedicarboxylic acid, dipentylester, branched and linear; N-pentyl-isopentylphthalate; Di-n-pentylphthalate;
DiisopentylphthalateBBP: Benzyl butyl phthalate
DEHP: Bis(2-ethylhexyl) phthalate; Di-(2-ethylhexyl) phthalate
DMEP: Bis(2-methoxyethyl) phthalateDIBP: Dissobutyl phthalate

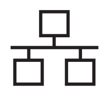
Electrical test certification

Date of Manufacture

Indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of equipment.



Sample gas inlet to scavenging



Network

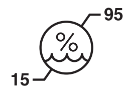
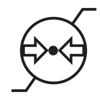
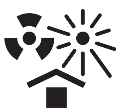
Not a USB port

XXX Kg

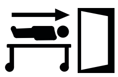
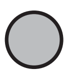
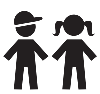
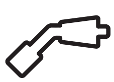
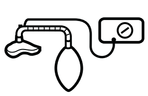
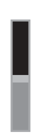
Maximum mass of configured mobile equipment

Do not stack

Stepping prohibited

	GOST R Russian certification
	Union made
	Keep dry
	Fragile, handle with care
	Temperature limitation
	Humidity limitation
	Interference
	Atmospheric limitation
	Protect from heat and radioactive source
	When moving or transporting anesthesia machine, place the display arm in the transport position as shown.
xxxx	Systems with this mark agree with the European Council Directive (93/42/EEC) for Medical Devices when they are used as specified in their User's Reference manuals. The xxxx is the certification number of the Notified Body used by Datex-Ohmeda's Quality Systems.

1.11.1 Symbols on the user interface

	Alarm off		Home screen
	Start/end case		Lock/unlock button Button label to lock or unlock the touchscreen.
	Audio Pause		Lock Indicates the touchscreen is locked.
	O2% indicator on left and balance gas indictor on right. Colors associated with gas settings.		Gas indicator. Color associated with gas settings.
	Drop-down menu		Submenu
	Test indicator: red for failure, yellow for conditional outcome, and green for pass.		Alarm low and alarm high limit indicator
	No battery/battery failure		Battery in use. Bar indicates amount of battery power remaining.
	Pediatric		Adult
	Lung procedure		Timer
	Pipeline		Cylinder
	ACGO active		Airway module indicator
	Agent level unknown		Enhanced temperature sensing
	Manual ventilation		Agent level sensing supported. Bar indicates amount of agent remaining.

2 Theory of Operation

In this section

2.1 Electrical system

The electrical system consists of two main computing units: the Display Unit and the Anesthesia Control board. Additional subsystems interact with these computing hosts to perform various gas delivery, ventilation, and monitoring functions.

The Display Unit handles the main user interface functions and connections to external devices. The Display Unit software runs on the Windows CE operating system.

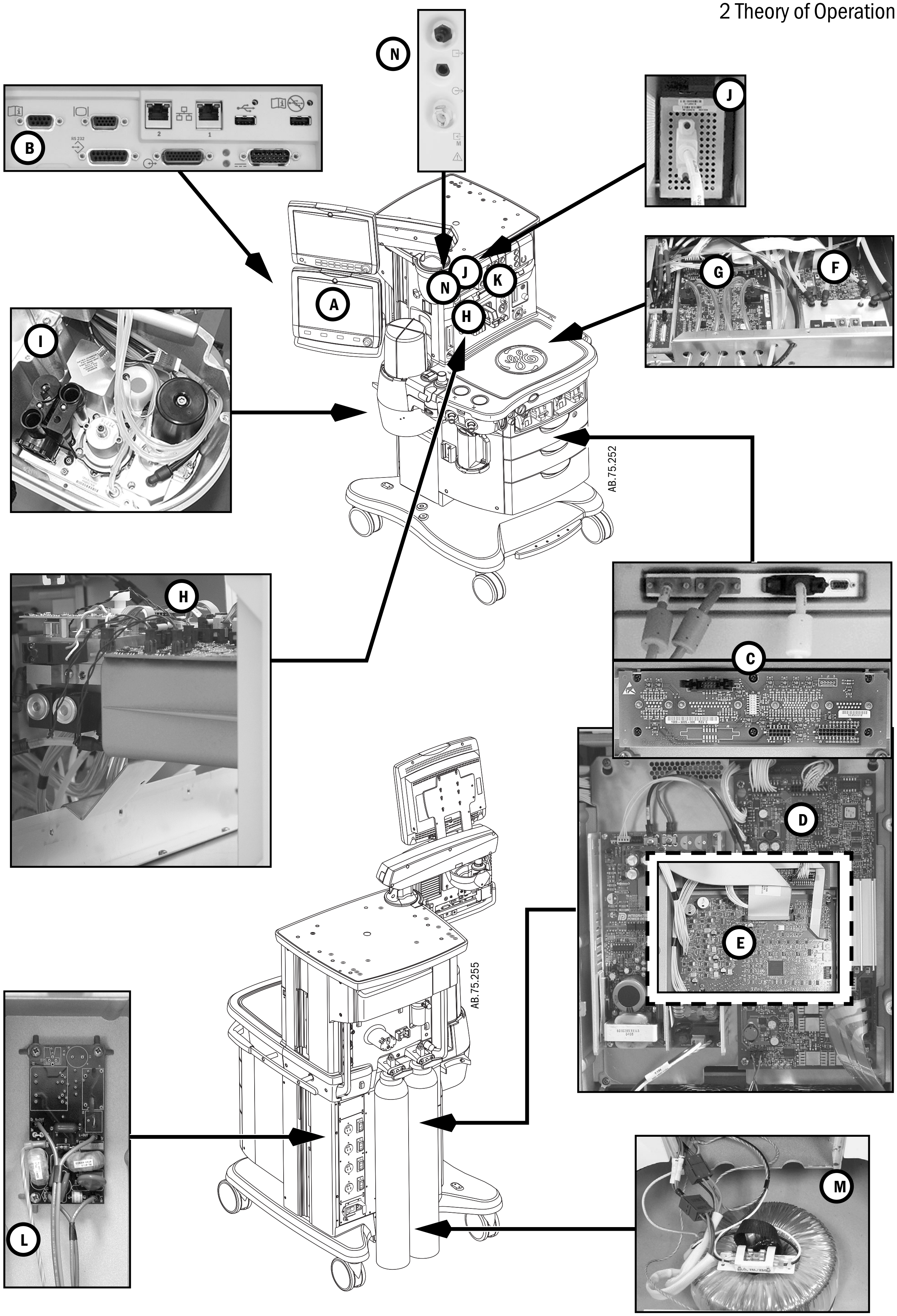
Therapy functions are handled by the Anesthesia Control board. The Anesthesia Control board is based on the Motorola Coldfire processor with a Nucleus operating system.

Embedded controllers are used to perform specific machine functions on subsystems like the Power Controller board and the Mixer board.

The processors communicate through serial bus channels.

The various functions of the electrical system are accomplished on the following:

- Display Unit CPU (**A**)
- Display Unit System Interconnect (**B**)
- Display Connector board (**C**)
- Power Controller board (**D**)
- Anesthesia Control board (**E**)
- Electronic Mixer board (**F**)
- Consolidated Ventilator Interface board (**G**)
- Electronic Vaporizer (**H**)
- Vent Engine (**I**)
- Airway Module Power Supply board (**J**)
- Light Strip board (**K**)
- Universal Surge Suppression board (**L**)
- Toroid (**M**)
- Et Control (optional) (**N**)


N
B
RS 232
2
1
J
G
F
A
K
H
I
AB.75.252
C
D
E
AB.75.255
L
M

2.2 Power subsystem

Mains power enters the system through the AC Inlet module (**A**), which includes a line filter and the system circuit breaker. Mains power is routed through the Inrush (**B**) board (or Universal Surge board) to the isolation transformer (**C**).

The isolation transformer provides line isolation to meet system leakage-current requirements for the machine and for the AC outlets. The isolated secondary output of the transformer (approximately 180 VAC) is routed through two, 5-amp fuses (**D**) to the universal power supply (**E**). The DC output of the power supply feeds into the Power Controller board (**F**). The transformer also supplies isolated power to the electrical outlets through individual circuit breakers.

The Power Controller board interfaces with the system through:

- the Anesthesia Control board connector (**G**),
- the Display Connector board connector (**H**),
- the battery connector (**I**) and fan connectors (**J**),

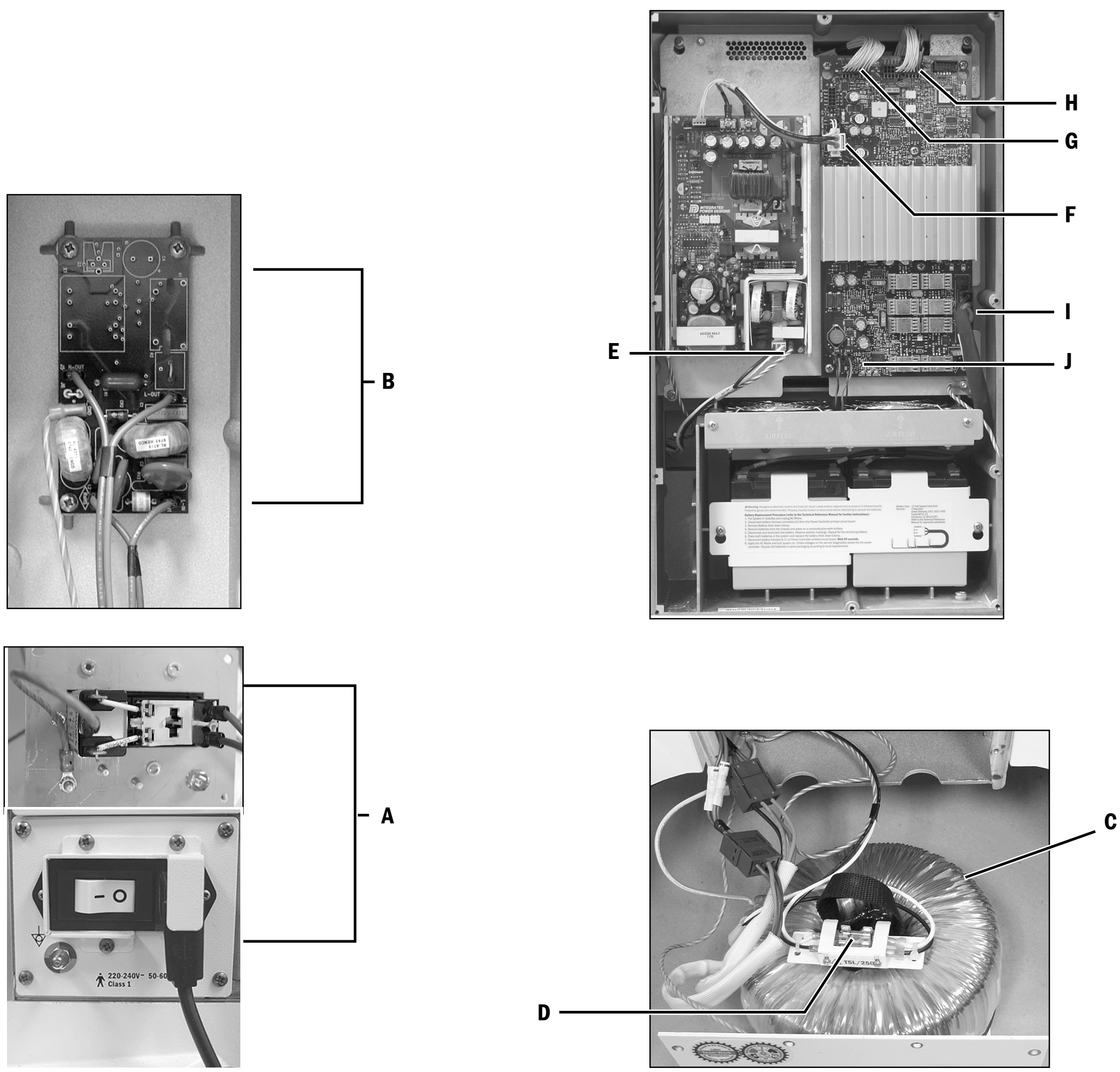


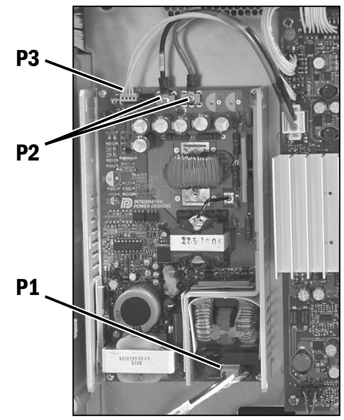
Figure 2-12 • Power subsystem

2.2.1 U-Frame Power Supply

The power supply provides a regulated voltage of approximately 28 VDC input to the Power Controller board.

The supply has three electrical connections:

- P1 is the 180 VAC inlet,
- P2 is the output to the Power Controller board of approximately 28 VDC,
- P3 is a four conductor (white wires) that provides feedback between the U-Frame Power Supply and the Power Controller board.



2.2.2 Power Controller board overview

The system uses a distributed power bus. The Power Controller board contains:

- a DC/DC converter that converts the input from the universal power supply to the 12.5 VDC system bus voltage.

The Power Controller contains supervisory circuitry that performs:

- battery charge control (battery switch circuits provide a minimum of 30 minutes of system power in the event of AC power failure);
- current, voltage, and temperature monitoring;
- AC sensing;
- fan control;
- monitor battery backup.

Two 12-volt batteries, wired in series, provide the back-up power.

The Power Controller communicates with the Display Unit through a RS-422, 9.6 kB channel. It receives the On/Standby signal from the system switch through the Anesthesia Control board.

Battery Backup is available for an AM monitor that uses a 12-inch DC powered display.

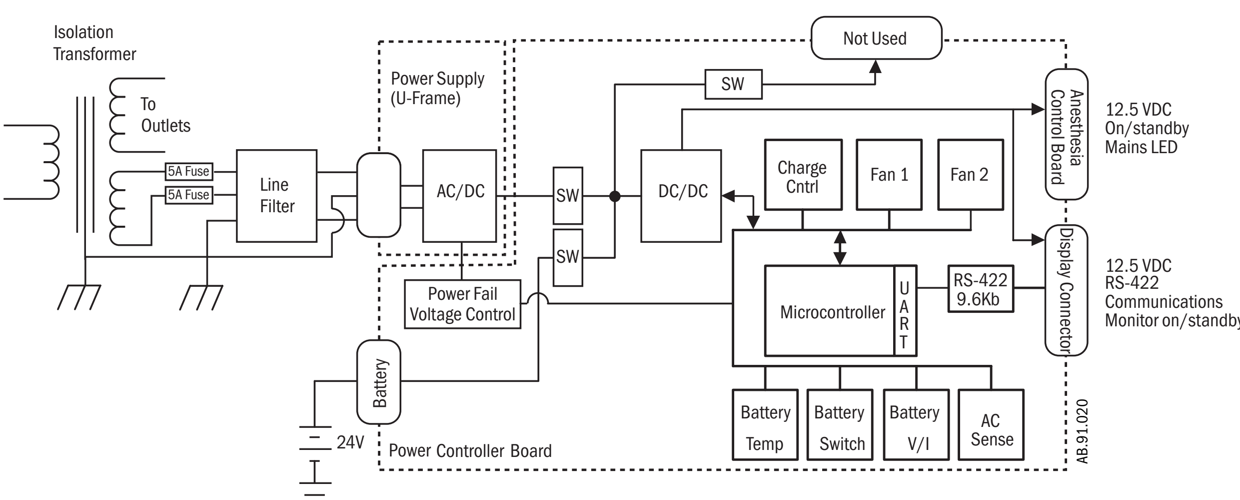


Figure 2-13 • Power subsystem

2.2.3 Power distribution

The Power Controller board provides outputs to the Anesthesia Control board and the Display Connector board. These boards provide distribution of power supplies required by the system.

The Anesthesia Control board interfaces directly with the Consolidated Ventilator Interface board and with the Mixer board and the Agent Delivery board through the Consolidated Ventilator Interface board.

The Display Connector board interfaces with the Display Unit and the Module assembly.

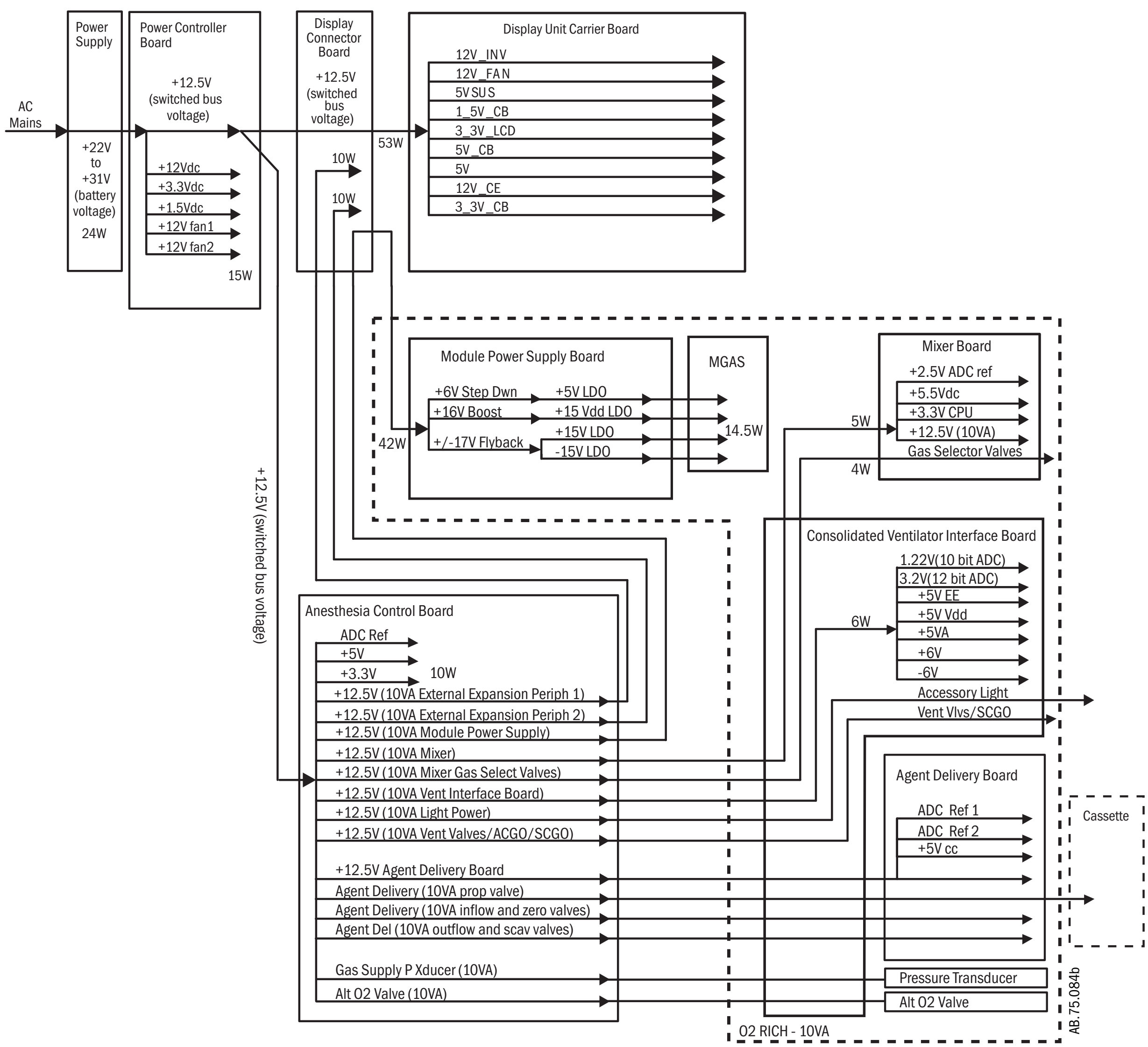


Figure 2-14 • Power distribution

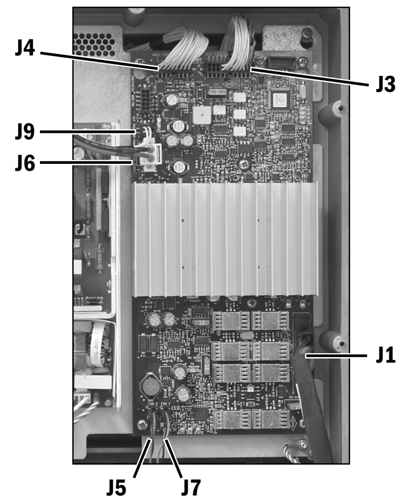
2.2.4 Power Controller Board

This board is a self-monitored and self-controlled by an on-board microcontroller. Much of its circuitry is used to monitor things like operating temperature of the board, battery status, battery charging, and communication to the Display Unit.

Its primary function is to distribute voltages to other subsystems and to keep the batteries charged.

The Power Controller Board has eight (8) connectors (populated):

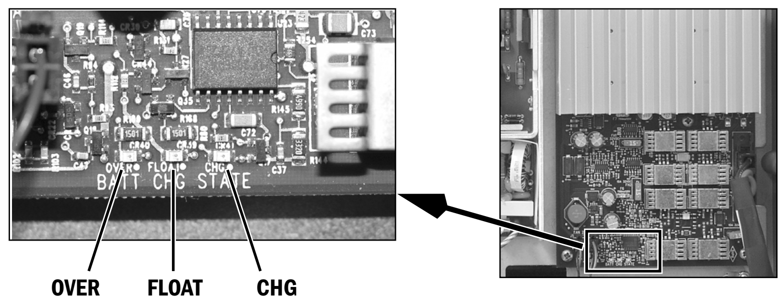
- J1 is the battery connector
- J2 is not used
- J3 is Power Out to the Display Controller (Display Unit)
- J4 is the Power Out to the Anesthesia Control Board
- J5 is Fan 2
- J6 is the 28 VDC in from the U-Frame Power Supply
- J7 is Fan 1
- J9 is the voltage adjust connector for the U-Frame Power Supply



Connector J9 connects the U-Frame Power Supply to the Power Controller Board where circuits on the Power Controller Board monitor the battery charge requirements. Signals sent through J9 can “boost” or “reduce” (adjust) the 28VDC output of the U-Frame Power Supply when the batteries need charge or they are fully charged.

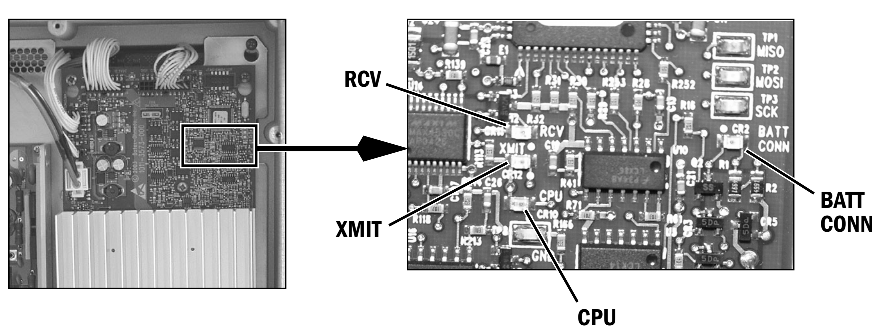
The Power Controller Board has seven LEDs: three indicate battery charge status:

- OVER: When in “Over Charge” mode, a high voltage (+ 16 VDC), but current limited, is applied to the batteries. This is used to ‘top-off’ the batteries. This also breaks-down the oxidation that happens with lead acid batteries.
- FLOAT: Trickle charge used to maintain fully charged batteries.
- CHG: Also known as Bulk Charge. Used to charge the batteries with constant current.



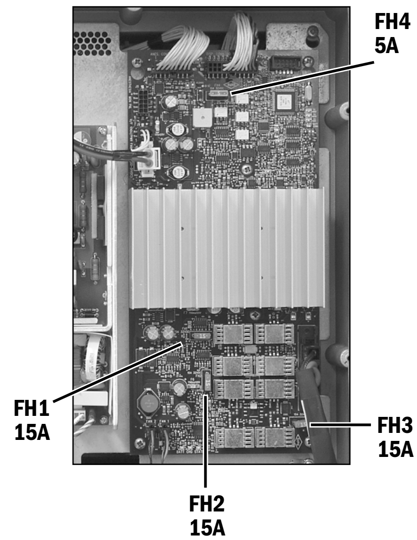
The remaining LEDs are status indicators:

- Battery Connected: is turned on and off by a time-delay circuit on the POWER CONTROLLER BOARD. Evidence of this is to disconnect AC Mains and place the unit in the Standby position. The fans will run for several seconds (on battery) until the battery is disconnected.
- CPU: The CPU Led should flash at a 2 Hz rate when application is running in the Power Controller Board. It will be dimly lit (or fast flashing) when Boot Code is running. If the CPU LED is not lit, then either NO power (28 VDC from U-Frame and Battery) or No Boot Code in the board. In the event of absence of Boot Code, the board needs to be replaced.
    - Note: The CPU Led flashing at the 2 Hz rate indicates the watchdog circuit is functioning.
- XMIT: Flashing of the XMIT LED indicates communication is being sent to the Display Unit (DU). The Power Controller Board only communicates to the Display Unit when asked to by the Display OR the Power Controller has encountered an error or alarm. It will mostly remain off.
- RCV: The RCV LED flashes when the Display Unit communicates with the Power Controller Board. RCV LED will be on solid if not connected to or not communicating with the Display Unit.



There are four field replaceable fuses on the Power Controller Board. They are automotive type fuses and can be purchased locally.

- FH1: 15 A (32 VDC) –
  Battery Backup for the AM Monitor (Smart Switch for S/5 Monitor).
- FH2: 15 A (32 VDC) –
  Machine Battery charging circuit.
- FH3: 15 A (32 VDC) –
  Machine Battery.
- FH4: 5 A (32 VDC) –
  Display Power
  (Note: Silk screening indicates “15A”)



The Power Controller board produces other voltages.

- The 28 VDC that is generated by the U-Frame comes on the Power Controller board and is used to charge the machine batteries in one of three (3) modes. The charge voltage varies depending on the condition of the batteries.
- The 28 VDC is regulated down to +12 VDC, +12.5 VDC and 3.3 VDC.
- The 12 VDC and 3.3 VDC remain local on the Power Controller board and are used by on-board circuits and the on-board processor.
- The +12.5 VDC, created by the circuit (Brick) under the large heat sink, is a high current output. It supplies power to subsystems remote from the Power Controller board (Display Unit and Anesthesia Control board).
- Fan 1 and Fan 2 are capable of running at one of two speeds (high and low). They are controlled by the Power Controller board’s microcontroller as it monitors temperature by circuitry also on the Power Controller board.

There are four conditions the Power Controller board can be placed into:

1. **OFF**: System unplugged from AC Mains or the AC Mains Circuit Breaker open and the On/Standby Switch in the Standby position.
    - In this condition, the Power Controller board is truly OFF. This is indicated by No Fans and No illuminated LEDs. There is no Battery Charging.
2. **Standby**: The system is plugged into AC Mains and Mains Circuit Breaker closed (receiving 28 VDC from U-Frame Power Supply) and the system switch in the Standby position.
    - In this condition, 180 VAC is sent to the U-Frame Power Supply, which converts it to approximately 28 VDC and sends a signal "AC_GOOD" to the Power Controller board (along with the 28 VDC). A "green" AC Mains LED on the front panel of the machine will illuminate because of this signal.
    - Even though the On/Standby Switch is in the Standby position, the Power Controller board will receive the 28 VDC and create from it a +12 VDC, a battery charge voltage, and a +3.3 VDC (for microprocessor, ROM, RAM, etc.).
    - The microprocessor will run its Boot Code. During this brief time, the CPU LED may be dimly lit (or fast flashing). Soon it will begin flashing at a 2 Hz rate (indicating it is running application program). Almost immediately, the fans should turn on. One or more of the battery status LEDs should illuminate and the battery connected LED should also illuminate. The XMIT LED will remain OFF (indicating no communication to the Display Unit). The RCV LED will be on solid (indicating no communication to the Display Unit).
3. **ON**: system is plugged into AC Mains and Mains Circuit Breaker closed (receiving 28 VDC from U-Frame Power Supply) and the system switch in the ON position.
    - The movement of the System Switch to the ON position will trigger the CPU (via On/Standby Logic circuitry) to enable the +12.5 V DC/DC Brick to send +12.5 VDC to the Display Unit and the Anesthesia Control Board. Notice a 12.5v LED under connector J4 (Anesthesia Control Board connector) illuminates solid. Within approximately one minute, the XMIT and RCV LED's will be mostly off but will briefly and randomly flash indicating communication with the Display Unit.
    - Recap LED Status: CPU flashing at 2 Hz rate, XMIT/RCV flash randomly, 12.5v constant illuminated, BATTery CONNected constantly illuminated, battery status LEDs illuminated depending on the battery condition.
4. **ON** (no AC mains) **Batteries ONLY**: The system is NOT plugged into AC Mains or the Mains Circuit Breaker is Open and the On/Standby Switch in the On position. The system will switch to battery operation for up to 30 minutes.
    - There should be no interruption of operation and the "green" AC Mains LED on the front panel of the machine will NOT be illuminated. The LEDs that indicate battery condition will turn off (this may not happen immediately).

2.3 System communications

RS-422 serial communication is used between the two main processors — Display Unit and Anesthesia Computer — and the subsystem processors. Various baud rates accommodate data requirements between subsystem and host. External communication uses the standard RS-232 interface.

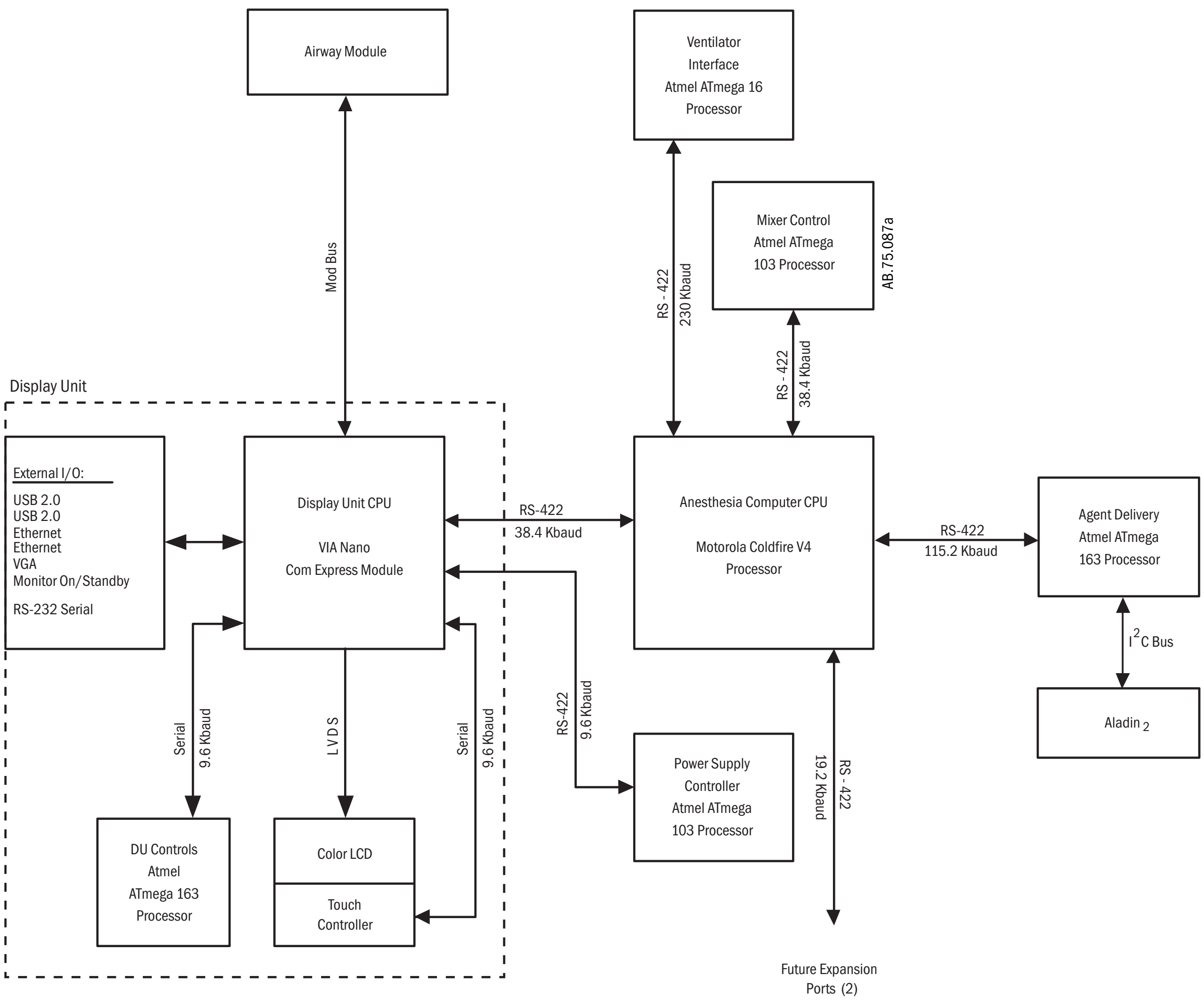


Figure 2-15 • System communications

2.3.1 Software Power On Self Tests (POST)

Off State:

- *AC Power is not connected to the machine and the On/Standby Switch is in the "Standby" position.*

Standby State:

- *AC Power is connected to the machine while the On/Standby Switch is in the "Standby" position.*

On State:

- *AC Power is connected to the machine and the On/Standby Switch is set to the "ON" position.*

When the machine is in the "Off" state, there is no machine activity. Circuitry on the Power Controller Board (PCB) and on the Anesthesia Control Board ACB) monitors the On/Standby Switch for movement.

If the On/Standby switch is moved to the "On" position while the machine is in the "Off" state (machine not connected to AC mains supply), the circuitry on the PCB engages the batteries to power the CPU on the PCB. Standard CPU tests are performed and the PCB application starts. Once the PCB has passed its CPU tests and the application is running, it activates the +12 VDC circuit to power the DU and the ACB. The DU and ACB simultaneously begin powering on. The PCB evaluates the battery capacity.

If the machine state changes from the "Off" state to the "Standby" state (machine connected to AC mains supply), the hospital AC (stepped to approximately 180 VAC by the isolation transformer) enters the U-frame Power Supply. The AC voltage is converted to +12 VDC. Standard CPU tests are performed (including but not limited to RAM, ROM, Watchdog, and application CRC) and the PCB application starts. The PCB evaluates the battery capacity and charges the batteries, if necessary.

If the machine state changes from the "Standby" state to the "On" state, the +12 VDC circuit to power the Display Unit (DU) and the ACB is activated. The DU and ACB simultaneously begin powering on.

Both the ACB and the DU begin by converting the incoming +12 VDC to local needed power (+3.3 V, +4 V, +5 V, +8 V, and others) and perform standard CPU tests. Each board loads their software (that resides locally) and begins their appropriate self tests described below:

- Once the ACB passes all CPU tests and application is loaded, independent circuitry turns on 10 VA limited (+12 VDC) power to the Gas Mixer, the Ventilator Interface Board, the Agent Delivery Board (eVap) and the M-Gas Power Supply Board. These boards convert the incoming +12 VDC into locally need power supplies and simultaneously begin to power up. The ACB energizes the Alt O_2 Selector Valve, which closes the valve. The ACB begins testing the GIV.
  - The processor on the Gas Mixer board performs standard CPU tests, checks communication link with the ACB, reports to the ACB that it has begun to perform Power-On Self Tests (POST). The Gas Mixer tests the O_2 and Balance Gas channels for leaks and flow delivery from both channels. Once completed, reports to the ACB that all Self-Tests have been completed and the Gas Mixer compatibility information (serial number, hardware revision, and software revision).
  - The processor on the consolidated Ventilator Interface Board (cVIB) performs standard CPU tests and begins to download application software and ventilator calibration constants from the ACB. The cVIB works in conjunction with the ACB to perform the Gas Inlet Valve (GIV) test (ACB provides valve status information to the cVIB, the cVIB calculates the voltage necessary to open the valve to the desired value). Once completed, the cVIB reports to the ACB that the Self-Tests have been completed and the cVIB compatibility information (serial number, hardware revision, and software revision).

- The processor on the Agent Delivery Board performs standard CPU tests and establishes communications with the Anesthesia Control Board. The Anesthesia Control Board directs other POST activities including valve conditioning (full power for 15 seconds), reading and integrity checking of sensor calibration data, and reporting on serial number, hardware revision, and software revision.
- There is no processor on the Airway Module Power Supply. Local voltages are produced for the Airway Module and available if an Airway Module is installed. The Airway Module performs its own POST.

* Once the DU passes all the CPU tests, the DU application is started. Part of this application is software that enables the DU CPU to communicate with the Airway Module. These applications take longer to start than any other system in the machine. When the applications have completely loaded and communication has been established with the ACB, all the systems compatibility information is transferred to the DU for comparison with the compatibility table created during the last software download. If the compatibility does not match, the machine enters the System Malfunction mode.

If the On /Standby switch is moved to the “On” position while the machine is in the “Off” state (unplugged from AC Mains), the circuitry on the Power Controller Board engages the batteries to power the CPU on the PCB. Standard CPU tests are performed and the PCB application starts. Once the PCB has passed its CPU tests and the application is running, it activates the +12 v circuit to power the DU and the ACB. The DU and ACB simultaneously begin powering on. The PCB evaluates the battery capacity.

2.4 Display Unit

The display unit handles the majority of the anesthesia machine's user interface functions through its front panel controls, the touchscreen and the LCD display. It is the primary interface to external peripherals.

The display unit's CPU board uses an x86 architecture and chipset that is WIN CE compatible. It is highly integrated and contains the functions of a personal computer with a few support chips.

In addition to the main processor, additional processors handle the following interfaces:

- Front panel controller (Atmel Atmega microprocessor)
- Monitoring module / ModBus controller (Altera FPGA)
- Display processor supports 640 x 480 through 1600x1200 LCDs with 256 color depth or greater

Alarm volume and display brightness are controlled in a "soft" fashion through the user interface.

Software is updated via USB.

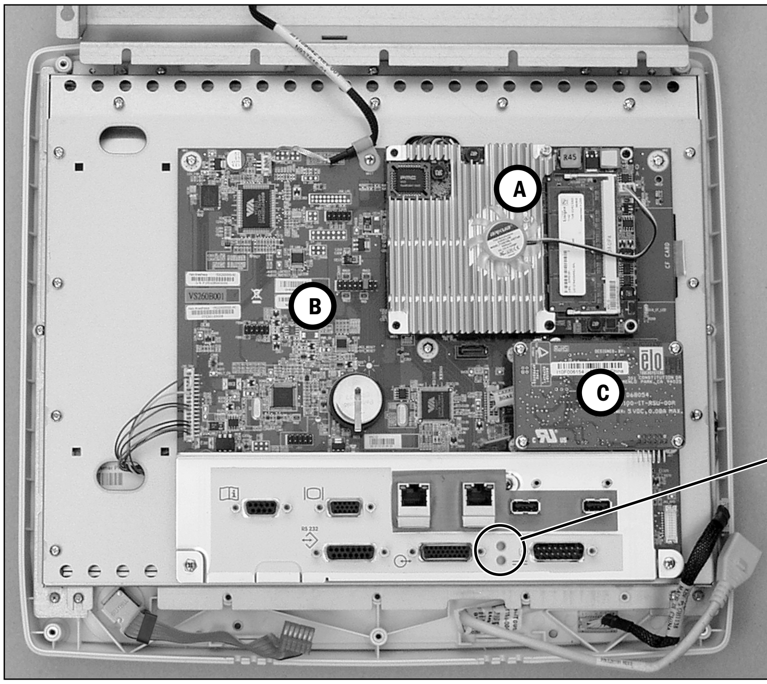
DC Input from Display Connector Board powers the display unit from +12.5V.

The display unit has high-speed signals and many peripherals. These require special attention to meet electromagnetic compatibility requirements, which are accomplished through a combination of shielding and filtering. To meet emissions requirements, the display unit has a metal shield. High-speed signals within the display unit are filtered to control waveform edges, and signals on connectors leaving the display unit are filtered. Immunity is accomplished through the metal display unit enclosure and the shield layer in the keypads.

The display unit consists of the following subassemblies and main components:

- Enclosure - EMC shielding for electrical components
- Com Express Board (**A**) and Carrier Board (**B**) - contains main processor, real time clock, memory, audio, and the following peripherals; USB, Ethernet, UART for serial interfaces, and network ID
- LCD - high brightness and wide viewing angle
- Touchscreen and Touch Controller (**C**) - Provides control of the User Interface
- Keypad - Provide direct access to frequently used features
- ComWheel / Encoder - One optical rotary encoder for control/confirmation of general UI parameters
- Speakers
- Fan

The DU uses a lithium battery to power the real time clock when the machine is in Standby or Off states. The DU also uses the lithium battery to retain theCPU setup information.



LED Indicators:

Amber LED - Mod Bus to Airway Module

- **Turns ON when the display transmits**
- **Turns OFF when the display receives data or the board resets**
- **Blinks during normal communication**
- **Stays ON if the display transmits and nothing is received back from the Airway Module.**

Green LED - DC Power

- **Turns ON when +12V is available from the Power Controller Board**

Figure 2-16 • Display Unit

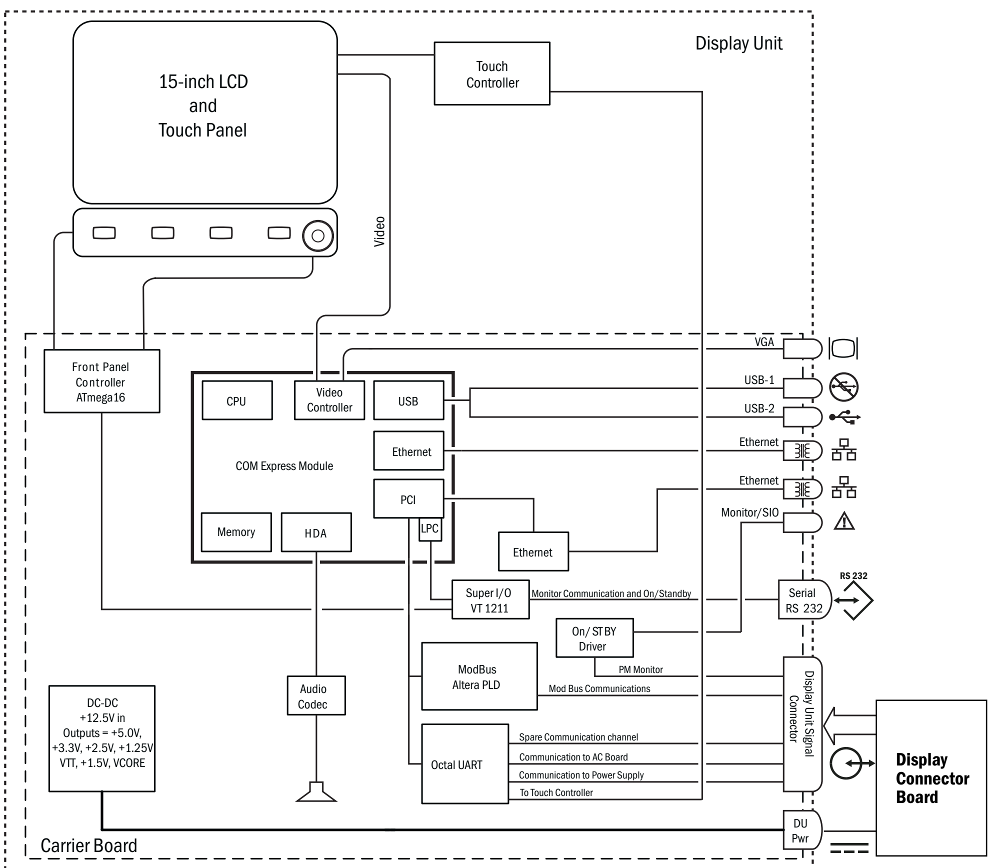


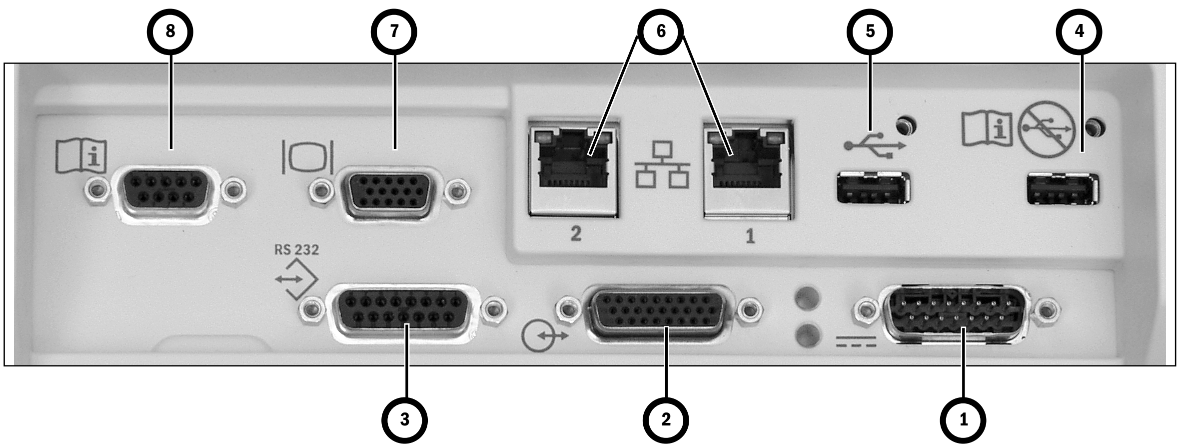
Figure 2-17 • Display Unit block diagram

2.5 System connections

2.5.1 Display Unit

The DU accommodates the following connections:

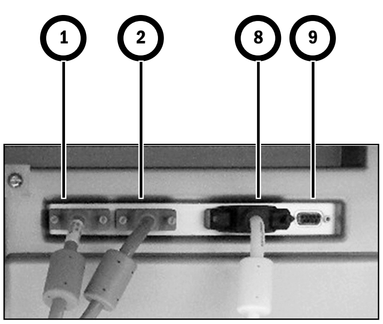
- System Power Interface (**1**).
- System Signal Interface (**2**).
- Serial Port — standard RS-232 interface for external communication (**3**).
- USB port — standard USB 2.0 interface — System Software Download port (**4**).
- USB port — standard USB 2.0 interface (**5**).
- Network connection — Standard Ethernet port for network connectivity (**6**).
- VGA port — standard Video interface (**7**).
- Remote monitor On/Standby (**8**).

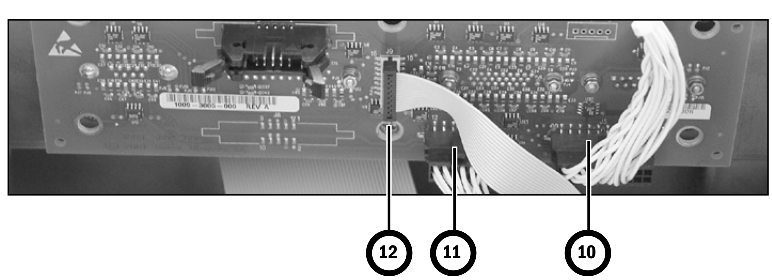


2.5.2 Display Connector board

The front side of the Display Connector board accepts the following cables:

- System Power Interface to Display Unit (**1**).
- System Signal Interface to Display Unit (**2**).
- Airway Module (M-Gas) Power Supply board (**8**).
- Not used (**9**).
- The back side of the Display Connector board accepts the following cables:
- Power Controller board (**10**).
- Anesthesia Control board (MGAS power) connector (**11**).
- Anesthesia Control board (signal) connector (**12**).





2.6 Power Controller and Anesthesia Control board connections

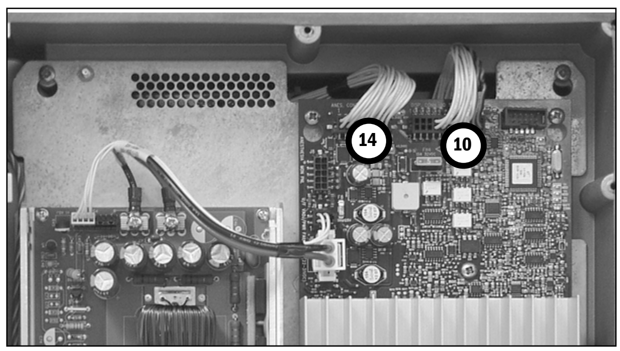
The Power Controller:

- Distributes 12.5 VDC power and communicates with the Display Unit (by way of the Display Connector board) through connector (**10**).
- Distributes 12.5 VDC power to the Anesthesia Control board through connector (**14**).

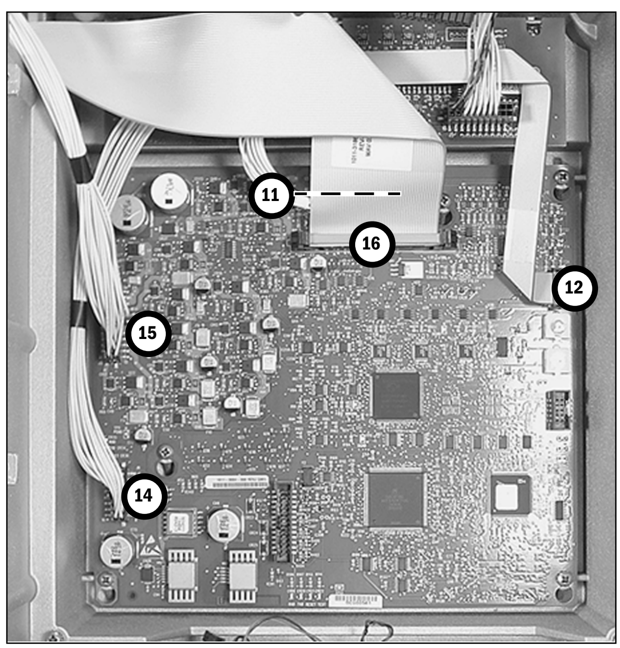
The Anesthesia Control board:

- Receives power from the Power Controller board through connector (**14**).
- Distributes 10VA power supplies to the Pan Connector board through connector (**15**).
- Communicates with Pan assemblies through connector (**16**).
- Communicates with Display Unit through connector (**12**).
- Distributes 10VA power supplies to the Display Unit through connector (**11**).

Power Controller board



Anesthesia Control board



2.7 Anesthesia Control board

2.7.1 Overview

The Anesthesia Control board (**A**) uses a Motorola MCF5407 Coldfire microcontroller with 4M Flash and 16M error correcting DRAM. The Anesthesia Control board includes 6 UARTs with a 64 byte FIFO and RS-422 communications to interface with the Display Unit, an accessory port, and anesthesia delivery subsystems located in the pan electronic enclosure. These include the Gas Mixer, Electronic Vaporizer, and the Ventilator Interface board.

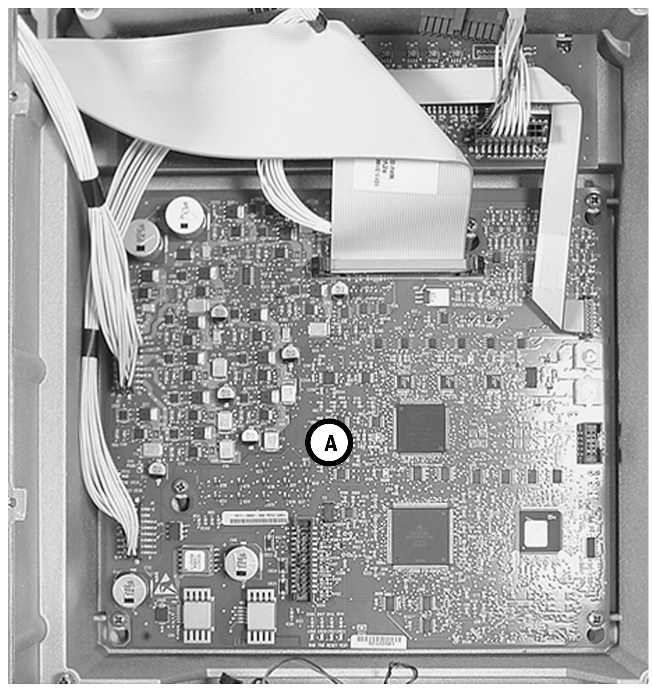


Figure 2-18 • Anesthesia Control board

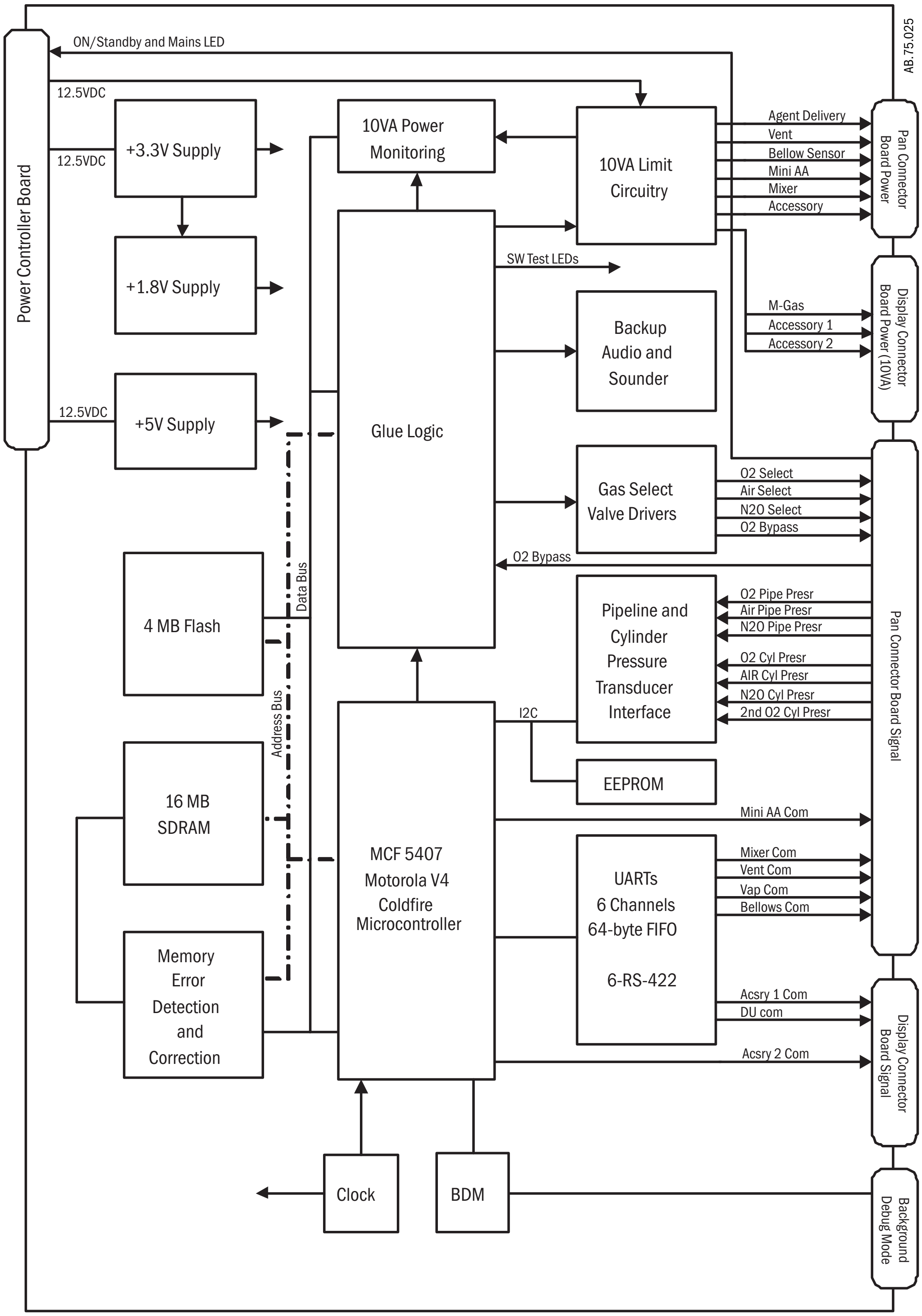


Figure 2-19 • Anesthesia Control board block diagram

2.7.2 Anesthesia Control Board details

The 12.5 VDC power enters the Anesthesia Controller Board via connector J6 (see item 14 in Section 2.6). This 12.5 VDC is further regulated down to five additional voltages used by the Anesthesia Controller Board. These include:

- 3.3VDC – VR2
- 1.8VDC – VR3
- 5.0VDC – VR1: Used for Pipeline and Cylinder Pressure Transducers
- 2.5VDC
- 5.0VDC

These voltages are self-monitored for out-of-range.

The Anesthesia Controller Board also supplies 10VA-limited power (+12.5VDC and +5.0 VDC) to External subsystems and Pipeline and Cylinder Pressure Transducers.

Valve Drivers

The Anesthesia Controller Board contains logic circuits and valve drive circuits for the following devices that reside on subsystems:

- O_2 Select Valve (Gas Mixer Board)
- N_2O Select Valve (Gas Mixer Board)
- AIR Select Valve (Gas Mixer Board)
- Alt O_2 Select Valve (Gas Mixer Board)

Status LEDs

The Anesthesia Controller Board contains 2 sets of 4 each (8 total) status LEDs. They are located on the board at approximately the 6 and 9 o'clock positions, near connectors J5 and J6 respectively. Each set contains the following four LEDs:

- RXD (CR19 and CR35) – yellow – Indicating Display Unit communication activity
- TXD (CR20 and CR34) – yellow – Indicating Anesthesia Controller Board communication activity
- RESET (CR21 and CR36) – Red – Watchdog Reset
- RXD (CR22 and CR33) – yellow – Software LEDs

Connectors:

The Anesthesia Controller Board has five populated connectors:

- J1 – 50-pin connector to (signal) Pan Connector Board.
- J3 – 24-pin connector to (power) Pan Connector.
- J4 – 10-pin connector (JTAG). This is used by Engineering. Not Used by Service.
- J6 – 16-pin connector power in from Power Controller Board.
- J7 - 12-pin connector to (10VA power) display connector (M-Gas)

Alarms

The Anesthesia Controller Board has a backup audio alarm. This is sounded in the event of communication loss between the Anesthesia Controller Board and Display Unit.

Power and Communication to other Subsystems

The Anesthesia Controller Board provides power and communication to:

Consolidated Ventilator Interface Board (cVIB):

- Power = 12.5VDC
- Communication = RS422

Gas Mixer:

- Power = 12.5VDC
- Communication = RS422

Agent Delivery Board (ADB):

- Power = 12.5VDC
- Communication = RS422

M-Gas Power Board:

- Power = 12.5VDC
- Note: Communication to and from the M-Gas is via the Display Unit

Gas Pressure Transducers

Gas Pressure Transducers monitor the Pipeline pressures of all gases connected to the system. Gasses measured can include O_2, Air, and N_2O. Their measurement range is form 0 to 697 kPa (101 psi). Though these transducers are located near the machine pipeline connection points, they are maintained and monitored by the Anesthesia Controller Board.

Pressure transducers also monitor all cylinder pressures. Gasses measured can include O_2, second O_2, Air, and N_2O. Their range is:

- from 0 to 27580 kPA (4000 psi) for O_2 and Air
- from 0 to 9805 kPa (1422 psi) for N2O

The transducers are located on each cylinder yoke; they are maintained and monitored by the Anesthesia Controller Board.

Alt O_2 Switch

The Anesthesia Controller Board monitors the position of the Alt O2 Switch.

Display Unit

The Display Unit receives power from and has limited communication with the PCB. This limited communication allows for data like power supply status and voltage readings to be displayed in service mode.

The MAJOR communication responsible for getting clinical settings to the system and the ability to display parameters occurs between the Anesthesia Controller Board and Display Unit. The Anesthesia Controller Board and Display Unit communicate via RS422.

External Peripheral power (10VA) circuitry

This circuitry sends 10VA limited 12.5 VDC power to the following subsystems:

Note: These subsystems do not receive power directly from the PCB. Only the Anesthesia Controller Board and Display Unit receive power directly form the PCB.

- Consolidated Ventilator Interface Board (cVIB)
- Electronic Gas Mixer (Mixer)
- Agent Delivery Board (ADB)
- M-Gas Power Board
- External Peripheral #1
- External Peripheral #2
- Accessories (Task Light)

Hardware Reset will happen if:

- Watchdog is not reset
- During Anesthesia Controller Board Power-up (Normal)
- If the voltages produced on the board become out-of-range (3.3, 2.5, or 1.8VDC).

If the system evokes a Hardware Reset, all the peripheral devices, which is controlled by the Anesthesia Controller Board, loose power. All communication with these peripherals devices will cease to continue.

Summary of the Anesthesia Controller Board

The Anesthesia Controller Board is the central controller for the system. It provides the following services:

- Monitors pressures form the pipeline and cylinder transducers.
- Drives some of the valves located on the Electronic Gas Mixer.
- Monitors the Alt O2 Switch.
- Provides 10VA limited power and communication to the following subsystems:
    - Consolidated Ventilator Interface Board (cVIB)
    - Electronic Gas Mixer
    - Agent Delivery Board (ADB)
- Provides 10VA limited power (no communication) to the M-Gas Power Board.

The Anesthesia Controller Board receives power from the PCB on connector J6.

The Anesthesia Controller Board creates internal voltages that remain local to and are used exclusively by circuits on the Anesthesia Controller Board. These voltages are:

- 3.3 VDC
- 1.8 VDC (Processor and Digital)
- 2.5 VDC
- 5 VDC (Gas Pressure Transducers)

The Anesthesia Controller Board also creates fourteen independent 12VDC 10VA limited power sources used by the following subsystems:

- 10VA M-Gas
- 10VA Mixer
- 10VA eVap ADB Power
- 10VA eVap Outflow, Scavenging Power
- 10VA eVap Proportional Valve Power
- 10VA eVap Inflow, Zero Valve Power
- 10VA O_2 Bypass Valve
- 10VA Ventilator Interface Board
- 10VA Vent Valve Power
- 10VA Accessories
- 10VA Mixer / Pan Fan
- 10VA External Peripheral # 1
- 10VA External Peripheral # 2

The Anesthesia Controller Board has eight status LEDs. Each LED Status is duplicated on the board. Six are yellow status and two are red reset.

The TXD and RXD flash to indicate communication to and from the Display Unit. A RED LED would indicate a CPU watchdog (RESET) condition.

The Anesthesia Controller Board receives communication from the Display Unit, Electronic Vaporizer, Electronic Gas Mixer, and Ventilator Interface Board. It has a hand in virtually all-major decisions about the delivery of gas, ventilation, and agent to the patient.

2.8 Consolidated Ventilator Interface board (cVIB)

The Consolidated Ventilator Interface board (**A**) serves as the ventilator interface to the Anesthesia Control Board (ACB). The cVIB is also the conduit between the ACB and various switches, devices, and subsystems.

The ventilator interface section is managed by an ATMEGA16 microcontroller. The microcontroller communicates data values to the controlling CPU on the ACB via an RS-422 serial interface.

ACB provides power and communicates with the following subsystems via the cVIB:

- Electronic Gas Mixer
- Electronic Vaporizer and Fresh Gas Module

The cVIB is the conduit for the following system switches, devices and the ACB:

- Machine On/Standby switch and Mains LED
- Pipeline and Cylinder pressure transducers
- Accessory Power (for task lights)
- Alt O_2 switch

The ventilator interface segment of the cVIB senses or controls the following switches and components:

- Inspiratory (**B**) and expiratory (**C**) flow sensors (transducers)
- Patient airway (**D**) and manifold (**E**) pressures transducers
- Oxygen sensor (in breathing system) and Oxygen sensor disconnect signal
- ABS On, Bag/Vent and Canister Release (CO_2 Bypass) switches
- ACGO position switch (if ACGO installed)
- SCGO solenoid, SCGO/CGO position switches (if SCGO installed)
- O_2 Flush switch
- Gas Inlet Valve and Flow Control Valve

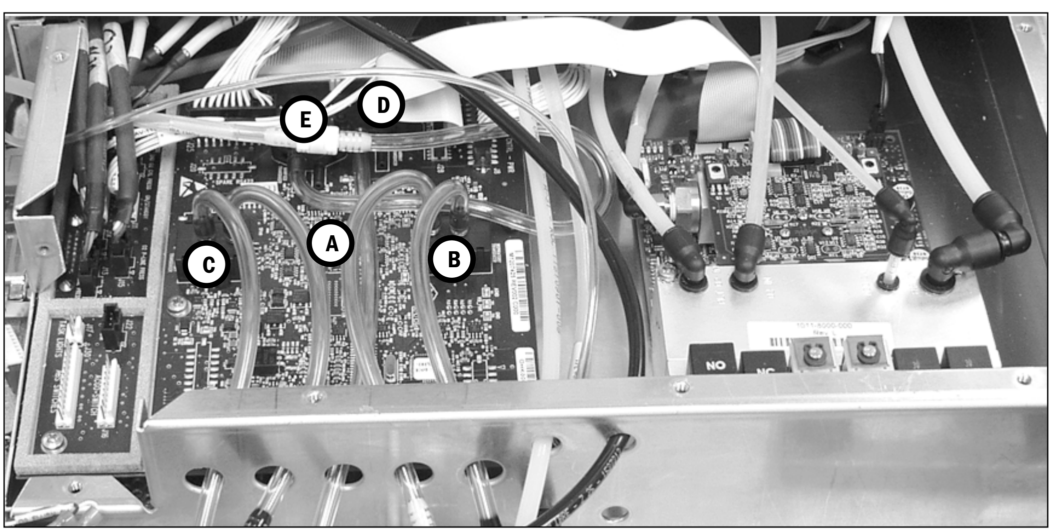


Figure 2-20 • Consolidated Ventilator Interface board

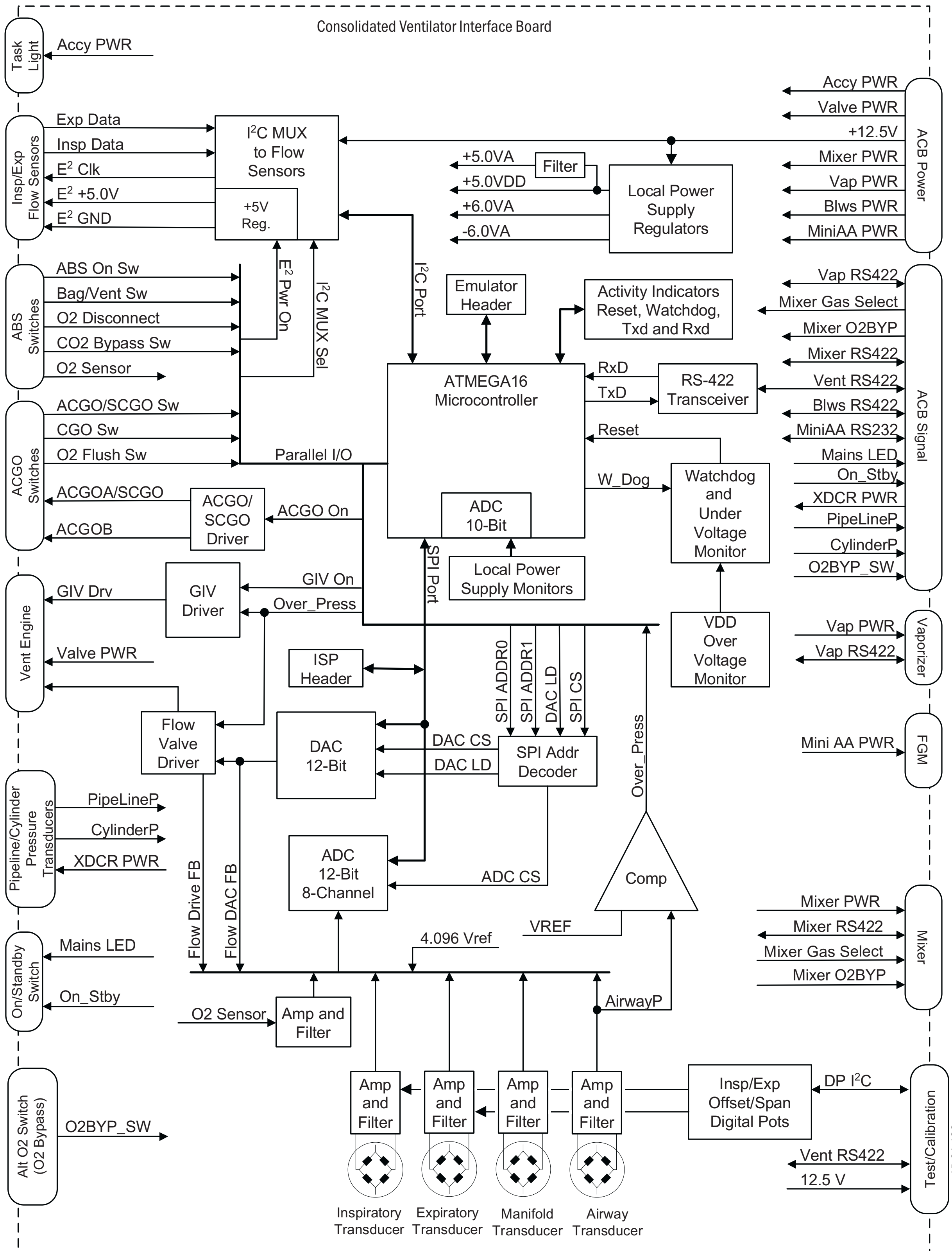


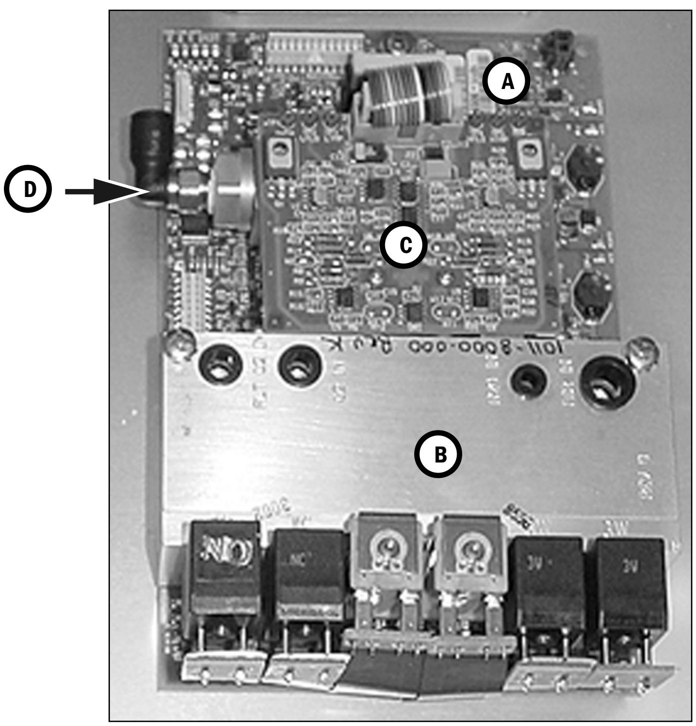
Figure 2-21 • Consolidated Ventilator Interface board (cVIB) block diagram

2.9 Electronic Gas Mixer

The Gas Mixer receives its pneumatic inputs from the pipeline and cylinder supplies and sends mixed gas to the vaporizer manifold. The Gas Mixer interfaces to the Anesthesia Control board for power and communications.

The Gas Mixer consists of the following subassemblies and main components:

- Gas Mixer board (**A**)
- Control Manifold (**B**) – manifold, selector valves, proportional valves
- Flow sensor assembly (**C**)
- Mixed gas manifold and exit check valve (**D**)



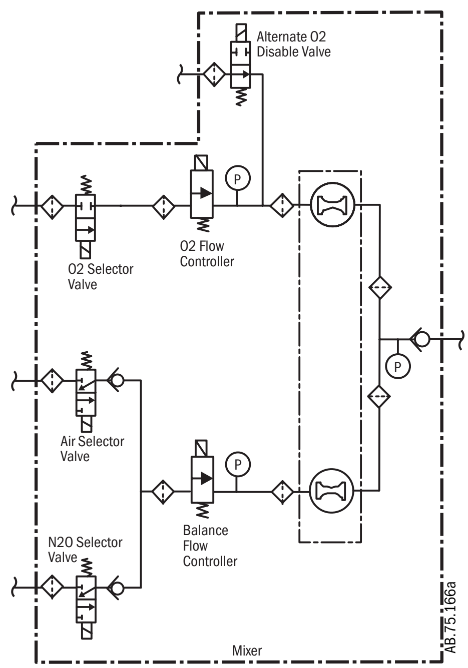


Figure 2-22 • Electronic Gas Mixer

Desired gas flows are sent from the Anesthesia Control board to the Gas Mixer.

Gas Mixer operation is controlled through a microcontroller which:

- Sends requests for the Anesthesia Control board to open and close selector valves for O_2, N_2O and Air.
- Regulates flow control valves for O_2 and balance gas (N_2O or Air).

Closed-loop flow control is accomplished through a hot-wire anemometer in concert with the flow control valves. Gas flow, based on a calibration table, is on target when the reference measurement equals the flow measurement.

Pressure measurements across each of the flow sensor channels are used as checks on the flow measurement for hazard mitigation, ambient pressure compensation, and compensation for back pressure downstream of the Mixer.

In case of certain failures or errors, Alternate O_2 control activates automatically to deliver O_2 and agent through an alternate pneumatic path to the patient circuit. Alternate O_2 can be activated manually through a front panel control. Agent delivery cannot be activated in case of certain Gas Mixer failures

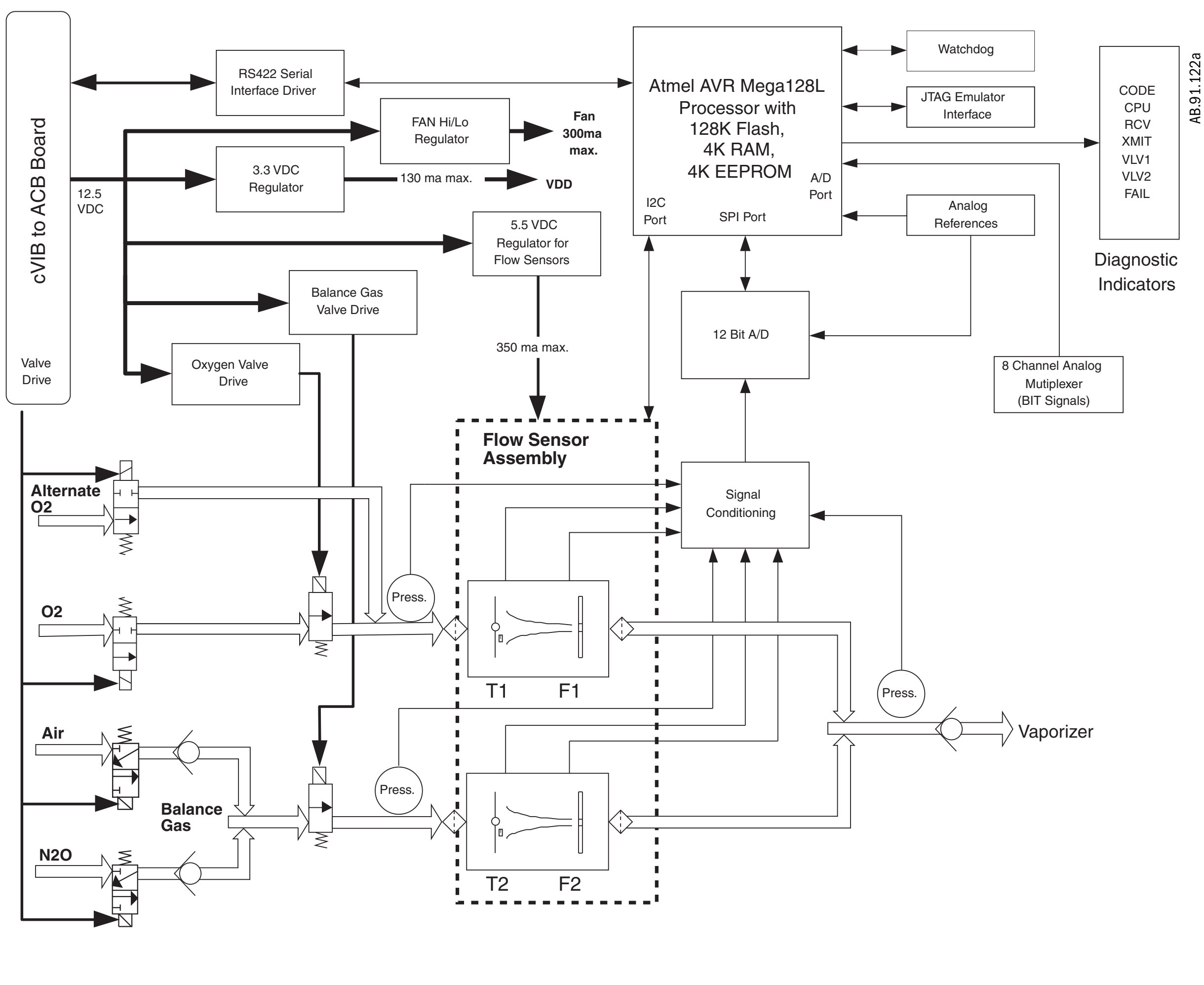


Figure 2-23 • Electronic Gas Mixer block diagram

2.9.1 Electronic Gas Mixer (details)

The function of the Electronic Gas Mixer is to deliver a combination of Oxygen and a Balance Gas (N_2O or Air) at a set percentage and flow rate as set by the user.

Total flow range for the system is 0.20 to 15 l/min of O_2 or mixed O_2 concentration that is greater than or equal to 25%. The system can flow Air only. The minimum flow though any single flow channel must be greater than or equal to 0.1 l/min.

- O_2 flow range is zero or 0.1 to 15 l/min
- N_2O flow range is zero or 0.1 to 12 l/min
- Air flow range is zero or 0.1 to 15 l/min

The flow accuracy of the Electronic Gas Mixer is +/- 20 ml/min or 5% of setting.

Diameter specific tubing (N_2O = 4mm; O_2 = 6mm; Air = 8mm; Mixed Gas = 1/4 inch) brings supply gasses O_2, Air, N_2O to the Electronic Gas Mixer control manifold.

The Electronic Gas Mixer contains 6 solenoid valves.

Electronics located on the Electronic Gas Mixer board and flow sensor assembly control and monitor the flow of gas delivered to the Electronic Gas Mixer output connection.

The Electronic Gas Mixer receives 12.5 VDC Accessory power from several of the 10VA power modules located on the Anesthesia Control Board Bd. Circuitry on the Electronic Gas Mixer board further generates internal voltages required for systems local to the Electronic Gas Mixer board. These voltages include: 3.3VDC and 5.5 VDC. The Electronic Gas Mixer also controls the pan fan speed (Hi/Low). All these voltages can be viewed in the service screens.

The microcontroller on the Electronic Gas Mixer has seven activity indicators. They are failcode, Mixer Code, CPU, XMIT, and RCV. Under normal operation, the CPU Activity LED will flash a 2 Hz (once per second) rate. The Red Fail LED should not be lit and the XMIT and RCV LEDs should flash briefly and randomly to indicate communication with the Anesthesia Control Board.

Two additional LEDs (Valve 1 and Valve 2) light to indicate when Channel 1 (O_2 Channel) or Channel 2 (Balance Gas Channel) Mixer Proportional Valves are opened.

Control of the Channel 1 and Channel 2 Proportional Valves is provided by circuitry on the Electronic Gas Mixer. Closed loop feedback for these valves is provided by the Hot-Wire Anemometers located on the flow sensor assembly (part of the Electronic Gas Mixer).

Three pressure transducers; located at distal of the O_2 Proportional Valve (P1), distal of the Balance Gas Proportional Valve (P2), and proximal of the Outlet Check Valve, are used to verify the accuracy of the flow in the gas channel. Hot-Wire Anemometer Selector Valves (O_2, N_2O, and Air) are controlled by signals that originate on the Anesthesia Control Board.

Summary

Shortly after Power-Up, the Anesthesia Control Board will generate fourteen independent 10 VA Power Circuits, two of which will be used to power the Electronic Gas Mixer.

The Electronic Gas Mixer will generate two local voltages: 5.5 VDC and 3 VDC.

The CPU LED will flash at a 2 Hz rate and the XMIT and RCV LEDs will flash randomly indicating communication with the Anesthesia Control Board.

As the system cycles through its self-tests, the six LEDs may cycle on and off throughout this process. It should also be observed the Valve 1 and Valve 2 LEDs cycle On and Off during Checkout. More detail on the timing and operation these valves will be covered later.

O_2 and Balance Gas Mixer Valves (Valves 1 and Valves 2) are controlled by circuitry on the Electronic Gas Mixer.

Anesthesia Control Board controls the O_2, Air, and N_2O Selector Valves.

The Sintered filters and check valves play critical roles in generating backpressure for delta pressure signals for flow verifications. Since the check valves play critical roles in generating backpressure for delta pressure signals for flow verifications, they are not field replaceable.

Three normally closed gas selector valves, two Proportional Valves, and one normally open Alt O_2 Valve makeup the valves that control gas flow on the Electronic Gas Mixer.

The Electronic Gas Mixer is a field replaceable unit and comes pre-calibrated. The valves are field replaceable, as well as the cables that interconnect the Electronic Gas Mixer assemblies.

The ONLY field calibration is the pressure transducers zero. Basic flow checks can be done in the service application.

Mixer Service / Diagnosis and Troubleshooting

Mixer CPU POST tests:

- Memory and CPU tested
- Communications tested
- Sensor validity tested
- Reference Voltage tested

Gas Tests:

- Alt O_2 Valve Leak Test
- Prop Valve Leak Test
- Flow Verification Tests
- Selector Valve Leak Tests
- Balance Gas Check Valve Leak Test

Failure of any POST Test will render the Electronic Gas Mixer as failed and the Alt O_2 will be enabled if the case is started.

CPU Tests include:

- EEPROM holds the flow and pressure calibrations (this is CRC tested)
- RAM stores Temp calculations
- Registers arithmetic operations

Communication tests include:

- Serial communication check between Electronic Gas Mixer CPU and TSI Flowmeter board
- Serial communication check between Electronic Gas Mixer CPU and Anesthesia Control Board

2.10 Electronic Vaporizer

The electronically controlled vaporizer consists of the internal electronic vaporization subsystem and the Aladin agent cassette. The agent cassettes are color coded, have indexed filling ports, and are magnetically coded for each agent. The electronic control unit governs the flow through the agent cassette and the agent concentration in the fresh gas flow.

Both the $Aladin_2$ and the Aladin cassettes can be used on this system.

2.10.1 Agent cassette

Aladin DES and all $Aladin_2$ cassettes have electronic agent level sensing. The agent level shows graphically in the agent settings area of the screen.

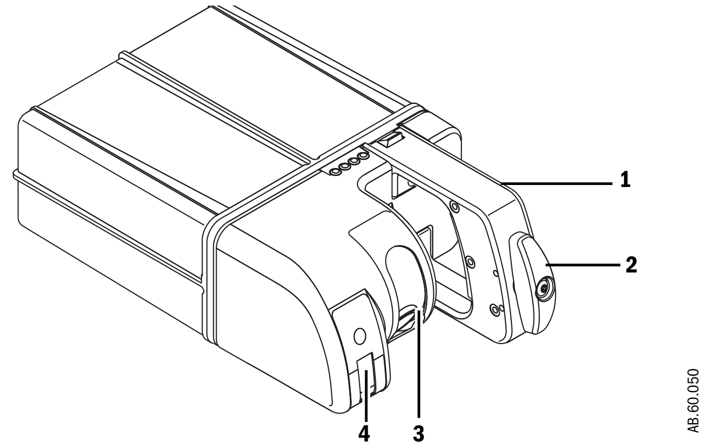
If the agent level is not available electronically, the agent level unknown symbol shows on the screen. In this case, refer to the liquid level indicator.

Some $Aladin_2$ cassettes have internal temperature sensing. If available, an enhanced temperature sensing symbol shows on the front of the cassette and the symbol shows in the agent settings area of the screen.

There are four types of $Aladin_2$ cassette filler systems. Enflurane, and isoflurane use a color-coded, Easy-Fil mechanism. Sevoflurane cassettes are available with a color-coded, Easy-Fil or Quik-Fil mechanism. The original desflurane cassettes have a filling mechanism that is compatible with Saf-T-Fil desflurane bottles. Newer desflurane cassettes use a Fixed Filler system.

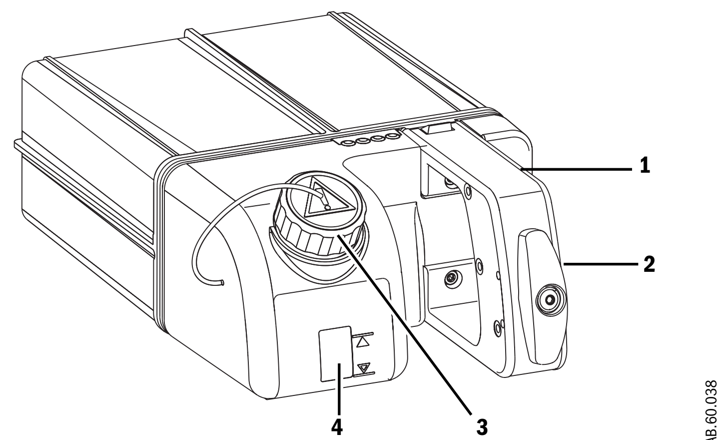
Note Sevoflurane Quik-Fil $Aladin_2$ cassettes are not available in all countries.

Anesthetic agent	Filling system	Color code
Enflurane	Easy-Fil	Orange
Isoflurane	Easy-Fil	Purple
Sevoflurane	Easy-Fil or Quik-Fil	Yellow
Desflurane	Compatible with Saf-T-Fil	Blue
Desflurane	Fixed Filler	Blue



1. Handle with release trigger
2. Lock
3. Agent filling port
4. Liquid level indicator

Figure 2-24 ▪ Aladin$_2$ desflurane cassette with Saf-T-Fil system



1. Handle with release trigger
2. Lock
3. Agent filling port
4. Liquid level indicator

Figure 2-25 ▪ Aladin$_2$ cassette for enflurane, isoflurane, for sevoflurane with Easy-Fil or Quik-Fil system, and for desflurane with Fixed Filler system

2.10.2 Electronic Vaporizer subsystem (eVap)

The Aisys CS2 system uses an integrated, electronic vaporization subsystem to add agent to the fresh gas flow. The main function of the Electronic Vaporizer subsystem is to mix the requested amount of anesthetic agent into the fresh gas stream.

Additional functions facilitated by the Electronic Vaporizer subsystem include cassette type detection, agent level detection, cassette overfill/overpressure handling, and safety features. Vaporization control algorithms depend on external reported parameters: user interface (agent setting, fresh gas composition), Mixer measured flow, and patient airway pressure information. (Patient airway pressure measurement is a combination of reading from gauge sensor and ambient pressure sampled at machine startup.)

Agent is delivered from the subsystem in one of two configurations depending on whether cassette pressure is below or above Mixer output pressure. If cassette pressure is above Mixer output pressure, all fresh gas is routed through the Backpressure Valve and agent is metered out of the pressurized cassette. If cassette pressure is below Mixer output pressure, some fresh gas is routed through the cassette, where it picks up agent vapor. The remaining fresh gas passes through the Backpressure Regulator. The mixed fresh gas and agent vapor from the subsystem is sent to the CGO.

To meet the requested agent concentration, outflow from the cassette (or flow through the cassette) is controlled with a proportional valve. This means the main subsystem control loop is on cassette flow, not agent concentration directly. If all fresh gas flow is through the Backpressure Valve, the control loop depends strongly on Mixer reported flow and the cassette flow reading. It depends weakly on reported fresh gas composition, manifold temperature reading, and reported patient airway pressure. If fresh gas flow is split between the cassette and the Backpressure Valve, the control loop depends strongly on Mixer reported flow, cassette flow reading, cassette pressure reading, and cassette temperature reading. It depends weakly on reported fresh gas composition, manifold temperature reading, and reported patient airway pressure.

Electrically, the subsystem interfaces to the Anesthesia Control board via the Pan Connector board for power (10VA limited) and communications (RS422). Power and communications to the Aladin cassette is supplied by the subsystem. While the subsystem contains a microcontroller, the vaporization control algorithms and safety functions run on the Anesthesia Control board. The subsystem microcontroller and other electronics simply handle the low-level tasks of sensor data gathering and command outputs to the actuators.

Cassette ID (type) is sensed by Hall Effect sensors that detect magnets embedded in the cassette.

Cassette temperature is read from the cassette (Aladin$_2$, if so equipped) or sensed with the Cassette Temperature assembly.

For Aladin DES and Aladin$_2$ cassettes, agent level is read from the cassette.

Refer to section 2.11.2 for detailed description of pneumatic operation.

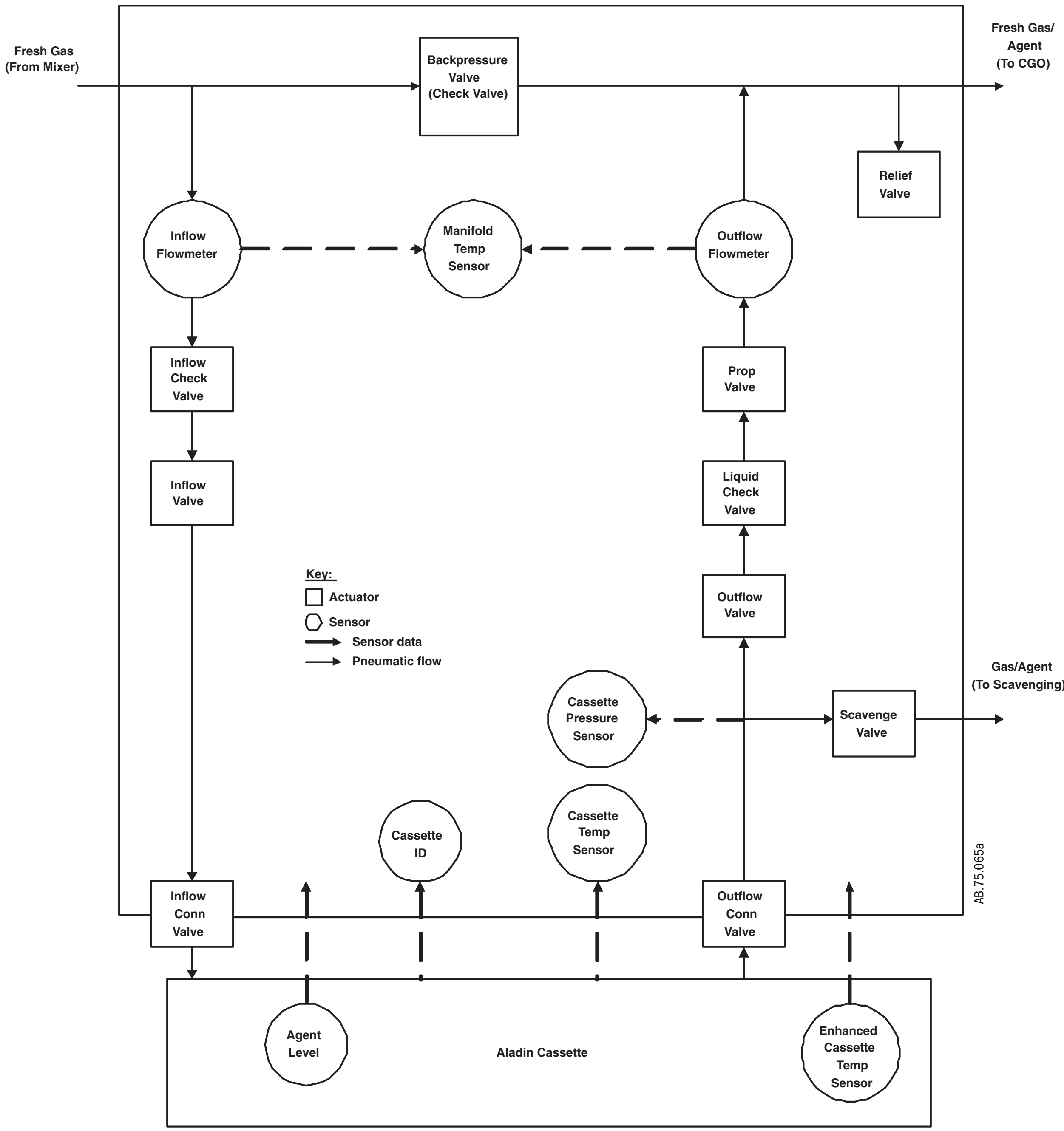


Figure 2-26 • Electronic Vaporizer electrical block diagram

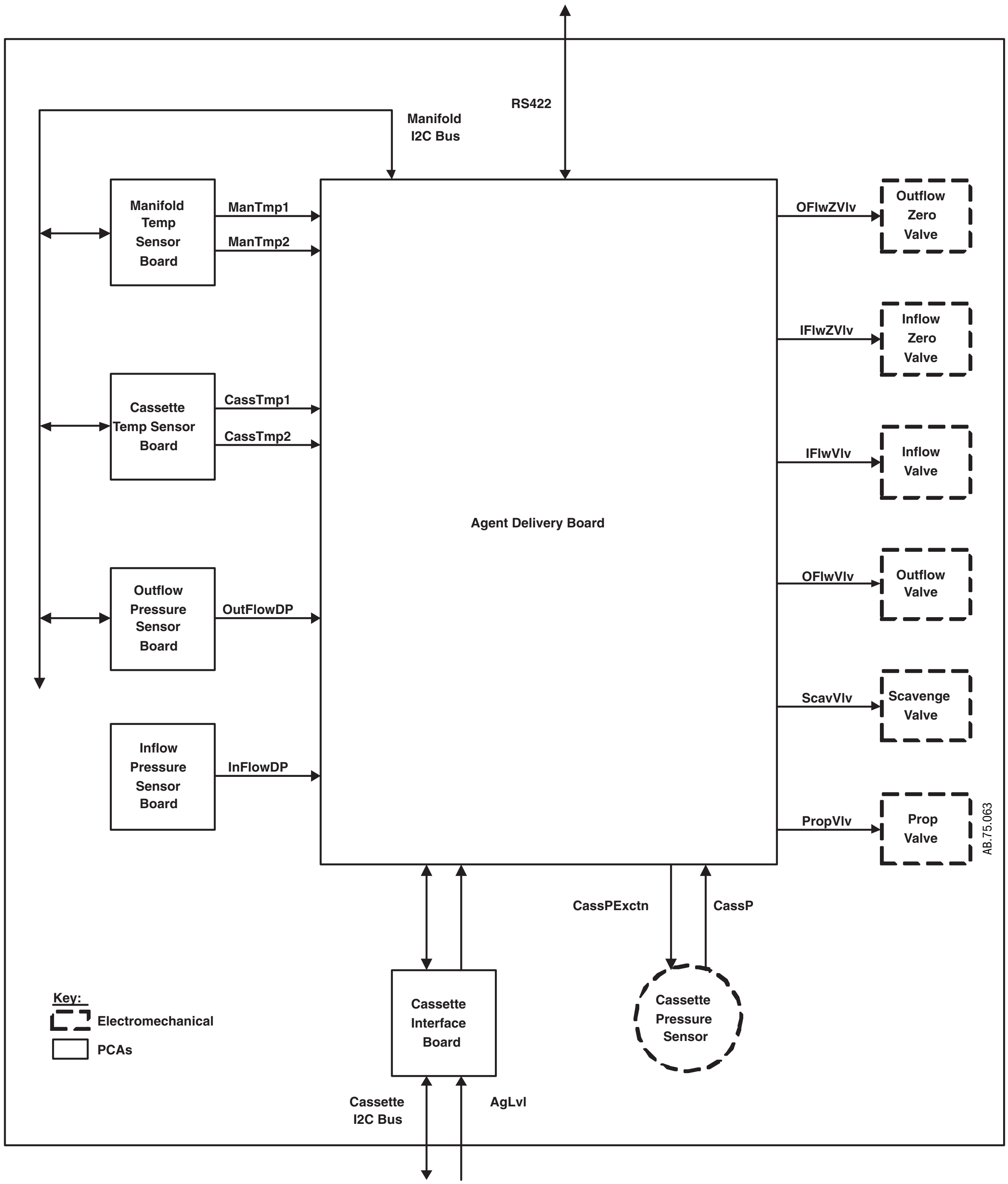


Figure 2-27 • Electronic Vaporizer electrical block diagram

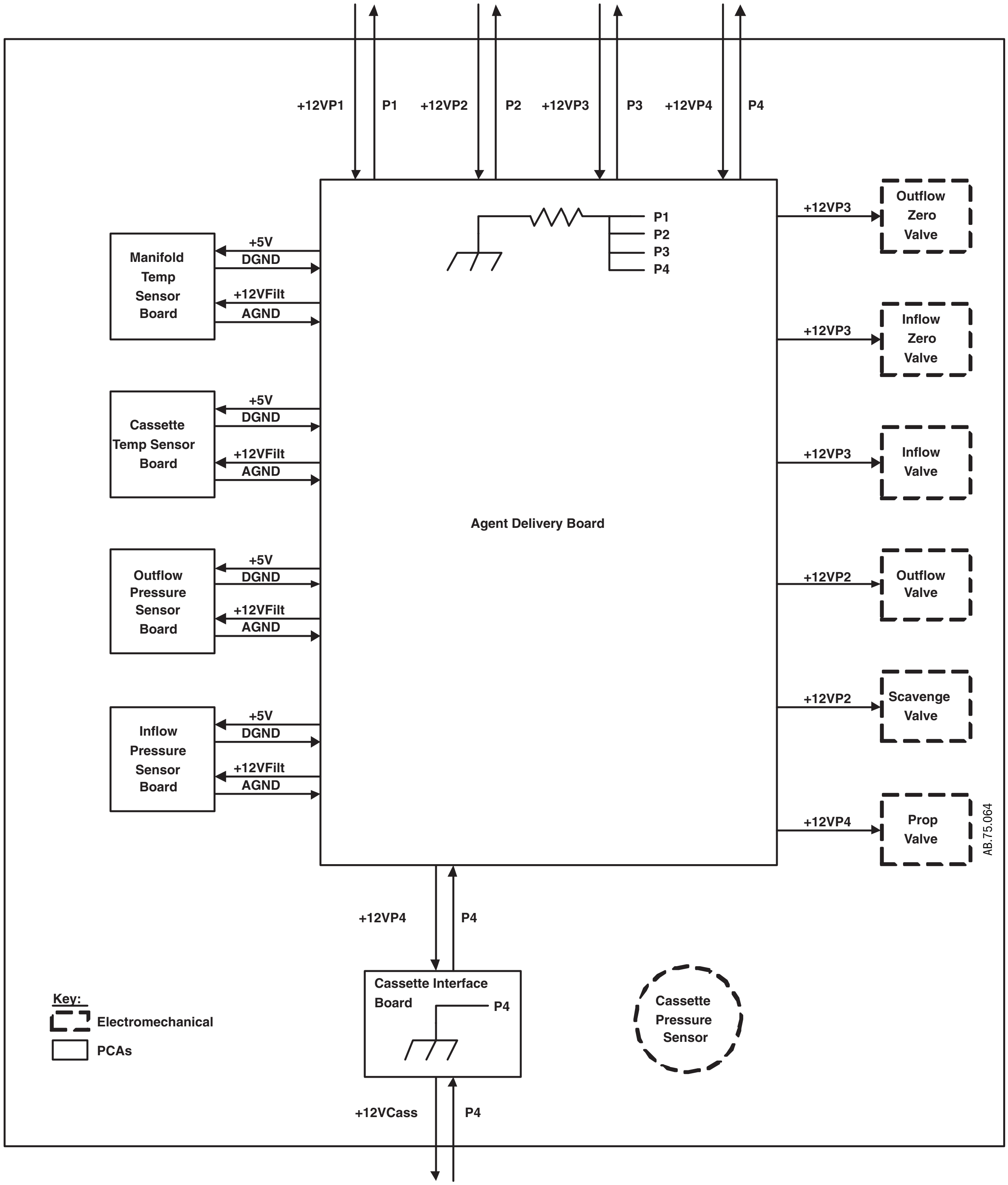


Figure 2-28 • Electronic Vaporizer power and grounding diagram

2.10.3 Agent Delivery board LED indicators

LED indicators are provided on the Agent Delivery Board to convey information about subsystem operation. Refer to the following table and to Figure 2-29.

Item	Marking	Indicates	Color
1	WDG	Blinks if microcontroller active	Yellow
2	TXD	Blinks if subsystem sending to Anesthesia Control Board	Yellow
3	RXD	Blinks if subsystem receiving from Anesthesia Control Board	Yellow
4	SCV	Lit if Scavenge Valve open	Yellow
5	OFV	Lit if Outflow Valve open	Yellow
6	OFZ	Lit if Outflow Zero Valve is performing zero measurement	Yellow
7	IFZ	Lit if Inflow Zero Valve is performing zero measurement	Yellow
8	IFV	Lit if Inflow Valve open	Yellow
9	CPWR	Lit if Cassette powered	Green
10	P1	Lit if voltage present on +12VP1 power rail	Green
11	P2	Lit if voltage present on +12VP2 power rail	Green
12	P3	Lit if voltage present on +12VP3 power rail	Green
13	P4	Lit if voltage present on +12VP4 power rail	Green
14		All segments lit immediately after reset. Segments flicker during subsystem POST. Segments extinguished upon communications established with ACB.	Red

Note: When a failure has been detected in the eVap, only the +12VP1 power rail will be powered. The rest are shut off.

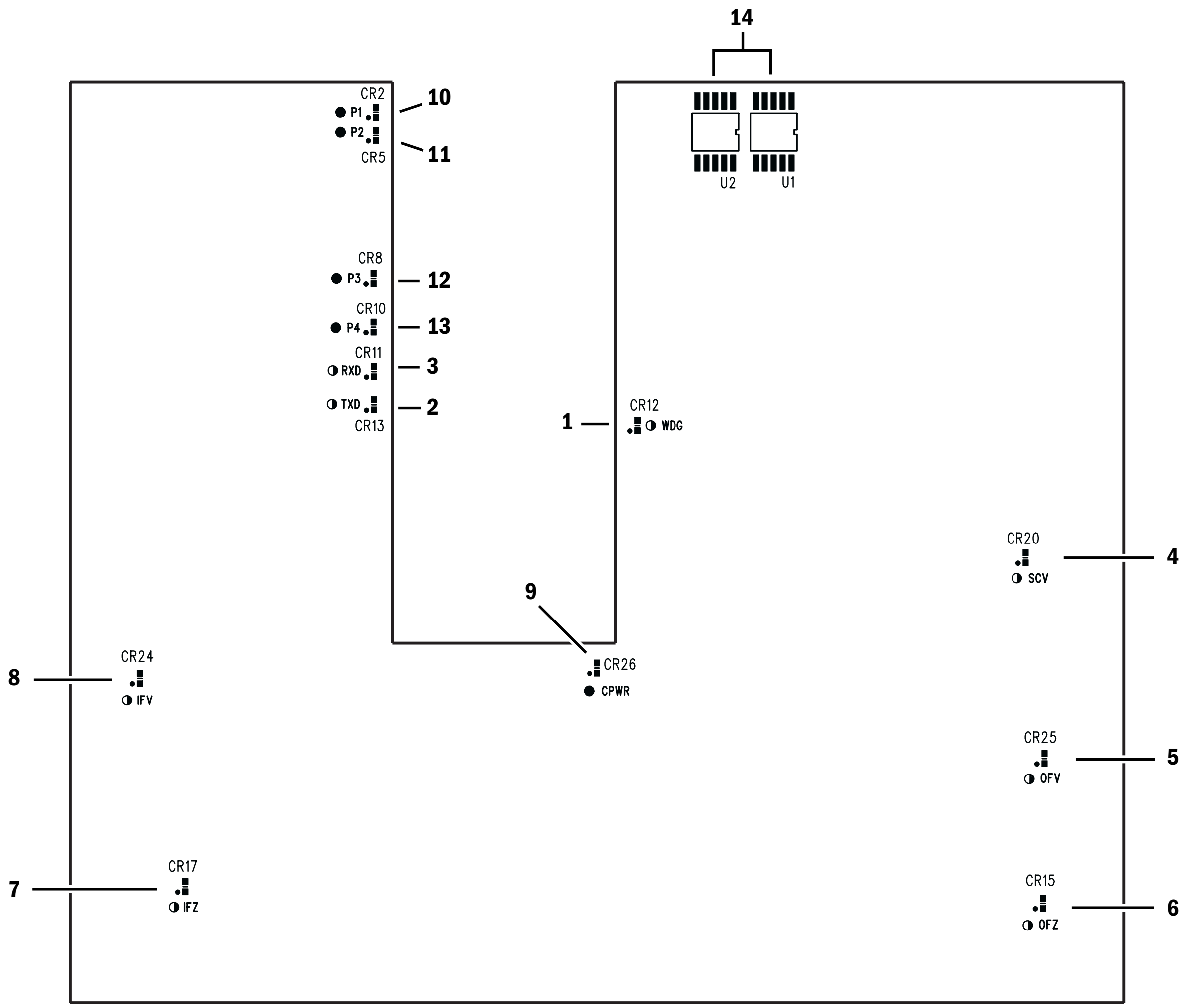


Figure 2-29 • Agent Delivery board LED indicators

2.10.4 Et Control

The Aisys CS2 is an integrated anesthesia delivery system. It includes electronic gas mixing (Mixer), electronic vaporization (eVaP), electronic ventilation, and optional integrated respiratory gas monitoring. Aisys CS2 machines include an optional feature called Et Control. Et Control is a user-selectable gas delivery mode on the Aisys CS2 system (System Software 10.0 or greater) that controls the patient's expired agent and expired O_2 concentration by automatically adjusting fresh gas composition and total flow to reach and maintain desired levels.

The electronic gas mixer and electronic vaporizer in the Aisys CS2 system use closed loop control in their delivery. Their output is monitored and then this information is fed back into the controller. This closed loop control makes sure that the Aisys CS2 delivers what is set.

The ventilator also uses closed loop control in its delivery. An example of this closed loop control is with regard to Pressure Control ventilation. The Aisys CS2 continues to deliver gas until the pressure in the patient's lungs reaches the set level.

Et Control automatically performs the adjustment for the clinician. In Et Control mode, the clinician sets the targeted EtAA value, targeted EtO_2 value, and minimum allowable flow value.

The Et Control system receives patient gas information through the Aisys CS2 system's integrated respiratory gas monitor. Airway module requirements for Et Control mode:

- E-series: E-CAiO, E-CAiOV, E-CAiOVX (software version 4.5 and above)
- M-series: M-CAiO, M-CAiOV, M-CAiOVX (software version 4.5 and above)
- CARESCAPE series: E-sCAiOE, E-sCAiOVE

Based on analysis of the current patient expired agent and expired O_2 concentrations versus the targeted values, the Et Control system sets the electronic mixer and the electronic vaporizer to the proper levels. The system continues to control the output from the mixer and vaporizer to achieve these settings. Changes to the mixer and vaporizer outputs are displayed on the screen to ensure the clinician is aware of output changes.

Et Control is available using Isoflurane, Desflurane, and Sevoflurane. A form of Et Control, expired oxygen control only, can also be used when not using an inhaled agent.

The device is intended for volume or pressure control ventilation. The Et Control feature is intended to control the patient's expired agent and expired O_2 concentrations by automatically adjusting fresh gas composition and total flow to reach and maintain desired levels.

Risk Management

The two major risks with the addition of Et Control are:

- the validity of the gas module reading (does the gas module read the expired gas concentration that is actually at the patient).
- the stability of the controller (is the controller delivering the right concentrations).

Validity of the gas module reading

The validity of the gas module reading is important because the system controls to this measurement. A number of checks are implemented to mitigate the risk of invalid gas module readings.

- The first of these checks samples fresh gas from the Aisys CS2 and thus system checks the accuracy of the gas module by comparing the reading from the gas module to the known values being delivered by the electronic vaporizer and electronic mixer.
  - There is an add-on for the M-Gas and E-Gas modules, called the Fresh Gas Module (FGM), that is used for fresh gas sampling. The CARESCAPE E-sGas modules used for Et Control are in-built with Fresh Gas measurement capabilities.

  Et Control is exited if the gas module fails this check.
- Leaks in the gas module sampling system would dilute the sample causing an inaccurate gas reading so checks are made to make sure that there are no leaks. The first of these checks sets a leak baseline. During this Et Control System check, the system flows 8 l/min 100% O_2 plus agent from the electronic mixer and monitors the O_2 value at the gas monitor for agreement.

  Once this check completes, another check trends the O_2 and CO_2 readings from the gas module. If the trend indicates that both values are heading toward ambient conditions (21% for O_2, 0% for CO_2), the system identifies this as a leak. Et Control is set to its fallback mode in case a leak is detected.
- The purpose of the Fresh Gas Sample Relief Valve, shown in Figure 2-30, is to ensure that during the module zeroing phase, no mixed gas or agent is detected by the E-sGas Module, possibly creating an inaccurate zero or reading. The valve is normally closed, which prevents any fresh gas from lowing to the Fresh Gas Module Sample port connection on the bezel.The valve is energized when the Module is performing the Fresh Gas Sample check associated with the Et Control option.

Controller stability

The second major risk, controller stability, is mitigated by a supervisor algorithm that runs while in Et Control. This algorithm causes Et Control to be exited if the EtAA concentration is ± 1/2 MAC (minimum alveolar concentration) from the targeted agent setting or if the EtO_2 concentration is less than 18%.

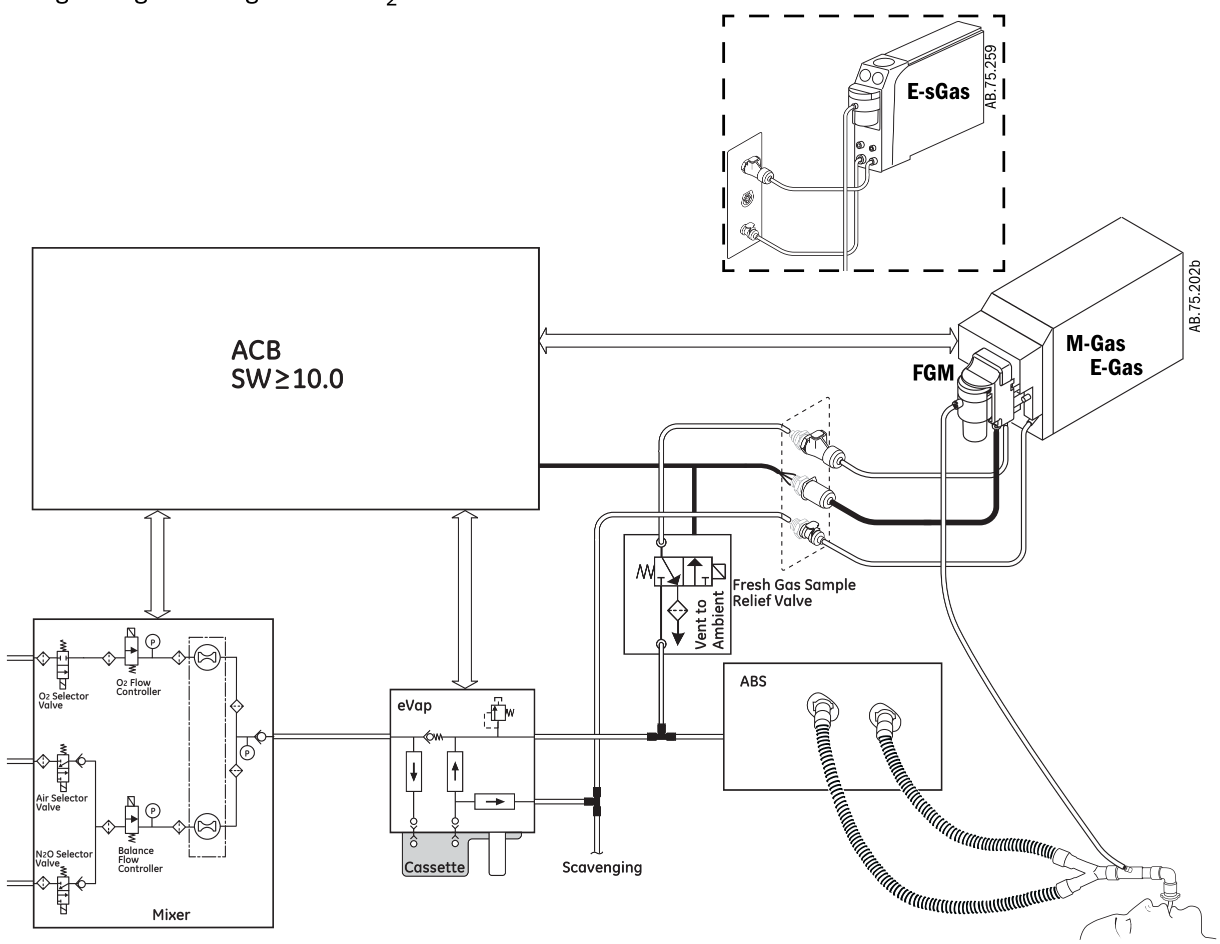


Figure 2-30 • Et Control

2.11 Gas flow through the anesthesia machine

2.11.1 Overview

Refer to Figure 2-31 and Figure 2-32.

Gas supplies

Gas comes into the system through a pipeline (**1**) or cylinder (**6**) connection. All connections have indexed fittings, filters, and check valves (one-way valves). Pressure transducers monitor the pipeline (**2**) and cylinder (**7**) pressures.

The O_2 supply failure alarm is derived from the O_2 pipeline and the O_2 cylinder pressure transducer inputs.

A primary regulator (**8**) decreases the cylinder pressures to approximately pipeline levels. A pressure relief valve (**3**) helps protect the system from high pressures.

To help prevent problems with the gas supplies:

- Install yoke plugs on all empty cylinder connections.
- When a pipeline supply is adequate, keep the cylinder valve closed.

Gas flow

Pipeline or regulated cylinder pressure supplies O_2 or Air directly to the ventilator engine (**4a** or **4b**) and as pilot pressure (**4**) for the SCGO assembly (**E**). Connection points are also available for venturi suction (**5a** or **5b**) drive gas supply. An additional O_2 regulator (**18**) decreases the pressure for the O_2 Flush valve (**19**) and the auxiliary O_2 flowmeter (**24**).

The O_2 Flush valve supplies high flows of O_2 to the fresh gas outlet (**22** or **23**) through the SCGO/ACGO assembly (**E/F**). The flush pressure switch (**20**) monitors activation of the flush valve.

Gas mixing

Under normal conditions, with the system switch (**10**) in the On position, the Alternate O_2 Disable valve (**13**) is energized to block alternate O2 flow. Normal gas flows are enabled through their respective selector valves (**11**). The system controls gas flow through the flow control valves (**12**) and derives the individual flow rates through the hot-wire anemometers (**14**).

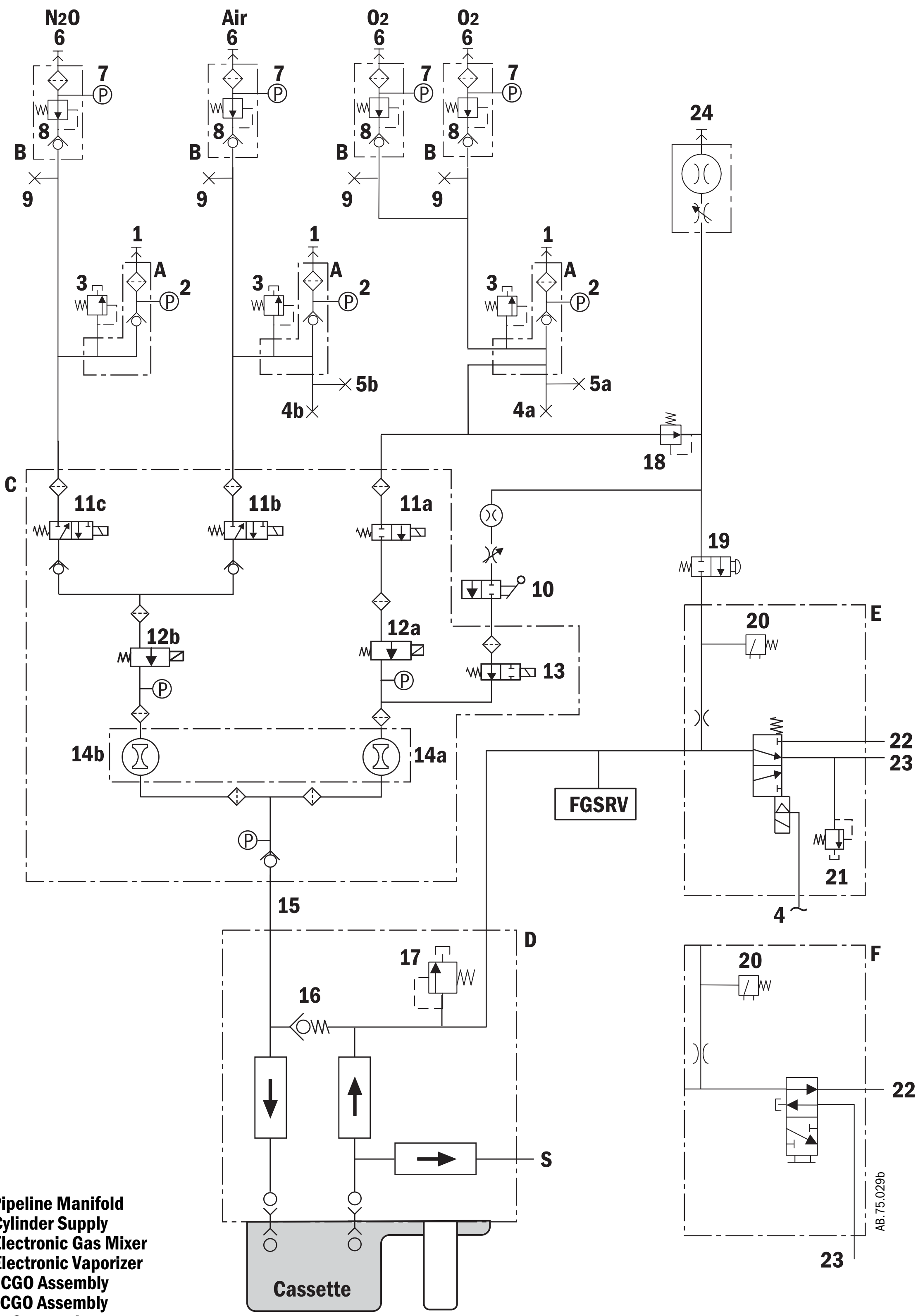
Under system failure conditions (or if Alt O_2 is selected), the normally-open Alternate O_2 Disable valve (**13**) allows delivery of O_2 through the Alternate O_2 Flowmeter when the system switch is in the On position.

Mixed gas

The mixed gas (**15**) flows through the electronic vaporizer (**D**) to the SCGO/ACGO assembly (**E/F**). A pressure relief valve (**17**) on the electronic vaporizer limits the maximum outlet pressure.

The SCGO assembly (**E**) directs the mixed gas to the selected circuit:
22 (ABS-circle) or **23** (to Inspiratory port of ABS). On SCGO assemblies, a relief valve (**21**) limits pressure in the breathing system to approximately 150 cmH_2O.

The ACGO assembly (**F**) directs the mixed gas to the selected circuit:
22 (ABS-circle) or **23** (external ACGO port).



A - Pipeline Manifold
B - Cylinder Supply
C - Electronic Gas Mixer
D - Electronic Vaporizer
E - SCGO Assembly
F - ACGO Assembly
S - To Scavenging
FGSRV - Fresh Gas Sample Relief Valve (Refer to Section 2.10.4)

Figure 2-31 • Pneumatic circuit

2.11.2 Electronic vaporizer

Agent is delivered from the subsystem in one of two configurations depending on whether cassette pressure is below or above Mixer output pressure. If cassette pressure is above Mixer output pressure, all fresh gas is routed through the Backpressure Regulator and agent is metered out of the pressurized cassette. If cassette pressure is below Mixer output pressure, some fresh gas is routed through the cassette, where it picks up agent vapor. The remaining fresh gas passes through the Backpressure Regulator. The mixed fresh gas and agent vapor from the subsystem is sent to the CGO.

A Backpressure Valve (**16**) builds a pressure at the input to the vaporizer to drive gas through the cassette, if necessary. It is not needed to check flow in the reverse direction. A pressure relief valve (**17**) limits the maximum outlet pressure.

The Inflow and Outflow Flowmeters (**26**, **27**) measure flow by developing a pressure drop across a flow restrictor. The Outflow Flowmeter is used for control, while the Inflow Flowmeter is used for safety. Each Flowmeter includes a zeroing valve that temporarily shorts a pressure transducer's ports together for an accurate zero measurement. The zeroing valves may be energized during Standby to heat the Flowmeter Manifold to prevent agent condensation.

An Inflow Check Valve (**28**) prevents unmetered agent vapor from flowing backwards and entering the fresh gas stream.

Inflow and Outflow Valves (**29**, **30**) direct flow in the subsystem, opening for agent delivery and closing for other system states, including safety conditions. The Outflow Valve must open for agent delivery, while the Inflow Valve opens if cassette pressure is lower than Mixer output pressure.

The Scavenge Valve (**31**) opens periodically during system checkout and, when a cassette is not installed, to automatically sample ambient pressure.

A liquid prevention valve (**32**) blocks liquid from entering the subsystem in the event that an overfilled cassette is present. This valve can also become temporarily blocked if cassette temperature exceeds Flowmeter Manifold temperature significantly, causing agent condensation. Clearing the blockage depends on the rate of agent evaporation.

Variable control of flow from the cassette is accomplished with a Proportional Valve (**33**) under software direction.

Connection Valves (**34**) open and close automatically when a cassette is installed into or removed from the cassette bay.

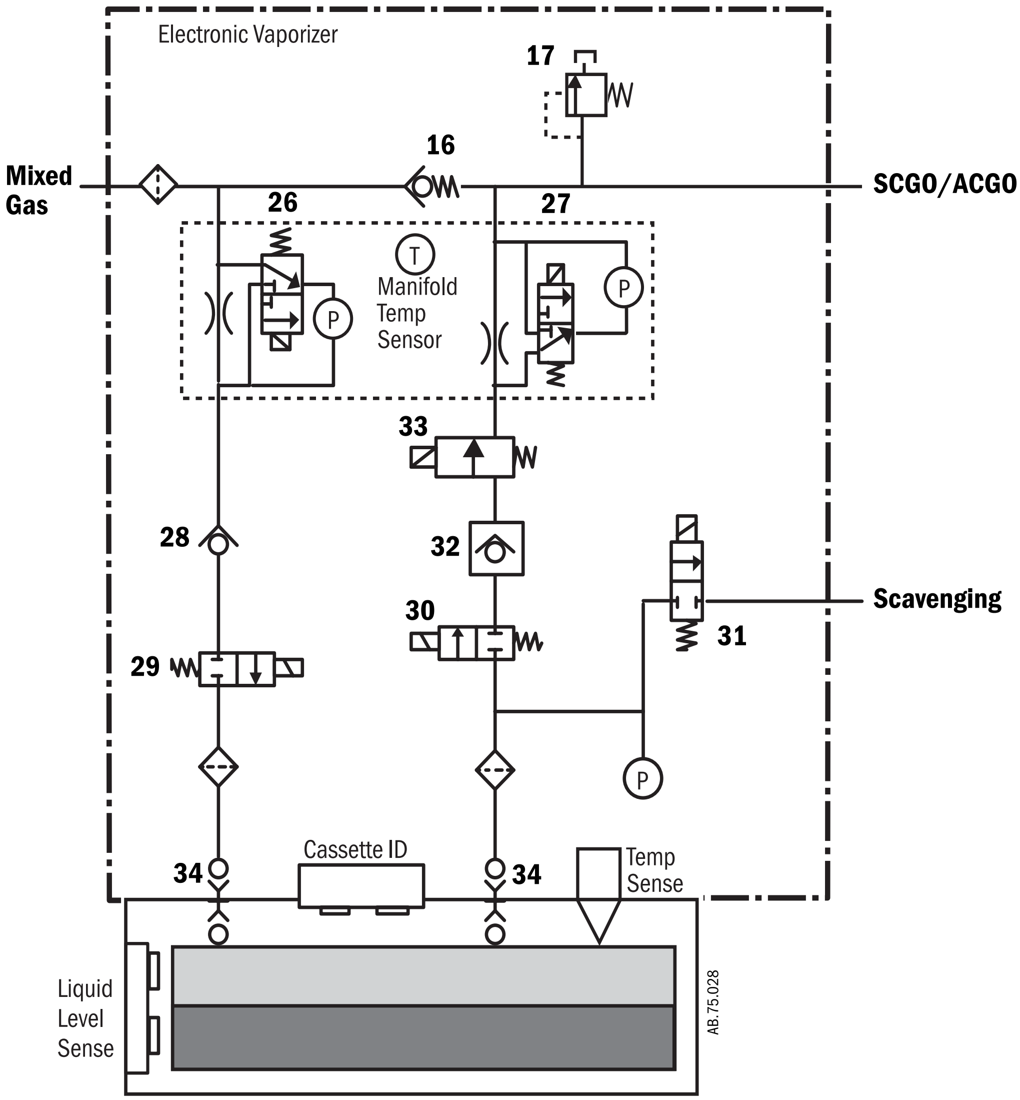
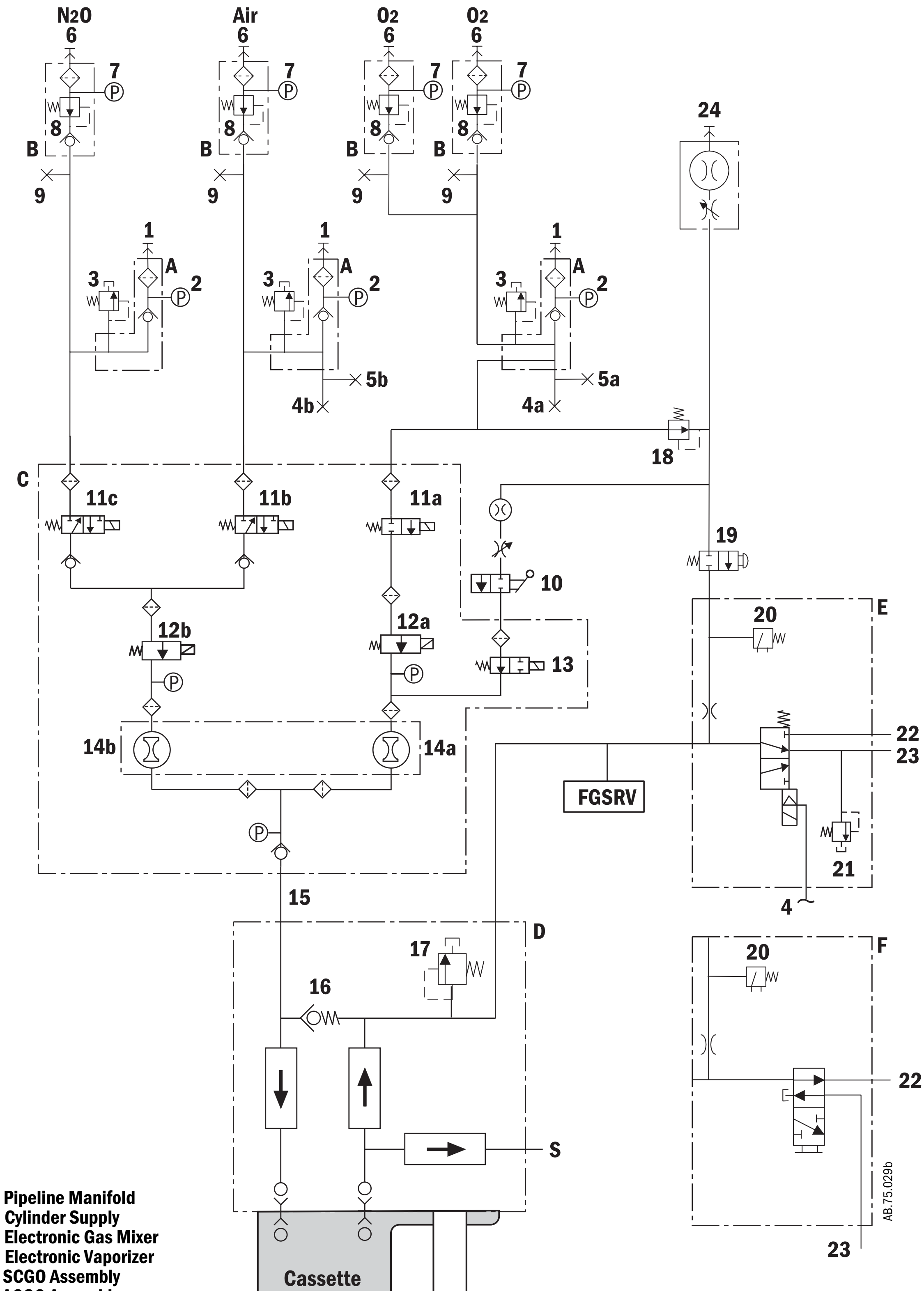


Figure 2-32 • Electronic vaporizer circuit



A - Pipeline Manifold
B - Cylinder Supply
C - Electronic Gas Mixer
D - Electronic Vaporizer
E - SCGO Assembly
F - ACGO Assembly
S - To Scavenging
FGSRV - Fresh Gas Sample Relief Valve (Refer to Section 2.10.4)

Figure 2-33 • Pneumatic circuit

Refer to Figure 2-33.

Key to Numbered Components

1. Pipeline inlet
2. Pipeline pressure transducer
3. High-pressure relief valve (758 kPa / 110 psi)*
4. Supply connections for the ventilator and pilot pressure for SCGO
    a. O_2 drive gas
    b. Air drive gas
5. Venturi suction supply connection
    a. O_2 drive gas
    b. Air drive gas
6. Cylinder inlet
7. Cylinder pressure transducer
8. Primary regulator (cylinder pressure)
9. Test port (primary regulator)
10. System switch
11. Selector valve
    a = O_2; b = Air; c = N_2O
12. Flow controller
    a = O_2; b = balance gas
13. Alternate O_2 disable valve
14. Hot-wire anemometer
    a = O_2 flow sensor channel; b = balance gas flow sensor channel
15. Mixed gas
16. Backpressure valve
17. Low-pressure relief valve (38 kPa / 5.5 psi)*
18. O_2 flush and auxiliary flowmeter regulator (241 kPa / 35 psi)*
19. O_2 Flush valve
20. Pressure switch (used with the ventilator)
21. Breathing system pressure relief valve (SCGO only — 150 cmH_2O)*
22. To Port 3 of ABS interface (circle)
23. For SCGO, to Port 2 of ABS interface (non-circle Inspiratory port)
    For ACGO, to external 22-mm ACGO connector
24. Auxiliary O_2 flowmeter

* Approximate values

Key to Symbols

Pneumatic Connection

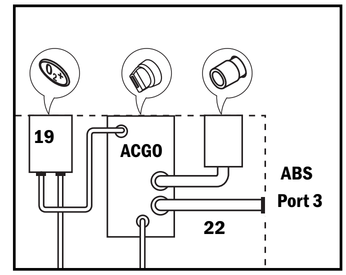
Filter

Pressure Transducer

Check Valve

2.11.3 Physical connections (O_2 supply)

Figure 2-34 shows the physical path that the O_2 gas supply takes. The item numbers are described in Figure 2-33.



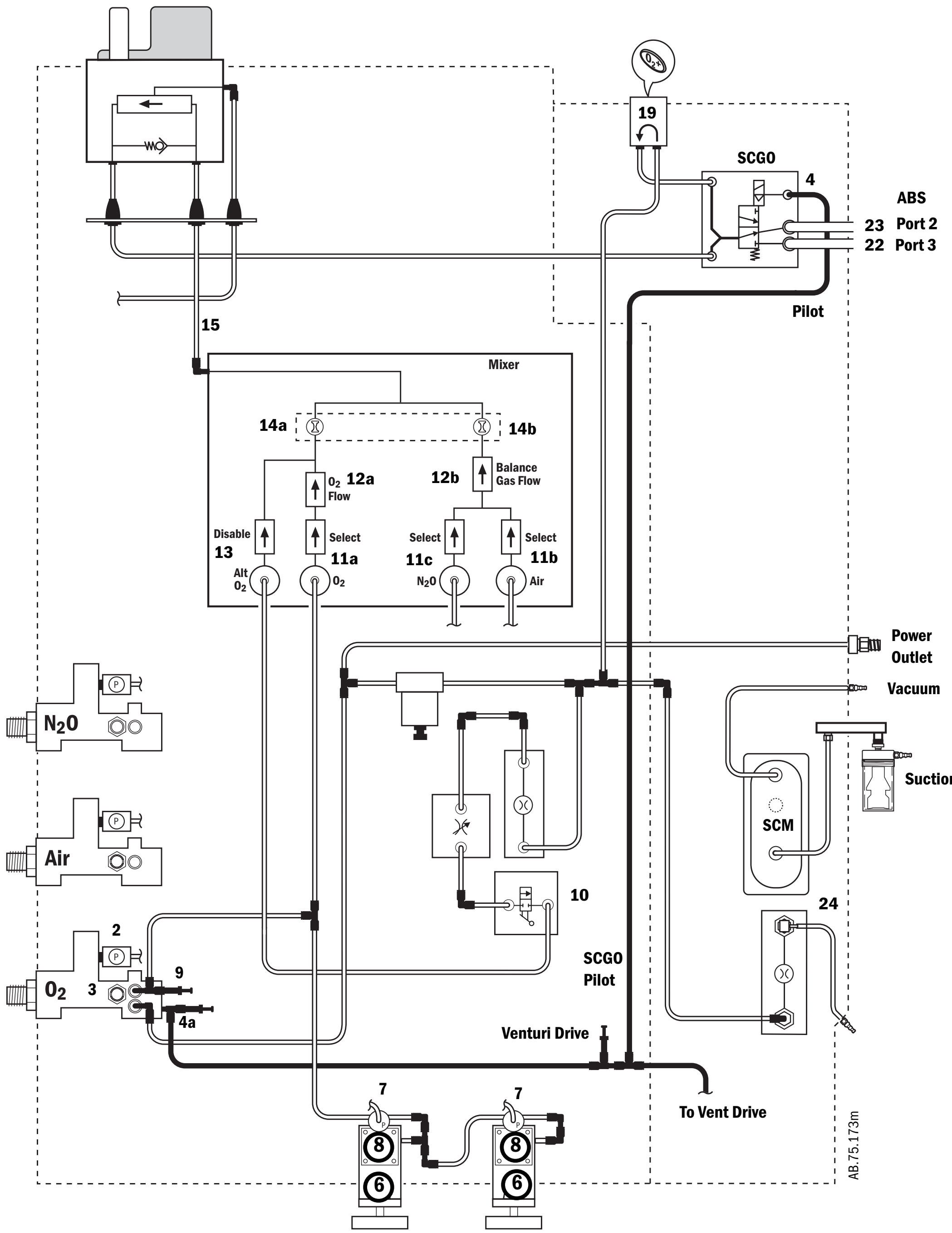
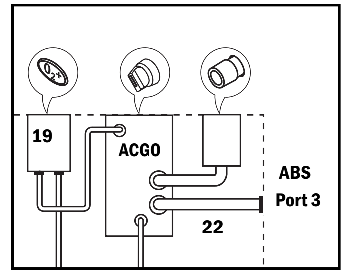


Figure 2-34 • Typical (O_2) tubing connections - pictorial

2.11.4 Physical connections (N2O and Air supplies)

Figure 2-35 shows the physical path that the N_2O and Air gas supplies take. The item numbers are described in Figure 2-33.



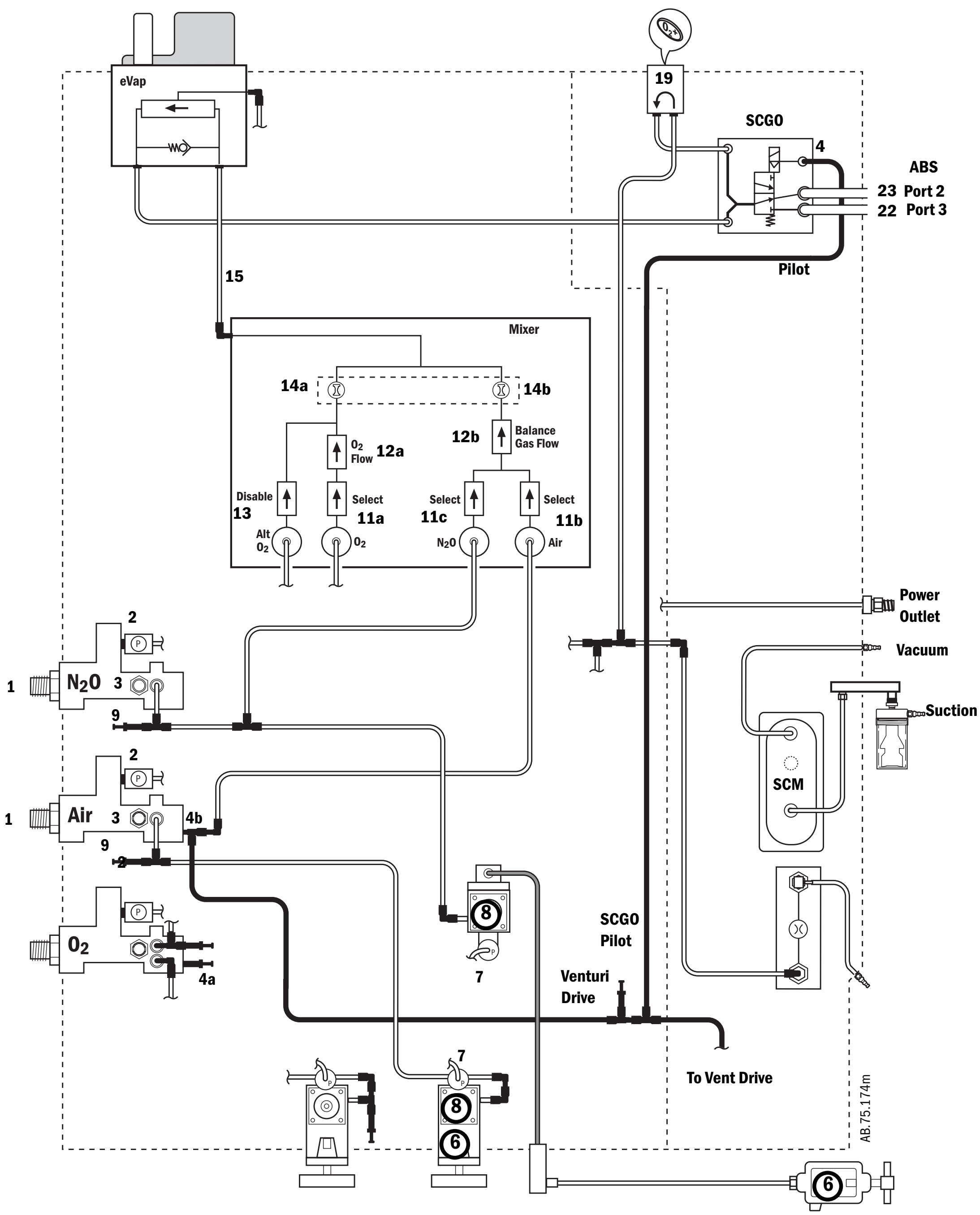


Figure 2-35 • Typical (N_2O and Air) tubing connections - pictorial

2.11.5 Suction regulators

Pipeline vacuum

The suction regulator (shown in Figure 2-34) uses an external vacuum source.

Venturi Drive vacuum

The suction regulator (shown in Figure 2-36) uses an internal, venturi derived vacuum source.

Drive gas (internally plumbed **Air** or **O_2**) enters the Venturi Module (**VM**) at the drive port (**A**). As the drive gas passes through the venturi module, a vacuum is created at port **B**. The drive gas exits the venturi module at port **C** and is exhausted outside the machine through the muffler (**D**).

The control port (**E**) on the venturi module responds to pneumatic signals from the front panel switch on the Suction Control Module (**SCM**) to turn the venturi vacuum drive gas on or off. The check valve (**CV**) helps prevent pressurization of the suction circuitry if the exhaust is occluded or the venturi unit fails.

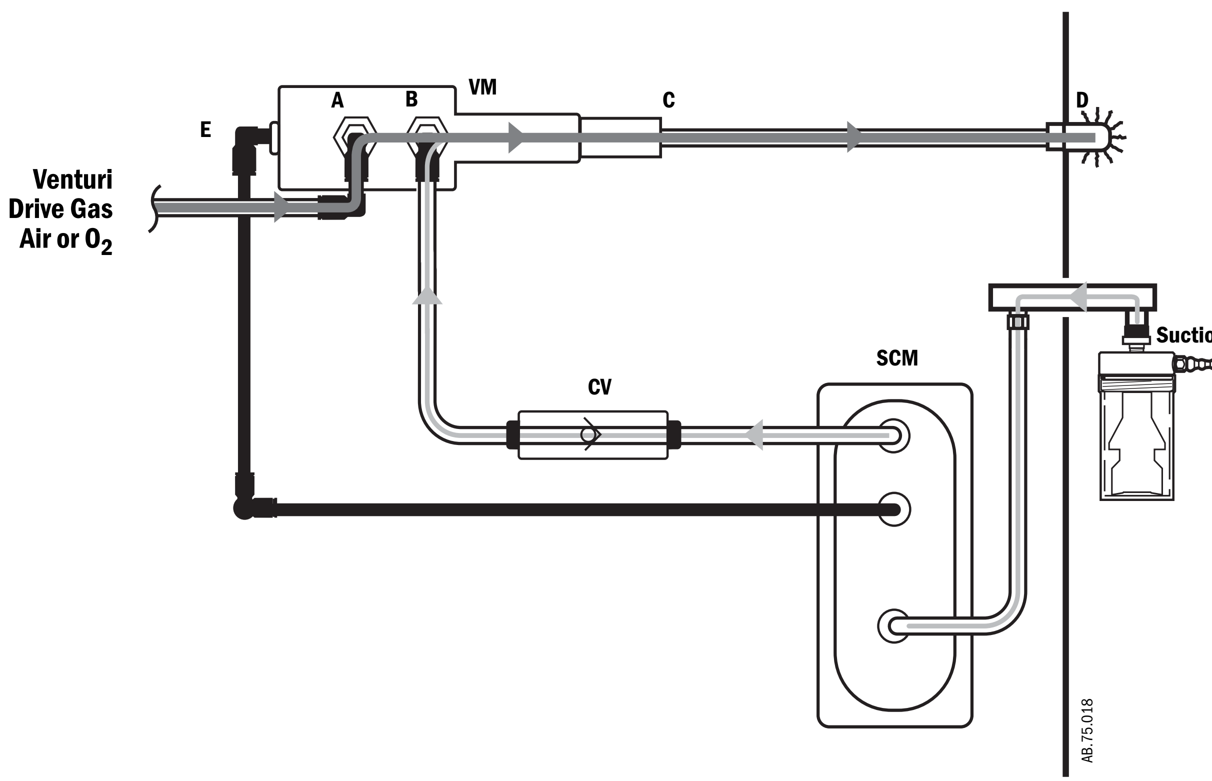


Figure 2-36 • Venturi suction

2.12 Flow through the breathing system

2.12.1 Overview of flow paths

This section looks at four types of flow paths.

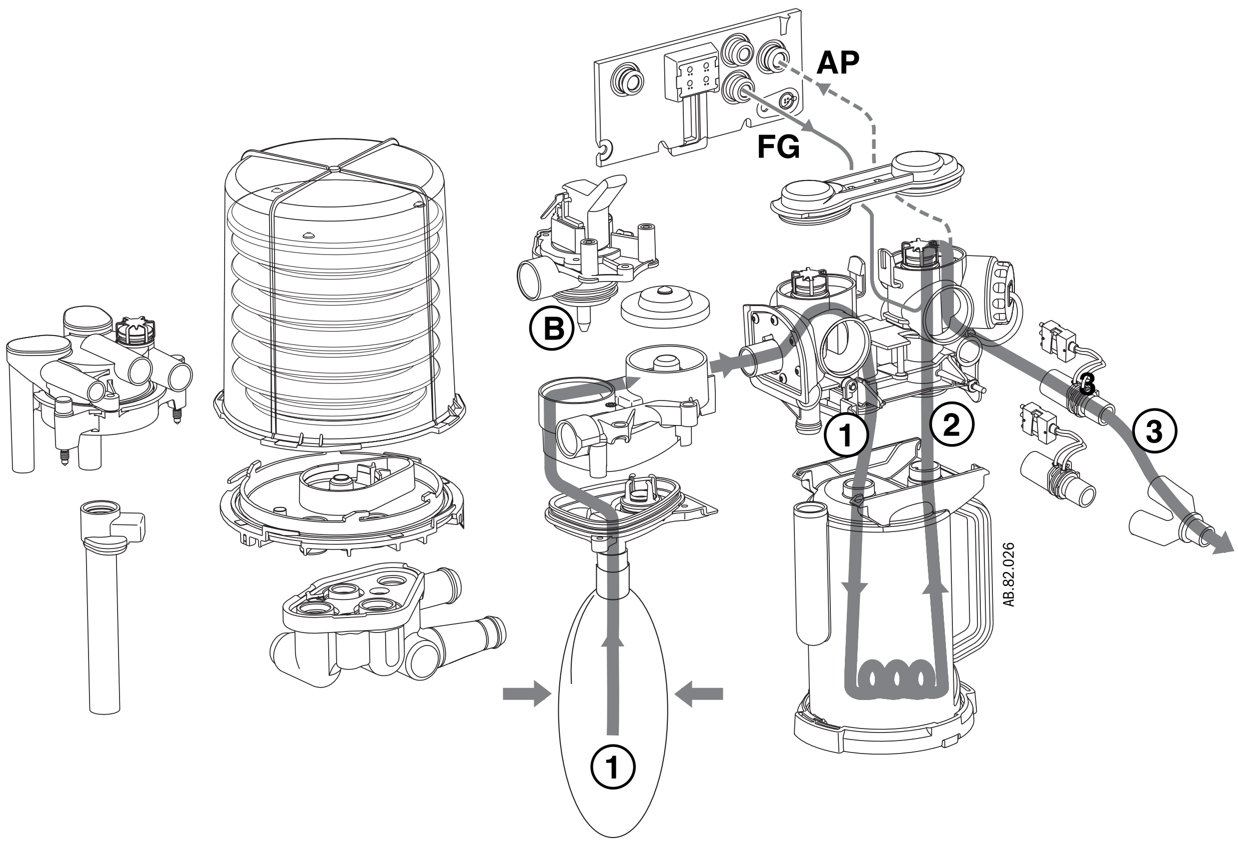
- **Ventilation paths:** How gas flows from the drive source (bag or bellows) to and from the patient.
- **Fresh gas paths:** Fresh gas can flow from the machine interface directly to the patient through the inspiratory check valve, or through the absorber into the expiratory flow, or directly to an external circuit through the optional auxiliary common gas outlet.
- **Scavenged gas paths:** APL or Pop-off.
- **Flow through the optional EZchange Canister and Condenser:** EZchange ON and EZchange OFF (CO_2 bypass).

2.12.2 Manual ventilation

Manual inspiration The Bag/Vent switch closes the ventilator path (**B**).

Gas flows from the bag (**1**), through the absorber (**2**), into the breathing circuit module, and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas (**FG**) flows from the machine into the inspiratory limb, upstream of the inspiratory check valve.



AP	Airway Pressure
B	Bag/Vent switch to Bag
FG	Fresh Gas
1	Flow to absorber
2	Flow from absorber
3	Inspiratory flow

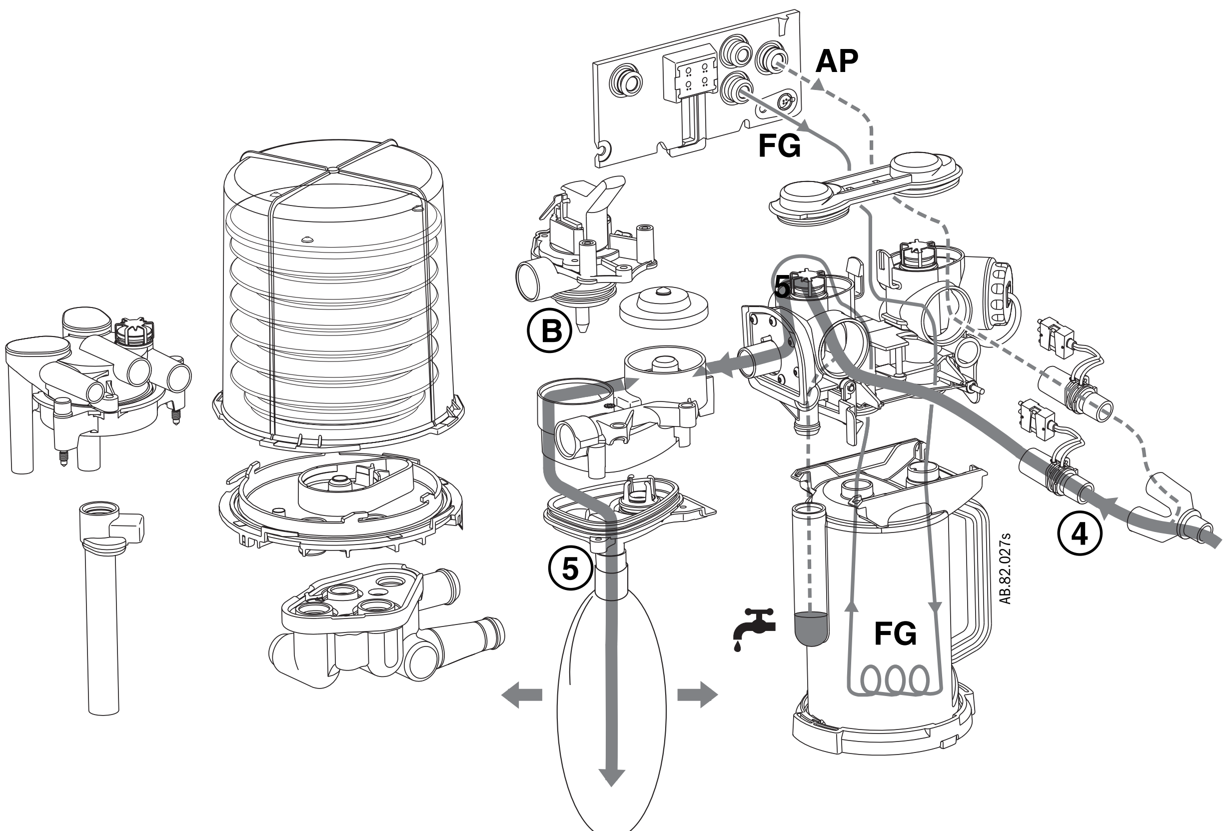
Figure 2-37 • Gas flow during manual inspiration

Manual expiration

The Bag/Vent switch keeps the ventilator path closed (**B**).

Gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve), and into the bag (**5**).

During exhalation, fresh gas flows backwards through the absorber (**FG**) into the expiratory limb, downstream of the expiratory check valve.

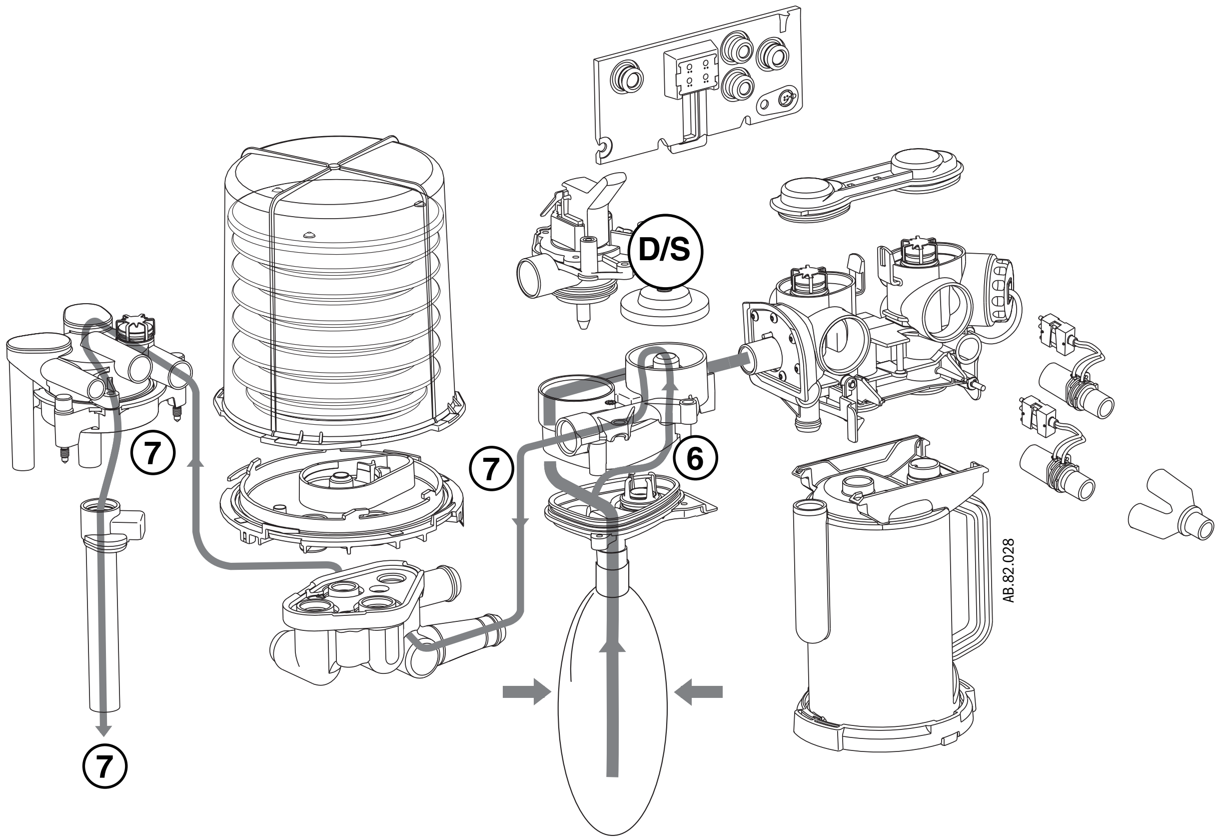


AP	Airway Pressure
B	Bag/Vent switch to Bag
FG	Fresh Gas
4	Expiratory flow
5	Flow to bag

Figure 2-38 • Flow during manual expiration

APL Valve The APL valve sets a pressure limit for manual ventilation.

As you turn the APL knob, it puts more or less force on the APL disc and seat (**D/S**). If the circuit pressure is too high (**6**), the disc and seat inside the diaphragm opens and vents gas to the scavenging system (**7**).



D/S	APL disc and seat
6	APL flow
7	To scavenging

Figure 2-39 • Flow through the APL Valve

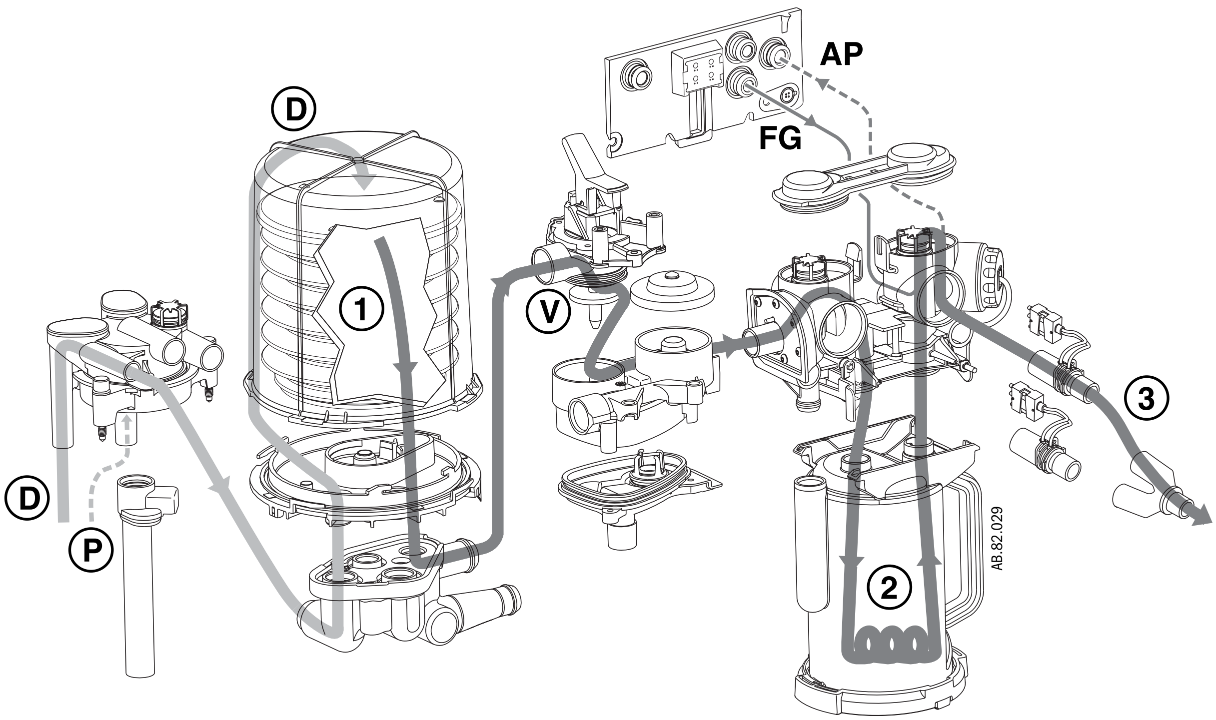
2.12.3 Mechanical ventilation

Mechanical inspiration

The Bag/Vent switch closes the manual path (**V**). Pilot pressure (**P**) closes the exhalation valve.

Drive gas (**D**) pushes down on the bellows. Gas flows from the bellows (**1**), through the absorber (**2**), and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas flows into the inspiratory limb, upstream of the inspiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
P	Pilot pressure
V	Bag/Vent switch to Vent
1	Flow to absorber
2	Flow from absorber
3	Inspiratory flow

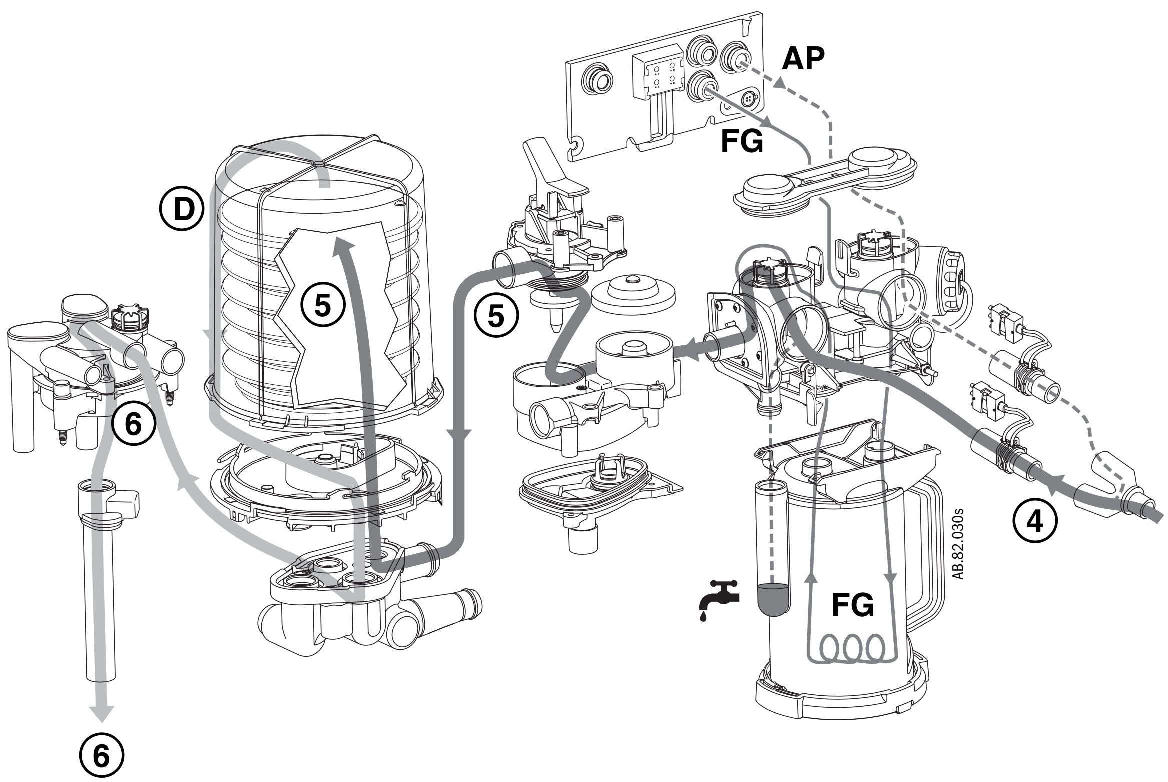
Figure 2-40 • Mechanical inspiration

Mechanical expiration

Drive-gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve) and into the bellows (**5**). Residual drive gas (**D**) flows out of the bellows to the scavenging system (**6**).

If PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level.

During exhalation, fresh gas flows backwards through the absorber (**FG**) into the expiratory limb, downstream of the expiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
4	Expiratory flow
5	Flow to bellows
6	To scavenging

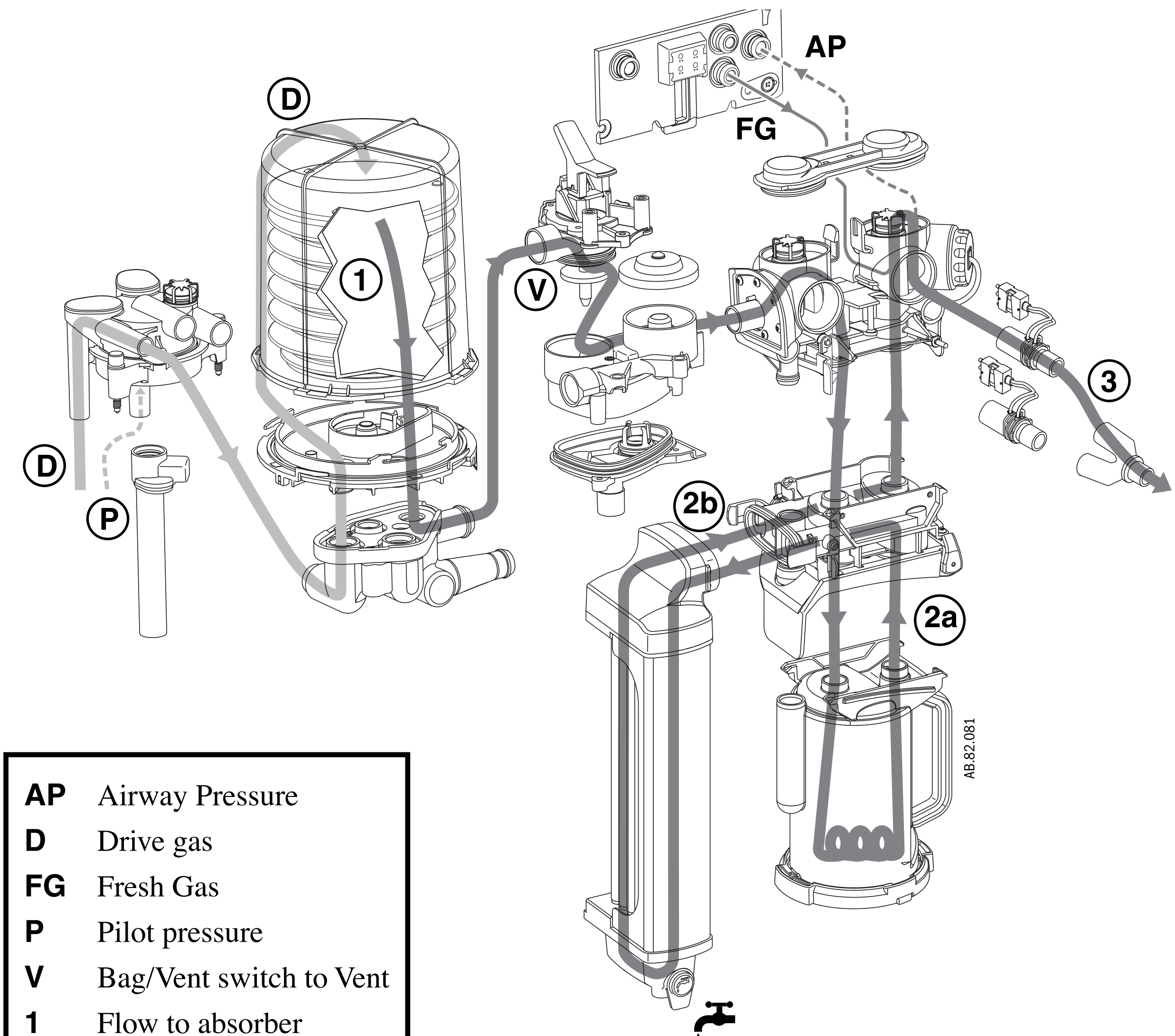
Figure 2-41 • Mechanical expiration

Mechanical inspiration (EZchange and condenser ON)

The Bag/Vent switch closes the manual path (**V**). Pilot pressure (**P**) closes the exhalation valve.

Drive gas (**D**) pushes down on the bellows. Gas flows from the bellows (**1**), through the absorber (**2a**), Condenser (**2b**), and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas flows into the inspiratory limb, upstream of the inspiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
P	Pilot pressure
V	Bag/Vent switch to Vent
1	Flow to absorber
2a	Flow from absorber
2b	Flow from condenser
3	Inspiratory flow

Figure 2-42 • Mechanical inspiration through Condenser with EZchange Canister and Condenser ON

Mechanical expiration (EZchange and condenser ON)

Drive-gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve) and into the bellows (**5**). Residual drive gas (**D**) flows out of the bellows to the scavenging system (**6**).

If PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level.

During exhalation, fresh gas flows backwards through the Condenser and absorber (**FG**) into the expiratory limb, downstream of the expiratory check valve.

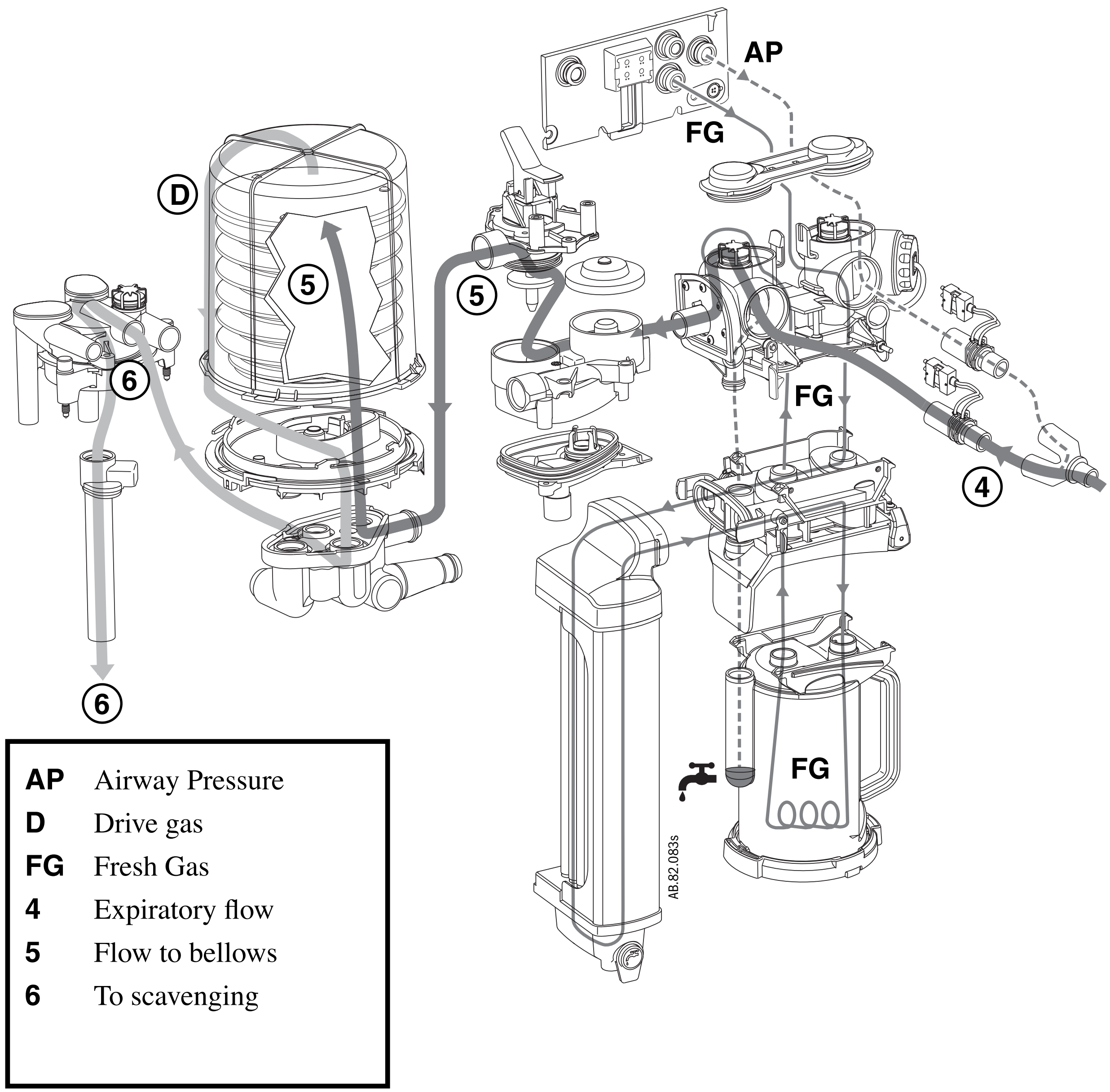


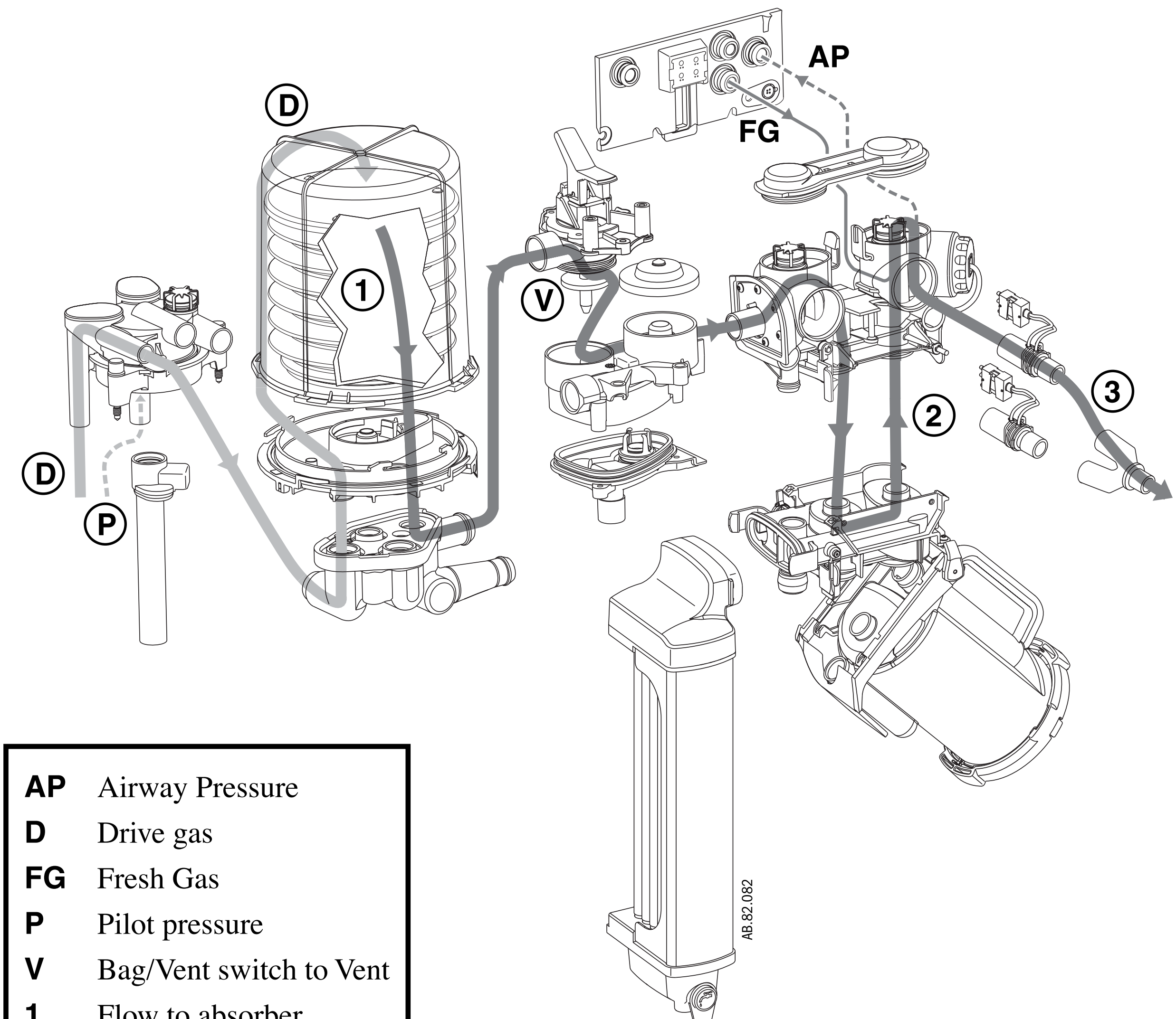
Figure 2-43 • Mechanical expiration through Condenser with EZchange Canister and Condenser ON

Mechanical inspiration (EZchange and condenser OFF)

The Bag/Vent switch closes the manual path (**V**). Pilot pressure (**P**) closes the exhalation valve.

Drive gas (**D**) pushes down on the bellows. Gas flows from the bellows (**1**), through the EZchange module bypassing the absorber (**2**), and through a unidirectional valve (inspiratory check valve) to the patient (**3**).

During inspiration, fresh gas flows into the inspiratory limb, upstream of the inspiratory check valve.



AP	Airway Pressure
D	Drive gas
FG	Fresh Gas
P	Pilot pressure
V	Bag/Vent switch to Vent
1	Flow to absorber
2	Bypass flow
3	Inspiratory flow

Figure 2-44 • Mechanical inspiration with EZchange Canister and Condenser OFF

Mechanical expiration (EZchange and condenser OFF)

Drive-gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient (**4**), through a unidirectional valve (expiratory check valve) and into the bellows (**5**). Residual drive gas (**D**) flows out of the bellows to the scavenging system (**6**).

If PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level.

During exhalation, fresh gas flows backwards through the EZchange module (**FG**) into the expiratory limb, downstream of the expiratory check valve.

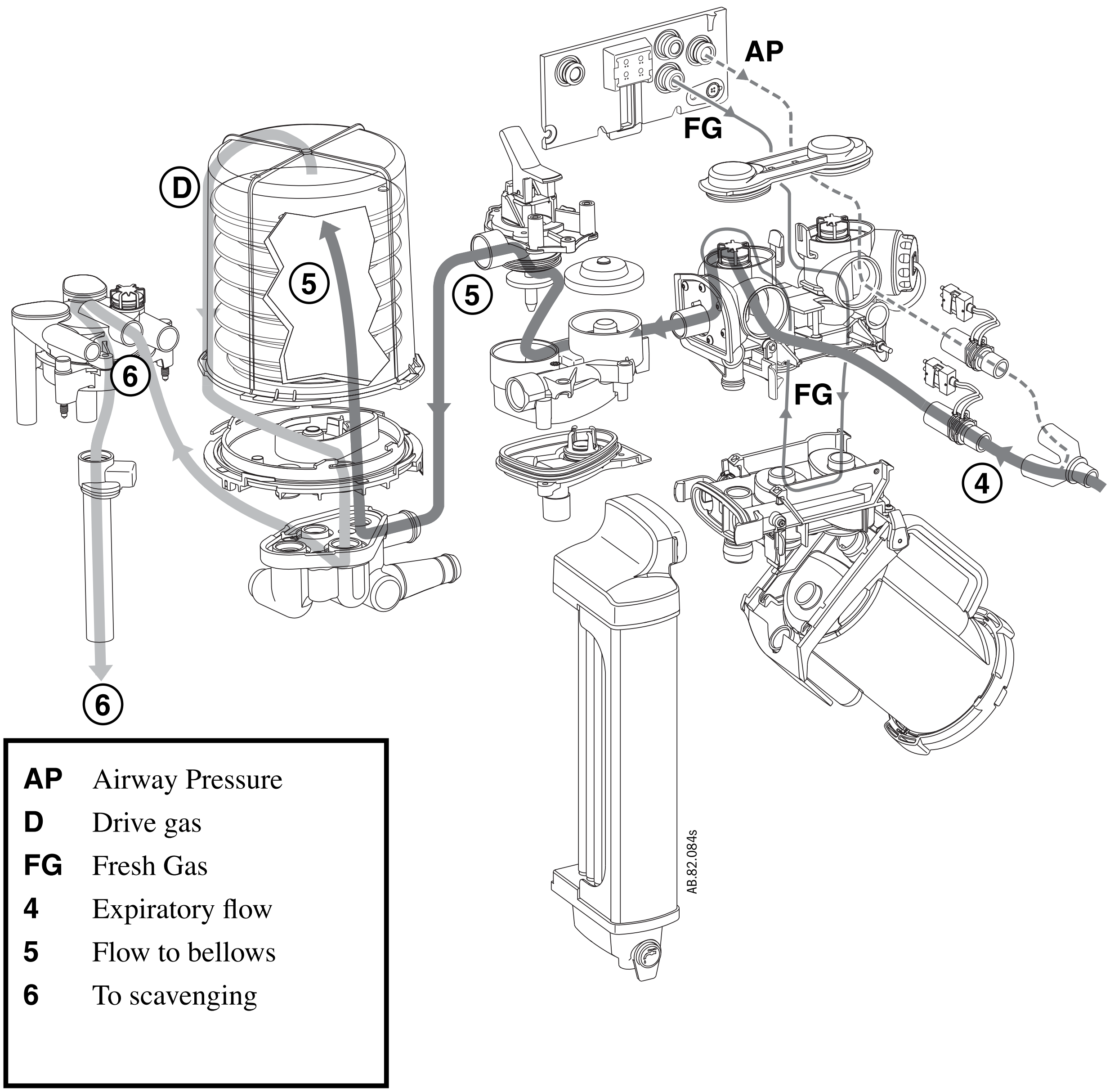
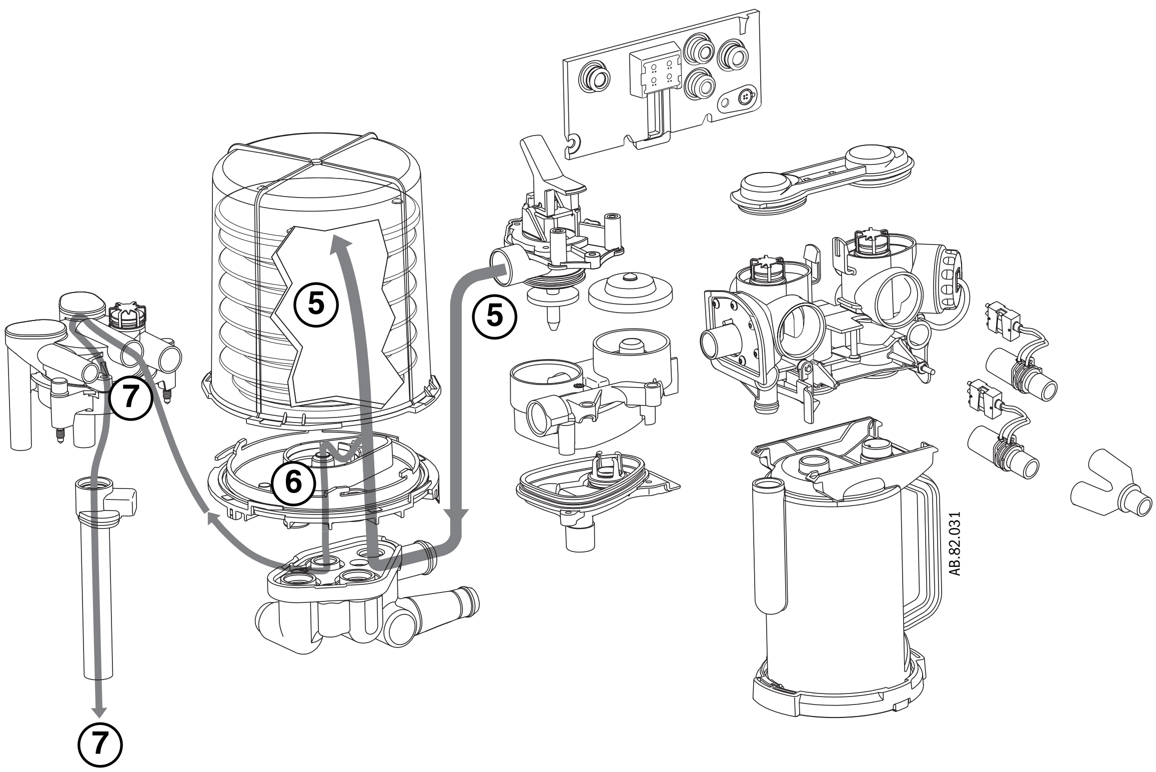


Figure 2-45 • Mechanical expiration with EZchange Canister and Condenser OFF

Pop-off valve The pop-off valve limits the pressure inside the bellows to 2.5 cm H_2O above the drive-gas pressure. This normally occurs when the bellows reaches the top of the housing at the end of exhalation (**5**).

Excess gas (**6**) vents to the scavenging system (**7**) through the pop-off valve and the exhalation valve.



5	Flow to bellows
6	Pop-off flow
7	To scavenging

Figure 2-46 • Flow through the pop-off valve

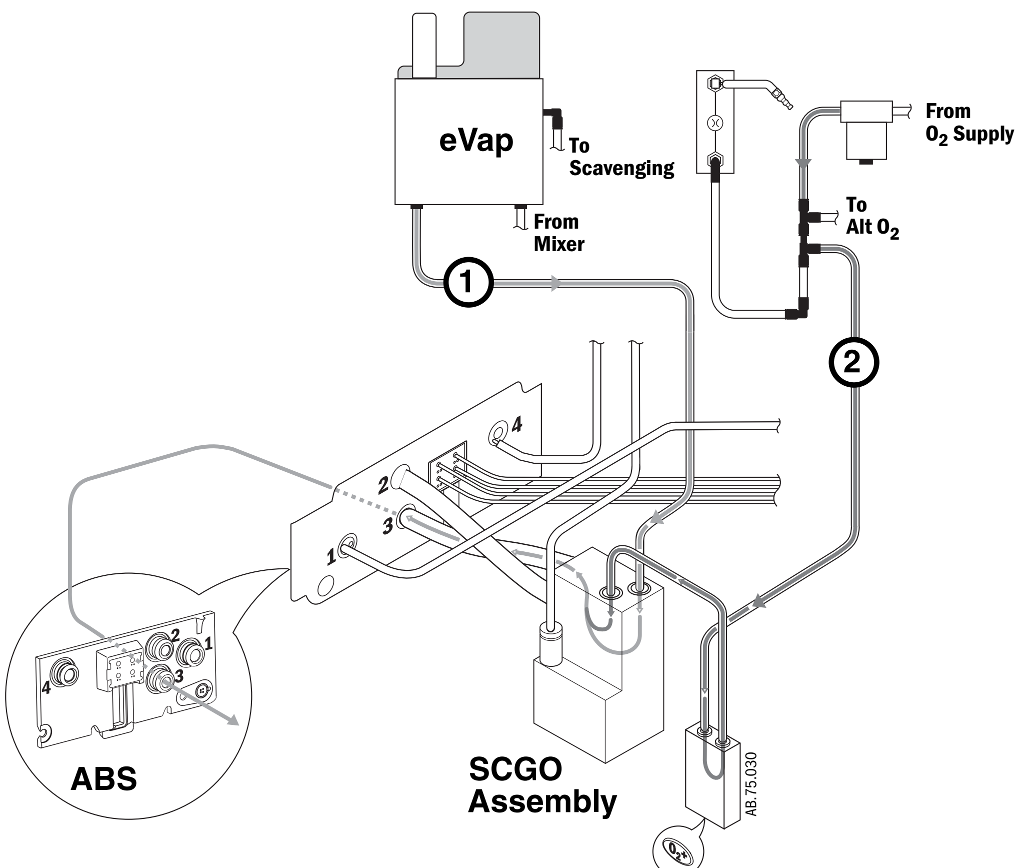
2.12.4 Fresh gas and O_2 flush flow (with SCGO)

To ABS (Circle) breathing system

Fresh gas (**1**) flows from the electronic vaporizer (**eVap**) to the SCGO assembly.

With the Circle system selected, fresh gas flow is channeled to Port 3 of the breathing system (before the inspiratory check valve).

The output of the O_2 Flush regulator (**2**) is channeled to the O_2 Flush valve. When activate, O_2 flush flow joins the fresh gas flow in the SCGO assembly.



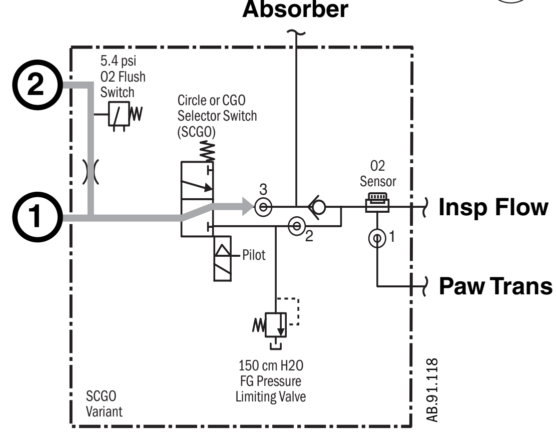


Figure 2-47 • Fresh gas and O_2 flush flow (to ABS)

Switched (Non-circle) Common Gas Outlet

Fresh gas (**1**) flows from the electronic vaporizer (**eVap**) to the SCGO assembly.

With the Non-Circle system selected, fresh gas flow is channeled to Port 2 of the breathing system (after the inspiratory check valve - to an external patient circuit through the Inspiratory port).

The output of the O_2 Flush regulator (**2**) is channeled to the O_2 Flush valve. When activated, O_2 flush flow joins the fresh gas flow in the SCGO assembly.

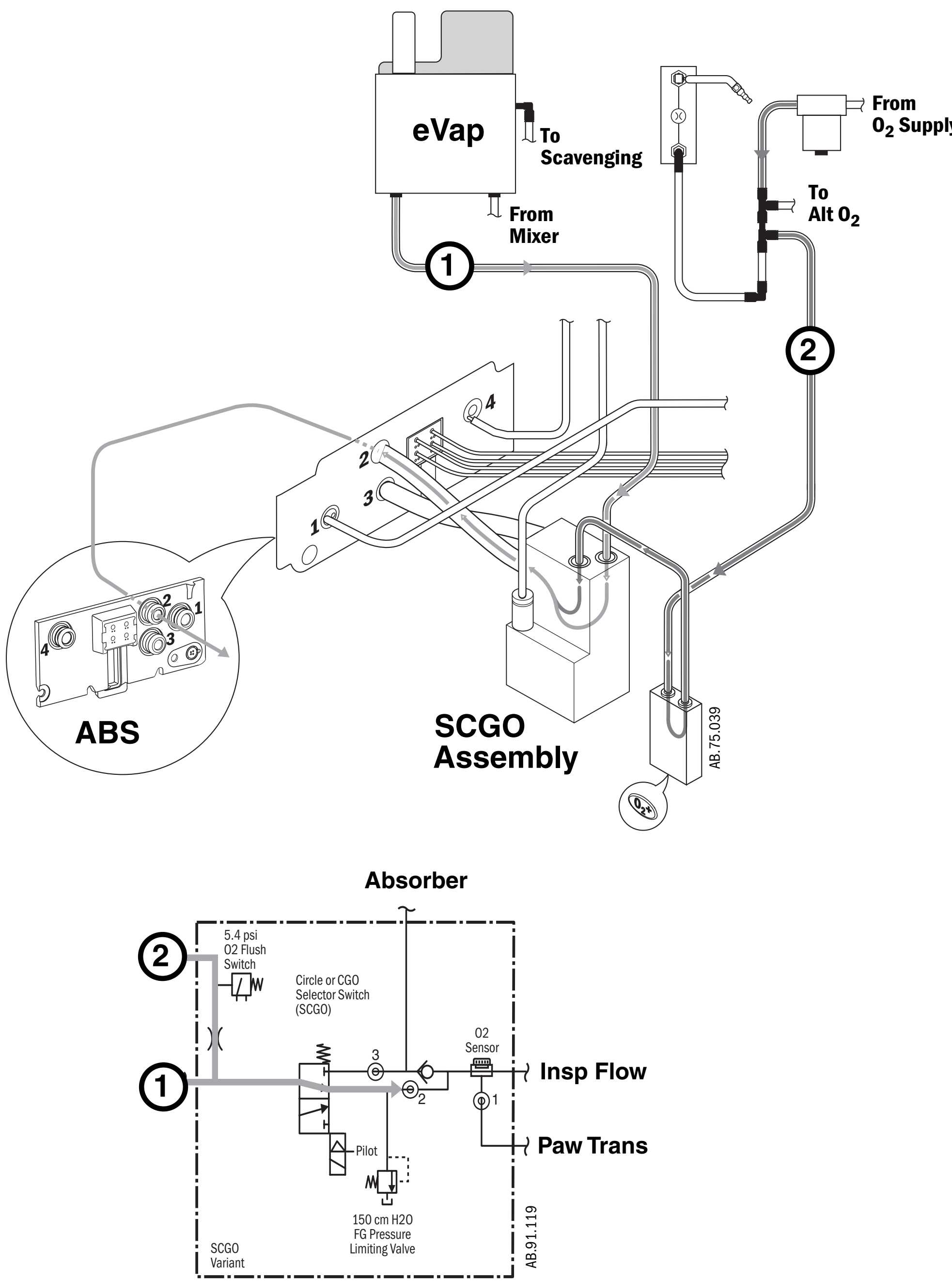


Figure 2-48 • Fresh gas and O_2 flush flow (to Insp port)

2.12.5 Fresh gas and O_2 flush flow (with ACGO)

To ABS (Circle) breathing system

Fresh gas (**1**) flows from the electronic vaporizer (**eVap**) to the ACGO Selector Switch.

With the ACGO Selector Switch in the ABS position, fresh gas flow is channeled to the breathing system through port 3.

The output of the O_2 Flush regulator (**2**) is channeled to the O_2 Flush valve.
When activate, O_2 flush flow joins the fresh gas flow in the ACGO Selector Switch.

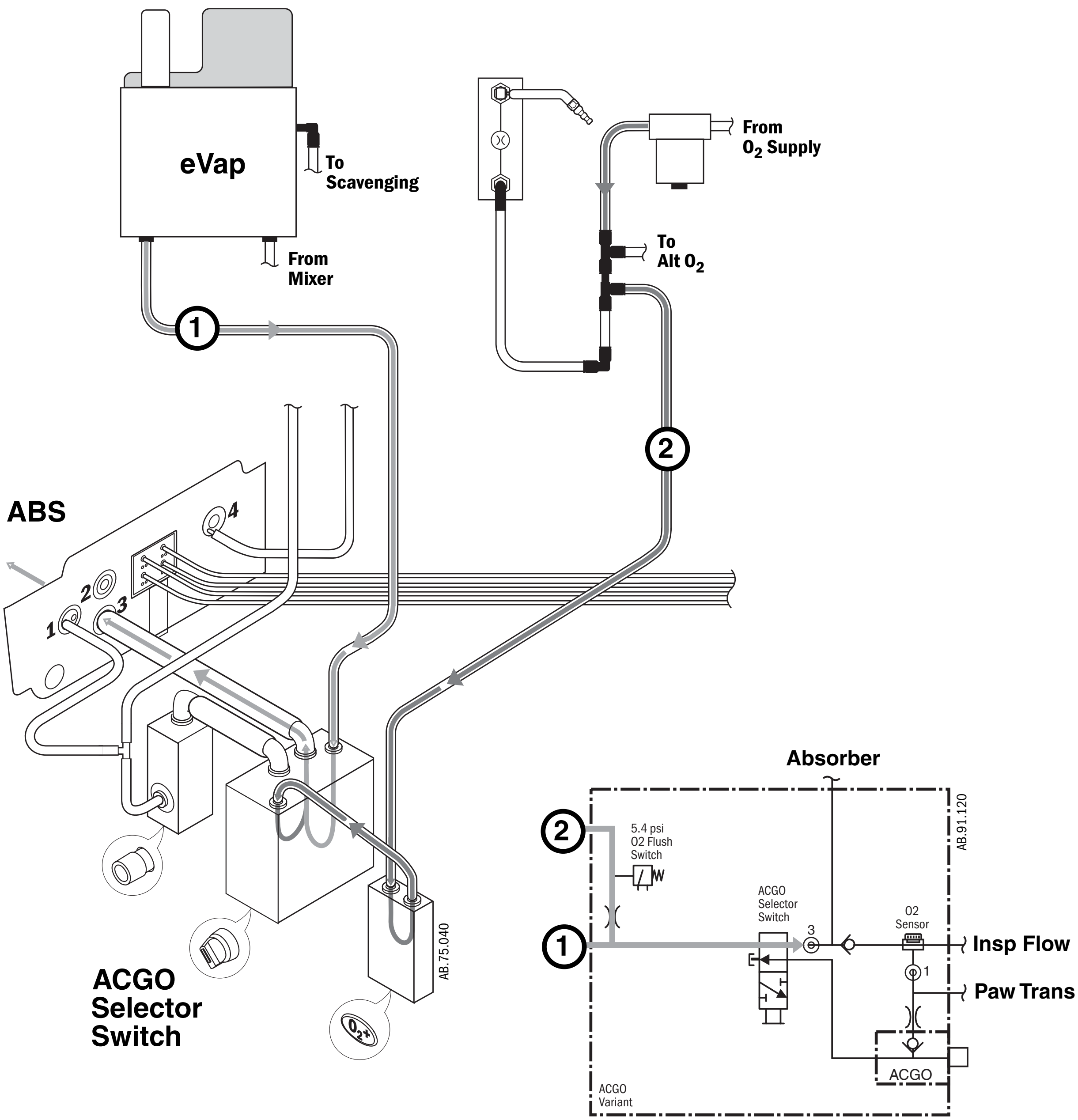


Figure 2-49 • Fresh gas and O_2 flush flow (to ABS)

Auxiliary (Non-circle) Common Gas Outlet

Fresh gas (**1**) flows from the electronic vaporizer (**eVap**) to the ACGO Selector Switch.

With the ACGO Selector Switch in the ACGO position, fresh gas flow is channeled to the ACGO outlet.

At the ACGO outlet, a small sample is diverted to the O_2 Cell in the ABS for O_2 monitoring.

The output of the O_2 Flush regulator (**2**) is channeled to the O_2 Flush valve.
When activated, O_2 flush flow joins the fresh gas flow in the ACGO Selector Switch.

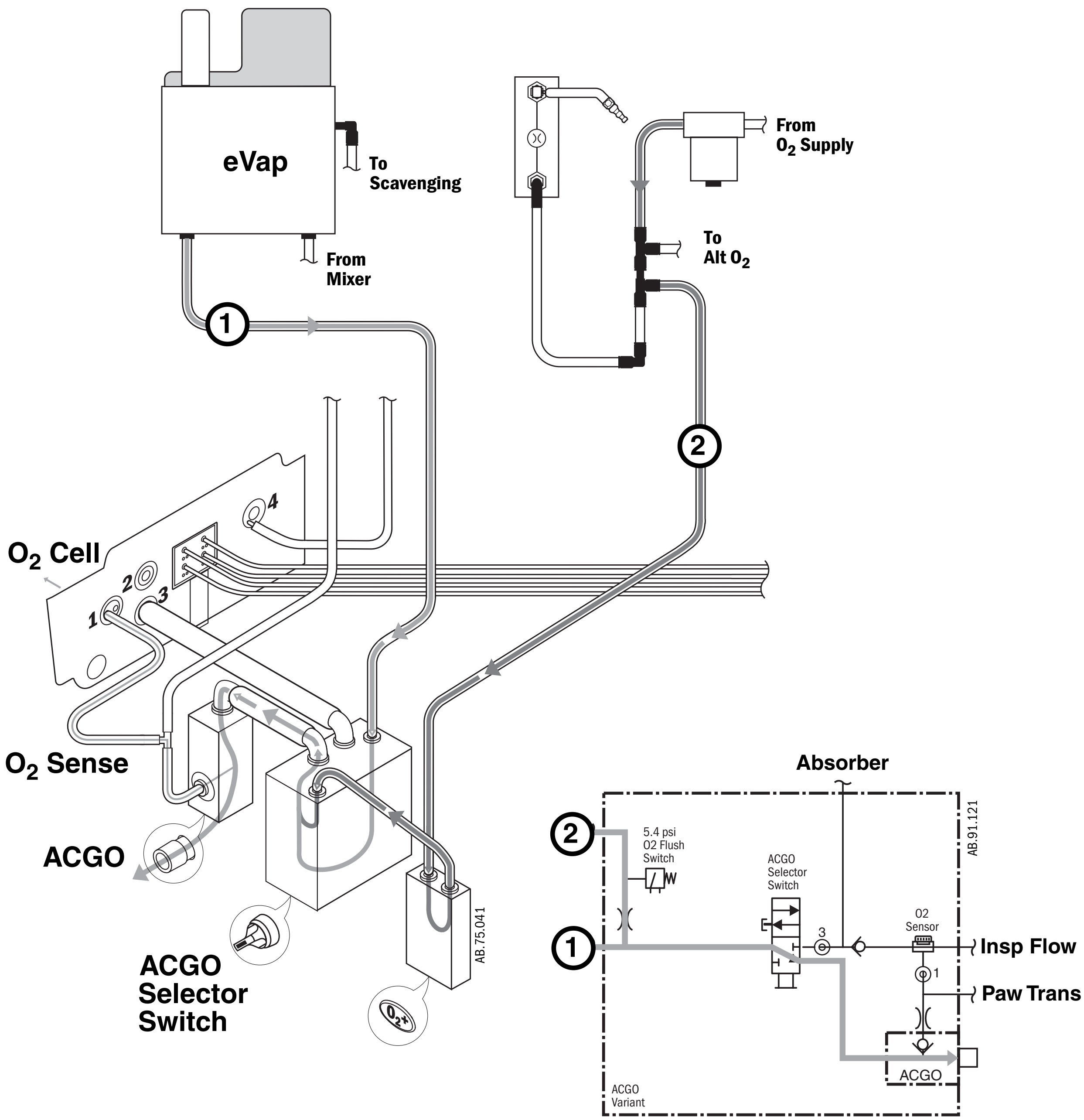


Figure 2-50 • Fresh gas and O_2 flush flow (to ACGO)

2.13 Ventilator

The ventilator components in the Aisys CS2 system are electronically-controlled and pneumatically-driven.

- Sensors in the breathing circuit are used to control and monitor patient ventilation and measure inspired oxygen concentration. This lets the ventilator compensate for compression losses, fresh gas contribution, valve and regulator drift, and small leakages in the breathing absorber, the bellows, and the system.
- Positive End Expiratory Pressure (PEEP) is regulated electronically. During mechanical ventilation the software maintains the set airway pressure. PEEP is not active when mechanical ventilation is off.
- User settings and microprocessor calculations control breathing patterns. User interface settings are kept in non-volatile memory.
- Mechanical ventilation is started with the Bag/Vent switch on the breathing system.
- Ventilator hardware is regularly monitored by software tests.
- An RS-232 serial digital communications port connects to and communicates with external devices.
- An exhalation valve modulates flow in the pressure mode.
- Pressure and volume modes are selectable by the operator.
- Exhausted drive gas and bellows pressure relief valve gases are mixed and go through the ventilator exhalation valve.
- Exhalation valve block is autoclavable.
- Excess fresh gas released from the bellows and ventilator drive gas is transferred from the exhalation valve to the Anesthesia Gas Scavenging System (AGSS).
- Optimized for service with a low number of components.

2.13.1 Safety features

- Airway overpressure protection linked to Pmax setting.
- Dual redundant, software independent, airway overpressure devices.
- Volume over-delivery limits and protection.
- Proprietary hose connections and fixed manifolds.
- 10 VA electrical power limiting to potential oxygen enriched environment.
- 150 psi burst overpressure protection.

2.14 Ventilator mechanical subsystems

Refer to Figure 11-1, "*System circuit diagram*" in Section11, for the complete pneumatic/mechanical subsystem diagram.

The mechanical subsystems for the ventilator include:

Pneumatic Vent Engine

- Drive gas inlet filter
- Gas inlet valve
- Supply gas pressure regulator
- Flow control valve
- Drive gas check valve
- Mechanical Overpressure Valve (MOPV)
- Bleed resistor
- Free breathing valve

Exhalation valve

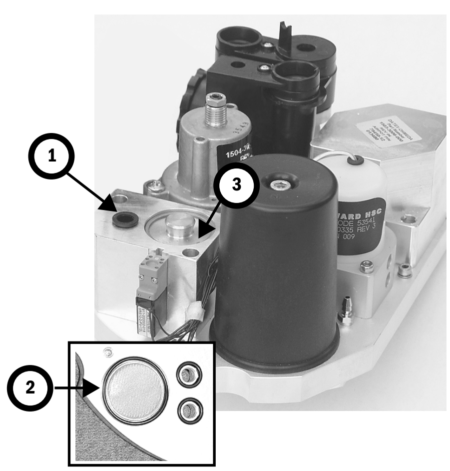
Bellows assembly

Breathing circuit flow sensors

2.14.1 Drive gas filter and Gas Inlet Valve

Drive gas (can be selected from O_2 or Air) enters the Vent Engine (**1**) at a pressure of 241 to 690 kPa (35 to 100 psi) through a 2-micron filter (**2**) that is located under the Gas Inlet Valve (**3**).

During normal operation the Gas Inlet Valve (GIV) is open to let supply gas flow. The GIV shuts off supply gas to the ventilator under failure conditions detected by the CPU or over-pressure switch. The output from the GIV stays at the filtered supply gas pressure.



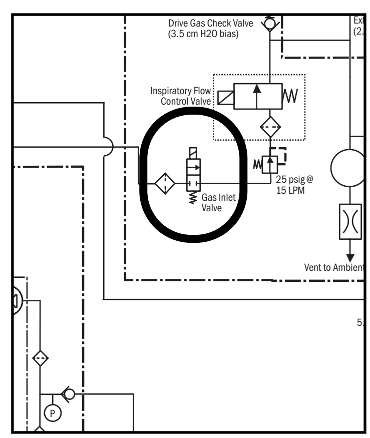


Figure 2-51 • Inlet filter and Gas Inlet Valve (GIV)

2.14.2 Pressure regulator

The pressure regulator (**4**) is a non-relieving pressure regulator that regulates high pressure filtered supply gas down to 172 kPa (25 psi).

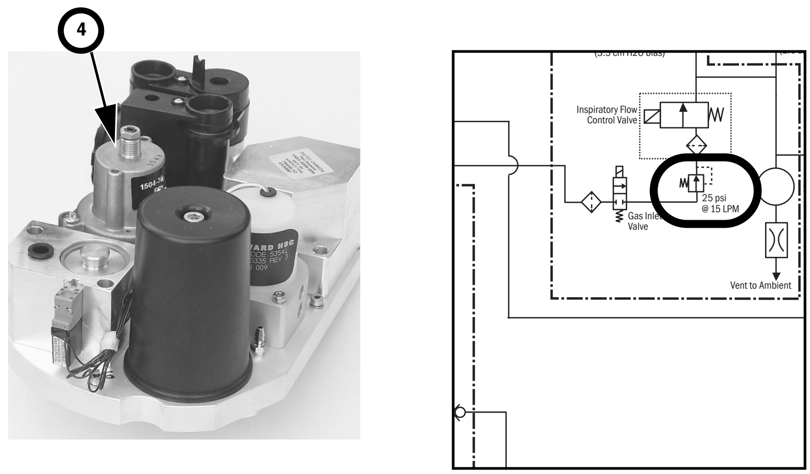


Figure 2-52 • Pressure regulator

2.14.3 Flow control valve

The flow control valve (**5**) is controlled by the CPU. Signals are sent to the flow control valve of the necessary flow determined by ventilator settings and sensor signals. The flow control valve modulates the incoming 172 kPa (25 psi) drive gases to an output from 0 to 120 liters per minute at pressures ranging from 0 to 100 cm H_2O.

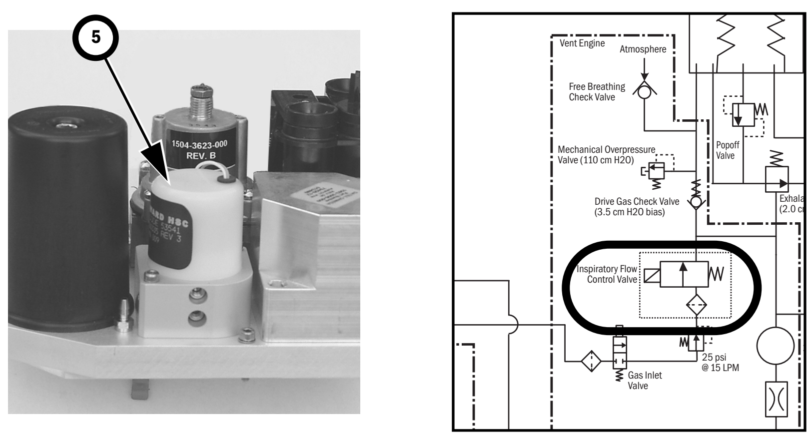
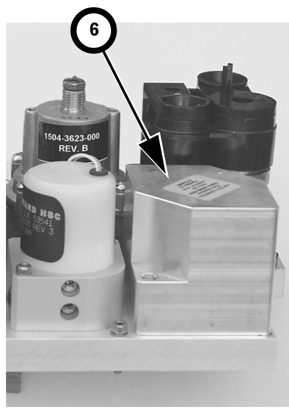


Figure 2-53 • Flow control valve

2.14.4 Drive Gas Check Valve (DGCV)

The Drive Gas Check Valve (**6**) is used downstream of the flow control valve to create the pilot pressure for closing the exhalation valve during inspiratory phases. The DGCV is biased shut by an integral weight that supplies approximately 3.5 cm H_2O of bias pressure before permitting flow downstream to the bellows assembly. When the ventilator is exhausting flow from the breathing circuit, the DGCV permits the exhalation valve pilot pressure to be de-coupled from the circuit pressure. This permits the exhalation valve to open and lets gas flow to the exhaust and the gas scavenging system.



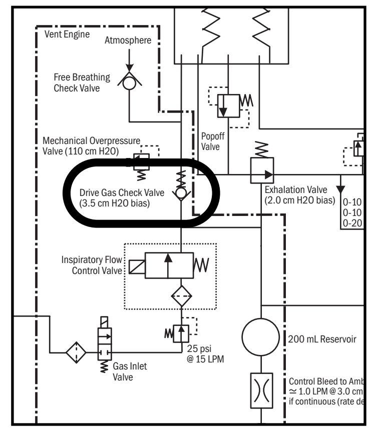


Figure 2-54 • Drive Gas Check Valve

2.14.5 Bellows Pressure Relief Valve

The Bellows assembly is the interface between drive gas and patient gas in the breathing system. The pressure relief valve (or pop-off valve) in the bellows assembly (**7**) controls the pressure in the breathing circuit and exhausts excess patient gas through the exhalation valve.

The pressure relief valve is normally closed, maintaining approximately 1.5 cm H_2O in the breathing circuit in a no-flow condition, enough to keep the bellows inflated. It is piloted closed during inspiration and remains closed until the bellows is refilled during exhalation. It will exhaust ≤ 4 l/min excess fresh gas flow at ≤ 4 cm H_2O.

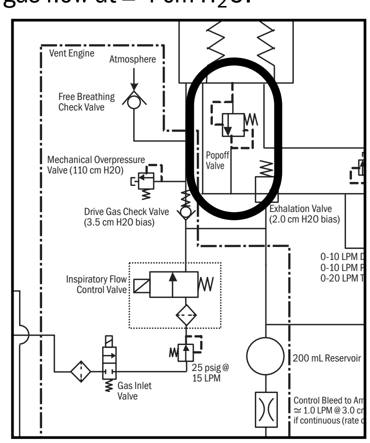


Figure 2-55 • Bellows pressure relief valve

2.14.6 Exhalation valve

The exhalation valve contains an elastomeric diaphragm that is used along with the flow valve to control the pressures in the breathing circuit. The exhalation valve includes two male ports on the bottom for:

- Bellows drive gas (**8**)
- Exhalation valve pilot (**9**) - (manifold pressure)

The exhalation valve includes three ports on top that connect to the bellows base manifold:

- Drive gas pass through (**10**)
- Drive gas return and pop-off valve flow (**11**)
- APL exhaust flow to scavenging (**12**)

A port at the back of the exhalation valve (**13**) connects to the down tube that directs all the exhaust flows to the scavenging receiver.

The exhalation valve is normally open. Approximately 2 cm H_2O of pilot pressure is necessary to close the valve. When the exhalation port is open, gas flows from the bellows housing to the scavenging port.

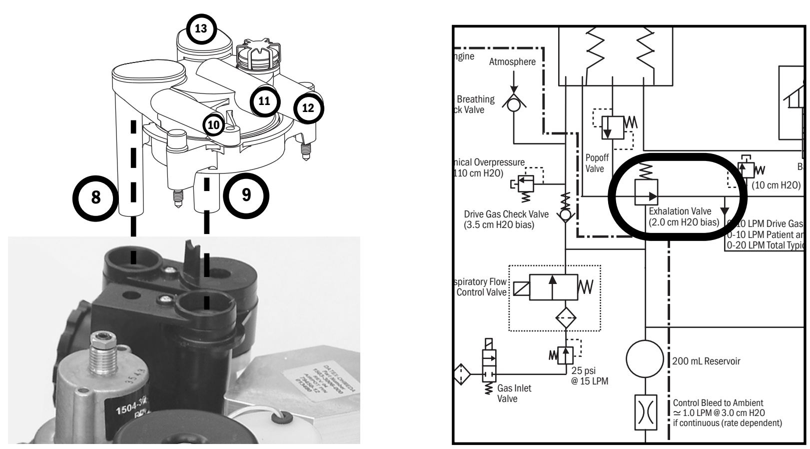


Figure 2-56 • Exhalation valve

2.14.7 Mechanical Overpressure Valve

The Mechanical Overpressure Valve (MOPV) is a mechanical valve (**14**) that operates regardless of electrical power. It functions as a third level of redundancy to the ventilator's pressure limit control functions, supplying pressure relief at approximately 110 cm H_2O.

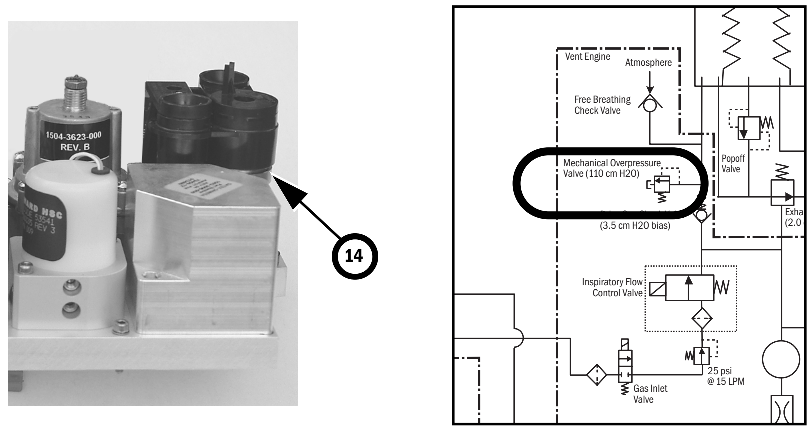


Figure 2-57 ▪ Mechanical overpressure valve

2.14.8 Reservoir and bleed resistor

The reservoir (**15**) is a 200 ml chamber that dampens the manifold (pilot) pressure pulses to the exhalation valve.

The bleed resistor (**16**) is a “controlled leak” from 0 to 12 l/min in response to circuit pressures from 0 to 100 cm H_2O. The small quantity of pneumatic flow exhausting through the bleed resistor permits control of the exhalation valve's pilot pressure by modulation of the valve output. The bleed resistor exhausts only clean drive gas and must not be connected to a waste gas scavenging circuit. The output is routed away from the electrical components to make sure that systems using oxygen drive gas meet the 10VA limitation requirement for oxygen enrichment.

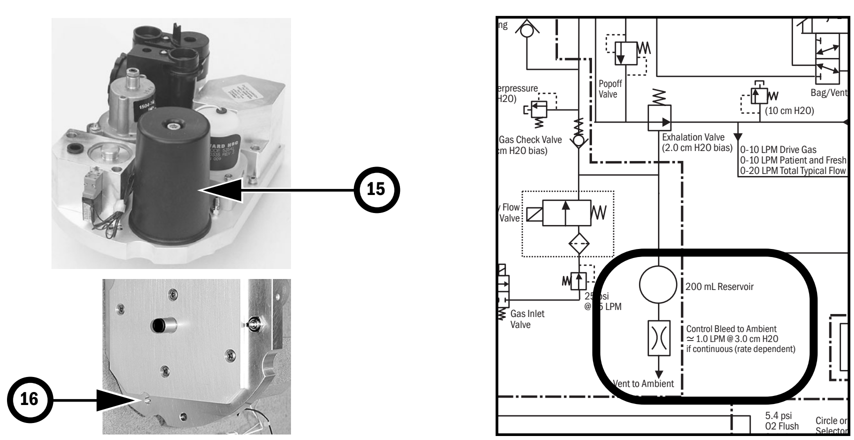


Figure 2-58 ▪ Reservoir and bleed resistor

2.14.9 Free breathing valve

The free breathing valve (**17**) helps assure the patient can spontaneously breathe. The ventilator is programmed to supply a specified number of breaths per minute to the patient in non-spontaneous modes (VCV, PCV). If, between one of these programmed cycles, the patient needs a breath (spontaneous), the free breathing valve permits the patient to inhale. The free breathing valve is closed on mechanical inspiration.

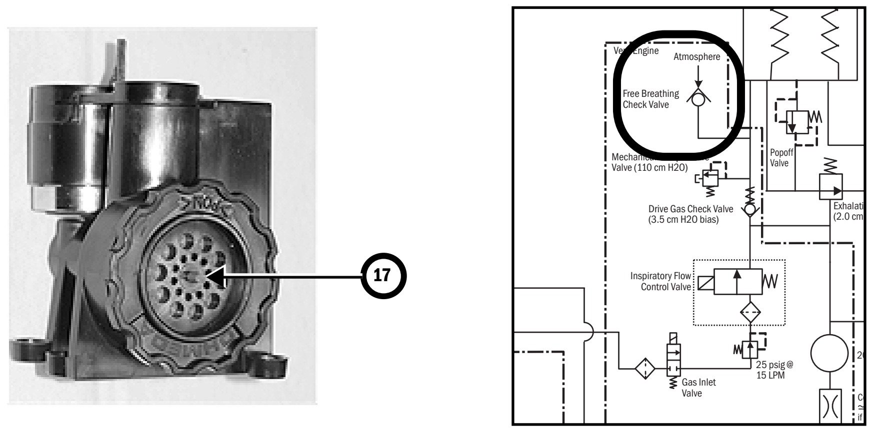


Figure 2-59 • Free breathing valve

2.14.10 Breathing circuit flow sensors

Two flow sensors are used to monitor inspiratory and expiratory gas flow:

- The inspiratory flow sensor is downstream of the breathing system inspiratory check valve.
- The expiratory flow sensor is located at the input to the breathing system expiratory check valve.

Feedback from both the inspiratory and expiratory transducers is used to:

- supply tidal volumes that make allowances for the effects of fresh gas flow and circuit compressibility.
- supply signals for expiratory tidal volume monitoring and the breath rate.

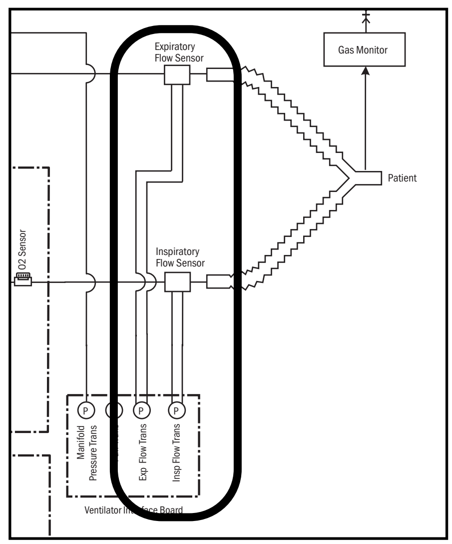


Figure 2-60 • Flow sensors

Notes

3 Checkout Procedure

In this section

⚠ **WARNING** After any repair or service of the Aisys CS2 system, complete all tests in this section.

Before you do the tests in this section:

- Complete all necessary calibrations and subassembly tests. Refer to the individual procedures for a list of necessary calibrations.
- Completely reassemble the system.

If a test failure occurs, make appropriate repairs and test for correct operation.

3.1 Inspect the system

⚠ **CAUTION** The upper shelf weight limit is 34 kg (75 lb).

⚠ **WARNING** Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

Before testing the system, ensure that:

- The equipment is not damaged.
- Components are correctly attached.
- The breathing circuit is correctly connected, not damaged.
- Pipeline gas supplies are connected.
- Cylinder valves are closed.
- Scavenging is connected and adjusted properly if needed.
- Models with cylinder supplies have a cylinder wrench attached to the system.
- Models with cylinder supplies have a reserve supply of O_2 connected to the machine during system checkout.
- The casters are not loose and the brakes are set and prevent movement.
- The power cord is connected to a wall outlet. The mains indicator comes on when AC Power is connected.
- Proper adjustment of the display arm for movement and maneuverability (Section 9.27).
  - Counterbalance of the display arm
  - Side to side movement of displays
  - Tilt position of the displays

3.1.1 Verify annunciators

The Aisys CS2 system includes several annunciators (speakers) that produce audible tones in response to system alarms and other hardware or software fault conditions. Verify the integrity of the annunciators at system startup.

1. Set the System switch to On.
   - Verify that an audible “beep” is heard immediately after the System switch is turned to On (Power Controller Board).
2. After several seconds into power-up:
   - Verify that a second audible “beep” is heard (Anesthesia Control Board).
3. Before the power-up is completed:
   - Verify that a third and fourth audible “beep” is heard from the Display Unit.

If any of the audible “beeps” are not heard, troubleshoot the related circuitry before continuing with the checkout procedure.

3.2 System checkout overview

The Checkout menu is displayed:

- when the system boots up,
- when the Checkout softkey is selected,
- or when Checkout History is selected from the System Setup menu.

Full Test

The **Full Test** is a series of individual tests run in succession. The test runs automatically and beeps to indicate when it is finished or if user interaction is required.

The individual tests performed by Full Test include the **Vent and Gas** test, **Circuit Leak** test, and **Circuit O2 Cell** test if a circuit O_2 cell is installed.

When one test completes, the next test begins. Once the tests have completed and the tests end with an outcome of pass,

- the ***External Gas Monitor Reminder Pane*** is displayed (if ***External Gas Monitor*** is set to ***Yes*** in Super User mode),
- followed by the ***Daily Reminders Pane***.

3.2.1 Individual Tests

Vent and Gas test

The **Vent and Gas** test is an automated two-stage test that checks agent delivery, the airway module, theBag/Vent switch, proper gas supply pressures, ventilator operation and leak, battery and electrical power, circuit compliance, and flow control operation.

Circuit Leak test

The **Circuit Leak** test is an automated test that checks the Bag/Vent switch, proper gas supply pressures, airway pressure measurement transducer, APL valve, and manual circuit leak. The test checks the Alt O_2 flow to ensure the flow is greater than 400 ml/min.

Circuit O2 Cell test

The **Circuit O2 Cell** test is a manual test that displays measured O_2%. If measured circuit O_2 does not stabilize at 21%, calibration is recommended.

3.2.2 Optional Tests

Low P Leak test on a SCGO equipped system

The **Low P Leak** test is not performed as part of the Full Test. This test is used to aid in troubleshooting if the Vent and Gas test fails.

In **SCGO equipped systems**, the Low P Leak test is automated positive pressure test that measures machine leaks before the breathing system, between the common gas outlet and the high-pressure pneumatics and includes the gas mixer and vaporizer. The test measures low pressure pneumatic leaks with a pass or fail limit of 50 ml.

Low P Leak test on an ACGO equipped system

The **Low P Leak** test is not performed as part of the Full Test. This test is used to aid in troubleshooting if the Vent and Gas test fails.

In **ACGO equipped systems**, the Low P Leak test is a manual negative pressure test that measures machine leaks before the breathing system, between the common gas outlet and the high-pressure pneumatics and includes the gas mixer and vaporizer. The test measures low pressure pneumatic leaks with a pass or fail limit of 50 ml.

Agent delivery

The agent delivery test checks the agent delivery systems and the cassette. This check releases agent to the circuit.

Any cassette may be used during the test. Use a non-desflurane cassette during the test to check the full functionality of the internal electronic control unit.

3.2.3 Test outcomes

The final result of a check will be: “OK”, “Fail”, or the result will be a line of highlighted text that will describe a “Conditional Pass”.

The “OK” outcome means the check has met result criteria and the user can proceed to the next check.

The “Fail” outcome means the check has not met result criteria and the user will need to correct the issue and repeat the check.

The “Conditional Pass” is a line of highlighted text that is displayed next to the check, which describes a detected event that is not a failure, but allows the user to accept the condition described and proceed.

3.3 System checkout procedure

To display the Checkout menu select the Checkout softkey on the Button Bar or select Checkout History on the System Setup menu.

1. Connect scavenging.
2. Open and close thecylinders.
3. Connect a patient circuit.
4. Check the absorber and the absorbent.
5. Select a test form the menu.
6. Complete instructions and start the test.
7. Automatic test beeps if action is required.

3.3.1 Full Test

The Full Test runs automatically and beeps to indicate when it is finished or if user interaction is required.

The ***Full Test*** does a:

- ***Vent and Gas*** check (Ventilator Circuit),
- ***Circuit Leak*** check (Bag Circuit),
- and a ***Circuit O2 Cell*** check (if circuit O_2 cell is present).

1. Select ***Full Test*** and follow the instructions on the screen.
2. If a check fails, follow the instructions to perform a recheck or accept the results.

Full Test - Vent and Gas (Ventilator Circuit testing)

The ***Full Test - Vent and Gas*** checks agent delivery, the airway module, the Bag/Vent switch, proper gas supply pressures, ventilator operation and leak, battery and electrical power, circuit compliance, flow control operation, and vaporizer operation.

This test is performed in two stages.

Stage 1

1. Set the Bag/Vent switch to Vent.
2. Open the patient wye.
3. (ACGO option only) Set the ACGO switch to Circle.
4. Calibrate (remove, reinsert, latch) flow sensors.
   - Wait for “NO INSP/EXP FLOW SENSOR” messages to appear.
5. Select ***Start***.
6. Test runs automatically. Beeps when done.

The display shows the checks being run and the results.

Stage 2

1. Make sure the bellows is fully collapsed.
2. Occlude the patient wye.
3. Select ***Continue***.

The display shows the checks being run and the results.

When the check passes, the system will transition to the next step.

Full Test - Circuit Leak (Bag Circuit testing)

The ***Full Test - Circuit Leak*** checks the Bag/Vent switch, proper gas supply pressures, airway pressure measurement transducer, APL valve, and manual circuit leak.

1. Occlude the patient wye.
2. Set Bag/Vent switch to Bag.
3. Set the APL valve halfway between 30 and 70.
4. (ACGO option only) Set the ACGO switch to Circle.
5. Select ***Start***.
6. Test runs automatically. Beeps when done.

The display shows the checks being run and the results.

When the check passes, the system will transition to the next step.

Full Test - Circuit O2 Cell

This check only appears if a machine circuit O_2 cell is connected.

Note: An Air supply is required to complete this test.

The ***Full Test - Circuit O2 Cell*** check displays the measured O_2%.

Select Done when the measured circuit O_2% is stable.

1. Open the patient wye.
2. Set the Bag/Vent switch to Vent.
3. (ACGO option only) Set the ACGO switch to Circle.

The display show the measured O_2%.

Do not select ***Done*** when 21 is first displayed. Allow the reading to stabilize, then select ***Done***. Calibrate the O_2 cell if necessary (measured reading outside 21% ±3%).

Calibration is on the System Setup menu.

Full Test - Monitor

When ***External Gas Monitor*** is set to ***Yes*** by the Super User, the ***Machine Check-Monitor*** reminder occurs. This is not a test. This is a reminder to connect a respiratory gas monitor.

3.4 Individual Tests

Individual tests allow you to perform any combination of single checks. These checks are helpful if there is a specific problem/alarm and you want to test only that portion of the system.

The checks do not automatically move on to the next check.

3.4.1 Vent and Gas

The ***Vent and Gas*** test checks the agent delivery, the airway module, the Bag/Vent switch, proper gas supply pressures, ventilator operation and leak, battery and electrical power, circuit compliance, flow control operation, and vaporizer operation.

Note: This check is performed during the Full Test of the system checkout.

Stage 1

1. Set the Bag/Vent switch to Vent.
2. Open the patient wye.
3. (ACGO option only) Set the ACGO switch to Circle.
4. Calibrate (remove, reinsert, latch) flow sensors.
   - Wait for "NO INSP/EXP FLOW SENSOR" messages to appear.
5. Select ***Start***.
6. Test runs automatically. Beeps when done.

The display shows the checks being run and the results.

- Bag/Vent Switch
- O2 Pressure
- Ventilator Drive Gas

Stage 2

1. Make sure the bellows is fully collapsed.
2. Occlude the patient wye.
3. Select ***Continue***.

The display shows the checks being run and the results.

- Verify Bellows Emptied
- Circuit Leak*
- Agent Delivery
- Mechanical Vent
- Circuit Compliance
- O2 Flow Control
- Air Flow Control
- N2O Flow Control
- Battery and Elec. Power
- Airway Gas Module

* The Circuit Leak acceptance limits are set in the Service Installation menu (refer to Section 4.4.3).

4. When the check passes, select ***Back***.
5. Select another check or select ***Start Case*** to go to the ***Start Case*** menu.

3.4.2 Circuit Leak

The ***Circuit Leak*** test checks the Bag/Vent switch, proper gas supply pressures, airway pressure measurement transducer, APL valve, and manual circuit leak.

Note: This check is performed during the Full Test of the system checkout.

1. Occlude the patient wye.
2. Set Bag/Vent switch to Bag.
3. Set the APL valve halfway between 30 and 70.
4. (ACGO option only) Set the ACGO switch to Circle.
5. Select ***Start***.
6. Test runs automatically. Beeps when done.

The display shows the checks being run and the results.

- Bag/Vent Switch
- O2 Pressure
- Paw Sensor
- Circuit Leak*
- Alternate O2 Flow

* The Circuit Leak acceptance limits are set in the Service Installation menu (refer to Section 4.4.3).

7. When the check passes, select ***Back***.
8. Select another check or select ***Start Case*** to go to the ***Start Case*** menu.

3.4.3 Circuit O2 Cell

This check only appears if a machine circuit O_2 cell is connected.

Note: An Air supply is required to complete this test.

The ***Full Test - Circuit O2 Cell*** check displays the measured O_2%.

Note: This check is performed during the Full Test of the system checkout.

1. Open the patient wye.
2. Set the Bag/Vent switch to Vent.
3. (ACGO option only) Set the ACGO switch to Circle.

The display show the measured O_2%.

Do not select ***Done*** when 21 is first displayed. Allow the reading to stabilize, then select ***Done***. Calibrate the O_2 cell if necessary (measured reading outside 21% ±3%).

Calibration is on the System Setup menu.

4. Select another check or select ***Start Case*** to go to the ***Start Case*** menu.

3.4.4 Low P Leak test on a SCGO equipped system

⚠ **WARNING** Do not use a system with a low-pressure leak. Anesthetic gas will go into the atmosphere, not into the breathing circuit.

The positive pressure ***Low P Leak*** check measures machine leaks before the breathing system and between the gas mixer and the common gas outlet. It measures low-pressure pneumatic leaks with a pass or fail limit of 50 ml.

Note: This check is not performed during the Full Test of the system checkout. This test is used to aid in troubleshooting if the Full Test results in a failure.

1. Occlude the inspiratory (right-hand) port.
2. Select ***Start***. The display shows the checks being run and the results.

To exit the test:

- Open the inspiratory port.
- Reconnect the breathing circuit.
- Select Back.

3.4.5 Low P Leak test on an ACGO equipped system

The negative Low P Leak check measures machine leaks before the breathing system and between the gas mixer and the common gas outlet.

Note: This check is not performed during the Full Test of the system checkout. This test is used to aid in troubleshooting if the Full Test results in a failure.

This test requires a non-desflurane cassette.

1. Make sure the ACGO switch is set to ACGO.
2. Attach the squeeze bulb to the ACGO outlet.
3. Squeeze (collapse) the bulb.
4. If the bulb inflates in less than 30 seconds, select ***Fail***.
5. If the bulb remains collapsed, select ***Pass***.
6. Remove the squeeze bulb from the ACGO outlet.
7. Return the ACGO switch to the "Circle" position.

3.4.6 Agent Delivery

The Agent Delivery Check checks the Electronic Vaporization (EV) system.

Note: This check is performed during the Full Test of the system checkout.

1. Insert a test cassette, connect a patient circuit, and connect scavenging.
2. Set the Bag/Vent switch to Vent.
3. (ACGO option only.) Set the ACGO switch to Circle.
4. Occlude the patient wye.
5. Select ***Start***.
6. The display shows the checks being run. The system beeps when the check is done.
7. When the check passes, select ***Back***.
8. Select another check or select ***Start Case*** to go to the ***Start Case*** menu.

3.5 Bellows drop test

Note: This check is not performed during the Full Test of the system checkout. This test is used to aid in troubleshooting if the Full Test results in a failure.

1. End a case.
2. Set the Bag/Vent switch to Vent.
3. Occlude the patient wye.
4. Push the **O2 Flush** button until the bellows is full.
5. After the initial drop, if the bellows falls more than 100 ml/min,
   it has a leak.

3.6 Pipeline and cylinder tests

Cross-Connect and High Pressure Leak test

Ensure the Gas Supply window is visible on the screen.

1. Connect the pipeline supplies one at a time and ensure that the corresponding display indicates pipeline pressure.
2. Disconnect all pipeline supplies.
   a. Open each cylinder valve.
   b. Make sure that each cylinder has sufficient pressure. If not, close the applicable cylinder valve and install a full cylinder.
3. Test the cylinder supplies for a high pressure leak. Make sure that each cylinder has sufficient pressure:
   a. Turn the auxiliary O_2 flow control fully clockwise (no flow).
   b. If equipped, turn off venturi derived suction.
   c. Open each cylinder.
   d. Record the cylinder pressure.
   e. Close each cylinder valve.
   f. Record the cylinder pressure after one minute. If the pressure decreases more than indicated below, there is a leak.

      690 kPa (100 psig) for all gases.

      If a cylinder supply fails this test, install a new cylinder gasket and do this step again.
4. Close all cylinder valves.

⚠ **WARNING** Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

5. Select ***Start Case*** and ***Start Case Now***.

3.6.1 O_2 supply alarm test

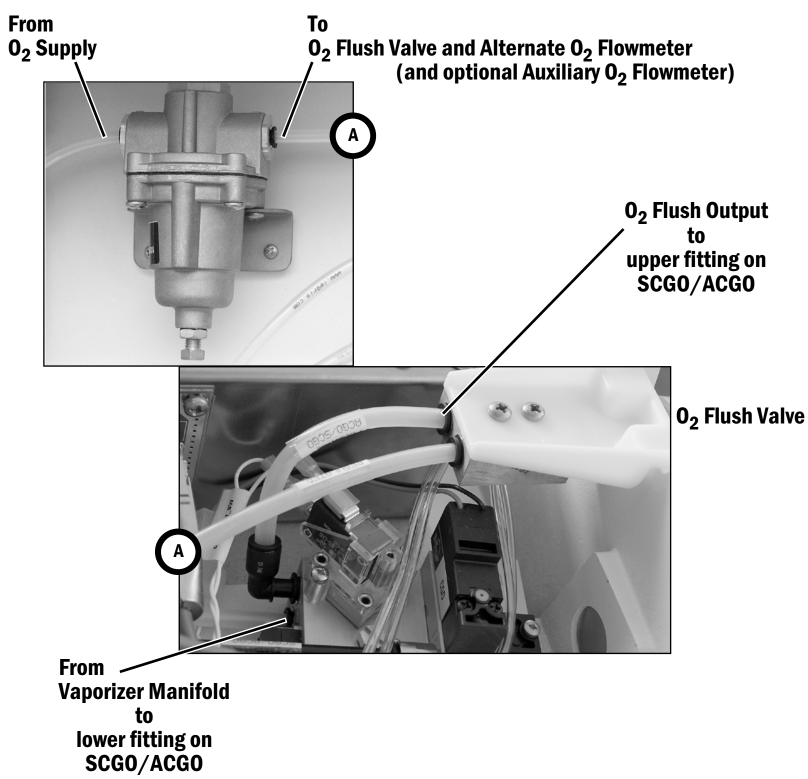
1. Establish O_2, Air, and (if equipped) N_2O gas supplies.
2. Set O_2 to 25% and (if equipped) N_2O as balance gas. For machines without N_2O, set Air as balance gas.
3. Set total flow to 3 L/min.
4. Stop the O_2 supply. (Disconnect the pipeline supply or close the cylinder valve.)
5. Verify that the low “O2 supply pressure low” alarm occurs and the “O2 Supply Fail” popup box appears.
6. Select No to decline “Air Only”. The popup box should close.
7. Verify that the N_2O (if equipped) and O_2 flows drop to zero on the flow indicators.
   - If Air is set as the balance gas, verify that Air continues to flow.
8. Reconnect the O_2 supply.
9. Select ***End Case*** and ***End Case Now***.

3.7 Flush Flow Test

1. With Bag/Vent switch in Bag, verify case has ended.
2. Set the Bag/Vent switch to Vent.
3. Attach a patient circuit and plug the patient port.
4. For ACGO equipped machines, set the ACGO selector switch to Circle.
5. Ensure that the bellows is completely collapsed.
6. Measure the amount of time it takes to fill the bellows when the O_2 Flush button is fully and continuously depressed.
7. Repeat the above measurement two more times (deflate bellows by removing the plug from the patient port).
   - The bellows should fill in 1.8 to 2.3 seconds.

Possible Causes of Failure

- Large leak in breathing system (if long filling time).
- Flush regulator setting (Section 5.2).
- Flush regulator cross-connection (if long filling time).
- SCGO/ACGO selector valve inlet cross-connection (if short filling time).



3.8 Alarm tests

> **NOTE**: If an Airway Gas Module is installed, ***FiO2*** readings are taken from the module instead of the O_2 sensor in the breathing circuit. When using an Airway Gas Module, a sample line must be connected to the patient circuit for testing the O_2 alarms.

1. Connect a test lung to the patient connection.
2. Start a case.
3. Set the Bag/Vent switch to Vent.
4. Set the O_2 concentration to 30%, and allow the O_2 reading to stabilize.
   - For machines configured to individual gas control, set O_2 flow to approximately 500 ml/min and Air flow to approximately 5 l/min.
5. Test the O_2 alarms:
   - Set the ***FiO2 low*** alarm limit to 50%. Make sure an ***FiO2 low*** alarm occurs.
   - Set the ***FiO2 low*** alarm limit to 21% and make sure that the ***FiO2 low*** alarm cancels.
   - Set the ***FiO2 high*** alarm limit to 50%.
   - Push and hold the O_2 flush button.
   - Make sure the ***FiO2 high*** alarm occurs.
   - Release the O_2 flush button.
   - Set the ***FiO2 high*** alarm limit to 100%. Make sure that the ***FiO2 high*** alarm cancels.
6. Test the ***MVexp low*** alarm:
   - Go to the ***Alarm Setup*** menu.
   - Set the ***MV low*** alarm limit to greater than the measured minute volume.
   - Make sure that a ***MVexp low*** alarm occurs.
   - Set the ***MV low*** alarm limit to off.
7. Test the ***Ppeak high*** alarm:
   - Set the ***Pmax*** to less than the peak airway pressure.
   - Make sure that the ***Ppeak high*** alarm occurs.
   - Set the ***Pmax*** to the desired level.
8. Test the ***PEEP high. Blockage?*** alarm:
   - Close the APL valve.
   - Set the Bag/Vent switch to Bag. Mechanical ventilation stops.
   - Block the patient connection and push the O_2 flush button.
   - Make sure that the ***PEEP high. Blockage?*** alarm occurs after approximately 15 seconds.
9. Test the ***Ppeak low. Leak?*** alarm:
   - Unblock the patient connection.
   - Set the Bag/Vent switch to Vent.
   - Set the tidal volume and total flow to minimum.
   - Other alarms such as ***MVexp low*** can occur.
   - Make sure that the ***Ppeak low. Leak?*** alarm occurs.
10. Set all alarm limits to approved clinical values.

3.9 Alternate O_2 flowmeter tests

1. Open the O_2 cylinder valve or connect an O_2 pipeline.
2. Rotate the Alt O_2 flow control fully clockwise to minimum flow.
3. Press the Alternate O_2 switch to turn on Alternate O_2 flow.
   The flowmeter should indicate 0.5 to 0.7 L/min.
4. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
5. Rotate the flow control clockwise to minimum flow.
6. Press the Alternate O_2 switch to turn off Alternate O_2 flow;
   push the ComWheel to confirm yes.

3.10 Auxiliary O_2 flowmeter tests

1. Open the O_2 cylinder valve or connect an O_2 pipeline.
2. Rotate the flow control clockwise (decrease) to shut off the flow. The ball should rest at the bottom of the flow tube and not move.
3. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
4. Occlude the auxiliary O_2 outlet. The ball should rest at the bottom of the flow tube and not move. A ball that does not rest at the bottom of the flow tube indicates a leak and requires service.
5. Rotate the flow control clockwise to shut off the flow.

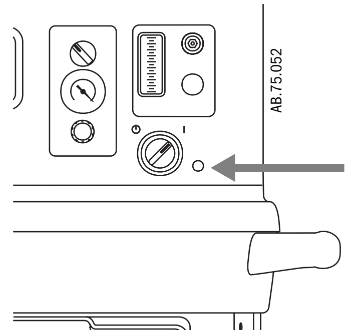
3.11 Integrated Suction Regulator tests

The gauge needle should come to rest within the zero range bracket when no suction is being supplied. Gauges which do not comply may be out of calibration.

1. Adjust the regulator setting to minimum.
2. Turn the mode selector to I (On).
3. Ensure the gauge remains less than 200 mmHg (26 kPa, 0.26 Bar).
4. Occlude the inlet.
5. Ensure the gauge remains less than 200 mmHg (26 kPa, 0.26 Bar).
6. Adjust the regulator in an increasing vacuum level.
7. The gauge should rise after rotation has begun. The gauge should rise with continued rotation of the regulator adjustment.
8. Adjust the regulator setting to minimum.
9. Turn the Mode selector to O (Off).

3.12 Power failure test

1. Connect the power cord to a wall outlet. The mains indicator on the front panel comes on when AC Power is connected.



2. Set the system switch to On and Start a case.
3. Unplug the power cord with the system turned on.
4. Make sure that the power failure alarm comes on.
5. Make sure the following message is displayed:
   - Plug in power cable. On battery
6. Connect the power cable again.
7. Make sure the alarm cancels.

3.13 Electrical safety tests

Make sure the system is completely assembled and all accessory devices are connected to electrical outlets.

1. Connect an approved test device (for example; UL, CSA, or AAMI) and verify that the leakage current is less than:

Voltage	**Max. Leakage Current**
120/100 Vac	300 μAmps
220/240 Vac	500 μAmps

2. Make sure that the resistance to ground is less than 0.2Ω between an exposed metal surface and the ground pin on the power cord.

Notes

4 Installation and Service Menus

In this section

4.1 Installation and Service menu structure

This section describes the Service level functions that are part of the main software installed in the anesthesia machine.

Section 8, "*Software Download*," covers the functions of the USB Flash Drive used to download system software.

Section 12, "*Service Application*," covers a separate, Windows based service application used to run service diagnostics and other service tests.

Menu structure

The Service menu structure has two levels which are password protected:

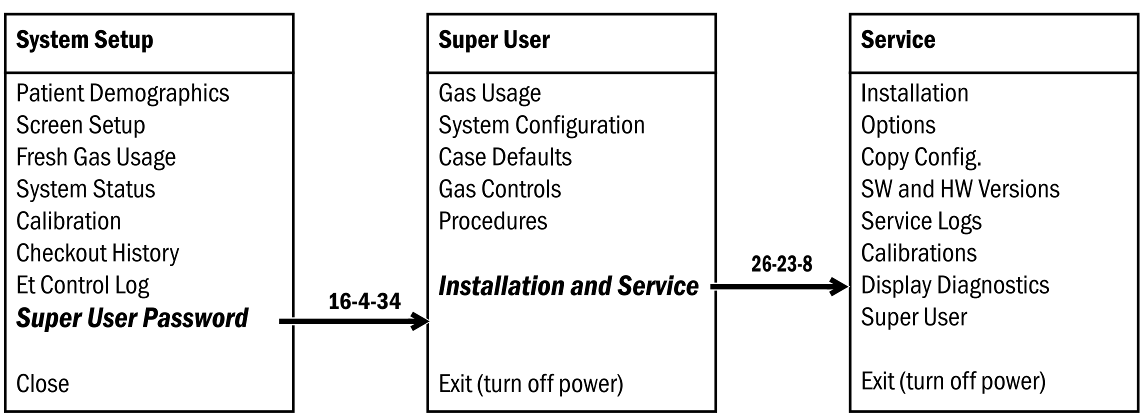
- Super User
  (refer to the User's Reference Manual for "*Super User Mode*" details)
- Installation and Service

The **Super User** level (super-user password) supports standard hospital system cofigurations.

The **Installation and Service** level requires the service password and supports machine configurations, enabling software options, service calibrations and display diagnostics.

Follow the menu structure to access the various service screens:

- on the **System Setup** menu, select **Super User** (with super-user password)
- on the **Super User** menu, select **Installation and Service** (with service password).



4.2 Super User

Use the super-user password to access the Super User menus: “16-4-34.”

The Super User menus support the selection of default hospital preferences for the anesthesia machine. Refer to the User’s Reference Manual for a detailed description of the Super User functions.

Menu Item	**Functions**
Gas Usage	Cumulative Gas Usage; ecoFLOW*; Agent Costs*
System Configuration	Colors; Units; Ventilator Settings; Alarm Settings; Parameter Settings; Trend Setup; Pages Setup
Case Defaults	ADULT; PEDIATRIC; LOCAL; CUSTOM 1; Volume Apnea Setup
Gas Controls	Presets: - O2%; Total Flow; O2% and Total Flow; Agents Fresh Gas Controls: - O2%
Procedures	Vital Capacity: Cycling
Installation and Service	Installation and service mode is restricted to qualified, trained technicians.
Exit	To exit, turn the power switch OFF. Any setting changes go into effect when you turn the system back On.

* "ecoFLOW" and "Agent Costs" are only displayed if the ecoFLOW option is installed (Section 4.5).

4.3 Service menu

Use the service-level password to access the Service menu:
"26-23-8."

Whenever the service menu is entered,
"Enter Service dd-mmm-yyyy hh:mm:ss" is recorded in the Event log.

Menu Item	Functions
Installation	Config.; Units; Leakage Limits; Depressurize Cassette; Factory Defaults
Options	Installed Options; System Information
Copy Config.	Save to USB; Load from USB
SW and HW Versions	Scroll through Software and Hardware system information.
Service Logs	All Recent; Error Log; Event Log; Alarm Log; Key Press Log; Copy Logs; Reset Breath Log; Reset Logs
Calibrations	User Calibrations; Manifold P Span; Inspiratory Flow Valve; Bleed Resistor; Paw Span; Zero Gas Transducers; Mixer P Zero
Display Diagnostics	Test LEDs; Test Speaker; Test Battery Test Hard Keys; Test LCD; Calibrate Touch
Super User	Return to Super User mode
Exit	To exit turn off power.

4.4 Installation menu

Menu Item	Message text
Config.	Decimal Marker; Language; Gas Supply Colors; O2 Flowtube; Drive Gas; Altitude; ACGO Installed; N2O Enabled
Units	Patient Weight; CO2; Gas Supply Pressure; Paw; Currency*
Leakage Limits	Auto Pass Limit; Fail if Greater than
Depressurize Cassette Yes - No	Depressurize cassette when agent is turned off.
Factory Defaults	Set all device settings (defaults, configurations, units, etc.) not related to hardware back to factory defaults.

* "Currency" is only displayed if the ecoFLOW option is installed (Section 4.5).

4.4.1 Configuration

Menu Item	Message text	Values	Comments
Decimal Marker	Select decimal delineator.	0.01, 0 01 or 0,01	
Language	Change language translation of screen texts.	Chinese (simplified), Czech, Danish Dutch, English, Finnish, French German, Greek, Hungarian, Italian Japanese, Norwegian, Polish, Portuguese Russian, Spanish, Swedish, Turkish	Default: English
Gas supply Colors	Change color of O2, N2O, and Air.	ANSI, ISO, Neutral	ANSI: O2 green, Air yellow, N2O blue; ISO: O2 white, Air black/white, N2O blue; Neutral: All gases white.
O2 Flowtube	O2 on left or right-hand side.	Left, Right	
Drive Gas	Change drive gas to match machine configuration.	Air, O2	
Altitude m	Change altitude used for gas calculations.	–400 to 3000 m in 100-m increments	
ACGO Installed*	Change type of fresh gas outlet.	Yes, No	SCGO: Use Insp port. ACGO: Use auxiliary port.
N2O Enabled	Change to match machine configuration.	Yes, No	

* For machines without a separate auxiliary common gas outlet and selector switch, set to ***No*** for SCGO: Selectable Common Gas Outlet.

* For machines with an external auxiliary common gas outlet and selector switch, set to ***Yes*** for ACGO: Auxiliary Common Gas Outlet.

4.4.2 Units

This is the same menu that is accessible from the Super User/System Configuration/Units menu.

Menu Item	Message text	Values
Patient Weight	Change weight unit: kg or lb.	kg or lb
CO2	Change CO2 unit: %, kPa, or mmHg.	%, kPa, or mmHg
Gas Supply Pressure	Change gas supply pressure unit: kPa, psi, or bar.	psi, kPa, bar
Paw	Change Paw unit: kPa, hPa, cmH2O, mmHg, mbar.	kPa, hPa, cmH2O, mmHg, or mbar
Currency	Change currency units	$ € ¥ £ Indian Rupees, Korean Won, Krone, Swiss Franc, Taiwan Dollar, Turkish Liras

4.4.3 Leakage Limits

Menu Item	Default	Values
Auto Pass Limit (Acceptance Limit)	250 ml/min	100 to 250 ml/min in increments of 10 ml/min
Fail if Greater than (Fail Limit)	750 ml/min	100 to 750 ml/min in increments of 10 ml/min

When the Acceptance Limit and Fail Limit are set to the same value, decreasing the Fail Limit decreases the Acceptance Limit to the same value.

When the Acceptance Limit and Fail Limit are set to the same value, increasing the Acceptance Limit increases the Fail Limit to the same value.

4.4.4 Depressurize Cassette - Yes/No

Yes - is the default. This will depressurize the Aladin Cassette whenever the agent is turned off.

No - This will NOT depressurize the Aladin Cassette whenever the agent is turned off

4.4.5 Factory Defaults

Set all device settings (defaults, configurations, units, etc.) not related to hardware back to factory defaults.

Refer to “Default case type settings” in the User’s Reference Manual.

Menu Item	Values
Reset to Factory Defaults	No, Yes

4.5 Options

The Options menu is used to configure system software to include the features that the customer has purchased. The included features are shown in the Installed Options list.

Options Key-Code

Menu Item	Key-Code	Values
Entry 1	Enter first key-code value.	0 to 9, A to Z, ~, !, @, #, $, %, ^, *, (,), ?
Entry 2	Enter second key-code value.	
Entry 3	Enter third key-code value.	
Entry 4	Enter fourth key-code value.	
Entry 5	Enter fifth key-code value.	
Entry 6	Enter sixth key-code value.	
Entry 7	Enter seventh key-code value.	
Submit New Key	Confirm entries for key-code.	

When options are added, “Add <option> dd-MMM-yyy hh:mm:ss” is written to the event log.

If more than one option is added, each option is listed separately.

Installed Options

The Installed Options list shows which options are enabled.

Menu Item	Values *	Vent Mode
Installed Options		
PCV	Yes, No	Pressure Control
PCV-VG	Yes, No	Pressure Control-Volume Guarantee
SIMV VCV	Yes, No	Synchronized Volume Control
SIMV PCV	Yes, No	Synchronized Pressure Control
SIMV PCV-VG	Yes, No	Synchronized Pressure Control-Volume Guarantee
PSVPro	Yes, No	Pressure Support Ventilation with an Apnea Backup
CPAP + PSV	Yes, No	Continuous Positive Airway Pressure + PSV
VCV Cardiac Bypass	Yes, No	Allow VCV during cardiac bypass.
ecoFLOW	Yes, No	
Et Control	Yes, No	
System Information		
Current Key	XXXAXBC	
Control Board ID	XXX	

* Yes if option enabled. No if disabled.

4.5.1 Copy Configuration

Copy configuration includes:

- All super-user settings and defaults except External Gas Monitor and VCV Cardiac Bypass.
- All service settings except Ventilator drive gas, N2O enabled or disabled, and type of gas outlet (ACGO or SCGO).

Uninstalled options do not copy. Make sure all purchased options are installed (Options Menu) before copying a configuration.

Copy Configuration menu

Menu Item	Message text	Values	Comments
Save to USB	Save the configurations to USB memory.	<blank>, Fail, or OK. The field is blank until the data has either been written to the USB (OK) or the system determines it cannot write to the USB (Fail).	Saves all settings that are not hardware dependent, including facility defaults, colors, units, O2 flow tube position, decimal marker, and altitude.
Load from USB	Load the configurations from USB memory. When completed: Load from USB complete. Please reboot system.	<blank>, Fail, or OK. The field is blank until the data has either been read from the USB (OK) or the system determines it cannot read the USB or the USB does not have the required data (Fail).	

Systems cannot accept configuration files from a different product model.

The software version is stored with the saved configuration. A system will reject any configurations from other than the current version of software.

Selecting Save to USB overwrites any configuration on the USB.

4.6 Software/Hardware Information menu

Turn the ComWheel (or use the touch points) to scroll through the list box.

Select "Close" to return to the Service menu.

System Information menu

List box text with X=Number, A, B, C = letter
Total Time (HH:MM): XXXXX:XX
System Software Release: XX.XX
Model Code: XXX
Machine Serial Number: ABCDXXXXX
Option Package: XXX
Options Code: XXXXX
Anes Software Version: XX.XX
Anes Hardware Version: XXXX-XXXX-XXX REV A
Anes Board Serial Number: ABCXXXXX
Display Software Version: XX.XX
Display Front Panel SW Ver: XX.XX
Display BIOS Ver: XX.XX
Display Hardware Version: XXXX-XXXX-XXX REV A
Display Hardware Serial Number: ABCXXXXX
Display COMX Board HW Ver: MXXXXXXX XXX
Display COMX Board HW SN: ABCXXXXX
Mixer Software Version: XX.XX
Mixer Hardware Version: XXXX-XXXX-XXX REV A
Mixer Board Serial Number: ABCXXXXX
Mixer O2 Flow Sensor Serial Number: XXXXXXXXX
Mixer Balance Gas Flow Sensor Serial Number: XXXXXXXXX
Vent Software Version: XX.XX
Vent Hardware Version: XXXX-XXXX-XXX REV A
Vent Intf Board Serial Number: ABCXXXXX
Power Software Version: XX.XX
Power Hardware Version: XXXX-XXXX-XXX REV A
Power Board Serial Number: ABCXXXXX
Airway Module Software Version: X.X
Airway Module Hardware Version: <module type>
Airway Module Hardware Serial Number: XXXXXXXX
Elec Vap Software Version: XX.XX
EVap Agt Dlv Board Hardware Version: XXXX-XXXX-XXX RR CCC
EVap Agt Dlv Board Serial Number: XXXXXXXX
EVap Flowmeter Hardware Version: XXXX-XXXX-XXX RR CCC
EVap Flowmeter Serial Number: XXXXXXXX
EVap Cas Tmp Sns Hardware Version: XXXX-XXXX-XXX RR CCC
EVap Cas Tmp Sns Serial Number: XXXXXXXX

The Airway Module information is only displayed when an Airway Module is present.

4.7 Service Logs

The Service logs menu is an organized listing of stored events.

Menu Item	Message text
All Recent	Scroll through newest entries.
Error Log	Scroll through error log.
Event Log	Scroll through event log.
Alarm Log	Scroll through alarm log.
Key Press Log	Scroll through key press log.
Copy Logs	Save HW/SW info and all logs to USB memory device.
Reset Breath Log	Erase Breath Log.
Reset Logs	Erase Error and Alarm log entries.
Back	Return to Service menu.

Each log shows at the top of the screen the total "Running Hours" and the date when the logs were last reset.

Whenever logs are reset, "Reset Logs dd-MMM-yyy hh:mm:ss" is recorded in the Event log.

If the logs are saved to a memory device, the machine's serial number is saved along with the current contents of the logs and the date and time.

Error History ◂

The Error Log lists the last 200 errors logged since the last log reset, starting with the most recent. The system stores the last 1000 errors logged since the last log reset.

Event History ◂

The Event Log records the service history of the device. This includes: service calibrations, entry into the service mode, options enabled, and software installation. In the event of a board replacement, it is understood that this log like all others could be lost.

The Event Log lists the last 200 events logged starting with the most recent. The Event Log stores the last 1000 events.

The Event Log cannot be reset.

Alarm History ◂

The Alarm Log lists the last 200 medium and high priority parameter alarms since the last log reset starting with the most recent. The Alarm Log store the last 1000 entries.

Breath Logs

The Breath Log records patient parameter data and machine settings for each patient breath, as well as certain events such as gas and vent setting changes.

Copy Logs

The ***Copy Service Logs*** function copies Error, Event, and Alarm logs along with the software/hardware configuration to a text file on a USB memory device.

The ***Copy Breath Logs*** function copies Breath logs along with the software/hardware configuration to a text file on a USB memory device.

Note: The copying takes about one minute. Do not remove the USB memory device until the screen shows copy is complete.

4.8 Calibrations

For step-by-step instruction, refer to Section 5.4, "*Ventilator Calibrations*."

Before calibration, you must verify that the Drive Gas and the Altitude settings are set appropriately to match the current drive gas configuration and machine location.

Configuration

This data is used during calibration. Please verify and correct if necessary (See Section 4.4.1, "*Configuration*.").

If you change any of these settings, you must restart the system.

Menu Item	Message text	Values
Drive Gas	Change drive gas to match machine configuration.	Air, O2
Altitude	Change altitude used for gas calculations.	–400 to 3000 m (in 100-m increments)

Menu Item	Message text
User Calibrations	Shows the normal user calibration menu.
Manifold P Span	Calibrate manifold pressure transducer.
Inspiratory Flow Valve	Calibrate inspiratory flow valve.
Bleed Resistor	Calibrate bleed resister flow.
Paw Span	Calibrate the airway pressure transducer.
Zero Gas Transducers	Calibrate the gas supply transducers.
Mixer P Zero	Zero mixer pres transducer.
Close	Return to previous menu.

4.8.1 User Calibrations

User Calibration History is shown when you first enter the user Calibration screen. The instructions are displayed in the Language selected on the Configuration screen.

Calibration Item	Instructions
Flow and Pressure	1. Remove flow sensor module to start. 2. Reinstall flow sensor module when results appear. 3. Make sure the module latches securely. Status:
Circuit O2 Cell 21%	1. Remove the flow sensor module. 2. Hold the O2 cell in room air. 3. Select Start. Test may take up to 3 minutes. 4. Install the Circuit O2 cell and flow sensor module. 5. Make sure the module latches securely. Status:
Circuit O2 Cell 100%	1. Make sure the O2 cell is installed correctly. 2. Set the Bag/Vent switch to Vent. 3. Select Start. Status:
Airway Gas	Wait for Zeroing to complete. Status:
	Connect and feed calibration gas. Status:
	Adjust values to match callibration gas. Status:
	Disconnect calibration gas. Results:
Close	Selecting ***Close*** returns to the Service screen.

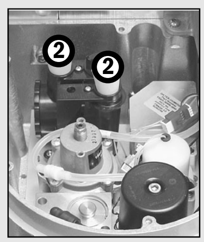
4.8.2 Manifold P Span

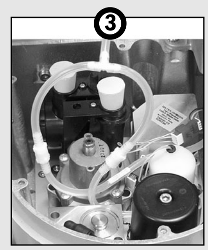
The Manifold P Span instructions appear when the focus is on Manifold P Span menu item.

Refer to Section 5.4.2, "*Manifold P Span*."

Instructions

1. Remove the breathing system, the exhalation valve, and the vent engine cover plate.
2. Put plugs in the manifold and the drive gas ports of the vent engine.
3. Connect a pressure gauge in line with the manifold pressure transducer.
4. Select Start Manifold P Span.





[***Back***] [***Start Manifold P Span***]

Instructions

1. Increase the inspiratory flow valve setting until the gauge shows 75 cmH2O (approximately 765 counts).
2. When the gauge shows 75 cmH2O, select Save calibration.

Inspiratory Flow Valve Setting (DAC Counts) [XXXX]

[***Save Calibration***] [***Cancel***]

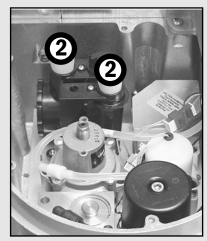
4.8.3 Inspiratory Flow Valve

The Inspiratory Flow Valve instructions appear when the focus is on the Insp Flow Valve menu item.

Refer to Section 5.4.3, "*Inspiratory Flow Valve Cal*."

Instructions

1. Complete the Manifold P Span Calibration.
2. Put plugs in the manifold and the drive gas ports of the vent engine.
3. Select Start Stage 1. The table fills with data.



[***Back***] [***Start Stage 1***]

During calibration, a separate menu shows the counts and corresponding flow at each step.

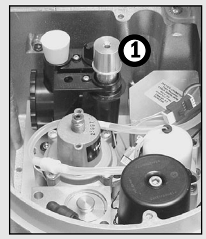
Stage 1 Status: . . .

Count	**Flow (l/min)**
XXXX	xxx
XXXX	xxx
....	.....

[***Back***] [***Scroll***] [***Cancel***]

Instructions

1. After Pass, replace the manifold port plug with the calibrated orifice.
2. Select Start Stage 2. The table fills with data.
3. You must do both stages for the calibration to be saved.



[***Back***] [***Start Stage 2***]

If the outcome of both stages of the calibration is Pass, the new calibration data is saved.

Stage 2 Status: . . .

Count	**Flow (l/min)**
XXXX	xxx
XXXX	xxx
....	.....

[***Scroll***] [***Cancel***]

If the outcome of either stage is Fail, the old calibration data is retained.

The results of each stage of the calibration are saved to the Event Log.

Selecting Close before the calibration is done, aborts the calibration in progress and keep the old calibration constants.

Insp Flow Valve Data menu

The Insp Flow Valve Data menu contains a table of 24 entries from the previous calibration. The table is erased at the start of Stage 1. The table is updated in real time during the calibration.

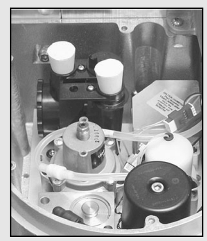
4.8.4 Bleed Resistor

The Bleed Resistor instructions appear when the focus is on the Bleed Resistor menu item.

Refer to Section 5.4.4, "*Bleed Resistor Cal*."

Instructions

1. Complete the Inspiratory Flow Valve calibration.
2. Put plugs in the manifold and the drive gas ports of the vent engine.
3. Select Start. The table fills with data.



[***Back***] [***Start***]

The calibration fails if the flow required to reach 91 cmH2O is > 16 l/min.

Status: . . .

Pressure cmH2O	**Flow (l/min)**
XXXX	xxx
XXXX	xxx
....	.....

[***Scroll***] [***Cancel***]

If the outcome of the calibration is Pass, the new calibration data is saved.

If the outcome is Fail, the old calibration data is retained.

The result of the calibration is saved to the Event Log.

Selecting Close before the calibration is done aborts the calibration in progress and keep the old calibration constants.

Bleed Resistor Data menu

The Bleed Resistor Data menu contains a table of 17 entries from a previous calibration. The table is erased at the start of the calibration. The table is updated in real time during the calibration.

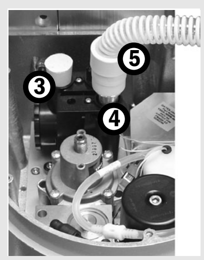
4.8.5 Paw Span

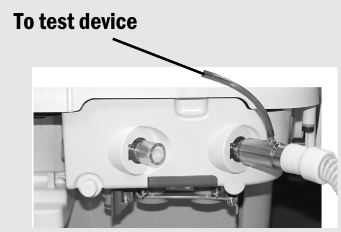
The Airway P Span instructions appear when the focus is on Paw Span menu item.

Refer to Section 5.4.5, "*Paw Span*."

Instructions

1. Complete the Bleed Resistor calibration.
2. Install the flow sensor and circuit module.
3. Put a plug in the drive gas port of the vent engine.
4. Put the calibrated orifice in the manifold port of the vent engine.
5. Connect a pressure tee to the inspiratory port. Connect the tee to the calibrated orifice with a 22 mm tube.
6. Connect a pressure gauge to the pressure tee.
7. Select Start Paw Span.





[***Back***] [***Start Paw Span***]

Instructions

1. Increase the flow valve setting until the gauge shows 75 cmH2O (approximately 765 counts).
2. Select Save Calibration.

Inspiratory Flow Valve Setting (DAC Counts) [XXXX]

[***Save Calibration***] [***Cancel***]

4.8.6 Zero Gas Transducers

The Zero Gas Transducers instructions appear when the focus is on the Zero Gas Transducers item.

Instructions

1. Remove all cylinders.
2. Disconnect all pipeline supplies.
3. Select Start Transducer Zero.

Status:

O2 Pipeline	XXXX Counts
O2 Cylinder 1	XXXX Counts
O2 Cylinder 2	XXXX Counts
N2O Pipeline	XXXX Counts
N2O Cylinder	XXXX Counts
Air Pipeline	XXXX Counts
Air Cylinder	XXXX Counts

[***Back***] [***Start Transducer Zero***]

A failed test is usually the result of a pipeline or cylinder still connected to the system.

- If the outcome of the calibration is Pass, the new calibration data is saved.
- If the outcome is Fail, the old calibration data is retained.
- The result of the calibration is saved to the Event Log.

Selecting Close before the calibration is done aborts the calibration in progress and keep the old calibration constants.

Zero Gas Xducrs menu

The Zero Gas Xducrs menu shows only transducers that are installed.
If not installed, the menu row is blank.

4.8.7 Mixer P Zero

The Mixer P Zero instructions appear on the Mixer P Zero menu.

Instructions

1. Disconnect pipeline supplies.
2. Close the gas cylinders.
3. Remove the flow sensors.
4. Insert a non-desflurane cassette.
5. Push the O2 Flush button for 3 seconds.
6. Let the system sit without gas flow for > 5 min.
7. Select Start.

Do not disturb the system while waiting for results.

Status:
<Problem statement after failure>

To go back to factory defaults, select Defaults [***Factory Defaults***]

[***Back***] [***Start P Zero***]

Note If repeated zero attempts fail, follow the procedure below:

1. Gain access to the components in the pan electrical enclosure (Section 9.6).
2. Disconnect the Alt O2 inlet tubing elbow fitting from the Mixer manifold.
3. Disconnect the tubing from the Mixer outlet elbow fitting.
4. Repeat the Mixer P Zero following the instructions as they appear on the screen.
5. Reassemble in reverse order.

4.9 Display Diagnostics

Selecting ***Display Diagnostics*** brings up the Display Diagnostics menu.

Display Diagnostics	**Action when selected**
Test LEDs	All LEDs flash 5 times.
Test Speaker	Speaker sounds for 2 seconds.
Test Battery	Shut off the AC mains. After 2 minutes results appear. Battery 1 (right) = XX.XX Vdc Battery 2 (left) = XX.XX Vdc Battery Current = -X.XX A Battery test PASSED/FAILED* (* Fail if either battery voltage is <12.10 Vdc.) Restore AC mains power.
Test Hard Keys	Push each hard key and verify the speaker sounds.
Test LCD	Push the ComWheel to cycle through the color screens. The first press results in a “blank” screen.
Calibrate Touch *	You will exit this menu and targets appear on the screen. Touch targets as directed. Upon completion you will return.
Close	Selecting ***Close*** returns to the Service screen.

* If the Touch calibration is completely misaligned to where you are not able to access Service mode using the touch controls, you can use the ComWheel to navigate to this Display Diagnostics screen.

- Restart the system.
- On the Checkout Menu, Start a Case and then directly End a Case.
- At this point you can use the ComWheel to access ***System Setup*** on the right hand button bar.

Note Double tapping the screen in the Calibration Confirmation screen, restarts the calibration.

5 Calibration

In this section

⚠ **WARNING** After adjustments and calibration are completed, always perform the checkout procedure. Refer to Section 3 of this manual.

5.1 Primary Regulators

First, follow the procedure in Section 5.1.1 to gain access to the regulators.

Then, in Section 5.1.2, select the test that is appropriate for the regulator you are testing.

⚠ **WARNING** When testing/adjusting N_2O regulators, nitrous oxide flows through the system. Use a safe and approved procedure to collect and remove it.

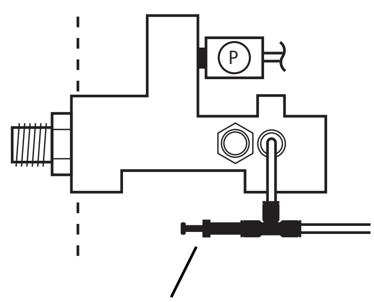
Note To test or calibrate the primary regulators, you must set the system to the Install/Service mode and use the PC based Service Application to control flow through the regulator.

5.1.1 Test setup for Primary Regulators

⚠ **WARNING** Wear safety glasses while test device is connected to the test port.

⚠ **CAUTION** Be careful not to plug the output of the primary regulator without having a pressure relief valve in the output circuit.

1. Set the system switch to Standby.
2. Disconnect all pipeline supplies.
3. Remove the upper cosmetic and rear panels (Section 9.4.1).
4. Turn the auxiliary O_2 flowmeter control fully clockwise (no flow).
5. Install a full cylinder in the cylinder supply to be tested. It is essential that the cylinder be within 10% of its full pressure.
6. Remove the plug from the test port. Connect a pressure test device [capable of measuring 689 kPa (100 psi) – Refer to section 10.1.2] to the open port.



5.1.2 Testing Primary Regulators

There are two variations of the test procedure for the primary regulators:

- Test A – For primary regulators that supply drive gas to the ventilator.
- Test B – For all gases not used to supply drive gas to the ventilator.

Test A **For primary regulators that supply drive gas to the ventilator (O_2 or Air):**

Under low flow conditions, the output pressure of a properly adjusted/functioning regulator should fall within specifications listed in step 5d.

Under high flow conditions, the output pressure should not drop below the specifications listed in step 6f.

1. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
2. If required,
   - set ***Gas Delivery Mode*** to ***Fresh Gas***.
   - set ***Balance Gas*** to ***Air***.
   - set ***Fresh Gas Control*** to ***O2 Concentration***.
3. Adjust the ***O2 Concentration*** so that 100% of the gas flow will be through the regulator being tested:
   - 100% for O_2 regulator
   - 21% for Air regulator
4. Slowly open the cylinder valve for the regulator being tested and observe the pressure reading for the cylinder.
5. **Low Flow Test:**
   a. Set ***Total Flow*** of the tested gas to 0.5 l/min.
   b. Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder pressure display.
   c. At the time that the cylinder pressure reaches 2068 kPa (300 psi), set ***Total Flow*** to 0.00 l/min to turn off gas flow.
   d. Within one minute, the test device reading must stabilize between:

      (60) DIN 372–400 kPa (54–58 psi)

      (50) Pin Indexed 310–341 kPa (45.0–49.5 psi).

      - If the test device pressure does not stabilize within one minute, replace the cylinder supply.
      - If the test device stabilizes within one minute, but the readings are not within specifications, readjust the regulator (Section 5.1.3).

6. **High Flow Test:**
    a. Slowly open the cylinder valve.
    b. Remove the ABS breathing system from the machine to allow continuous Insp Valve flow through the exhalation valve.
    c. Access the Ventilation Schematic (Section 12.3.3) of the Service Application.
    d. Set ***Gas Inlet Valve*** to ***On***.
    e. Adjust the ***Insp Flow Valve*** counts until the inspiratory flow value on the schematic reads approximately 65 l/min.
    f. While watching the test device, toggle the Gas Inlet Valve several times (Off, On, Off):
        - The minimum test device reading observed must be greater than:
          (60) DIN 221 kPa (32 psi)
          (50) Pin Indexed 207 kPa (30 psi)
        - Repeat this step (6f) three times.

    If the test device reading under "high flow" conditions is less than specified, readjust the regulator per the procedure in Section 5.1.3; however, set the regulated pressure higher by the difference you noted in this step plus 7 kPa (1 psi). This adjusts the "low flow" regulated output to the high side of the specification so that the "high flow" regulated pressure can fall within the specification.

    If the regulator subsequently fails the "low flow" specification (step 5d) because the reading is too high, replace the cylinder supply.

7. Set the system switch to Standby.
8. Close the cylinder valve.
9. Bleed the system of all pressure.
10. Disconnect the test device and plug the test port (pull on the plug to ensure it is locked in the fitting).
11. Replace the ABS breathing system.
12. Replace the rear panel.
13. Perform the checkout procedure (Section 3).

Test B **For all gases not used to supply drive gas to the ventilator:**

Under low flow conditions, the output pressure of a properly adjusted/ functioning regulator should fall within specifications listed in step 5d.

Under high flow conditions, the output pressure should not drop below the specifications in step 6a.

1. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
2. If required,
   - set ***Gas Delivery Mode*** to ***Fresh Gas***.
   - set ***Balance Gas*** to ***Air*** (for O_2 or Air) or ***N2O***.
   - set ***Fresh Gas Control*** to ***O2 Concentration***.
3. Adjust the ***O2 Concentration*** so that 100% of the gas flow will be through the regulator being tested:
   - 100% for O_2 regulator
   - 21% for Air regulator
   - 0% for N_2O regulator
4. Slowly open the cylinder valve for the regulator being tested and observe the pressure reading for the cylinder.
5. **Low Flow Test:**
   a. Set ***Total Flow*** of the tested gas to 0.5 l/min.
   b. Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder pressure display.
   c. At the time that the cylinder pressure reaches 2068 kPa (300 psi), set ***Total Flow*** to 0.00 l/min to turn off gas flow.
   d. Within one minute, the test device reading must stabilize between:

      (60) DIN 372–400 kPa (54–58 psi)

      (50) Pin Indexed 310–341 kPa (45.0–49.5 psi).

      - If the test device pressure does not stabilize within one minute, replace the cylinder supply.
      - If the test device stabilizes within one minute, but the readings are not within specifications, readjust the regulator (Section 5.1.3).

6. **High Flow Test:**
    a. Access the Gas Delivery Schematic.
    b. Open the cylinder valve for the regulator being tested.
    c. Set ***Total Flow*** of the tested gas to 10 l/min.

       The test device reading must be greater than:

       (60) DIN 221 kPa (32 psi)

       (50) Pin Indexed 221 kPa (32 psi)

       - If the test device reading under “high flow” conditions is less than specified, readjust the regulator per the procedure in Section 5.1.3; however, set the regulated pressure higher by the difference you noted in this step plus 7 kPa (1 psi). This adjusts the “low flow” regulated output to the high side of the specification so that the “high flow” regulated pressure can fall within the specification.
       - If the regulator subsequently fails the “low flow” specification (step 5d) because the reading is too high, replace the cylinder supply.
7. Set the system switch to Standby.
8. Close the cylinder valve.
9. Bleed the system of all pressure.
10. Disconnect the test device and plug the test port (pull on the plug to ensure it is locked in the fitting).
11. Replace the rear panel.
12. Perform the checkout procedure (Section 3).

5.1.3 Adjusting Primary Regulators

Important: Cylinder supplies in an Aisys CS2 machine must have all primary regulators set to the same pressure range:
(50) Pin Indexed or (60) DIN.

If a regulator is replaced, the replacement regulator must be set (as required) to the same specification as the one removed.

Important: Install a full cylinder in the cylinder supply to be adjusted. It is essential that the cylinder be within 10% of its full pressure.

To adjust the primary regulators, follow the procedure in Section 5.1.1 to gain access to the regulators.

Do not attempt to adjust without flow.

1. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
2. If required,
   - set ***Gas Delivery Mode*** to ***Fresh Gas***.
   - set ***Balance Gas*** to ***Air*** (for O_2 or Air) or ***N2O***.
   - set ***Fresh Gas Control*** to ***O2 Concentration***.

3. Adjust the ***O2 Concentration*** so that 100% of the gas flow will be through the regulator being tested:
   - 100% for O_2 regulator
   - 21% for Air regulator
   - 0% for N_2O regulator
4. Slowly open the cylinder valve for the regulator being tested and observe the pressure reading for the cylinder.
5. Set ***Total Flow*** of the tested gas to 0.5 l/min.
6. Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder pressure display.
7. When the cylinder gauge reaches 2068 kPa (300 psi), adjust the regulator output pressure to:

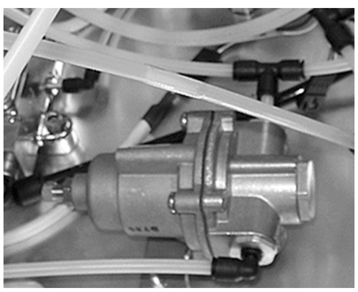
   (60) DIN 386–400 kPa (56–58 psi)

   (50) Pin Indexed 327–341 kPa (47.5–49.5 psi).

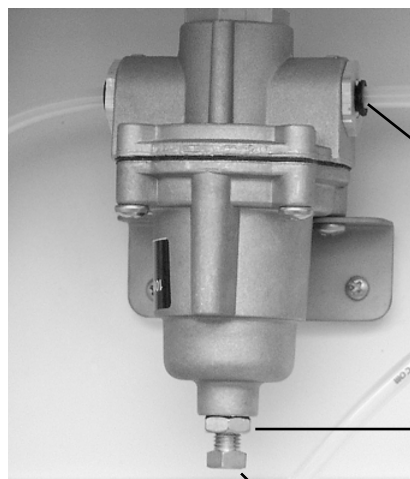
   Note: It may be necessary to open the cylinder valve and repeat steps 6 and 7 a number of times to achieve the above setting.
8. Test the regulator settings per the appropriate test in Section 5.1.2:
   - **Test A —** For primary regulators that supply drive gas to the ventilator.
   - **Test B —** For all gases not used to supply drive gas to the ventilator.

5.2 O_2 Flush Regulator

1. Bleed all gas pressure for the machine (Section 9.3).
2. Remove the tabletop (Section 9.5).
3. Remove the cover from the electronic enclosure.
4. Remove the O_2 Flush Regulator output tubing.
   Attach a 6-mm tee and a pressure test device
   (pressure gauge or a digital manometer — Refer to section 10.1.2)
   to the open port.



Upper (Pan) electronic enclosure



5. Connect an O_2 pipeline supply or slowly open the O_2 cylinder valve.
6. Push the flush button just enough to achieve a slight flow or open the auxiliary flowmeter if equipped with this option. Read the pressure shown on the test device.

   The pressure should be 241 ±7 kPa (35 ±1.0 psi).
7. If adjustment is required:
   a. Loosen the adjustment screw's jam nut.
   b. Adjust the regulator (in small steps) to the above specification.
   c. Tighten the jam nut.
   d. Verify the reading.
8. Disconnect the pipeline supply or close the cylinder valve.
9. Bleed gas pressure by pushing the flush button; then, disconnect the tee and test device.
10. Reattach the output tubing to the regulator.

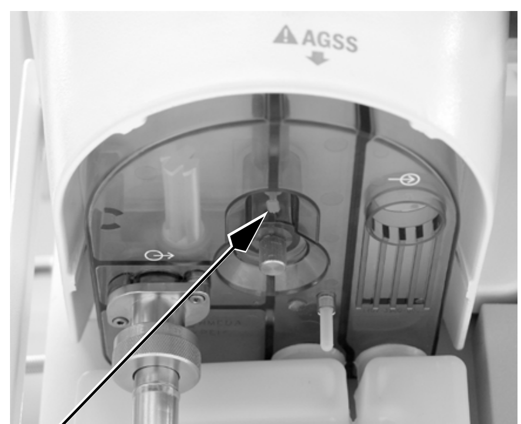
5.3 Adjust Drive Gas Regulator

The drive gas regulator must be adjusted while maintaining a flow of 15 l/min. To adjust the flow, you must set the system to the Install/Service mode and use the PC based Service Application to control flow through the regulator.

The drive gas regulator should provide a constant gas input pressure of 172 kPa (25 psi).

Calibration setup

1. Attach a pressure test device
   (pressure gauge or a digital manometer — Refer to section 10.1.2)
   to the regulator pressure port (shown below):
   - Remove the 6.35-mm (1/4 inch) plug.
   - Attach test device to the open port.
2. Remove the ABS breathing system from the machine to allow continuous Insp Valve flow through the exhalation valve.



3. Access the Ventilation Schematic (Section 12.3.3) of the Service Application.
4. Set ***Gas Inlet Valve*** to ***On***.
5. Adjust the ***Insp Flow Valve*** counts until the inspiratory flow value on the schematic reads approximately 15 l/min.
6. If required, adjust the regulator to 172 ±1.72 kPa (25 ±0.25 psi) through the access hole in the Vent Engine cover (Section 9.15.1).

5.4 Ventilator Calibrations

Before performing the ventilator calibrations, verify that the drive gas regulator is adjusted to specifications (Section 5.3).

The Service menu structure is detailed in Section 4. To access the Ventilator Calibrations menu:

1. Turn on the system.
2. Navigate the menu selections to the **Calibration** menu.
   - On the **Checkout** menu, select **Bypass Checks**.
   - On the **Start Case** menu, press the **Main Menu** button.
   - On the **Main Menu**, select **Screen Setup**.
   - On the **Screen Setup** menu, select **Install/Service** (dial in 16 - 4 - 34).
   - On the **Install/Service** menu, select **Service** (dial in 26 - 23 - 8).
   - On the **Service** menu, select **Calibration**.

Unless otherwise specified, perform the ventilator calibrations in the order that they appear on the Calibration menu.

- User Calibration
- Manifold P Span
- Insp Flow Valve
- Bleed Resistor
- Paw Span

The following calibrations should be performed as required:

- Zero Gas Xducer:
  - The pipeline and cylinder pressure transducer should be “zeroed” at least once a year.
  - Whenever a pipeline or cylinder pressure transducer is replaced.
- Cal Config:
  - Reset the ***Ventilator Drive Gas*** to match the machine configuration.
  - Reset the ***Altitude*** whenever the machine is moved to a new location that differs by more than 100 meters.
- Mixer P Zero:

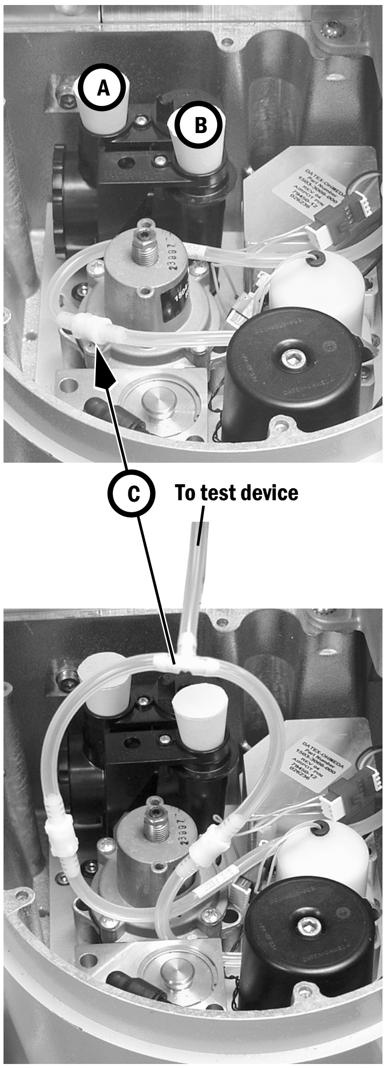
5.4.1 Cal Config

Before calibration, you must verify that the Ventilator Drive Gas and the Altitude settings are set appropriately to match the current drive gas configuration and machine location.

If you change any of the settings in the Cal Config menu, you must restart the system.

1. On the **Installation** menu, select **Configuration**.
2. On the **Configuration** menu, verify the **Ventilator Drive Gas** and the **Altitude** setting; adjust as necessary.
3. When done, reboot the system (System switch to Standby; then On).

5.4.2 Manifold P Span



Calibration setup:

1. Remove the ABS breathing system from the machine.
2. Remove the Exhalation Valve.
3. Remove the Vent Engine cover.
4. Plug the Drive Port (**A**) and the Manifold Port (**B**) on the Vent Engine interface valve.
5. Connect the manifold pressure tee adapter (**C**) – refer to Section 10.1.3 – to the Manifold Pressure Transducer tubing (white inline connectors).
6. Connect a pressure test device
   (pressure gauge or a digital manometer – Refer to section 10.1.2)
   to the open port of the tee adapter.

Calibration procedure:

1. On the Calibration menu, select ***Manifold P Span***.
2. Select ***Start Manifold P Span***.
3. Adjust the Insp Flow Valve (DAC) setting until the manometer reading equals 75 cmH_2O:
   - start at approximately 720 counts (press the ComWheel to activate).
   - continue to increment the count until the manometer reading equals 75 cmH_2O.
4. Select ***Save Calibration***.
5. Select ***Previous Menu***.
6. Disconnect the manometer from the tee adapter.
7. Remove the tee adapter and reconnect the Manifold Pressure Transducer tubing.

Troubleshooting

Manifold P Span Calibration Failure

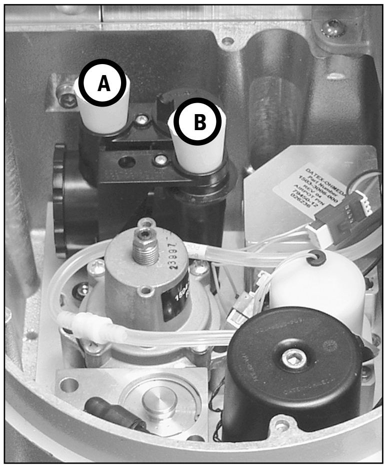
The Calibration will fail if the:

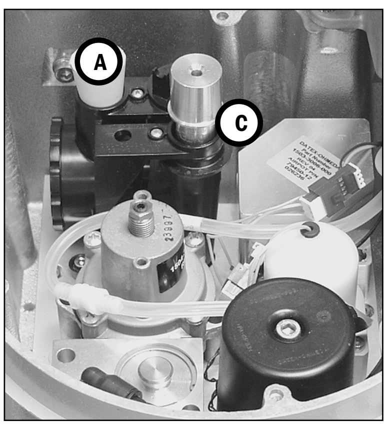
- ADC value calculated for span is outside the range of 15740-20250 counts.

Possible causes for calibration failure:

- Occlusion or moisture in bulkhead or tubing to cVIB transducers.
- Pressure transducer outside of range limits – Check Service Application for A/D value.

5.4.3 Inspiratory Flow Valve Cal



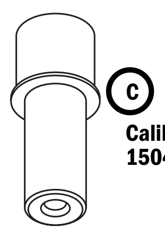


Calibration setup

Leave the Drive Port (**A**) and the Manifold Port (**B**) on the interface valve plugged.

Calibration procedure:

1. On the Calibration menu, select ***Insp Flow Valve***.
2. Push the ComWheel to enable the ***Stage 1*** calibration.
3. When Stage 1 is completed, remove the plug from the Manifold port and insert the calibrated orifice (**C**)
4. Push the ComWheel to enable the **Stage 2** calibration.
   (May take two minutes before you see any effects of the test on the screen.)
5. When Stage 2 is completed, select ***Back***.



Troubleshooting

Stage 1 Calibration Failures

The Calibration will fail if the:

- Flow valve DAC counts are ≥ 1000 counts while finding points 2 through 6.
- Previously found DAC value is ≥ to the current DAC value while finding points 2 through 6.
- Previously recorded flow for a previous DAC is > the previous flow for a previous DAC.
- Points 2, 3, and 4 have the same value stored for flow (this would cause a divide by zero when extrapolating).

Possible causes for calibration failure:

- Check Altitude and Drive Gas selection
- Leaks around the test plugs
- Leaks in Vent Engine Interface Manifold – Inspect for leaks
- Insp Flow Valve not closing completely (leaky) – Replace Insp Flow Valve
- Drive gas regulator not adjusted / stable – Check regulator calibration
- Insp Flow Valve not linear – Replace Insp Flow Valve

Troubleshooting

Stage 2 Calibration Failures

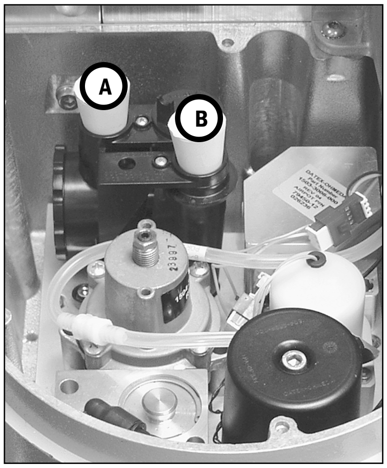
The Calibration will fail if the:

- Flow valve DAC reaches 4095 before determining the Lift-Off Point.
- Previously found DAC value is ≥ to the current DAC value while finding points 7 through 24.
- Previously recorded flow for a previous DAC is > the previous flow for a previous DAC.
- End point DAC of 4095 does not give a flow > 100 l/min.

Possible causes for calibration failure:

- Check Altitude and Drive Gas selection.
- Leaks around the test plug or Calibration Flow Orifice.
- Leaks in Vent Engine Interface Manifold – Inspect for leaks.
- Inadequate drive gas supply (cannot deliver > 100 l/min).
- Drive gas regulator not adjusted / stable – Check regulator calibration.
- Insp Flow Valve not linear – Replace Insp Flow Valve.

5.4.4 Bleed Resistor Cal



Calibration setup

Leave the Drive Port (**A**) and the Manifold Port (**B**) on the interface valve plugged.

Calibration procedure

1. On the Calibration menu, select ***Bleed Resistor***.
2. Select ***Start***.
3. When the test is completed, select ***Previous Menu***.

Troubleshooting

Bleed Resistor Calibration Failures

The Calibration will fail if the:

- Flow is greater than 50 l/min before the following pressure is reached:
    - 95 cmH_2O for System Software 4.X or greater
- Table created has a pressure or flow that is greater than or equal to the next flow or pressure point in the table.

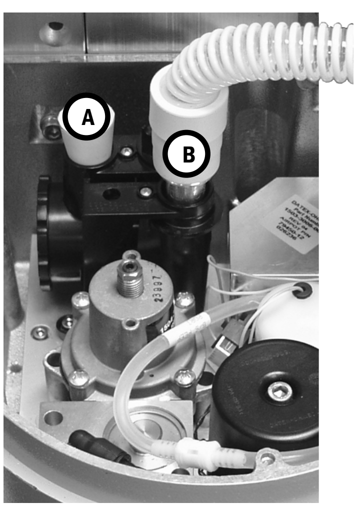
Possible causes for calibration failure:

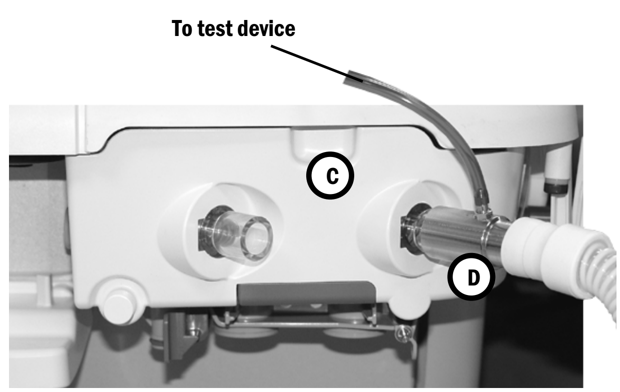
- Check Altitude and Drive Gas selection.
- Leaks around the test plugs.
- Drive gas regulator not adjusted / stable – Check regulator calibration.
- Inspiratory Valve Calibration not complete – Perform Calibration.
- Insp Flow Valve not closing completely (leaky) – Replace Insp Flow Valve.
- Insp Flow Valve not linear – Replace Insp Flow Valve.

5.4.5 Paw Span

Calibration setup

1. Leave the Drive port (**A**) port plugged.
2. Remove the plug from the Manifold port.
3. Attach a patient circuit tube to the Calibrated Flow Orifice.
4. Insert the Calibrated Flow Orifice into the Manifold port (**B**).
5. Separate the Circuit module from the ABS Bellows module.
6. Install only the Circuit module (**C**) on to the machine.
7. Connect a pressure sensing tee (**D**) to the inspiratory flow patient connection.
8. Connect the open end of the patient circuit tube to the flow port of the pressure sensing tee.
9. Connect a pressure test device (pressure gauge or a digital manometer — Refer to section 10.1.2) to the pressure sensing port of the tee connector.





Calibration procedure

1. On the Calibration menu, select ***Paw Span***.
2. Select ***Start Paw Span***.
3. Adjust the Insp Flow Valve (DAC) setting until the manometer reading equals 75 cmH_2O:
   - start at approximately 720 counts (press the ComWheel to activate).
   - continue to increment the count until the manometer reading equals 75 cmH_2O.
4. Select ***Save Calibration***.
5. Select ***Previous Menu***.

Troubleshooting

Paw Span Calibration Failure

The Calibration will fail if the:

- ADC value calculated for span is outside the range of 15740-20250 counts.

Possible causes for calibration failure:

- Occlusion or moisture in bulkhead or tubing to cVIB transducers.
- Pressure transducer outside of range limits – Check Service Application for A/D value.

Notes

6 Installation and Functional Checks

In this section

This section covers the regular maintenance procedures (minimum requirements) needed to make sure that the Aisys CS2 anesthesia machine operates to specifications.

⚠ **WARNING**

Do not perform testing or maintenance on the Aisys CS2 anesthesia machine while it is being used on a patient. Possible injury can result.

Items can be contaminated due to infectious patients. Wear sterile rubber gloves. Contamination can spread to you and others.

Obey infection control and safety procedures. Used equipment may contain blood and body fluids.

6.1 Aisys CS2 Installation Checklist

Serial Number:	Date: (YY/MM/DD) / /
Hospital:	Performed by:

☐ 1. Unpack and assemble the Aisys CS2 System.

☐ 2. Install any Display Arm mounted Patient Monitors before adjusting the display arm Counterbalance and Tilt movements. Verify proper adjustment of the display arm for movement and maneuverability (*TRM - Section 9.27*).
- Counterbalance of the display arm
- Side to side movement of displays
- Tilt position of the displays

3. Access the Installation menu from the Install/Service menu and change the following as required:

☐ a. Configuration (*TRM - Section 4.4.1*)
- Decimal Marker
- Language
- Gas Supply Colors
- O_2 Flowtube
- Ventilator Drive Gas
- Altitude
- ACGO Installed
- N_2O Enabled

☐ b. Units Menu (*TRM - Section 4.4.2*)
- Weight
- CO_2
- Gas Supply Pressure
- Paw
- Currency (If Applicable)

☐ c. Leakage Limits (*TRM - Section 4.4.3*)

☐ d. Depressurize Cassette (*TRM - Section 4.4.4*)

☐ e. Options List (*TRM - Section 4.5*)
- Check that the factory installed ventilation options match the configuration purchased with the machine.

☐ f. Copy Configuration Menu (*TRM - Section 4.5.1*)
- Can be used to save a configuration to a Compact Flash card and then copy the configuration to additional machines.

☐ g. From the Service Menu select the Service Log Menu (*TRM - Section 4.7*)
- Review and reset the error and alarm log entries.

☐ h. From the Service Menu select Calibration and perform the following calibrations (*TRM - Section 4.8*):
- User Calibration
- Manifold P Span
- Insp Flow Valve
- Bleed Resistor
- Paw Span
- Zero Gas Xducers
- Mixer P Zero

☐ 4. Verify the "Schedule Service Calibration" message is not present in the normal display.

☐ 5. Complete the System Checkout by performing the following steps:

a. Inspect the system (*TRM - Section 3.1*)

b. System checkout (*TRM - Section 3.3*)

Note: You must insert a Test Cassette for the Machine Check - System Agent Delivery Test to run the extended diagnostic Vaporizer Test.

c. Pipeline and Cylinder tests (*TRM - Section 3.6*)

d. Flush Flow test (*TRM - Section 3.7*)

e. Alarm tests (*TRM - Section 3.8*)

f. Alternate O_2 flowmeter tests (*TRM - Section 3.9*)

g. Auxiliary O_2 flowmeter tests (*TRM - Section 3.10*)

h. Integrated suction regulator tests, if equipped with option (*TRM - Section 3.11*)

i. Power failure test (*TRM - Section 3.12*)

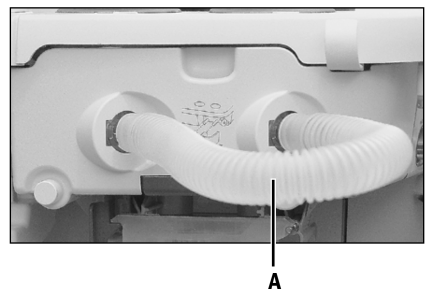
j. Electrical safety tests (*TRM - Section 3.13*)

6.2 Respiratory Gas Modules

The Aisys CS2 anesthesia machine may be configured for use with a GEHC Respiratory Gas Module. When the GEHC Respiratory Gas Module is configured with the Aisys CS2 anesthesia system, reference the appropriate GEHC Respiratory Gas Module Technical Reference Manual for relevant information regarding Theory of Operation, Installation procedures, Maintenance and Checkout, Calibration and Adjustments, Troubleshooting, Disassembly and Reassembly, and Service Parts.

6.3 Positive pressure relief valve functional check

1. Connect short tubing (**A**) from the inspiratory to the expiratory ports.
2. Occlude the bag port (**B**).
3. Remove the scavenger reservoir cover.
   - For some machines with an optional outboard 3rd cylinder, the cylinder basket may have to be removed to gain access to the cover and reservoir.
4. Remove the scavenger reservoir and the receiver.
5. Occlude the downtube (**C**) located under Vent Engine housing.



6. Set the APL Valve to Min and the Bag/Vent switch to Bag position.
7. Adjust the O_2 flow to 6 l/min.
8. After one minute, observe the Mean Pressure on the screen.
   - The pressure should rise to approximately 10 cmH_2O (some noise chattering should be heard).
   - The pressure should indicate a pressure rise of less than 10 cmH_2O.
   - If the pressure rise is greater than 10 cmH_2O, replace the dead weight and seat on the Exhalation Valve (refer to *TRM - Section 10.42.6*).
     - Repeat this test procedure.
9. Remove the occlusions from the downtube (**C**) and bag port (**B**).
10. Remove the short tube (**A**) from the inspiratory and expiratory ports.
11. Reinstall scavenger receiver, the reservoir, and the reservoir cover.
    - If the optional 3rd cylinder basket was removed in a previous step, reinstall the cylinder basket.
12. Connect the AGSS to the hospital evacuation system and verify proper scavenging flow.

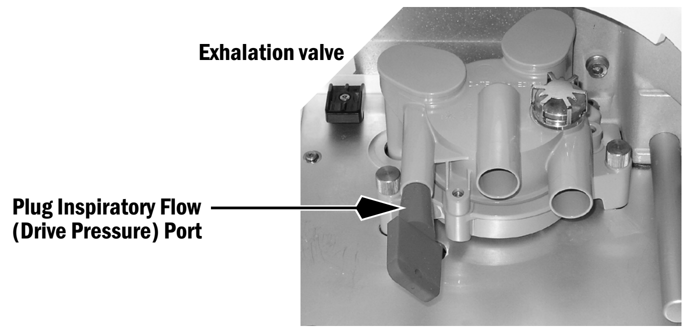
6.4 MOPV pressure relief valve test

⚠ **WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

6.4.1 Test setup

1. Remove the ABS breathing system.
2. Plug the inspiratory flow (drive pressure) port of the exhalation valve with a stopper.



6.4.2 Test procedure

To test the pressure relief valve, you must establish a flow (blocked by setup above) of 30 l/min through the Inspiratory Flow Control valve.

1. Access the Ventilation Schematic (*TRM - Section 12.3.3*) of the Service Application.
2. Set ***Gas Inlet Valve*** to ***On***.
3. Adjust the ***Insp Flow Valve*** counts until the inspiratory flow value on the schematic reads approximately 30 l/min.
4. Carefully listen for the MOPV relief weight to be relieving and "popping off" from its seat (a purring sound). This indicates the valve is functioning correctly.
5. Set the system switch to Standby.
6. Remove the stopper from the inspiratory flow port.
7. Reassemble the system.
8. Perform the Preoperative Checkout Procedure
   (refer to the User's Reference manual).

6.5 Pressure Limit Circuit test

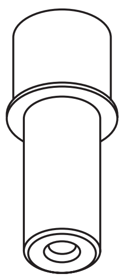
Test overview

To perform the test:

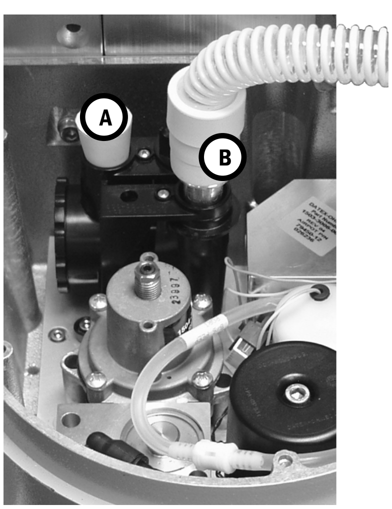
- Establish a closed patient airway circuit.
- Start the PC Service Application.
- Increment the pressure in the airway circuit.
- Observe the output of the airway pressure transducer.
- Note that the “pressure limit circuit” trips at approximately 109 cmH_2O.

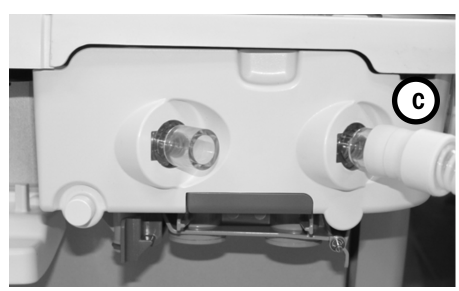
Test setup

1. Remove the ABS breathing system from the machine.
2. Remove the Exhalation Valve.
3. Remove the Vent Engine cover.
4. Separate the Circuit Module from the ABS Bellows Module.
5. Install the Circuit Module only.
6. Plug the Drive Port (**A**) on the Vent Engine interface valve.
7. Attach a patient circuit tube to the Calibrated Flow Orifice test tool.
8. Insert the Calibrated Flow Orifice into the Manifold (pilot) Port (**B**).
9. Connect the open end of the patient circuit tube to the inspiratory flow patient connection (**C**).



Calibrated Flow Orifice
1504-3016-000





Test Procedure

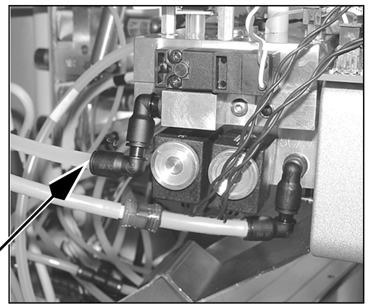
10. Access the Ventilation Schematic (*TRM - Section 12.3.3*) of the Service Application.
11. Select ***Vent Status*** and verify that ***Over Pressure Circuit*** reads ***OK***.
12. Select ***Gas Inlet Valve*** to ***ON***.
13. Adjust the ***Insp Flow Valve*** counts to approximately 1000 counts and observe the ***Airway Pressure*** reading on the Ventilator Schematic.
14. Increase the flow count slowly until the ***Airway Pressure*** reading reaches approximately 109 cmH_2O.
15. Continue to increase the flow by one count and observe the airway pressure until gas flow stops.
16. On the Status page, verify that:
    - ***Over Pressure Circuit*** reads ***OK***.
    - ***Gas Inlet Valve Feedback*** reads ***Closed***.
17. Reassemble the system.
18. Perform the Preoperative Checkout Procedure (refer to the User's Reference manual).

6.6 Mixer test

To perform the mixer tests, you must gain access to the mixer outlet tubing which is connected to the inlet of the electronic vaporizer.

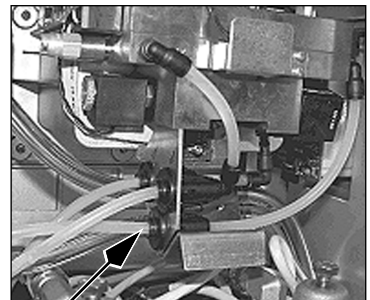
1. To access the electronic vaporizer, refer to Section 9.8
2. Disconnect the mixer outlet tube at the inlet to the electronic vaporizer.

With direct connection



(tubing connection may vary)

With bulkhead connectors



6.6.1 Mixer outlet check valve leak test

To test the mixer outlet check valve you must apply back pressure to the check valve through the mixer outlet tubing and time the leak down rate of the pressure.

1. Tee in a pressure test device
   (pressure gauge or a digital manometer — Refer to section 10.1.2)
   and a syringe to the mixer outlet tube.
2. Slowly pressurize the mixer outlet check valve to 200 mmHg.
3. The pressure shown on the test gauge should not decrease by more than 10 mmHg in 30 seconds.

6.6.2 Mixer flow verification

To perform the flow verification test,
you must attach a flow test device (Refer to section 10.1.2) to the mixer outlet tubing
and access the Gas Delivery Schematic (Section 12.3.2) on the Service Application.

1. Connect a flowmeter to the mixer outlet tubing.
2. If the system includes an N_2O supply, connect the output of the flowmeter to the input of the electronic vaporizer or to the scavenging system.

   Note: Some flowmeter test devices are not backpressure compensated. Connecting the output of the flowmeter test device to the input of the electronic vaporizer can cause readings outside limits.

3. On the Gas Delivery Schematic, establish the following flows and verify the readings on the test flowmeter.

	Verify Flowmeter Reading	
Set Flow	**Lower Limit sl/min**	**Upper Limit sl/min**
100% O_2 at 10 l/min	9.0	11.0
100% Air at 10 l/min	9.0	11.0
100% N_2O at 10 l/min	9.0	11.0
100% N_2O at 0.5 l/min	0.45	0.55
100% Air at 0.5 l/min	0.45	0.55
100% O_2 at 0.5 l/min	0.45	0.55

Note If you will be testing the Auxiliary O_2 flowmeter (*TRM - Section 6.7*), you can proceed to the Alternate O_2 "*Flow Accuracy Test*" at this point without reassembling the machine.

4. Remove the test device.
5. Connect the mixer outlet tubing to the electronic vaporizer.
6. Reassemble the machine.
7. Perform the Preoperative Checkout Procedure
   (refer to the User's Reference manual).

6.7 Alternate O_2 flowmeter tests

1. Open the O_2 cylinder valve or connect an O_2 pipeline.
2. Rotate the Alt O_2 flow control fully clockwise to minimum flow.
3. Press the Alternate O_2 switch to turn on Alternate O_2 flow.
   The flowmeter should indicate 0.5 to 0.7 L/min.
4. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
5. Rotate the flow control clockwise to minimum flow.
6. Press the Alternate O_2 switch to turn off Alternate O_2 flow;
   push the ComWheel to confirm yes.

Flow Accuracy Test

Note: To check flow accuracy, be sure that the flow test device is capable of measuring 0–15 l/min with an accuracy of ±2% of reading.

To perform the test, you must gain access to the mixer outlet tubing which is connected to the inlet of the electronic vaporizer.

1. To access the electronic vaporizer, refer to Section 9.8
2. Disconnect the mixer outlet tube at the inlet to the electronic vaporizer.
3. Connect a flowmeter to the mixer outlet tubing.
4. Press the Alternate O_2 switch to turn on Alternate O_2 flow.
5. Adjust the flowmeter so the **center** of the ball aligns with the selected test point (observe that the ball maintains a steady position for 10 seconds).
6. The test device reading should be between the limits shown for each of the selected settings in the table below.

	Flow Tester Reading	
Flowmeter Setting L/min	**Lower Limit l/min**	**Upper Limit l/min**
minimum (valve fully closed)	0.5	0.7
1	0.5	1.5
3	2.5	3.5
5	4.5	5.5
10	9.0	11.0
maximum (valve fully open)	10.0	13.0

7. Rotate the flow control clockwise to minimum flow.
8. Close the O_2 cylinder valve or disconnect the O_2 pipeline.
9. Remove the test device.
10. Connect the mixer outlet tubing to the electronic vaporizer.
11. Reassemble the machine.
12. Perform the Preoperative Checkout Procedure
    (refer to the User's Reference manual).

6.8 Auxiliary O_2 flowmeter tests

1. Open the O_2 cylinder valve or connect an O_2 pipeline.
2. Rotate the flow control clockwise (decrease) to shut off the flow. The ball should rest at the bottom of the flow tube and not move.
3. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
4. Rotate the flow control clockwise to shut off the flow.

Flow Accuracy Test

Note: To check flow accuracy, be sure that the flow test device is capable of measuring 0 to 15 L/min with an accuracy of ±2% of reading.

1. Connect the flowmeter outlet to the flow test device.
2. Adjust the flowmeter so the **center** of the ball aligns with the selected test point (observe that the ball maintains a steady position for 10 seconds).
3. The test device reading should be between the limits shown for each of the selected settings in the table below.

	Flow Tester Reading	
Flowmeter Setting L/min	**Lower Limit L/min**	**Upper Limit L/min**
1	0.5	1.5
3	2.5	3.5
5	4.5	5.5
10	9.0	11.0
maximum (valve fully open)	12.0	-------

4. Rotate the flow control clockwise to shut off the flow.
5. Close the O_2 cylinder valve or disconnect the O_2 pipeline.

6.9 Integrated Suction Regulator tests

Note There are two types of integrated suction systems for the Aisys CS2 anesthesia machine:

- Continuous Vacuum Regulator, Three-Mode, Pipeline Vacuum
- Continuous Vacuum Regulator, Three-Mode, Venturi Derived Vacuum

For Pipeline Vacuum systems,
a vacuum source of at least 500 mm Hg (67 kPa or 20 in Hg) is required for testing. The supply open flow must be a minimum of 50 L/min.

For Venturi Derived Vacuum systems,
an O_2 or Air source of at least 282 kPa (41 psi) is required for testing.

Gauge Accuracy The gauge needle should come to rest within the zero range bracket when no suction is being supplied. Gauges which do not comply may be out of tolerance.

Note To check gauge accuracy, be sure that the test gauge is capable of measuring 0 to 550 mm Hg with an accuracy of ±1% of reading.

1. Connect the suction patient port to the test gauge.
2. Turn the mode selector switch to I (ON).
3. Ensure that the vacuum test gauge is in agreement with the suction vacuum gauge ± 38 mm Hg/5 kPa at the following test points.

Test points

Suction vacuum gauge	**Test gauge tolerance**
100 mm Hg (13.3 kPa)	62–138 mm Hg (8.3–18.4 kPa)
300 mm Hg (40 kPa)	262–338 mm Hg (35–45 kPa)
500 mm Hg (66.7 kPa)	462-538 mm Hg (61.6–71.7) kPa)

Flow Test **Note:** To check flow accuracy, be sure that the flow test device is capable of measuring 0–30 L/min with an accuracy of ± 2% of reading.

1. Connect the patient port of the suction regulator to the flow test device.
2. Rotate the suction control knob fully clockwise (increase).
3. Turn the mode selector switch to I (ON) and verify that the flow rate is:
   - at least 20 L/min.
4. Disconnect the test flowmeter.

(Tests continue on next page.)

Regulation Test

1. Turn the mode selector switch to I (ON).
2. Occlude the patient port of the suction regulator.
3. Set the vacuum regulator gauge to 100 mm Hg/13 kPa.
4. Open and close the patient port several times.
5. With the patient port occluded, the gauge should return to 100 mm Hg/13 kPa within a tolerance of ± 10 mm Hg/1.3 kPa.

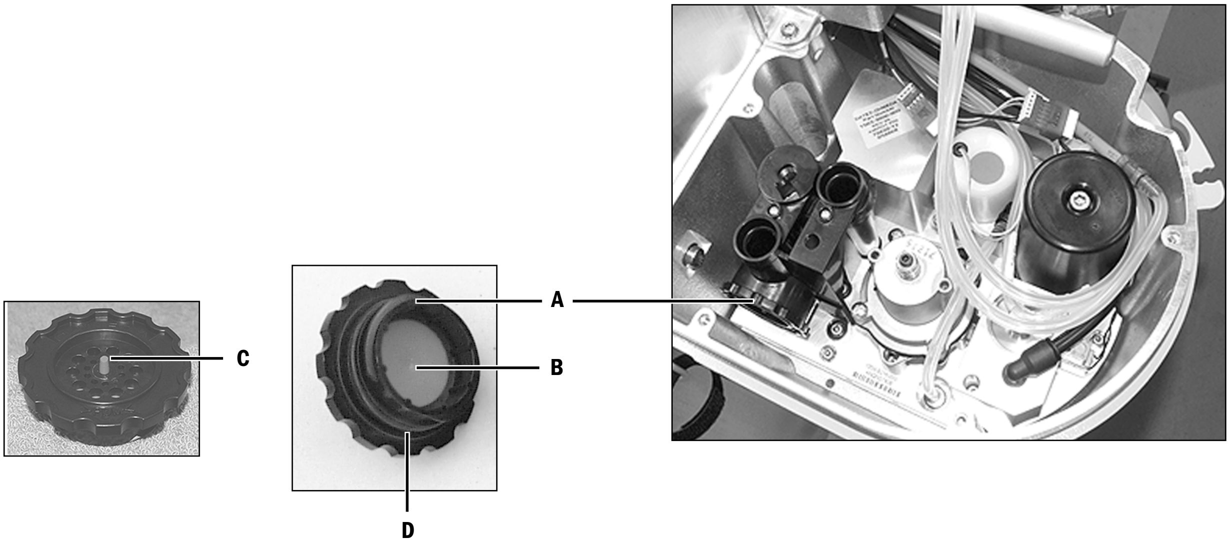
Vacuum Bleed Test

1. Occlude the patient port of the suction regulator.
2. Set the vacuum regulator gauge to 100 mm Hg/13 kPa.
3. Turn the mode selector switch to O (OFF) and observe the gauge needle. It must return to the zero range bracket or stop pin within 10 seconds.

Vacuum Leak Test

1. Turn the mode selector switch to O (OFF).
2. Rotate the suction control knob a minimum of two full turns in the clockwise direction (increase suction) to ensure its setting is not at the off position.
3. Occlude the patient port of the suction regulator.
4. Observe the suction gauge, the needle should not move.
5. Rotate the suction control knob fully counterclockwise to ensure its setting is at the fully off position.
6. Turn the mode selector switch to I (ON).
7. Observe the suction gauge, the needle should not move.

6.10 Free breathing valve maintenance



Refer to section 9.15 to access the Pneumatic Vent Engine.

Note You may have to remove the Vent Engine to be able to remove the valve seat.

1. Unscrew the valve seat (**A**) from the side of the interface manifold.
2. Inspect the flapper (**B**) and valve seat for nicks, debris and cleanliness.

To replace the flapper valve

3. If necessary, clean the new flapper valve with alcohol.
4. Pull the tail (**C**) of the new free breathing valve flapper through the center of the valve seat until it locks in place.
5. Trim the tail with 2 to 3 mm protruding outside surface of the valve seat (refer to the removed flapper).
6. Replace the O-ring (**D**). Lubricate with a thin film of Krytox.
7. Hand screw the assembly into the interface manifold.
8. Reassemble the system.
9. Perform the Preoperative Checkout Procedure
   (refer to the User's Reference manual).

6.11 Battery capacity test

Although replacement of the backup batteries is recommended at the end of 4 years, batteries that pass the capacity test can be considered viable for battery backup of the system for up to 6 years at the discretion of the hospital.

Before testing the batteries, ensure that they are fully charged.

Test procedure

1. Turn the system on and start a case (simulated).
2. Turn off the mains system breaker on the AC Inlet.
3. Allow the system to run on battery until it does an orderly shutdown and powers off (can be in excess of 90 minutes).
4. Set the system switch to Standby and turn on the mains system breaker.
5. Set the system switch to On and enter the Service Mode.
6. Launch the Service Application.
7. On the Power Diagnostics menu (Section 12.7) select ***Power Board***.
8. The Power Board window (Section 12.7.1) shows the ***Date battery Tested*** (the last full battery discharge) and the ***Last Full Discharge*** time.
   - If the ***Last Full Discharge*** time is greater than 45 minutes, the batteries can be left in service for one more year.
   - If the ***Last Full Discharge*** time is less than 45 minutes, both batteries should be replaced.

Notes

7 Troubleshooting

In this section

7.1 Troubleshooting Guidelines

Review system error logs using the Service Log menu (Section 4.7) or download the logs to PC files using the PC Service Application (Section 12.6.3). Review the logs to identify issues and follow the appropriate subsystem troubleshooting procedures.

⚠ **WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

7.2 Respiratory Gas Modules

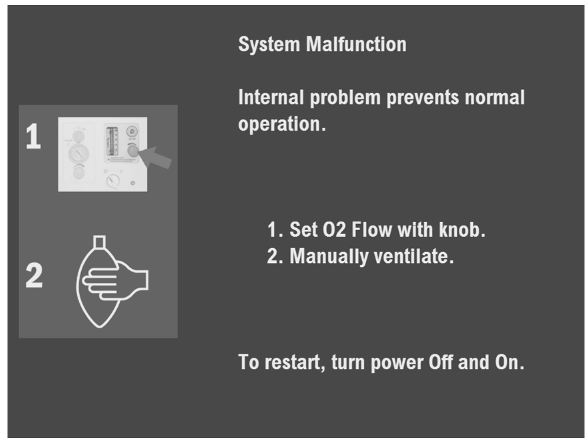
The Aisys CS2 anesthesia machine may be configured for use with a GEHC Respiratory Gas Module. When the GEHC Respiratory Gas Module is configured with the Aisys CS2 anesthesia system, reference the appropriate GEHC Respiratory Gas Module Technical Reference Manual for relevant information regarding Theory of Operation, Installation procedures, Maintenance and Checkout, Calibration and Adjustments, Troubleshooting, Disassembly and Reassembly, and Service Parts.

7.3 Troubleshooting high pressure and low pressure leaks

Problem	Possible Cause	Action
High Pressure Leak	Pipeline leak	Use a leak detector or Snoop to check for source of leak. Repair or replace defective parts.
	O_2 flush valve	Use a leak detector or Snoop to check for source of leak. Make sure tubing connections are tight. Replace valve if defective.
	System switch	Use a leak detector or Snoop to check for source of leak. Make sure tubing connections are tight. Replace switch if defective.
	Cylinder not installed properly	Make sure cylinder is correctly aligned. Verify that tee handles are tight.
	Cylinder transducer	Use a leak detector or Snoop to check for source of leak. Tighten/replace transducer if defective.
	Cylinder gaskets	Use a leak detector or Snoop to check for source of leak. Replace gasket if defective.
	Relief valves	Use a leak detector or Snoop to check for source of leak. Replace valve if defective.
Low Pressure Leak	Leak in mixer	Remove tubing from inlet port of vaporizer manifold (mixer outlet tube) and perform leak test of mixer.
	Leaking flush valve	Attach pressure measuring device on CGO. Replace valve if device shows increased pressure.
	Leaking system switch	Attach pressure measuring device on CGO. Replace switch if device shows increased pressure.
Bellows leak	Pop-off valve diaphragm not sealing properly	Disassemble pop-off valve; inspect and clean seats; reseat; reassemble.
	Bellows mounting rim loose	Remove rim and pop-off valve diaphragm; reseat diaphragm; snap rim (2) into place.
	Bellows improperly mounted or has a hole or tear	Check that only the last bellows convolute is mounted to the rim and that the ring roll is in the groove under the rim. Inspect the bellows for damage; replace.
Breathing System Leak	Absorber canister open or missing	Install canister properly.
	Damaged/missing canister o-ring	Check/replace o-rings.
Breathing System Leak (Intermittent)	ACGO O_2 sense check valve	Replace.
Unable to begin mechanical ventilation	ABS not fully engaged	Remount ABS.
	No O_2 supply	Check O_2 supply.
	Defective Bag/Vent switch	Check Bag/Vent switch.

7.4 Troubleshooting Failed State

In the Failed state, normal operations are not possible due to a problem in the system, The system is placed into a safe state where only Alternate O_2 mode and manual ventilation is available.



In a Failed state condition, you can copy Error, Alarm, and Event logs to a USB memory device.

1. With the system still in the Failed state, attach a USB memory device to the display unit.
2. Press the Home key on the keypad to start the download.
3. Wait approximately 60 seconds while the logs are downloaded to the USB memory device (no apparent activity).

Note: Do not remove the USB memory device until the screen shows copy is complete.

7.5 Troubleshooting Startup Screen (POST) messages

If the Aisys CS2 system encounters a problem at startup to where it cannot initiate system software, a BIOS error message indicating the failure will be displayed.

"***Note:" items generate 10 seconds of beeping .

Message	What it indicates	Troubleshooting Action Required
***NOTE: Alarm speaker not detected. Check connection.	Service is required to correct a faulty connection to the speaker.	Reconnect the speaker if possible. Replace the Carrier and Com Express board assembly if speaker connection can not be corrected.
***NOTE: CMOS battery is weak. Please replace.	Service is required to replace the Carrier board battery.	Replace the battery on the Carrier board. Reload software and check out the system.
***NOTE: CPU Board Supply Voltage Out of Range.	Indicates 1.5V_CB, 5V_CB, or 3.3V_CB voltage out of range.	Replace the Carrier and Com Express board assembly.
***NOTE: RTC date/time error. Battery may be weak.	Service is required to replace the Carrier board battery.	Replace the battery on the Carrier board. Reload software and check out the system.

Message	What it indicates	Troubleshooting Action Required
***ERROR: No bootable device available.	This indicates a problem with the internal CF card.	Check or replace the internal Compact Flash card.
***ERROR: Program load failed - CRC.	This usually indicates a software file corruption.	Reload the software and check out the system.
***ERROR: RAM memory error.	This indicates a hardware failure.	Replace the Memory Module. Replace the Carrier and Com Express board assembly.
***ERROR: System reset: ECxx xx xx . . .	This usually indicates a software failure.	Report this error, along with the machine logs, to Technical Support. Reload software. If problem persists, replace the internal Compact Flash card and reload software. If problem persists, replace the Carrier and Com Express board assembly.
***ERROR: watchdog circuit failed.	This indicates a hardware failure.	Replace the Carrier and Com Express board assembly.

7.6 Troubleshooting the Display

Symptom	**Resolution**
System will not boot from external USB Flash Drive during software installation process	1. Verify that the USB Flash Drive is the correct part number and is properly inserted. **Note**: Software USB Flash Drives are formatted at the factory and cannot be copied. 2. Attempt to load software using the secondary USB port. 3. Try loading software from a backup USB Flash Drive. 4. Replace the Carrier Board and Com Express Board Assembly.
Rotary encoder fails to work	1. Open the display and verify that the cable connecting the rotary encoder to the Carrier Board is properly seated within the mating connector. 2. Replace the rotary encoder. 3. Replace the Carrier Board and Com Express Board Assembly.
Unit fails to boot	Troubleshoot the display using **(Flowchart 8)**.
Excessive fan noise	1. Clean or replace the display case fan inlet filter. 2. Check for obstructions within the case fan and verify source of fan noise. 3. Open the display and verify Com Express fan noise. 4. Replace either fan assembly if causing excessive noise.
Touchscreen fails to work	1. Verify that screen lock is not On. 2. Check internal cables and connections. 3. Replace the Touch Controller Board. 4. Replace the Touch Bezel Assembly.
“App Not Loaded” message is displayed	1. Load software. 2. Replace CF card.
Touch points are misaligned (out of calibration)	Access the Display Diagnostics menu in Service mode and Calibrate the Touch points (**Section 4.9**).

7.7 Breathing System Leak Test Guide

Note Always do the ***System "Checkout"*** (Section 3.3) on the machine before proceeding with these breathing system leak tests.

Follow the troubleshooting flowcharts in Section 7.7.2 to determine the best sequence of tests for locating a breathing system leak.

The procedures in Section 7.7.3 test specific components of the breathing system for leaks.

⚠ **WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

7.7.1 Check Valves

Make sure that the check valves on the breathing circuit module work correctly: The Inspiratory check valve rises during inspiration and falls at the start of expiration. The Expiratory check valve rises during expiration and falls at the start of inspiration. A leak across one of the check valves may be great enough to cause a "reverse flow" alarm.

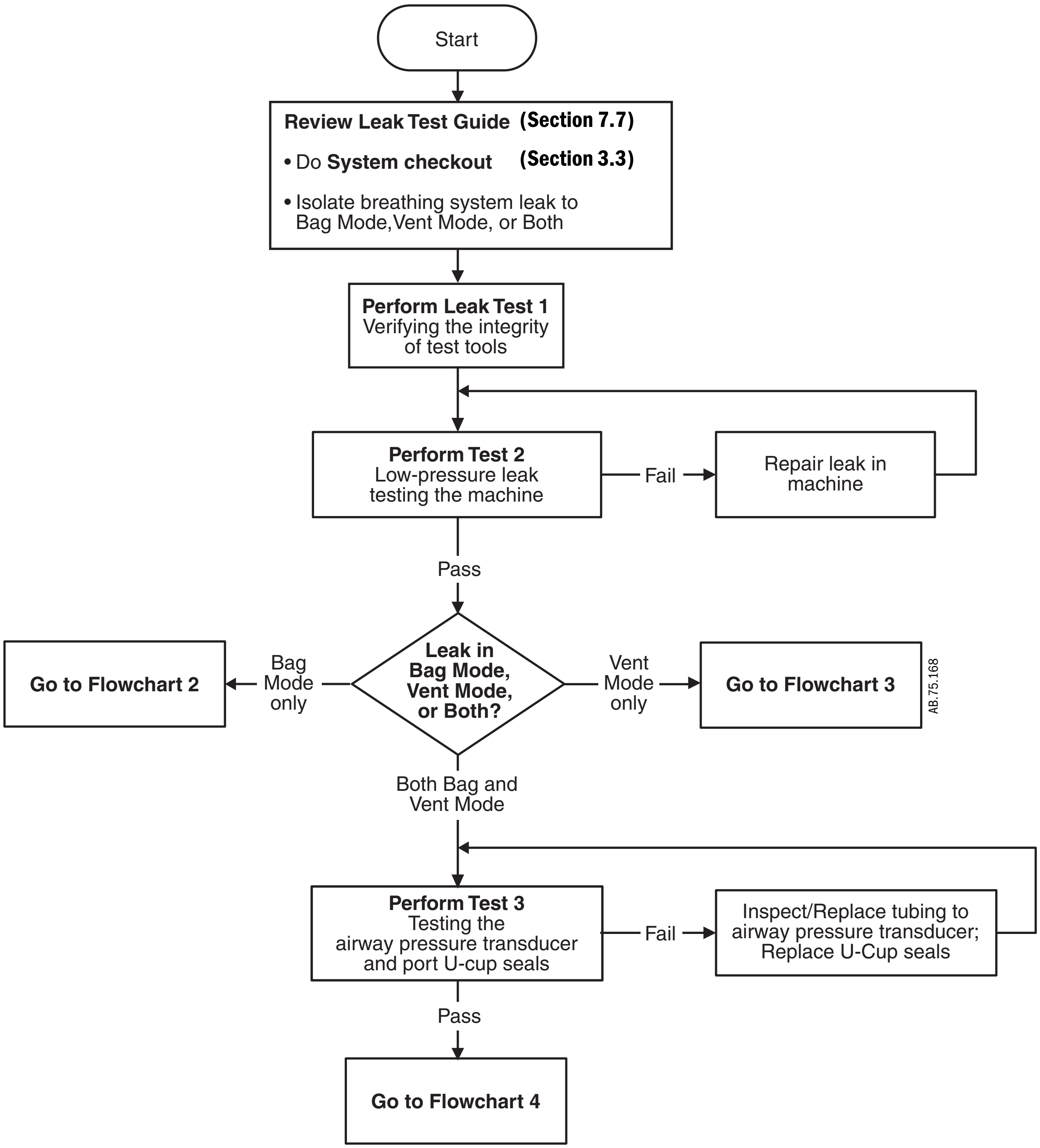
Inspiratory check valve

1. Set the system switch to On.
2. Set fresh gas flow to 200 ml/min (minimum).
3. If equipped with an ACGO, connect a tube between the ACGO outlet and the Inspiratory port.
   - Set the ACGO switch to the ACGO position.
   - Verify that the Airway Pressure reading increases to 10 cm H_2O in 30 seconds.
4. If not equipped with an ACGO, select End Case and connect a tube to the Inspiratory port.
   - Stretch the tube approximately 5 cm.
   - Occlude the open end of the tube.
   - Release the tension on the tube.
   - Ensure that the Airway Pressure reading increases to between 20 and 40 cm H_2O. If not, repeat the above steps, but stretch the tube a little further.
   - Verify that the Airway Pressure reading does not drop by more than 10 cm H_2O in 30 seconds.

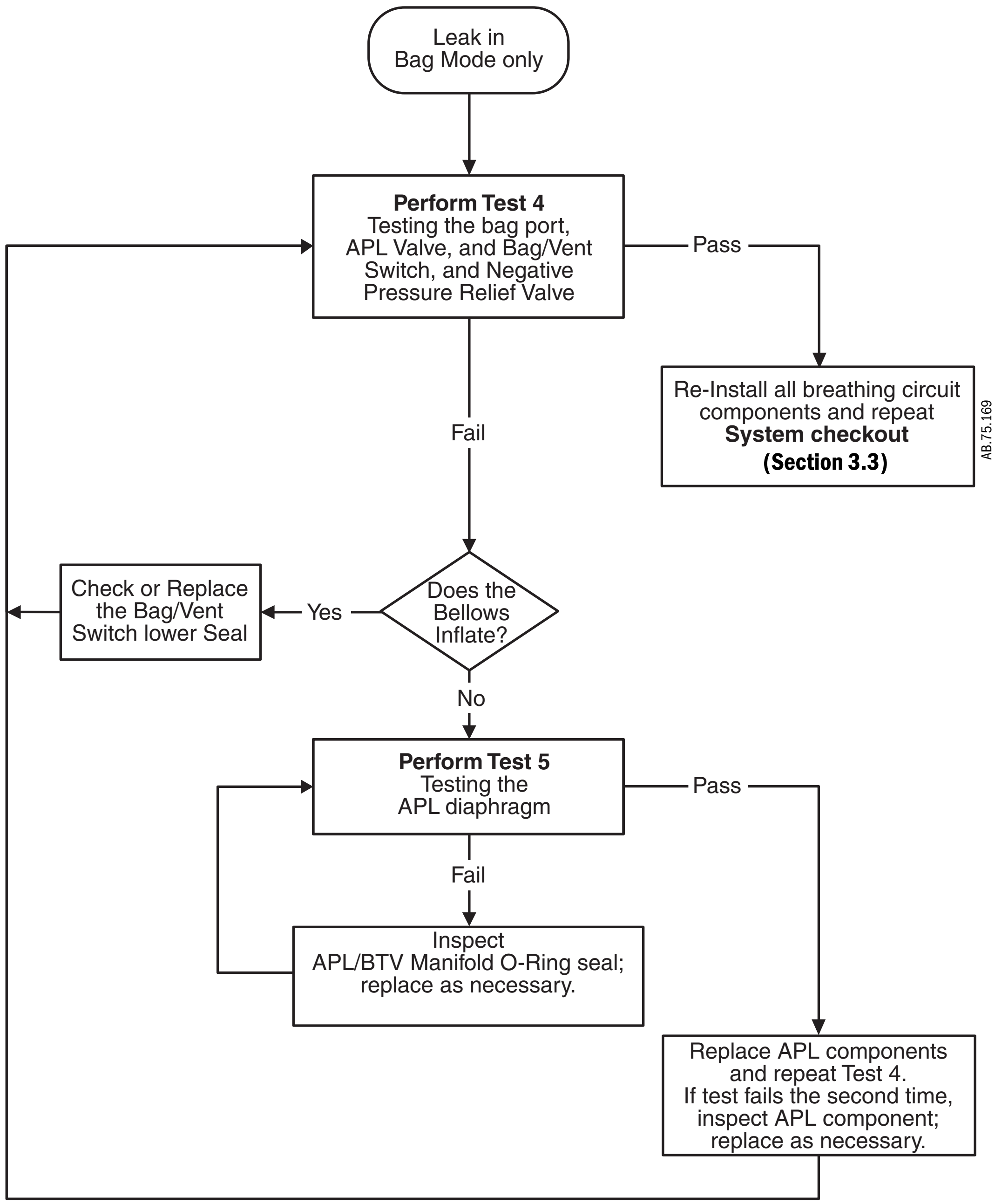
Expiratory check valve

1. Set all gas flows to minimum.
2. Set the Bag/Vent switch to Bag.
3. Fully close the APL valve (70 cm H_2O).
4. Connect a tube between the Inspiratory port and the Bag port.
5. Slowly increase the O_2 flow to achieve 30 cm H_2O.
   - The leak rate is equal to the flow needed to maintain 30 cm H_2O.
   - The leak rate should be less than 500 mL/min.

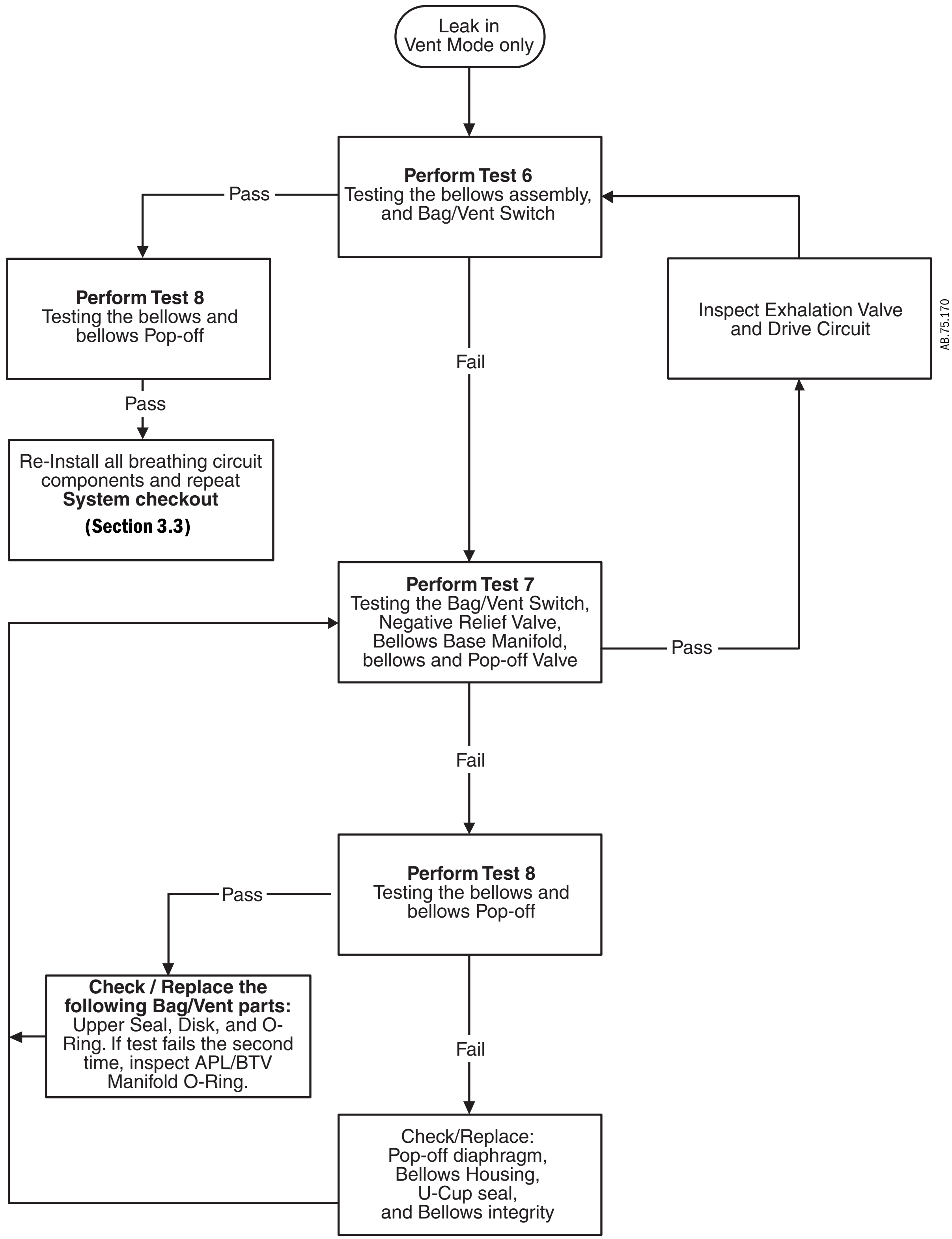
7.7.2 Breathing System Troubleshooting Flowcharts



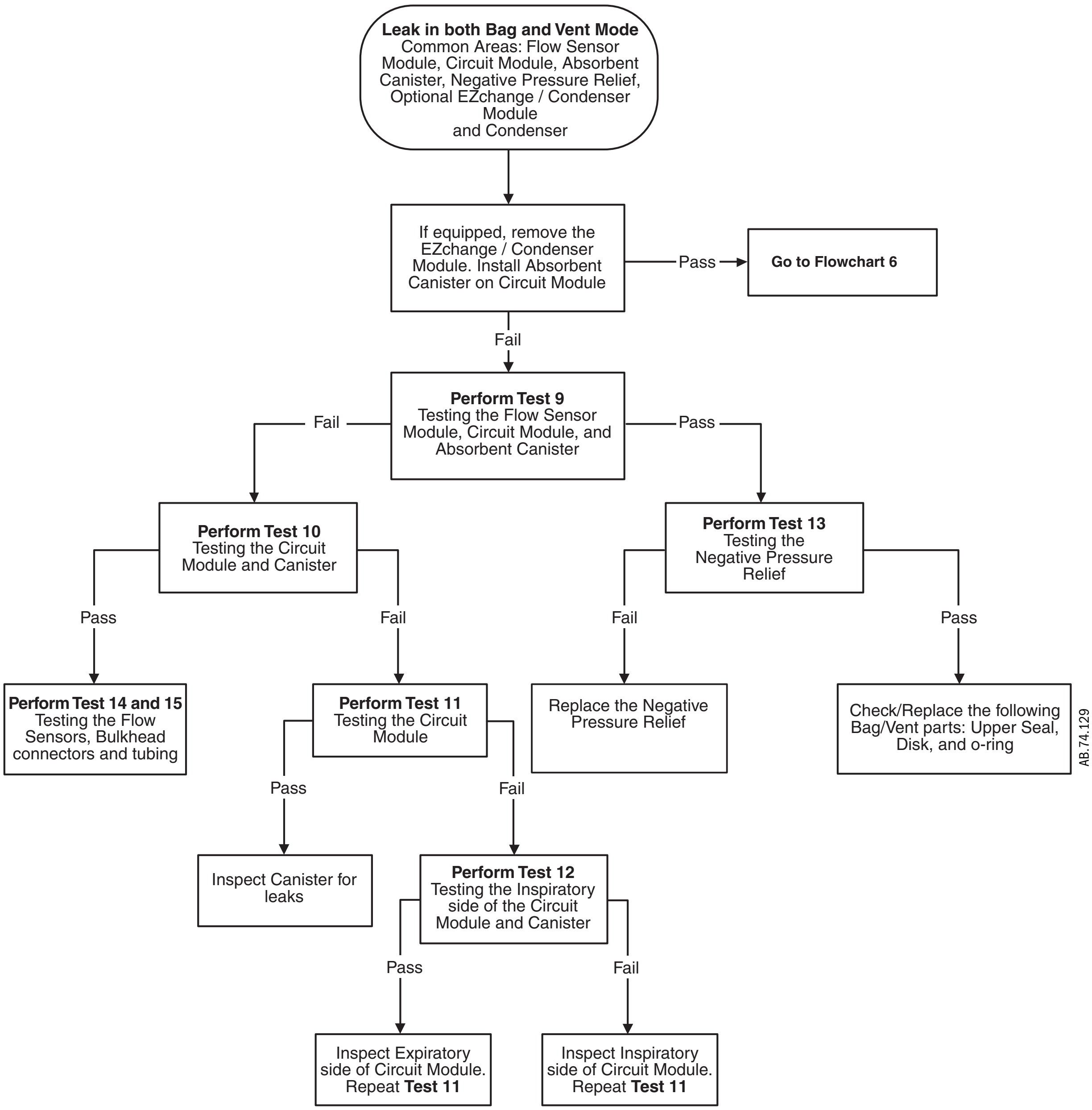
Flowchart **1**


Leak in
Bag Mode only
Perform Test 4
Testing the bag port,
APL Valve, and Bag/Vent
Switch, and Negative
Pressure Relief Valve
Pass
Re-Install all breathing circuit
components and repeat
System checkout
(Section 3.3)
AB.75.169
Fail
Does the
Bellows
Inflate?
Yes
Check or Replace
the Bag/Vent
Switch lower Seal
No
Perform Test 5
Testing the
APL diaphragm
Pass
Fail
Inspect
APL/BTV Manifold O-Ring seal;
replace as necessary.
Replace APL components
and repeat Test 4.
If test fails the second time,
inspect APL component;
replace as necessary.

Flowchart **2**

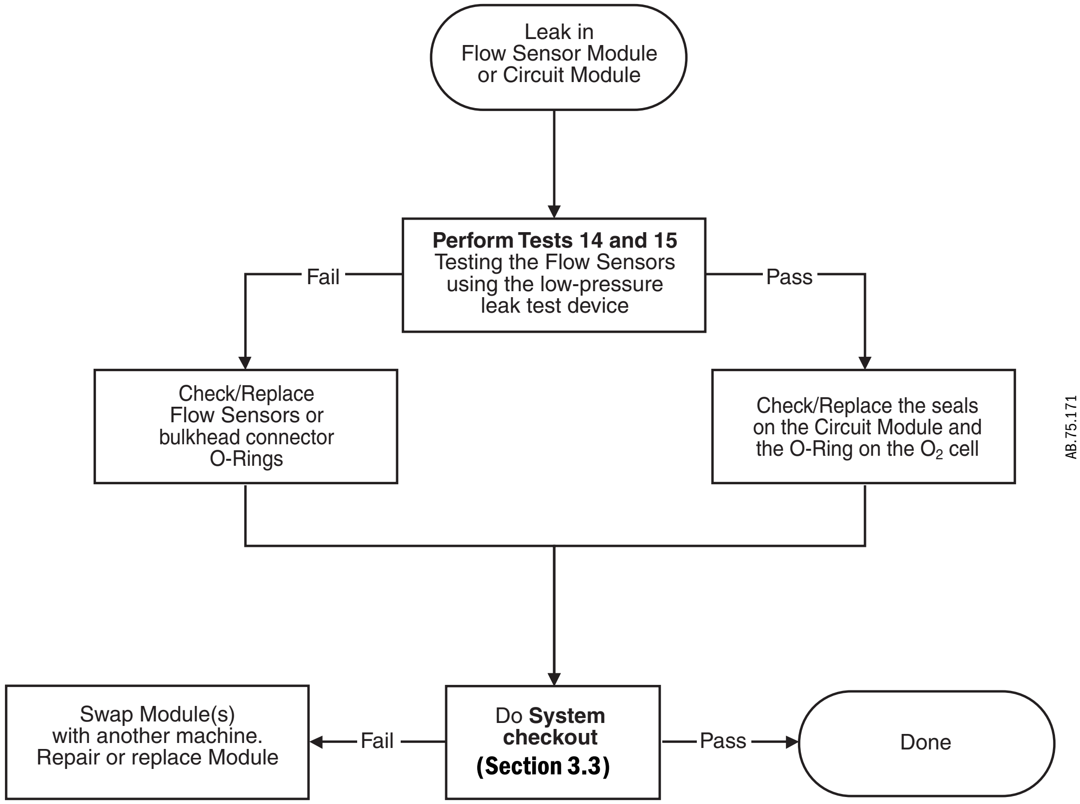

Leak in
Vent Mode only
Perform Test 6
Testing the bellows assembly, and Bag/Vent Switch
Pass
Fail
Perform Test 8
Testing the bellows and bellows Pop-off
Pass
Re-Install all breathing circuit components and repeat
System checkout
(Section 3.3)
Inspect Exhalation Valve and Drive Circuit
AB.75.170
Perform Test 7
Testing the Bag/Vent Switch, Negative Relief Valve, Bellows Base Manifold, bellows and Pop-off Valve
Pass
Fail
Perform Test 8
Testing the bellows and bellows Pop-off
Pass
Check / Replace the following Bag/Vent parts:
Upper Seal, Disk, and O-Ring. If test fails the second time, inspect APL/BTV Manifold O-Ring.
Fail
Check/Replace:
Pop-off diaphragm,
Bellows Housing,
U-Cup seal,
and Bellows integrity

Flowchart **3**

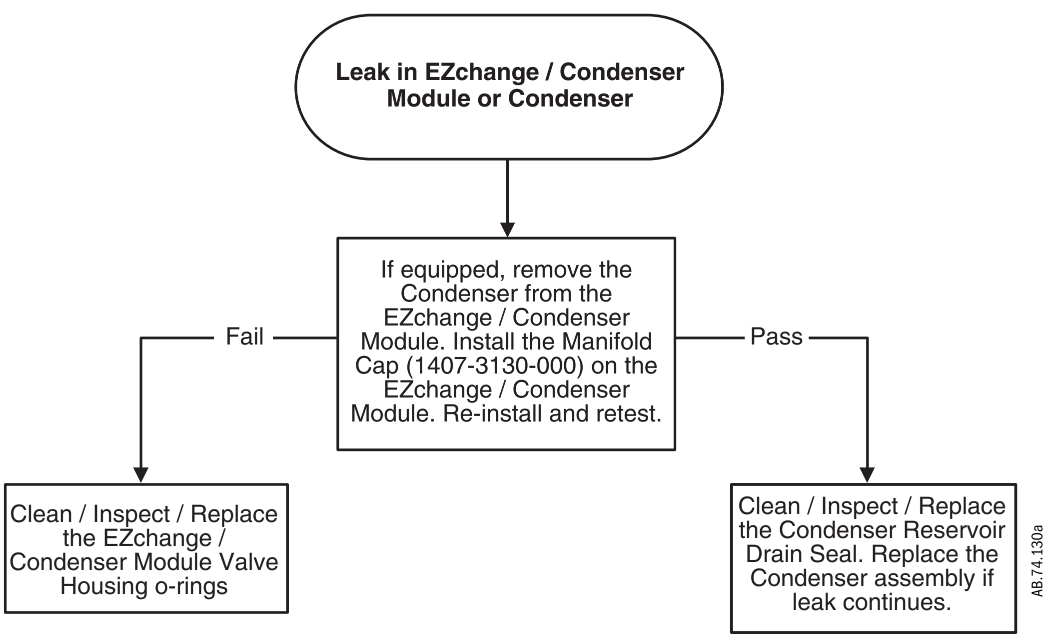


Leak in both Bag and Vent Mode
Common Areas: Flow Sensor Module, Circuit Module, Absorbent Canister, Negative Pressure Relief, Optional EZchange / Condenser Module and Condenser
If equipped, remove the EZchange / Condenser Module. Install Absorbent Canister on Circuit Module
Pass
Go to Flowchart 6
Fail
Perform Test 9
Testing the Flow Sensor Module, Circuit Module, and Absorbent Canister
Fail
Pass
Perform Test 10
Testing the Circuit Module and Canister
Perform Test 13
Testing the Negative Pressure Relief
Pass
Fail
Fail
Pass
Perform Test 14 and 15
Testing the Flow Sensors, Bulkhead connectors and tubing
Perform Test 11
Testing the Circuit Module
Replace the Negative Pressure Relief
Check/Replace the following Bag/Vent parts: Upper Seal, Disk, and o-ring
AB.74.129
Pass
Fail
Inspect Canister for leaks
Perform Test 12
Testing the Inspiratory side of the Circuit Module and Canister
Pass
Fail
Inspect Expiratory side of Circuit Module. Repeat **Test 11**
Inspect Inspiratory side of Circuit Module. Repeat **Test 11**

Flowchart 4



Flowchart **5**



Flowchart **6**

7.7.3 Leak Isolation Tests

The previous flowcharts refer you to the following tests.

These tests require the use of the Low Pressure Leak Test Device and the Leak Test Tool Kit (refer to Section 10.1, "Service tools").

The Leak Test Tool Kit includes:
- the Machine Test Tool
- the Circuit Test Tool
- and various Test Plugs

When performing these tests on machines with an ACGO outlet, ensure that the ACGO selector switch is set to the ABS (Circle circuit) position.

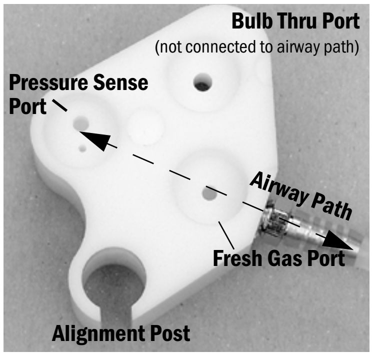
Note To perform most of these tests, you must boot the system with the PC Service Application and access the diagnostics functions as described in the test.

⚠ WARNING Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:
- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

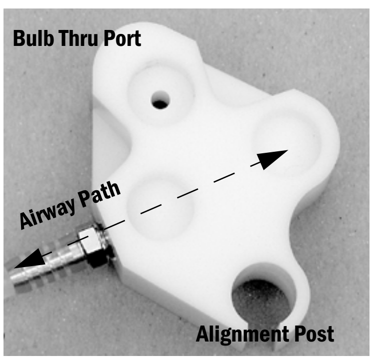
⚠ CAUTION Do not use O_2 Flush for leak isolation tests. Do not leave pressurized systems unattended. High pressure and equipment damage may result.

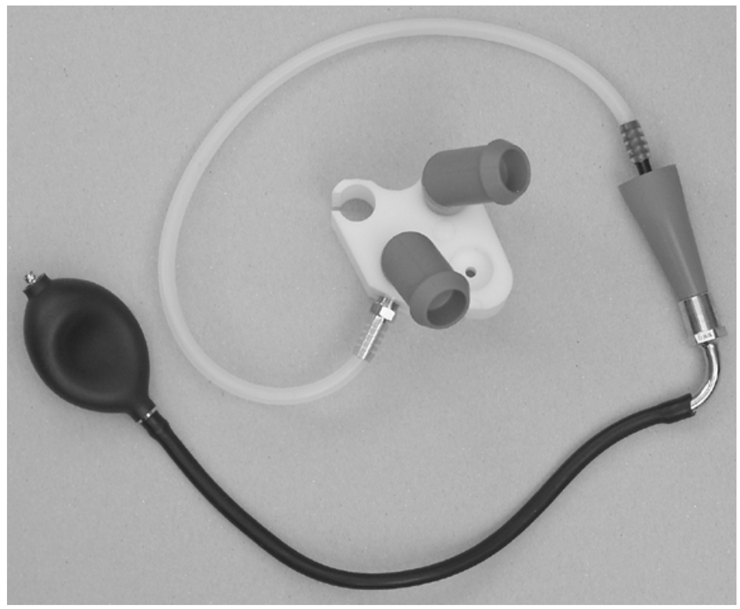
Test 1 Verifying the integrity of the test tools

Machine Test Tool
Front View

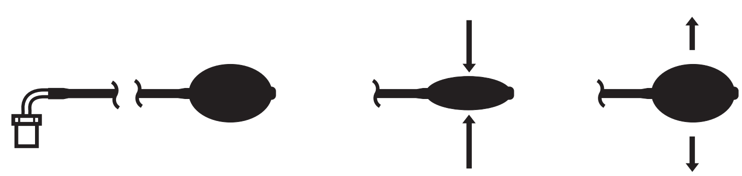


Back View



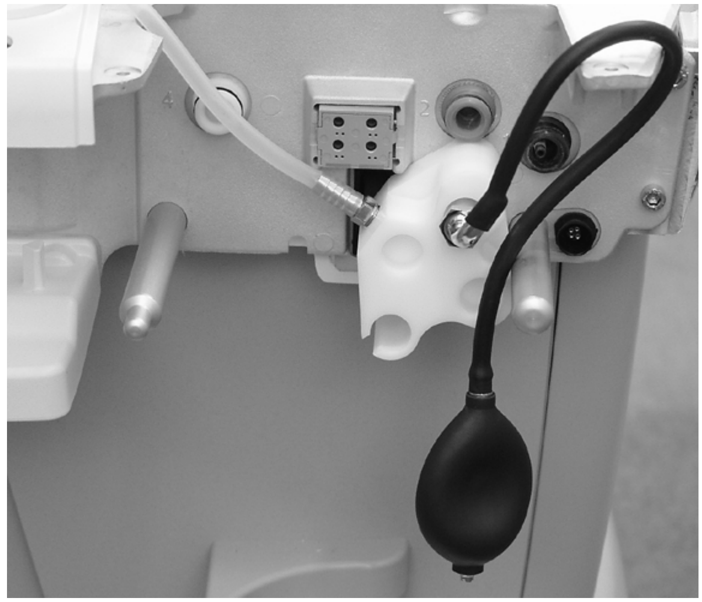


1. Verify integrity of low-pressure leak test device.
   - Put your hand on the inlet of the leak test device. Push hard for a good seal.
   - Squeeze the bulb to remove all air from the bulb.
   - If the bulb completely inflates in less than 60 seconds, replace the leak test device.



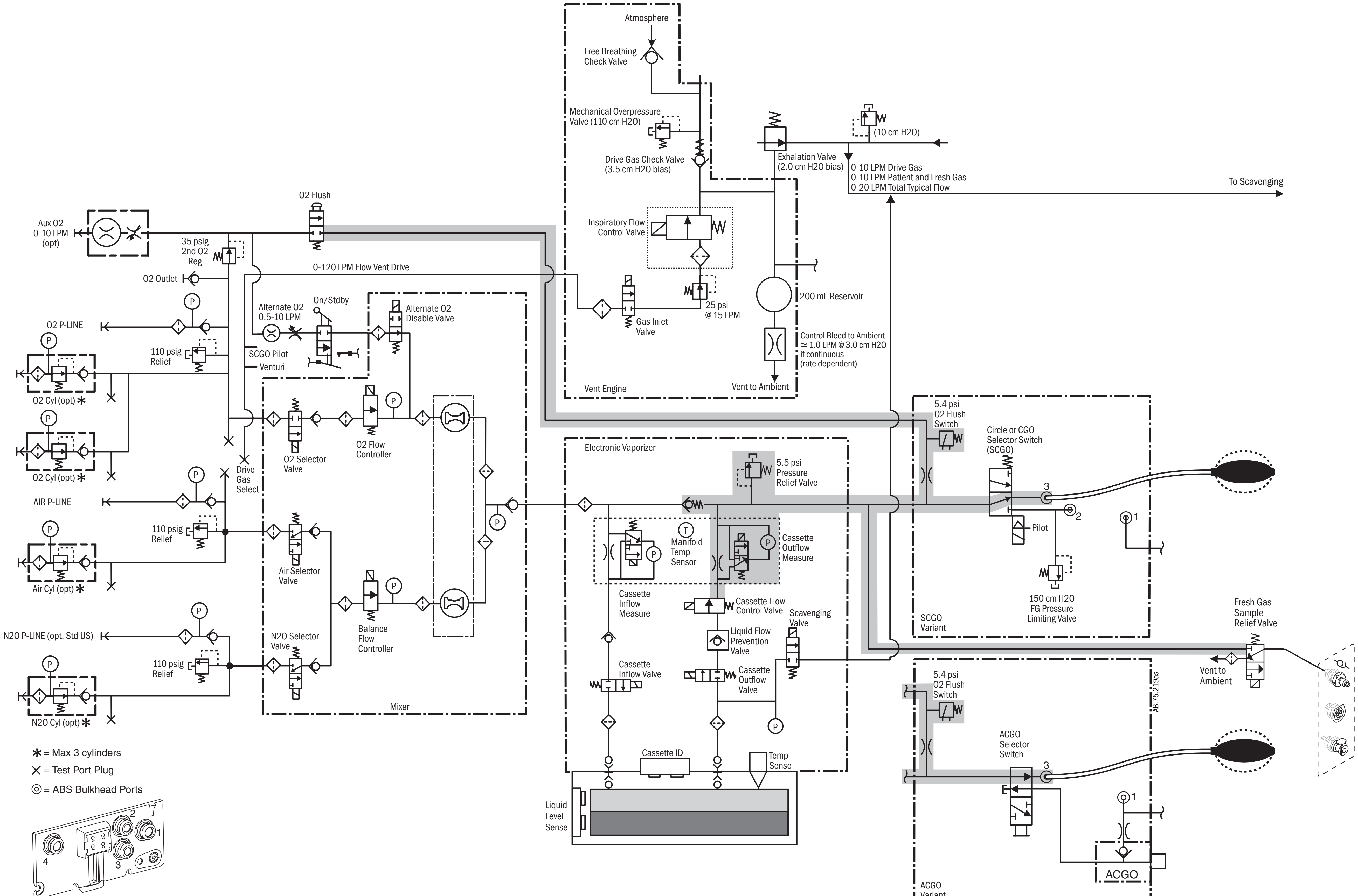
2. Attach the low-pressure leak test device to the Machine Test Tool.
3. Plug the two pressure orifices.
4. Repeatedly squeeze and release the hand bulb until it remains collapsed.
5. If the bulb inflates in less than 30 seconds, locate and correct the leak.

Test 2 Low-pressure leak testing the machine



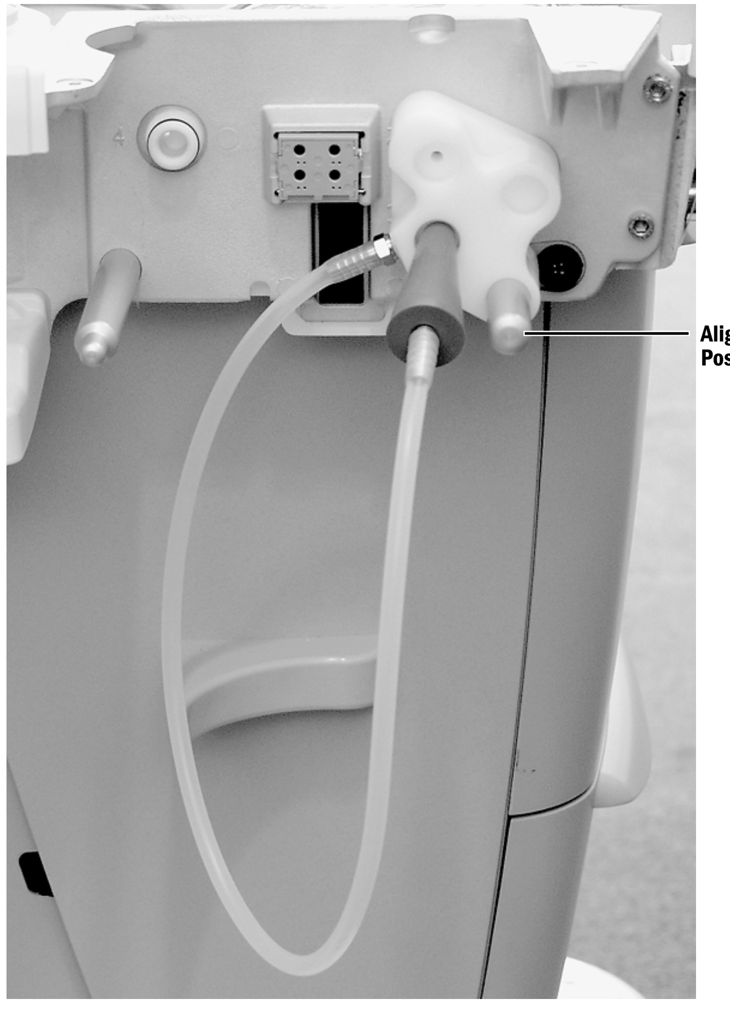
1. Remove the breathing system from the machine.
2. Attach the Machine Test Tool (using only the Thru Port) and the low-pressure leak test device to **Port 3** of the breathing system interface as shown above.

   Note: To prevent damage to the airway pressure transducer, ensure that the gauge port (**Port 1**) is not connected to the Test Tool.
3. Access the Ventilation Schematic (Section 12.3.3) of the Service Application.
4. Ensure that the ***Circuit Setting*** is set to Circle.
   - For machines with an ACGO outlet, ensure that the ACGO selector switch is set to the ABS (circle breathing circuit).
5. Compress and release the bulb until it is empty.
6. If the bulb completely inflates in 30 seconds or less, there is a leak in the low-pressure circuit.

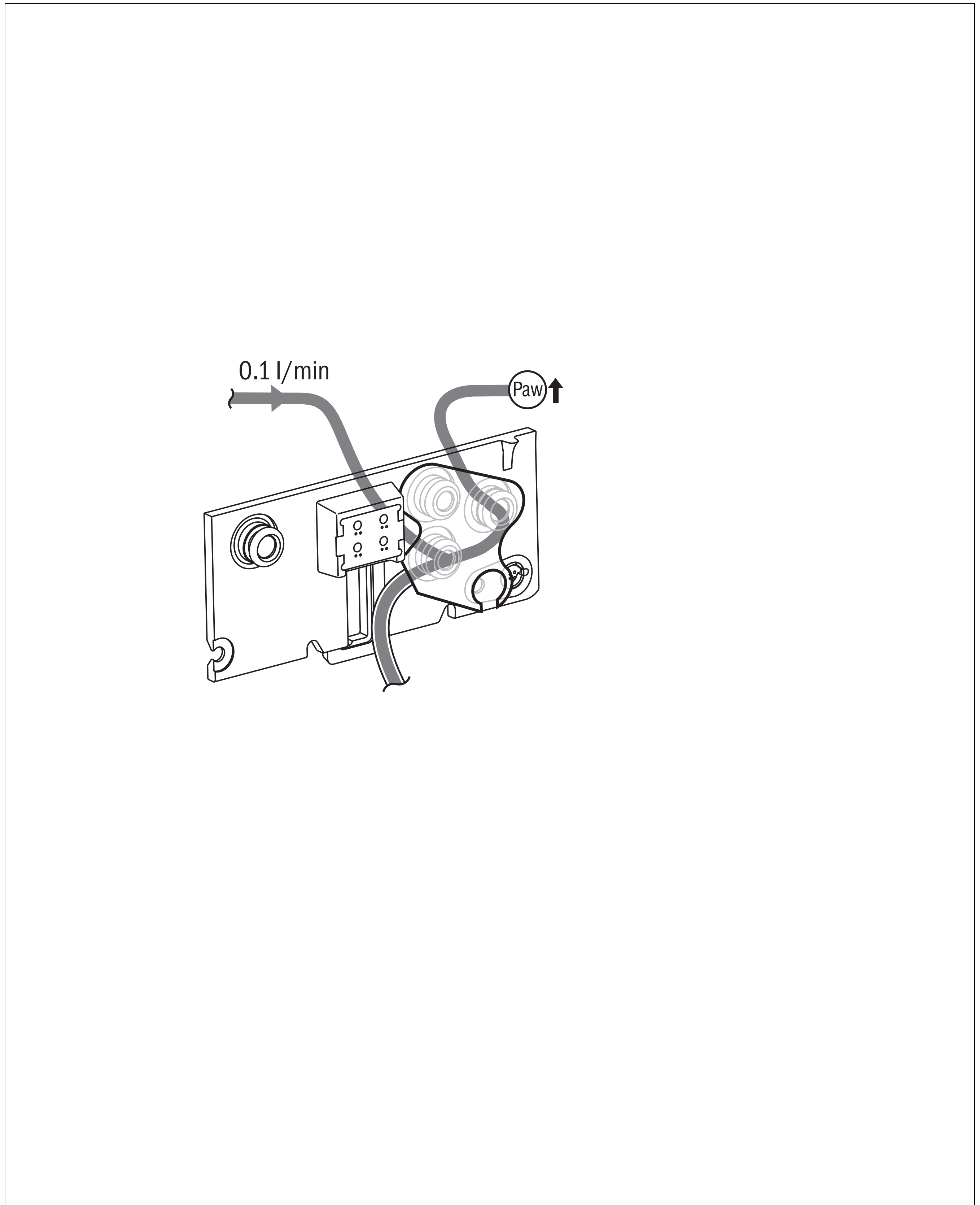


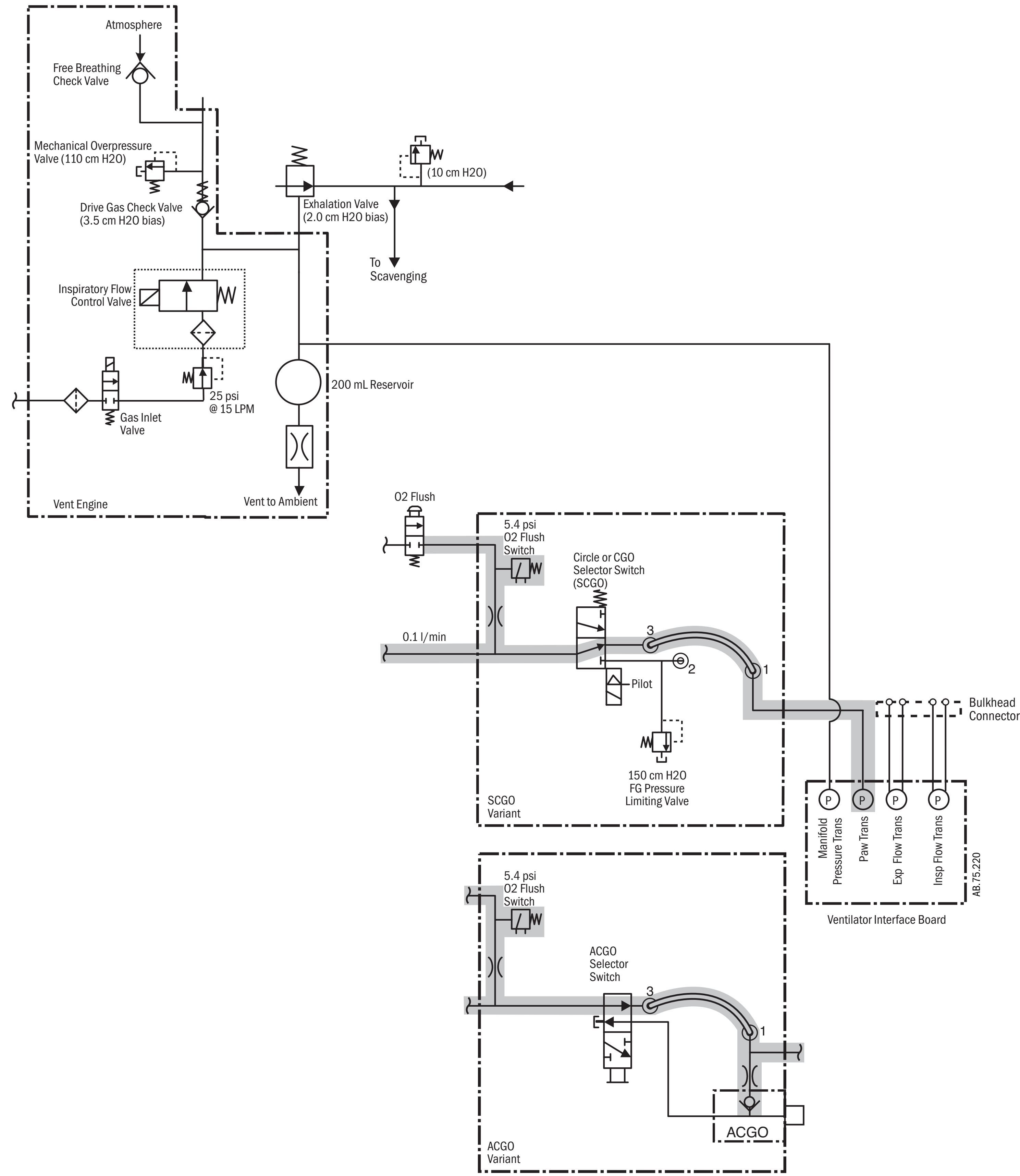
Test-2 • Low-pressure leak testing the machine

Test 3 Testing the airway pressure transducer, and Port 1 and Port 3 u-cup seals



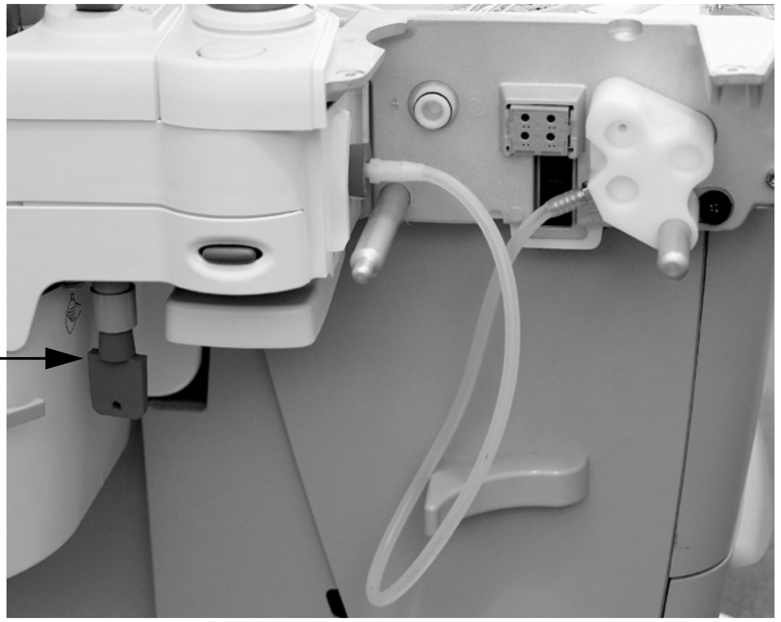
1. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
2. Set O_2 Flow to **0.15 l/min**.
3. Attach the Machine Test Tool to the breathing system interface ports (using the alignment post) as shown above.
4. Occlude the tapered plug.
   - the Airway Pressure reading should increase.
   - If not, there is a leak in the tested circuit.
5. Set O_2 Flow to 0.00 l/min.





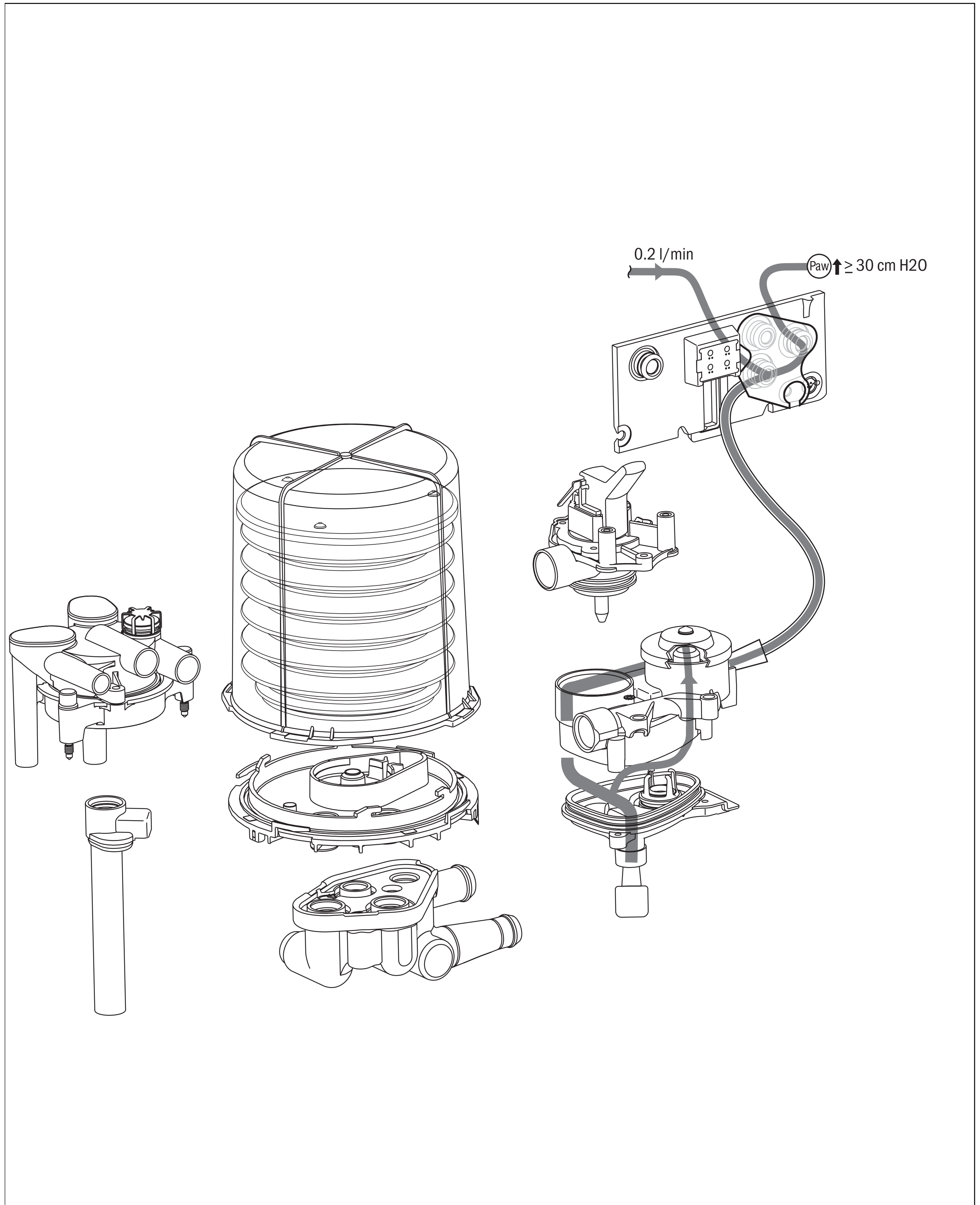
Test-3 ▪ *Testing the airway pressure transducer, and Port 1 and Port 3 u-cup seals*

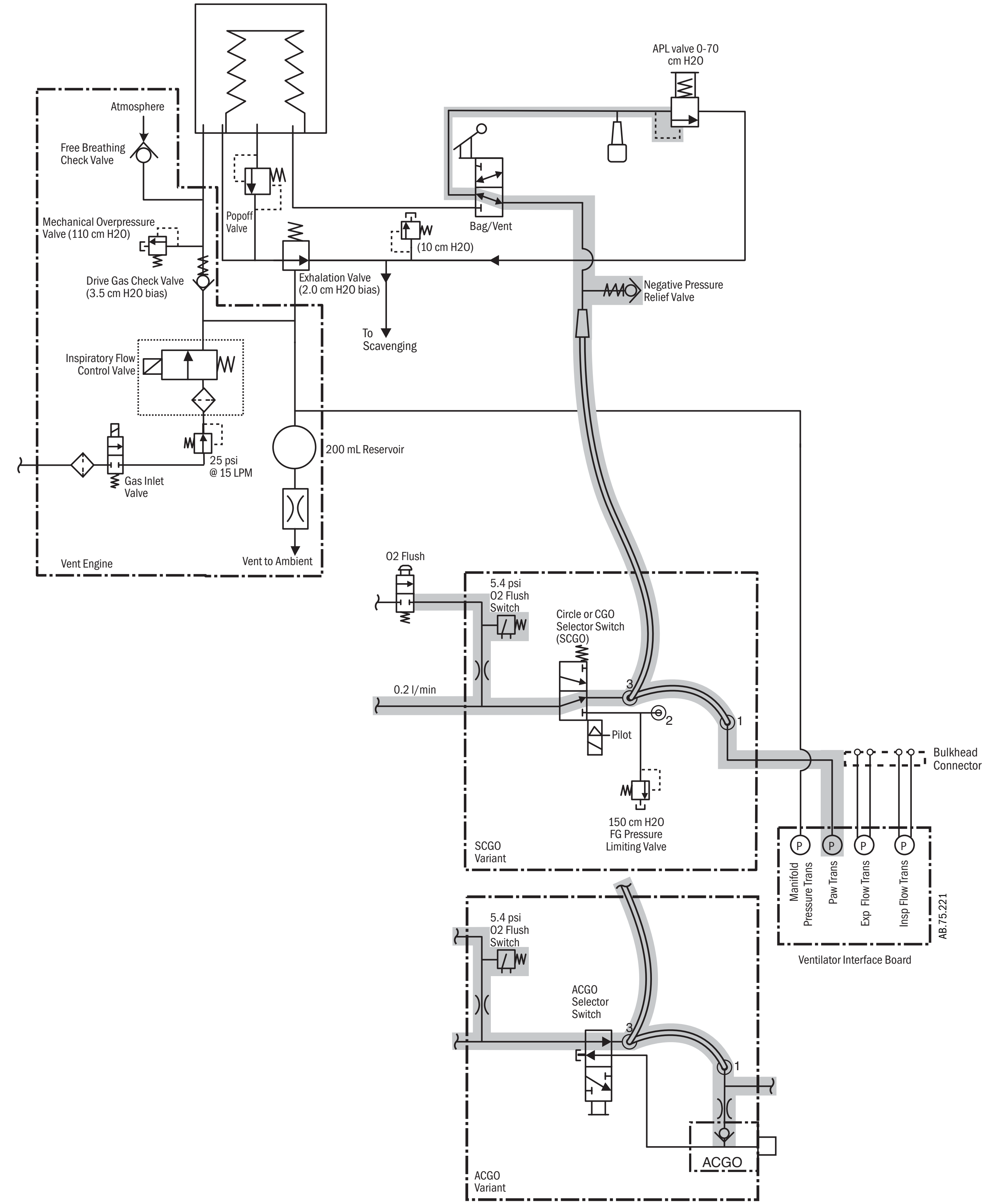
Test 4 Testing the bag port cover, the APL valve, the Bag/Vent switch, and the negative pressure relief valve



1. Separate the Bellows Module from the Circuit Module and re-install the Bellows Module.
2. Occlude the Bag Port connector.
3. Connect the Machine Test Tool to the interface ports as shown above.
4. Set the Bag /Vent switch to Bag and close the APL Valve (70 cm H_2O).
5. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
6. Set O_2 Flow to **0.2 l/min**.
   - Ensure that the Airway Pressure, as viewed on the gas schematic, rises to ≥ 30 cm H2O.

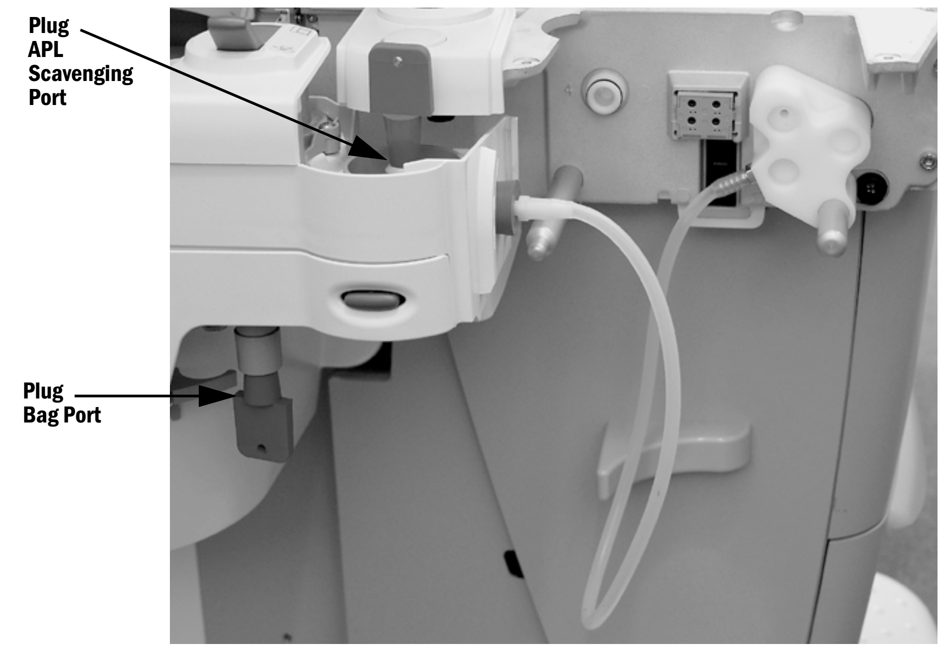
   Note: If the bellows rises, it indicates a leak in the Bag /Vent Switch.
7. Set O_2 Flow to 0.00 l/min.





Test-4 ▪ Testing the bag port cover, the APL valve, the Bag/Vent switch, and the negative pressure relief valve

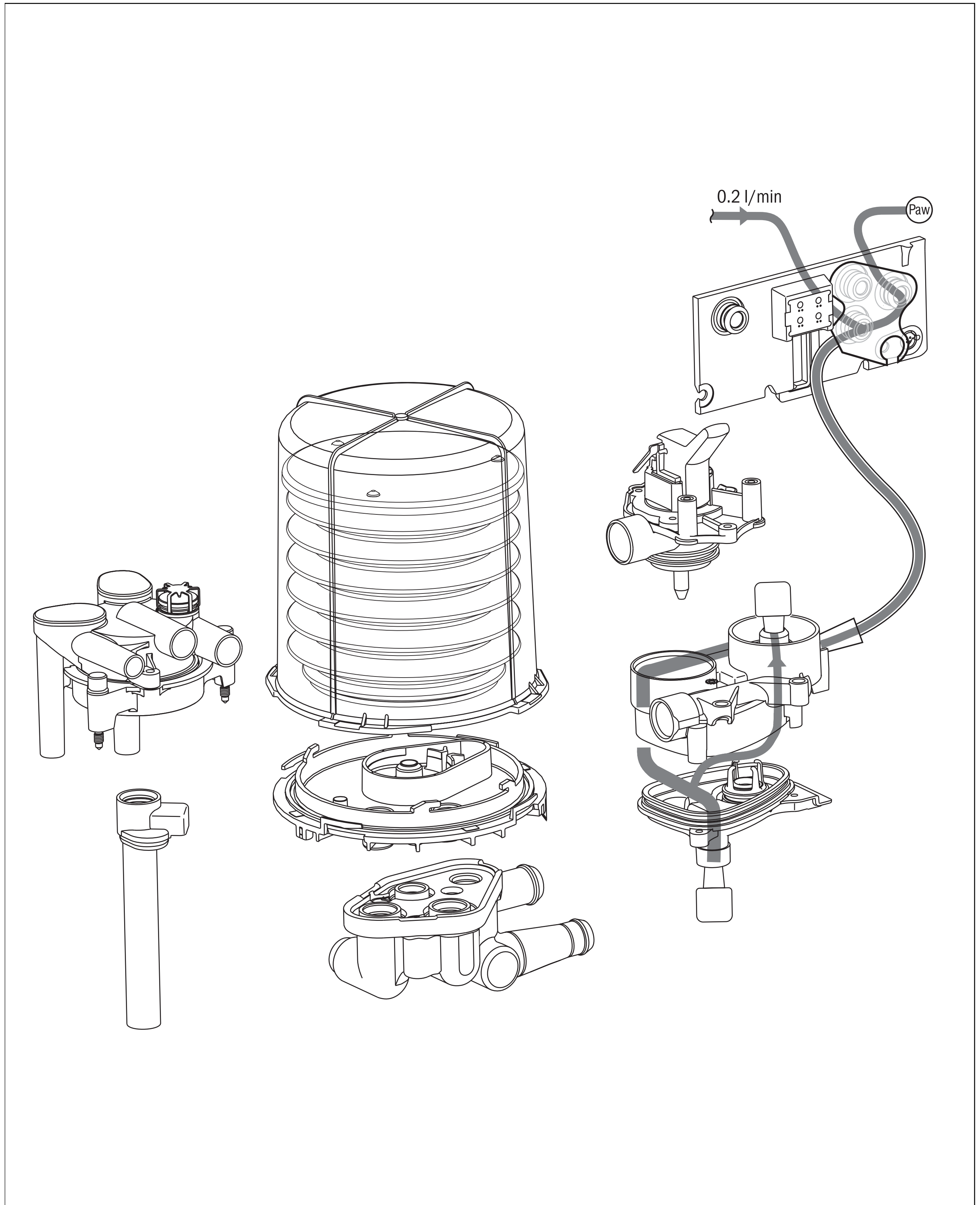
Test 5 Testing the APL diaphragm

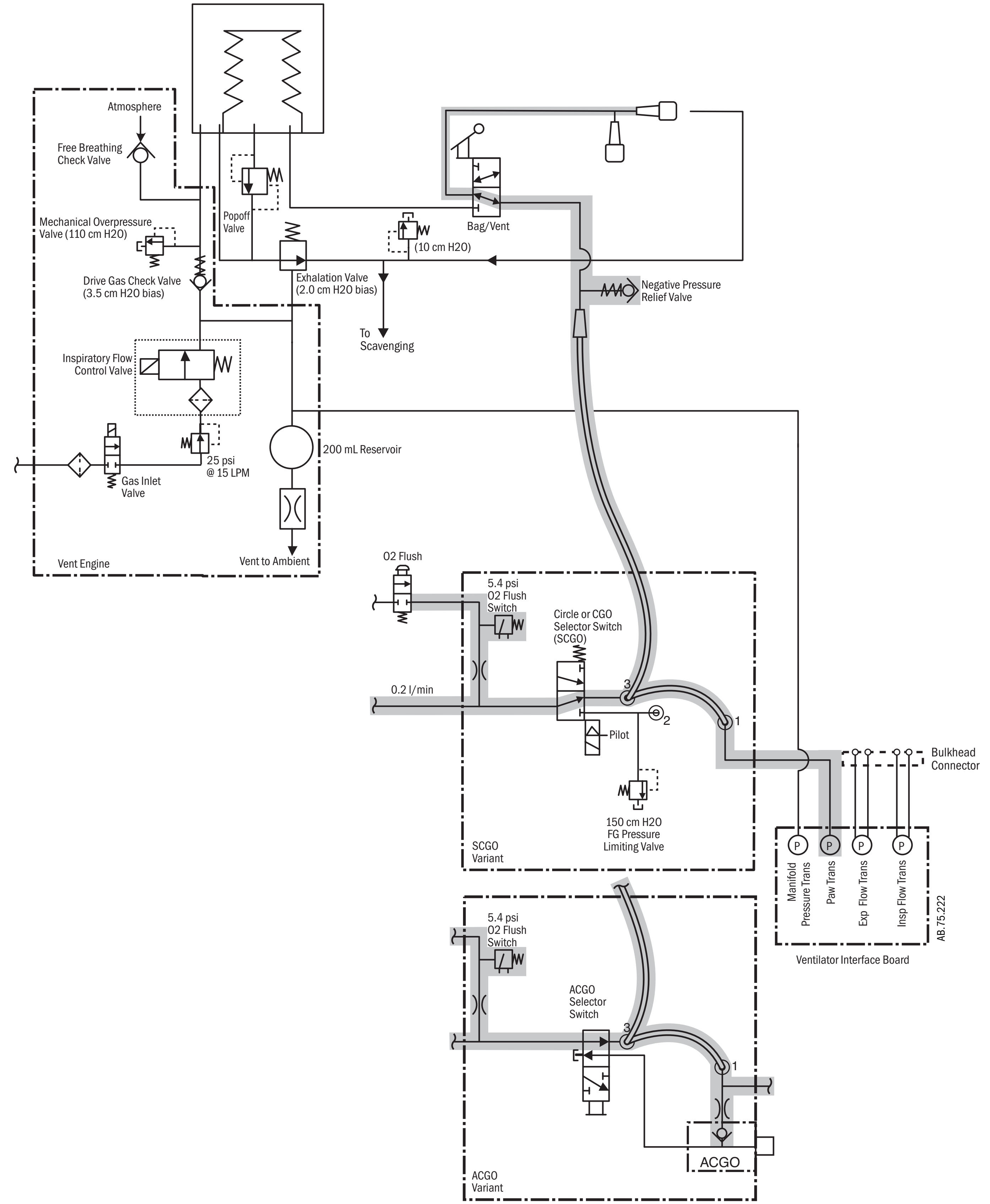


Note If required, set up the Machine Test Tool and breathing system as shown in Test 4.

1. Slide the Bellows Module away from the machine.
2. Remove the APL ramp and diaphragm.
3. Insert a Test Plug into the APL scavenging port, as shown above.
4. Slide the Bellows Module partially back onto the machine casting.
5. Ensure that the Bag Port is plugged and that the Bag/Vent switch is set to Bag.
6. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
7. Set O_2 Flow to **0.2 l/min**.
   - Ensure that the Airway Pressure, as viewed on the gas schematic, rises to ≥ 30 cm H2O.

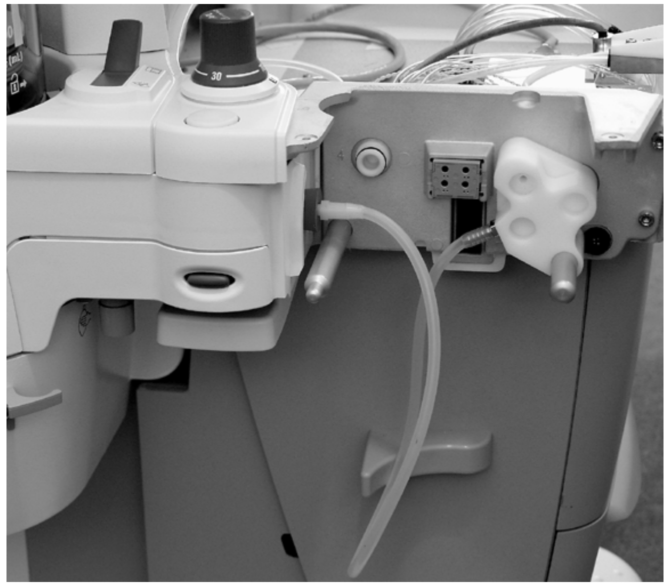
   Note: If the bellows rises, it indicates a leak in the Bag /Vent Switch.
8. Set O_2 Flow to 0.00 l/min.



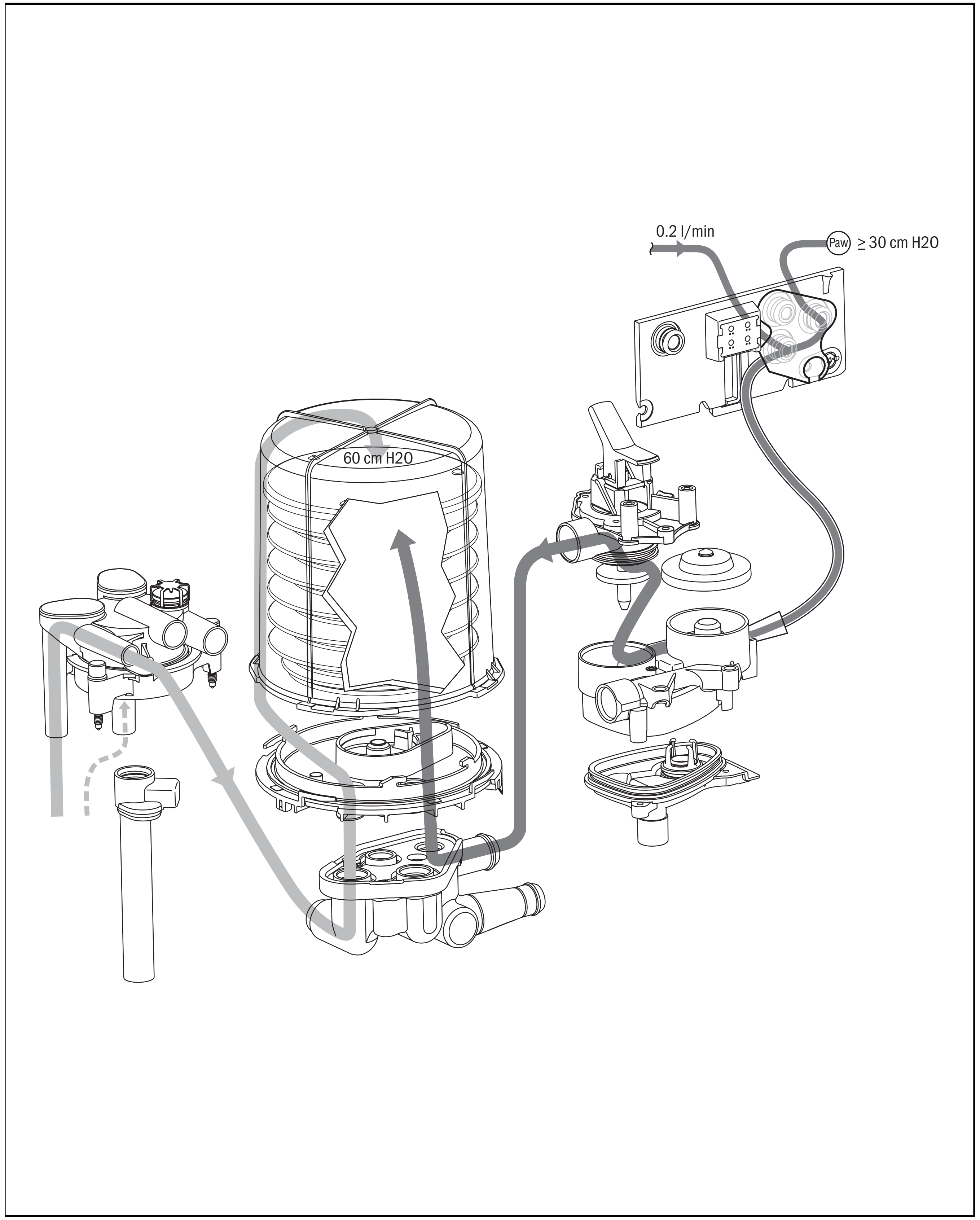


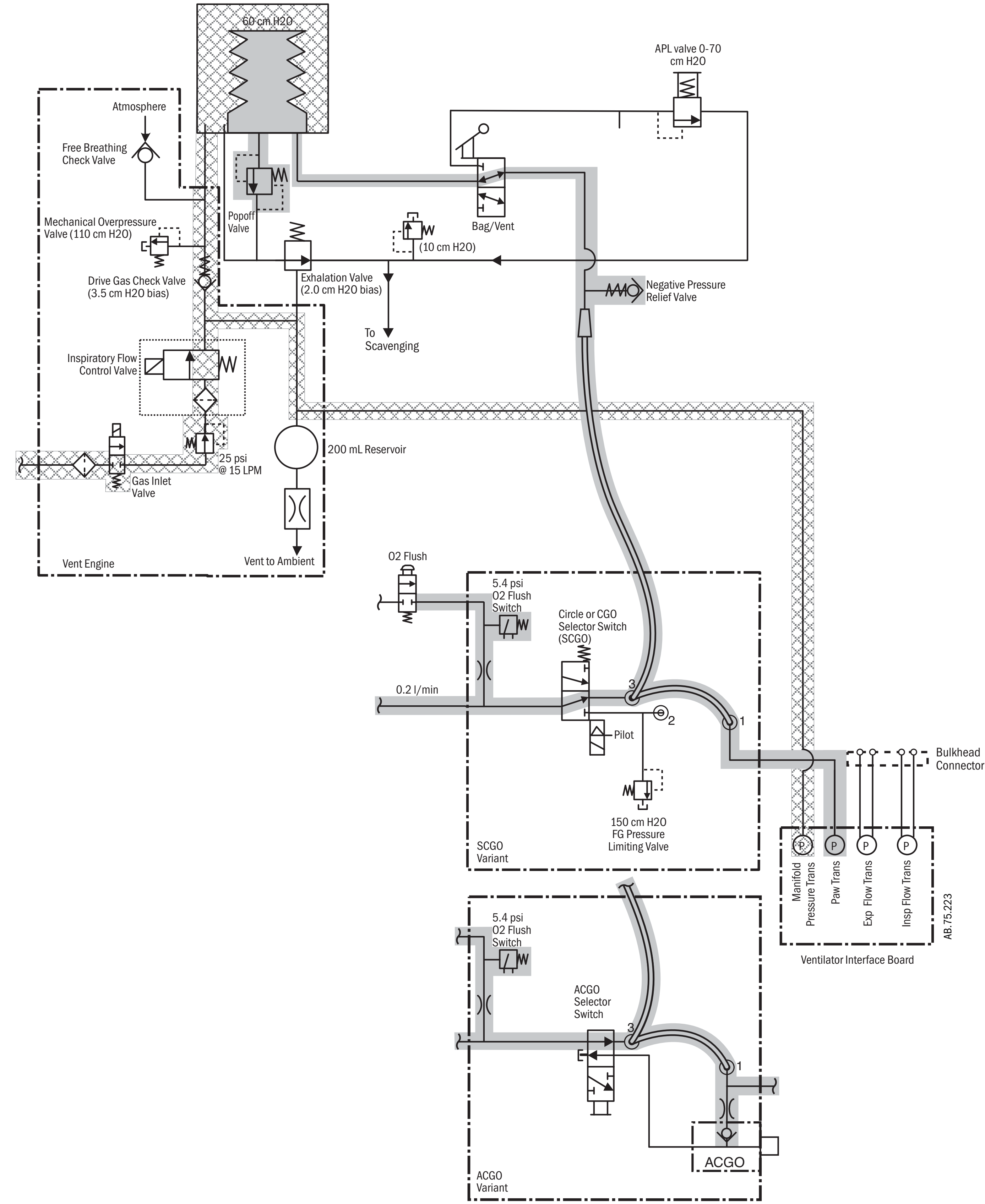
Test-5 ▪ Testing the APL diaphragm

Test 6 Testing the bellows module and the Bag/Vent switch



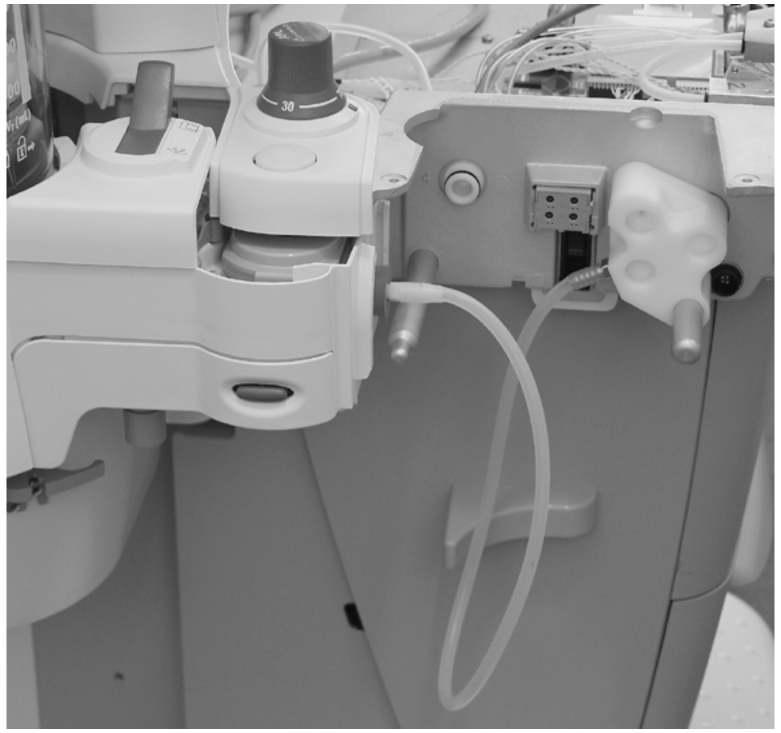
1. Separate the Bellows Module from the Circuit Module and re-install the Bellows Module.
2. Connect the Machine Test Tool to the interface ports as shown above.
3. Set the Bag/Vent switch to the Vent position.
4. Access the Ventilator Schematic (Section 12.3.3) of the Service Application.
5. Set ***Gas Inlet Valve*** to ***On***.
6. Set ***Insp Flow Valve*** to approximately 900 to 950 counts to achieve a Manifold Pressure of 60 cm H_2O.
7. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
8. Set O_2 Flow to **0.2 l/min**.
   - Ensure that the Airway Pressure, as viewed on the gas schematic, rises to ≥ 30 cm H2O.
9. Set O_2 Flow to 0.00 l/min.
10. Set ***Gas Inlet Valve*** to ***Off***.

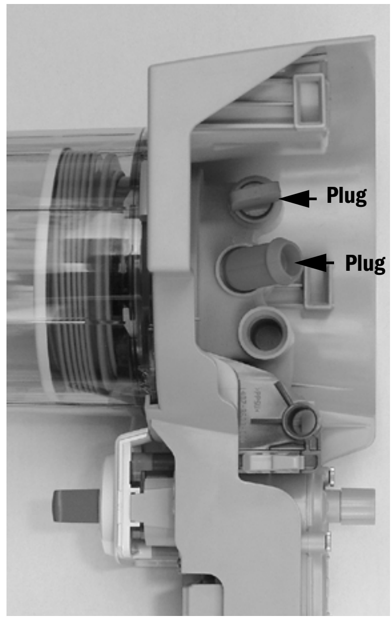




Test-6 ▪ Testing the bellows module and the Bag/Vent switch

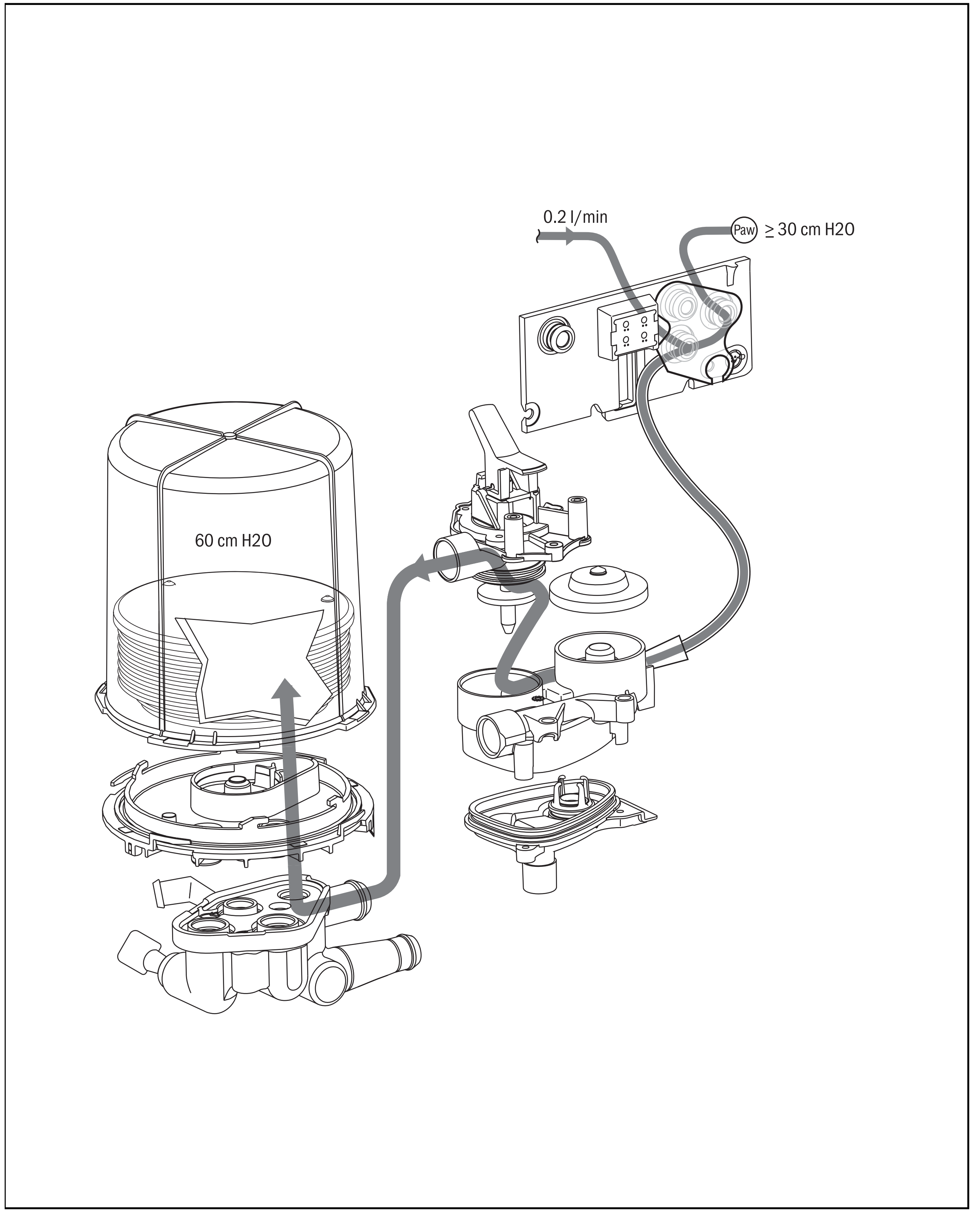
Test 7 Testing the bellows, the bellows pop-off valve, the bellows base manifold, and the Bag/Vent switch

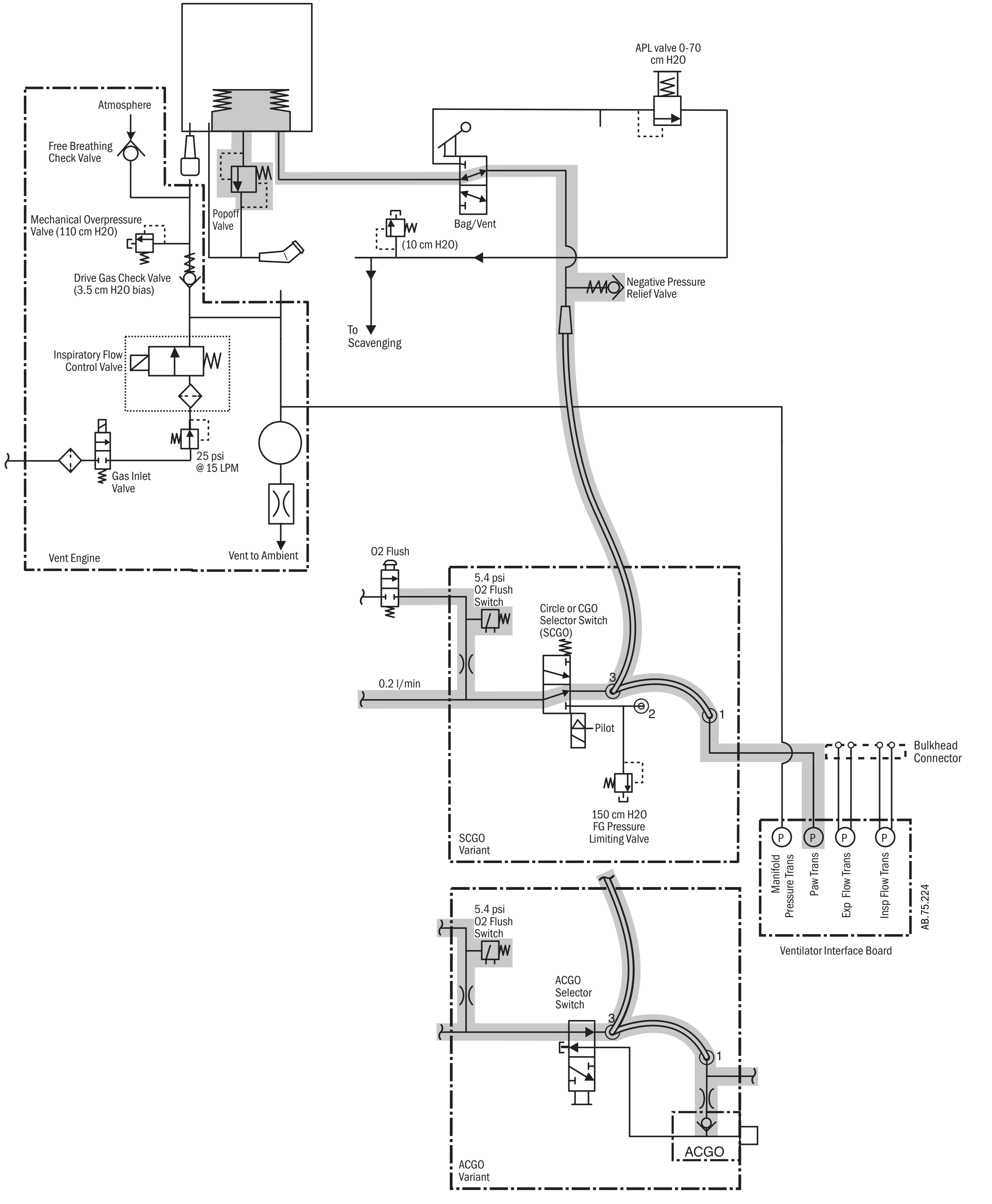




1. Separate the Bellows Module from the Circuit Module.
2. Insert appropriate test plugs into the bellows base manifold as shown to the left.

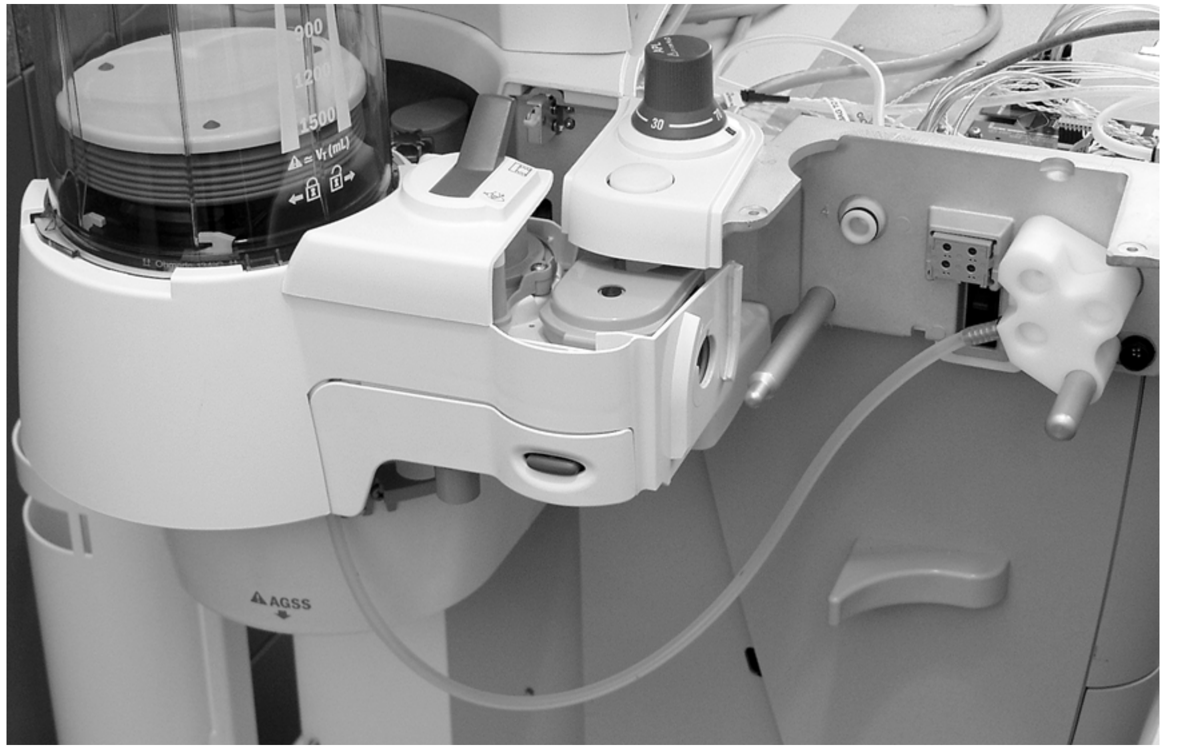
   Note: Position the bellows assembly so that the bellows remain collapsed as you plug the ports.
3. Set Bag/Vent switch to Vent.
4. Position the bellows upright with the bellows collapsed.
5. Connect the Machine Test Tool to the interface ports as shown above.
6. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
7. Set O_2 Flow to **0.2 l/min**.
   - Ensure that the Airway Pressure, as viewed on the gas schematic, rises to ≥ 30 cm H2O.
8. Set O_2 Flow to 0.00 l/min.



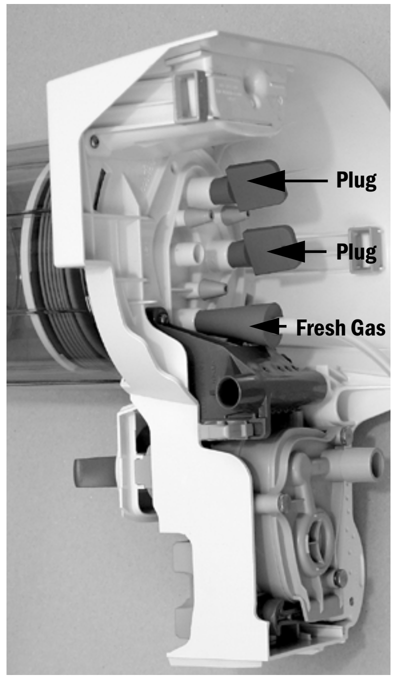


Test-7 ▪ Testing the bellows, the bellows pop-off valve, the bellows base manifold, and the Bag/Vent switch

Test 8 Testing the bellows assembly

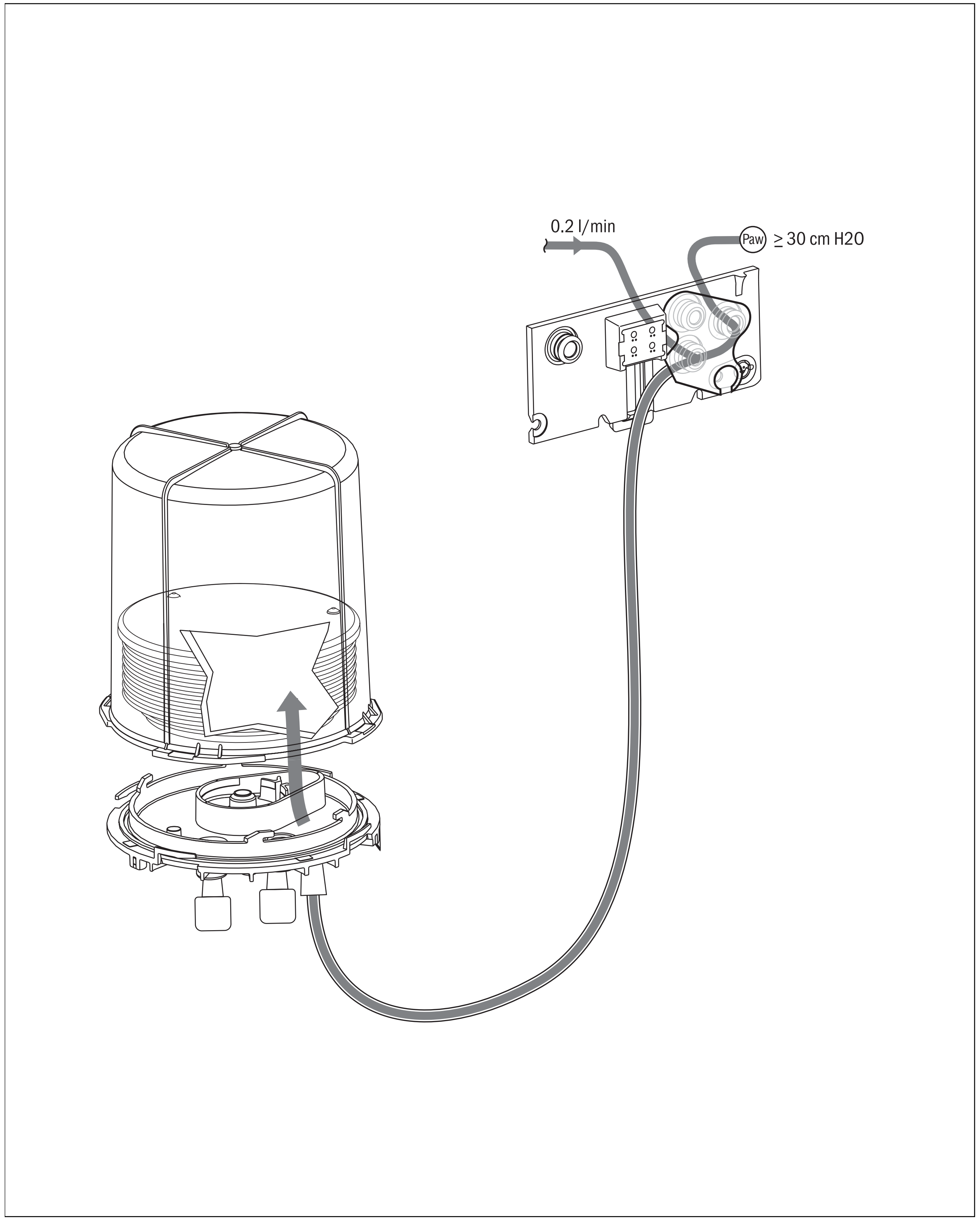


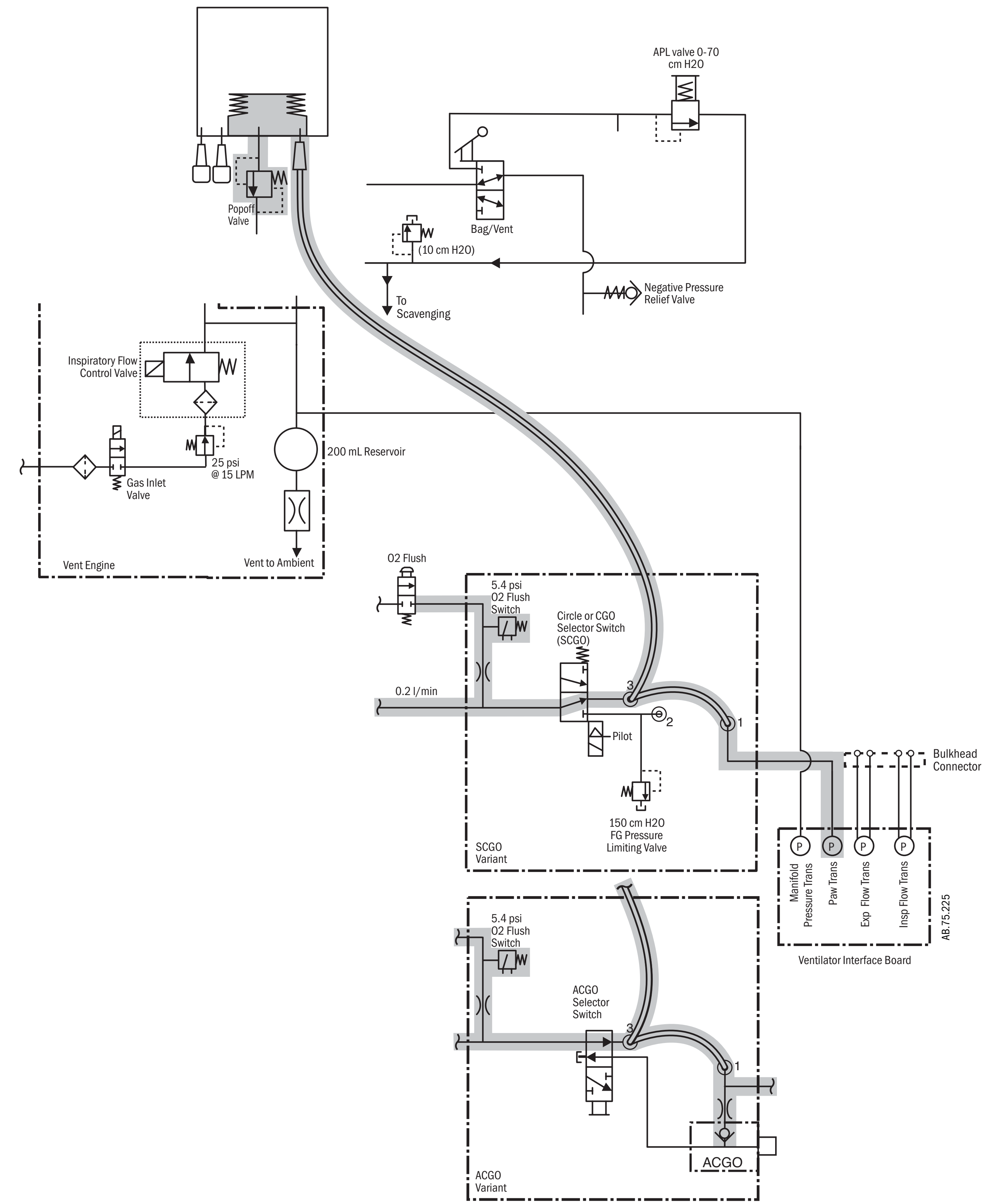
Note If required, set up the Machine Test Tool and breathing system as shown in Test 7.



1. Remove the bellows base manifold from the Bellows Module.
2. Insert appropriate test plugs into the bellows base manifold as shown to the left.

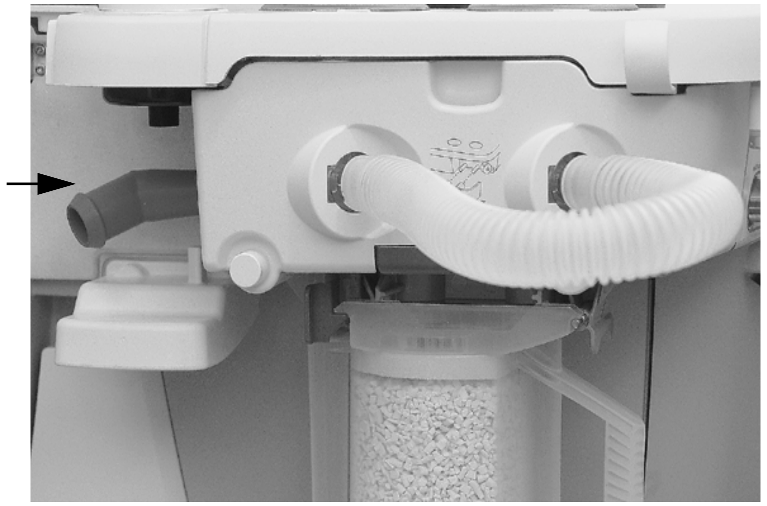
   Note: Position the bellows assembly so that the bellows remain collapsed as you plug the ports.
3. Connect the tapered plug of the Machine Test Tool to the bellows base inlet as shown to the left.
4. Position the bellows upright with the bellows collapsed.
5. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
6. Set O_2 Flow to **0.2 l/min**.
   - Ensure that the Airway Pressure, as viewed on the gas schematic, rises to ≥ 30 cm H2O.
7. Set O_2 Flow to 0.00 l/min.



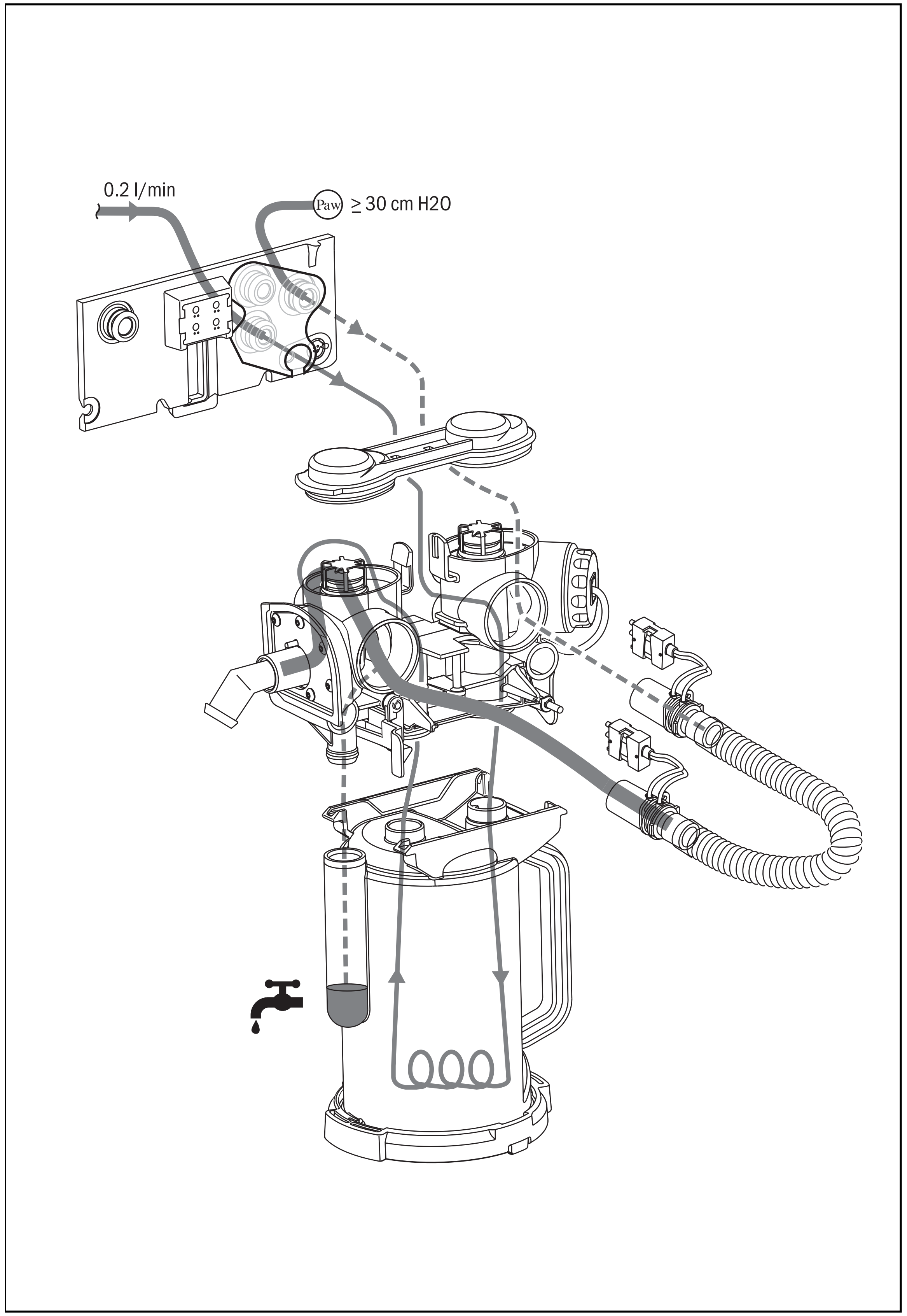


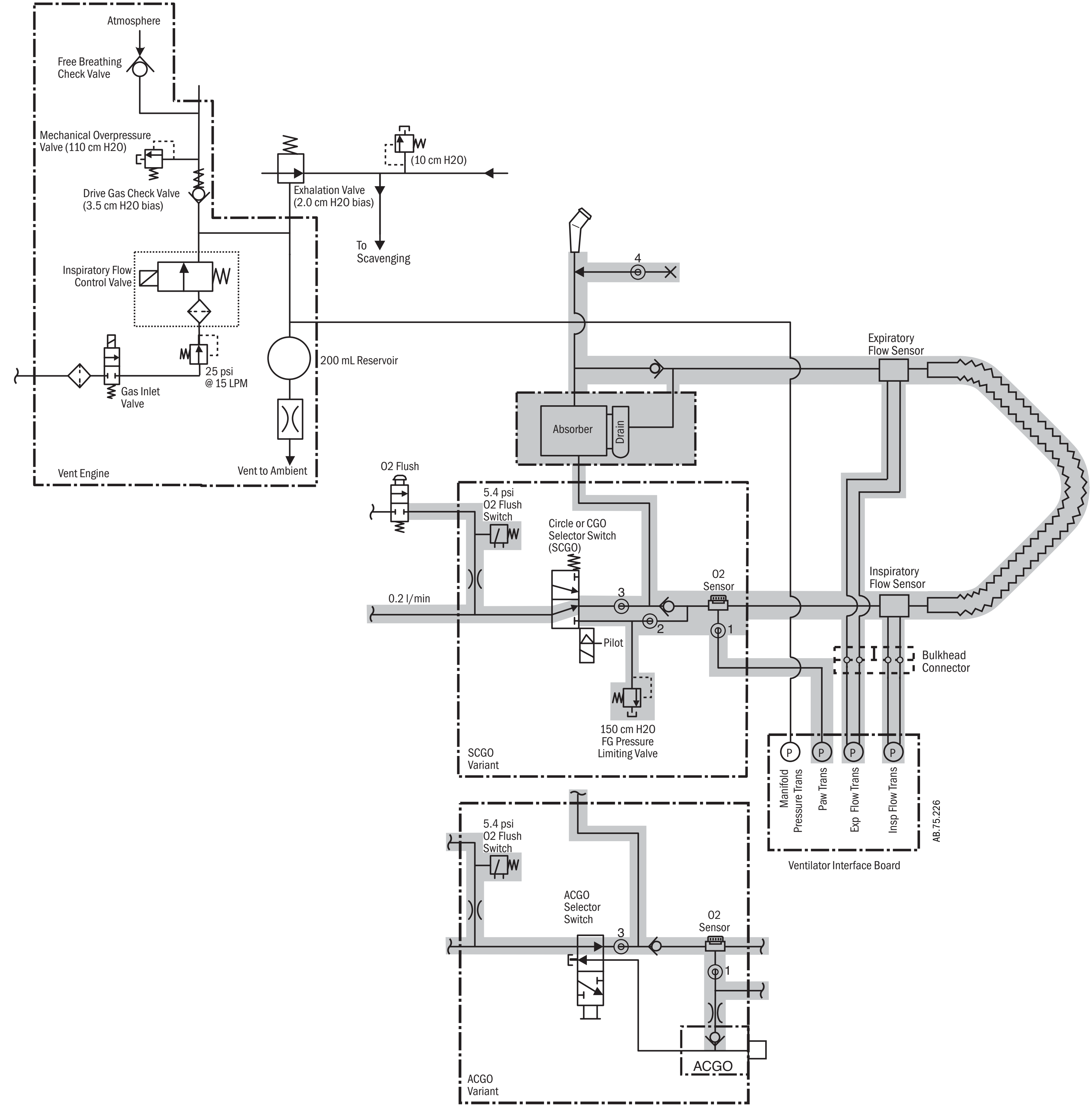
Test-8 • Testing the bellows assembly

Test 9 Testing the flow sensor module, the circuit module, and the soda lime canister



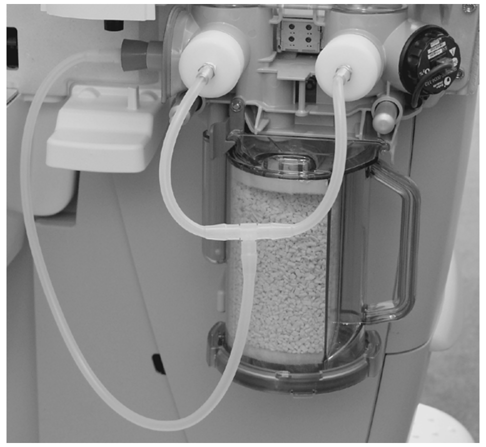
1. Separate the Bellows Module from the Circuit Module and re-install the Circuit/Flow Sensor Module.
2. Connect short tubing between the inhalation and exhalation ports of the breathing system.
3. Insert an appropriate test plug in the outlet port of the Circuit Module.
4. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
5. Set O_2 Flow to **0.2 l/min**.
   - Ensure that the Airway Pressure, as viewed on the gas schematic, rises to ≥ 30 cm H2O.
6. Set O_2 Flow to 0.00 l/min.
7. Remove the plug to release pressure.



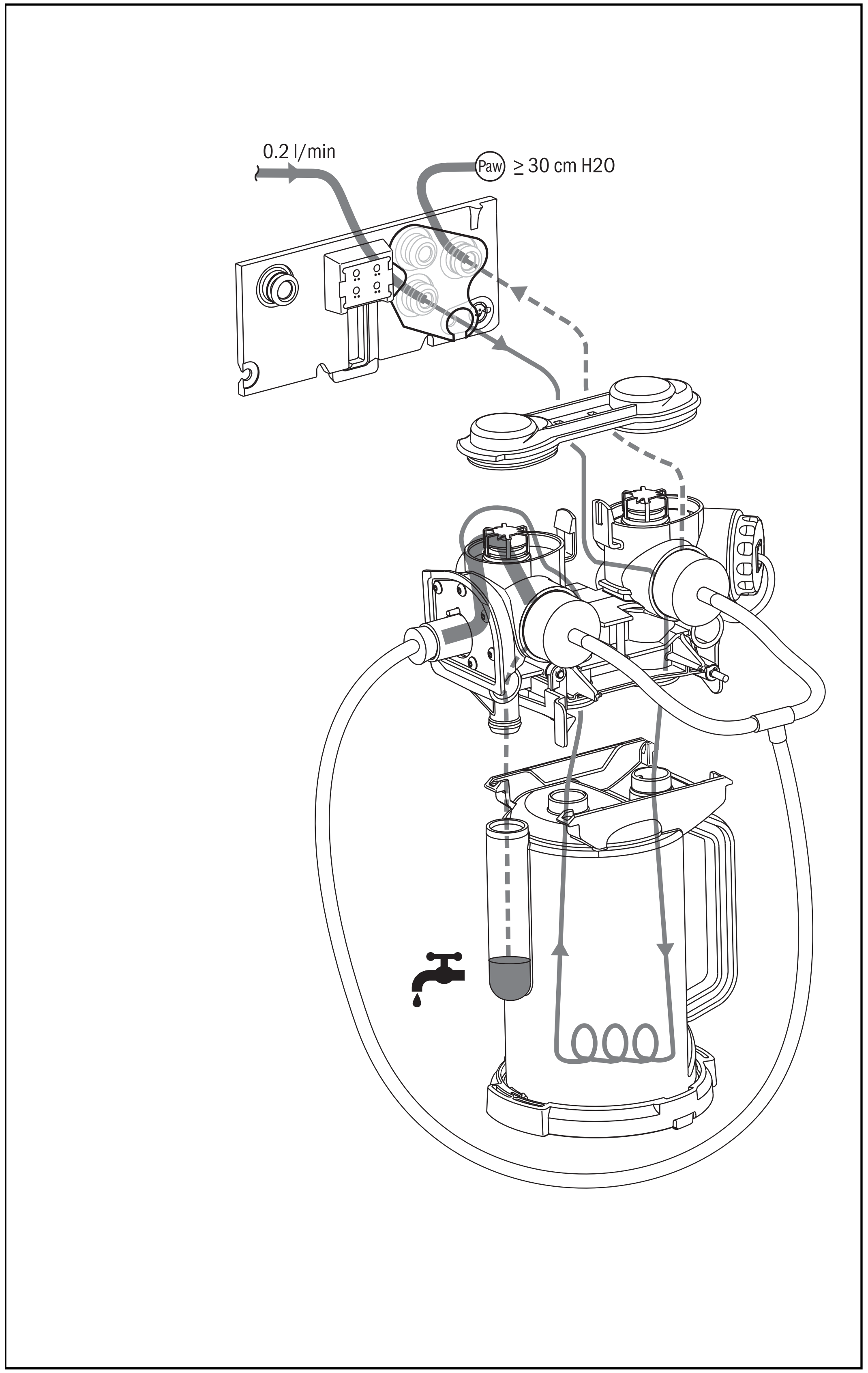


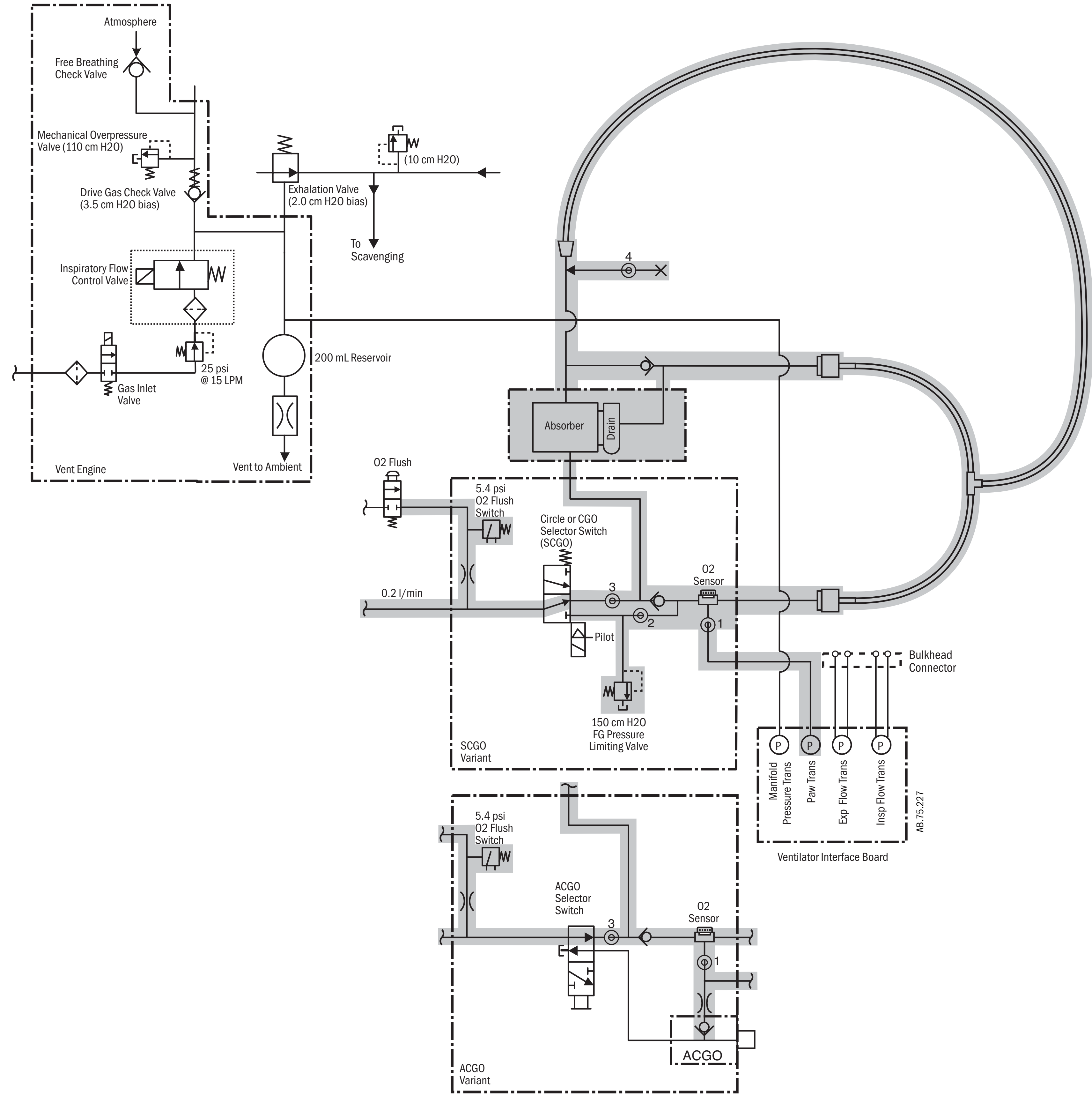
Test-9 ▪ Testing the flow sensor module, the circuit module, and the soda lime canister

Test 10 Testing the circuit module and the canister



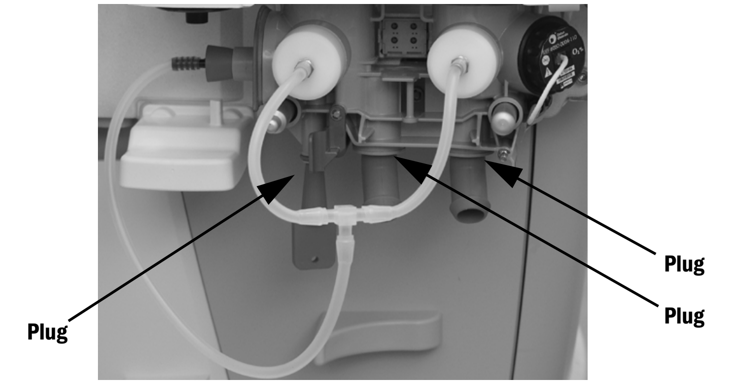
1. Remove the Flow Sensor module.
2. Connect the Circuit Test Tool to the Circuit Module as shown above.
3. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
4. Set O_2 Flow to **0.2 l/min**.
   - Ensure that the Airway Pressure, as viewed on the gas schematic, rises to ≥ 30 cm H2O.
5. Set O_2 Flow to 0.00 l/min.





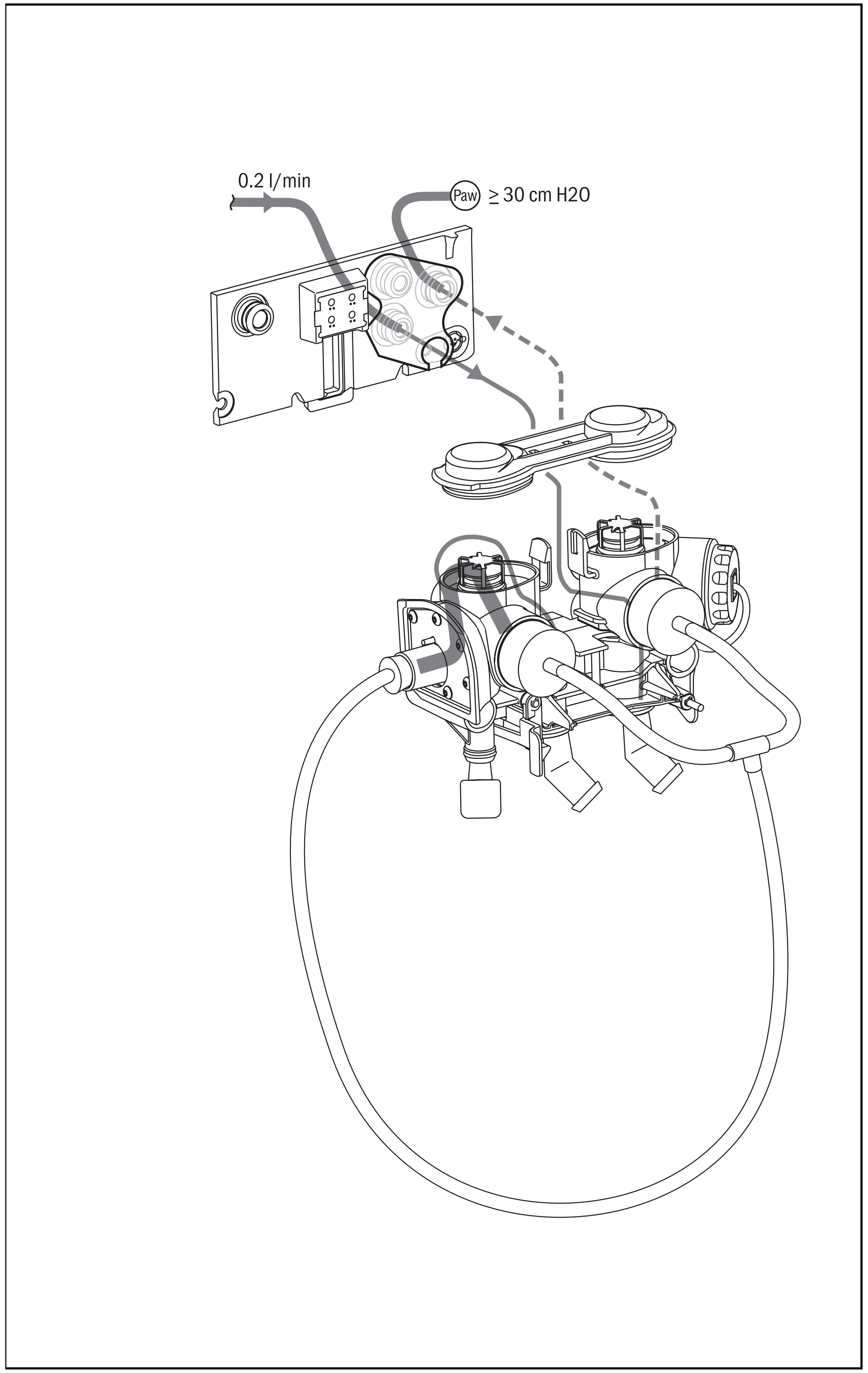
Test-10 ▪ Testing the circuit module and the canister

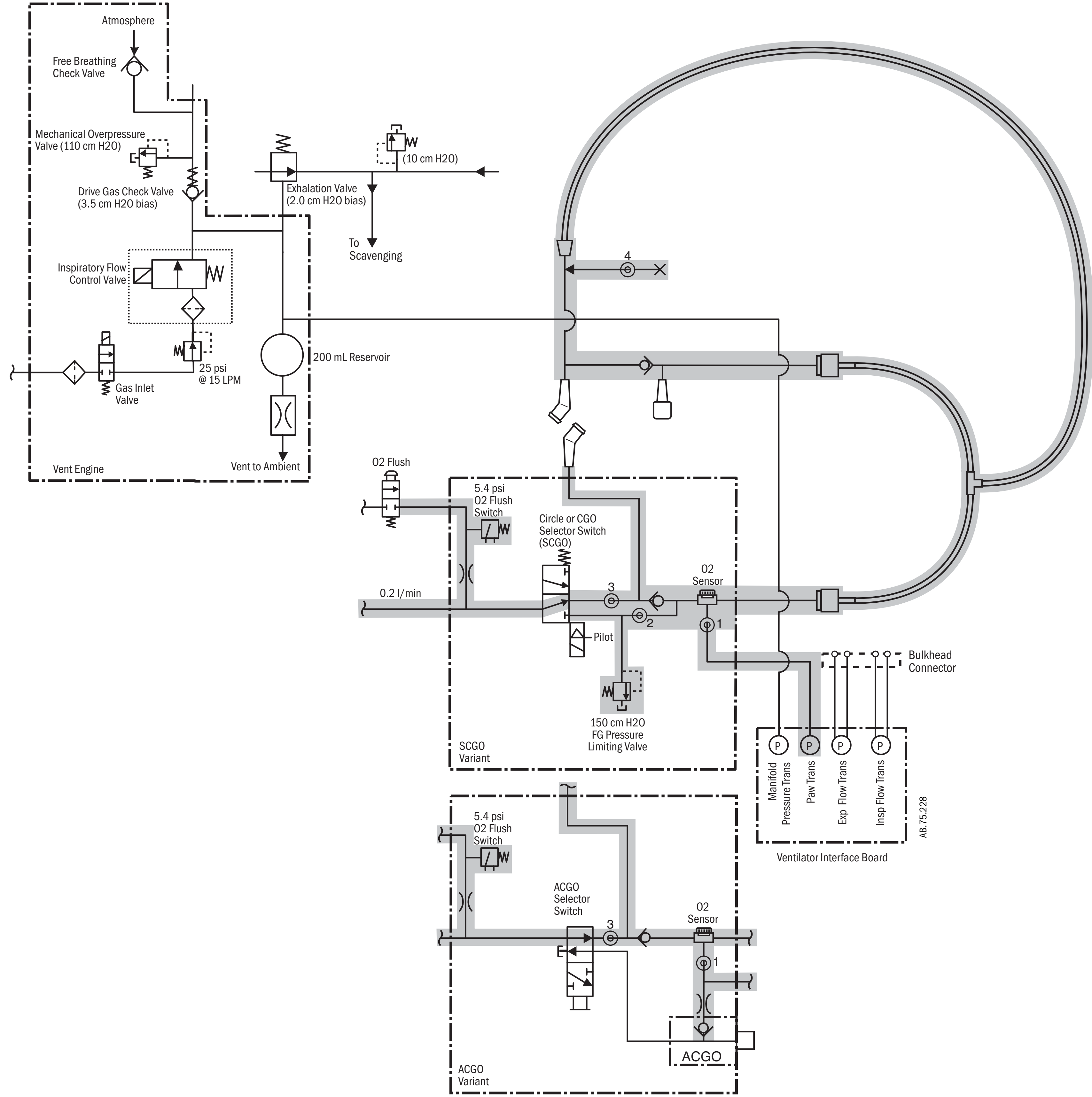
Test 11 Testing the circuit module



Note: If required, set up the machine as in Test 10.

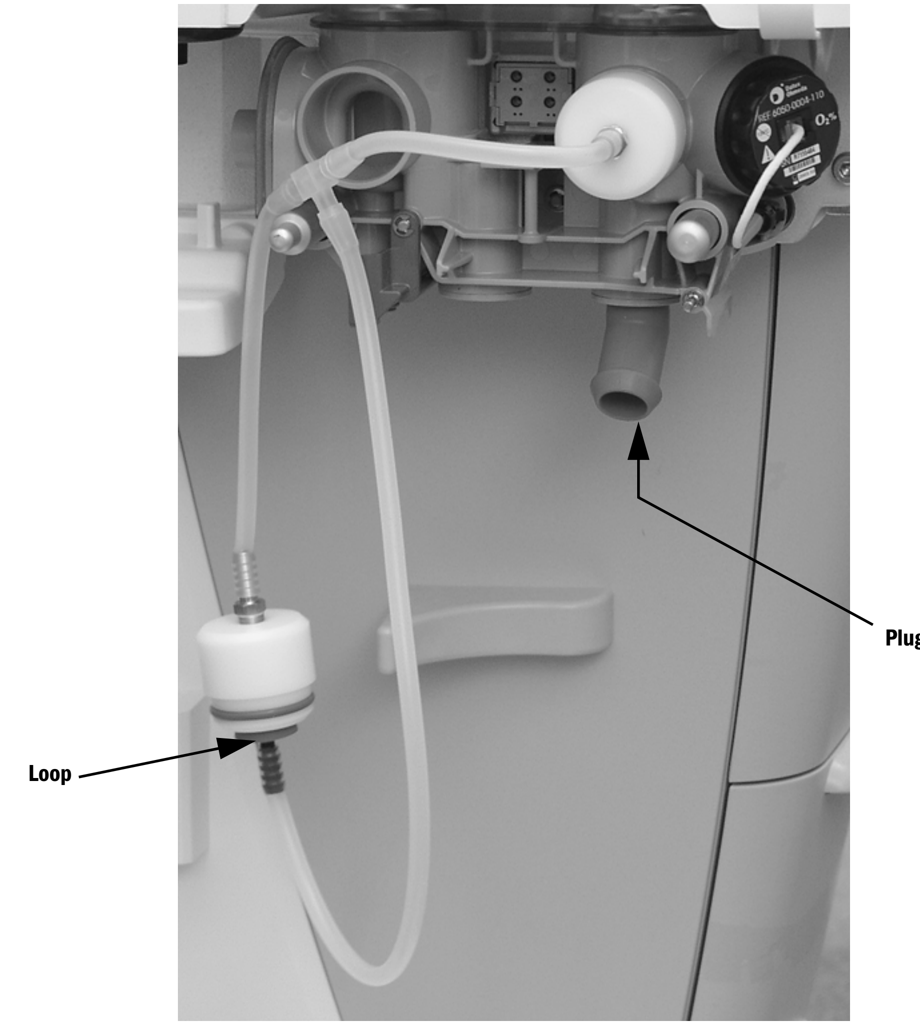
1. Remove the Soda Lime Canister.
2. Using appropriate Test Plugs, plug the three canister ports in the Circuit Module as shown above.
3. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
4. Set O_2 Flow to **0.2 l/min**.
    - Ensure that the Airway Pressure, as viewed on the gas schematic, rises to ≥ 30 cm H2O.
5. Set O_2 Flow to 0.00 l/min.





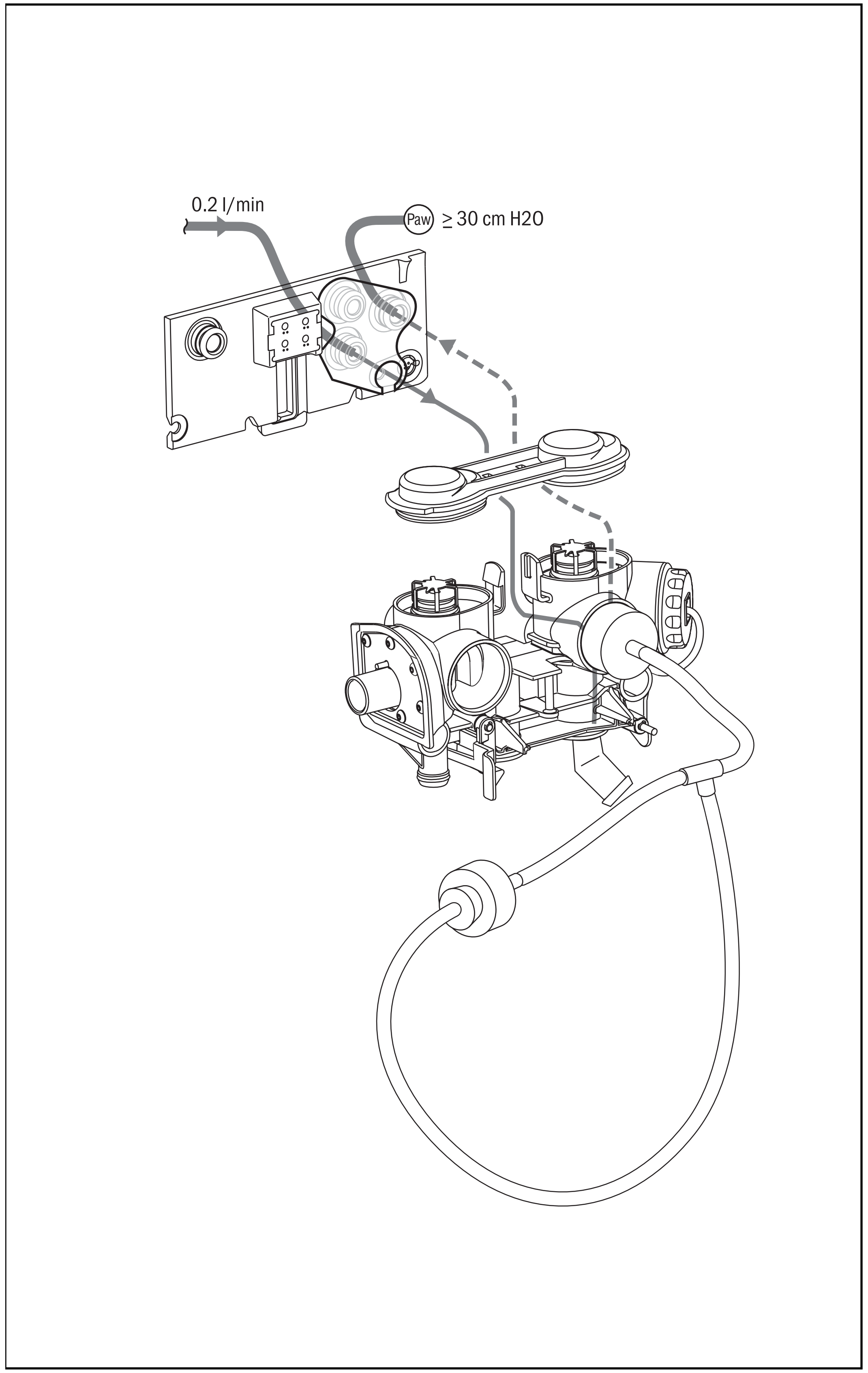
Test-11 • Testing the circuit module

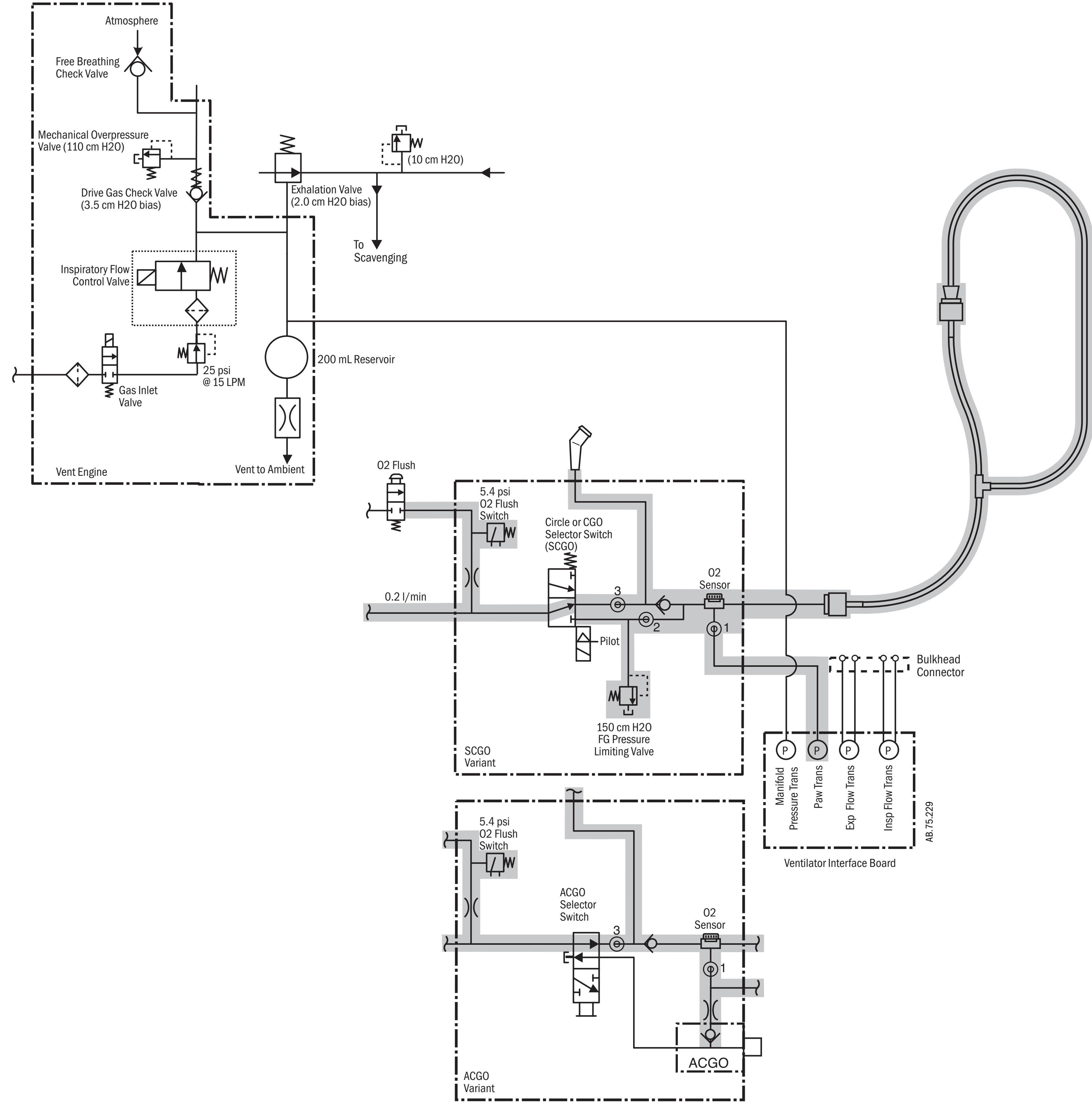
Test 12 Testing the inspiratory side of the circuit module



Note: If required, set up the machine as in Test 10 and 11.

1. Connect the Circuit Test Tool to the Circuit Module as shown above.
2. Insert an appropriate test plug in the inspiratory outlet to the canister as shown above.
3. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
4. Set O_2 Flow to **0.2 l/min**.
   - Ensure that the Airway Pressure, as viewed on the gas schematic, rises to ≥ 30 cm H2O.
5. Set O_2 Flow to 0.00 l/min.

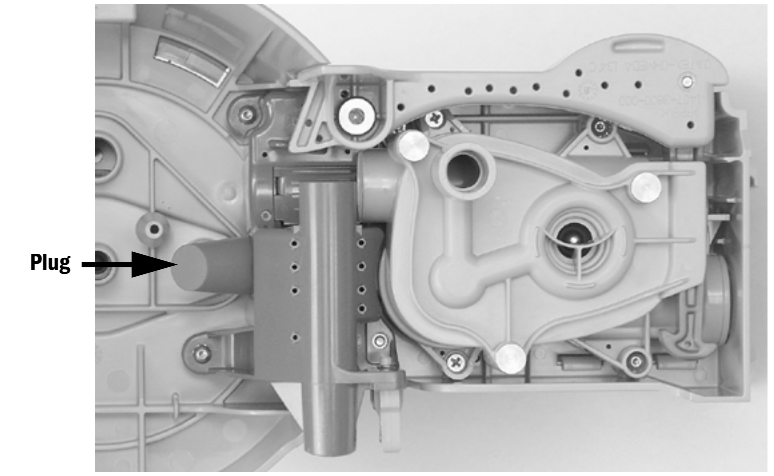




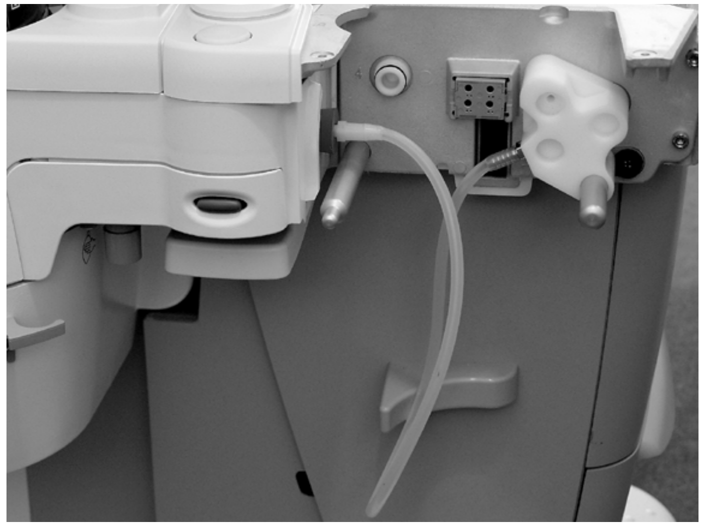
Test-12 • Testing the inspiratory side of the circuit module

Test 13 Testing the negative pressure relief valve

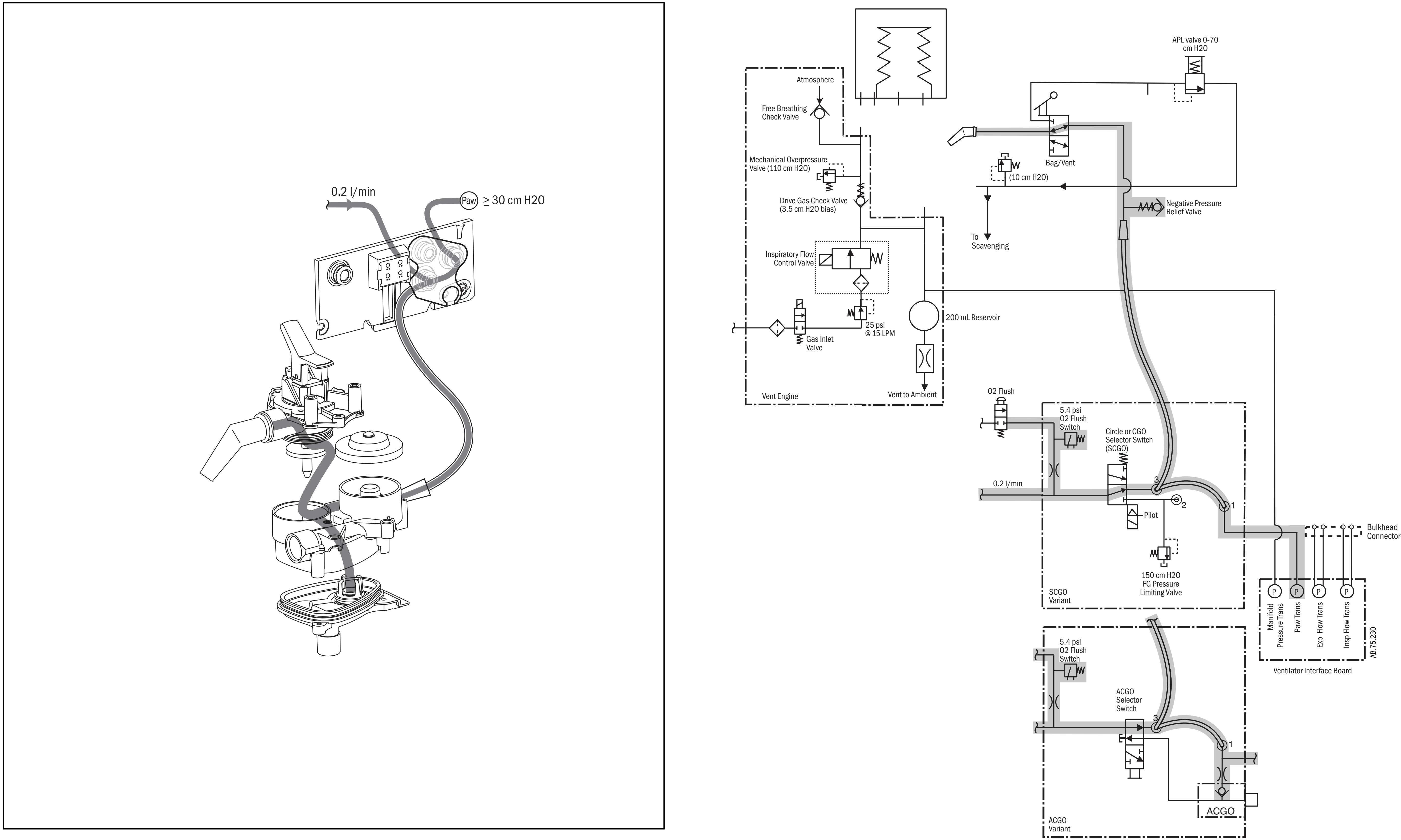
1. Separate the Bellows Module from the Circuit Module.
2. Remove the Bellows Interface Manifold.
3. Insert test plug (recessed end) into the rear Bag/Vent switch port as shown.



4. Install the Bellows Module.
5. Connect the Machine Test Tool to the interface ports and the Bellows Module as shown.

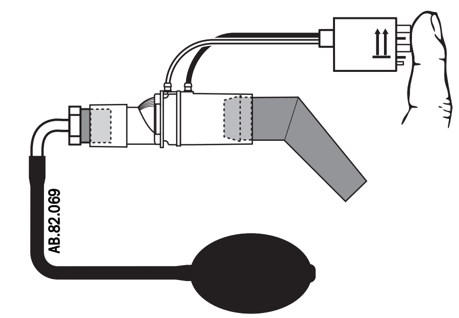


6. Set the Bag/Vent Switch to Vent.
7. Access the Gas Delivery Schematic (Section 12.3.2) of the Service Application.
8. Set O_2 Flow to **0.2 l/min**.
   - Ensure that the Airway Pressure, as viewed on the gas schematic, rises to ≥ 30 cm H2O.
9. Set O_2 Flow to 0.00 l/min.



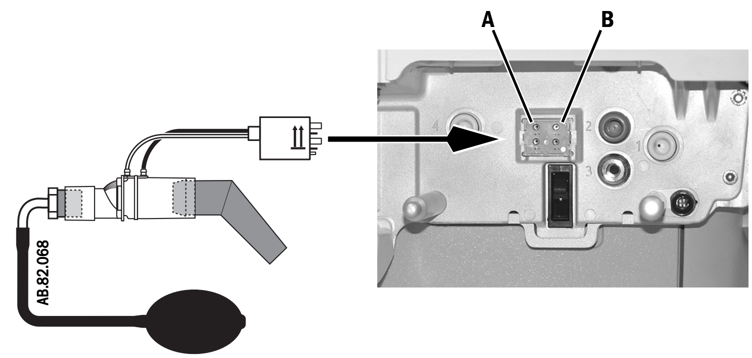
Test-13 ▪ Testing the negative pressure relief valve

Test 14 Testing the flow sensors only



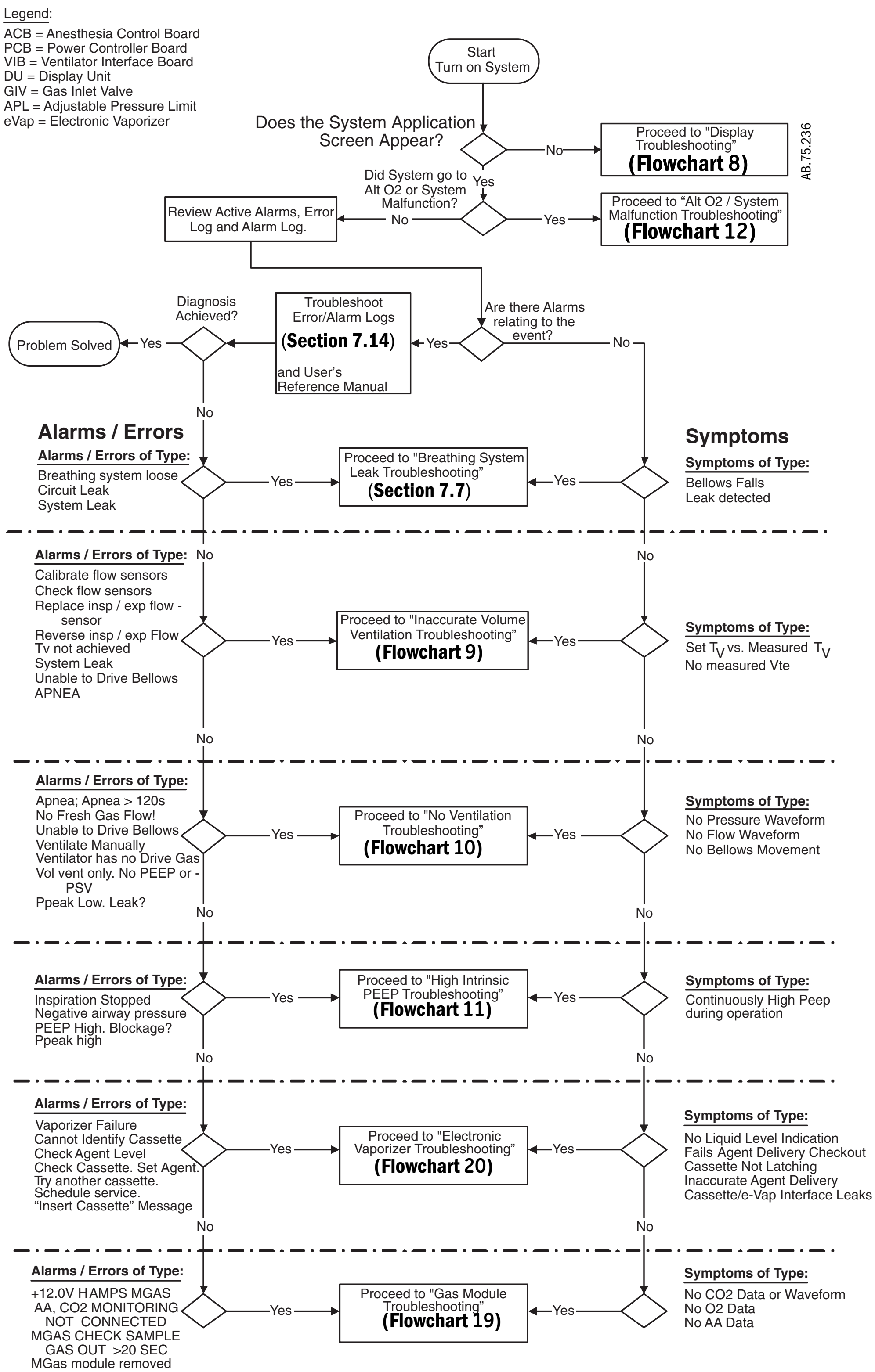
1. Remove the Flow Sensor Module.
2. Plug each Flow Sensor as shown above.
3. Connect the low-pressure leak test device to the open end of the Flow Sensor.
4. Block the connector end of the Flow Sensor with your hand.
5. Compress and release the bulb until it is empty.
6. If the bulb inflates in 30 seconds or less, there is a leak in the flow sensor.
7. If there are no leaks in the flow sensors, go to Test 15.

Test 15 Testing a flow sensor including the cVIB and interfacing components



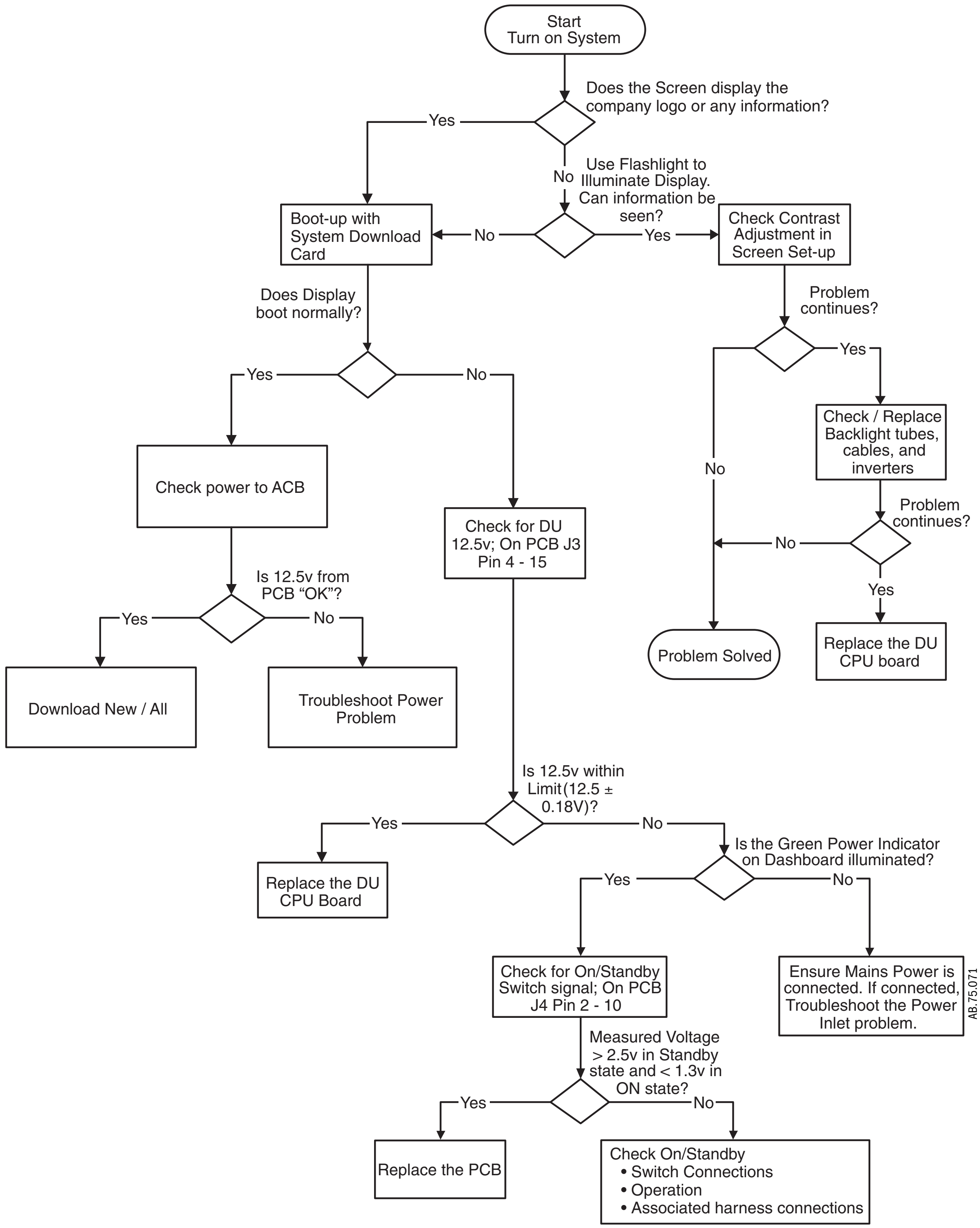
1. Remove both Flow Sensors from the Flow Sensor Module.
2. Attach a Flow Sensor to the Expiratory side (**A**) of the bulkhead connector.
3. Plug the Flow Sensor as shown.
4. Connect the low-pressure leak test device to the open end of the Flow Sensor.
5. Compress and release the bulb until it is empty.
   - If the bulb inflates in 30 seconds or less, there is a leak. The leak may be through the connector o-rings, in the internal tubing, or in the Transducer on the cVIB.
6. Repeat the test for the other Flow Sensor, connecting it to the Inspiratory side (**B**) of the bulkhead connector.

7.7 System Troubleshooting Flowcharts



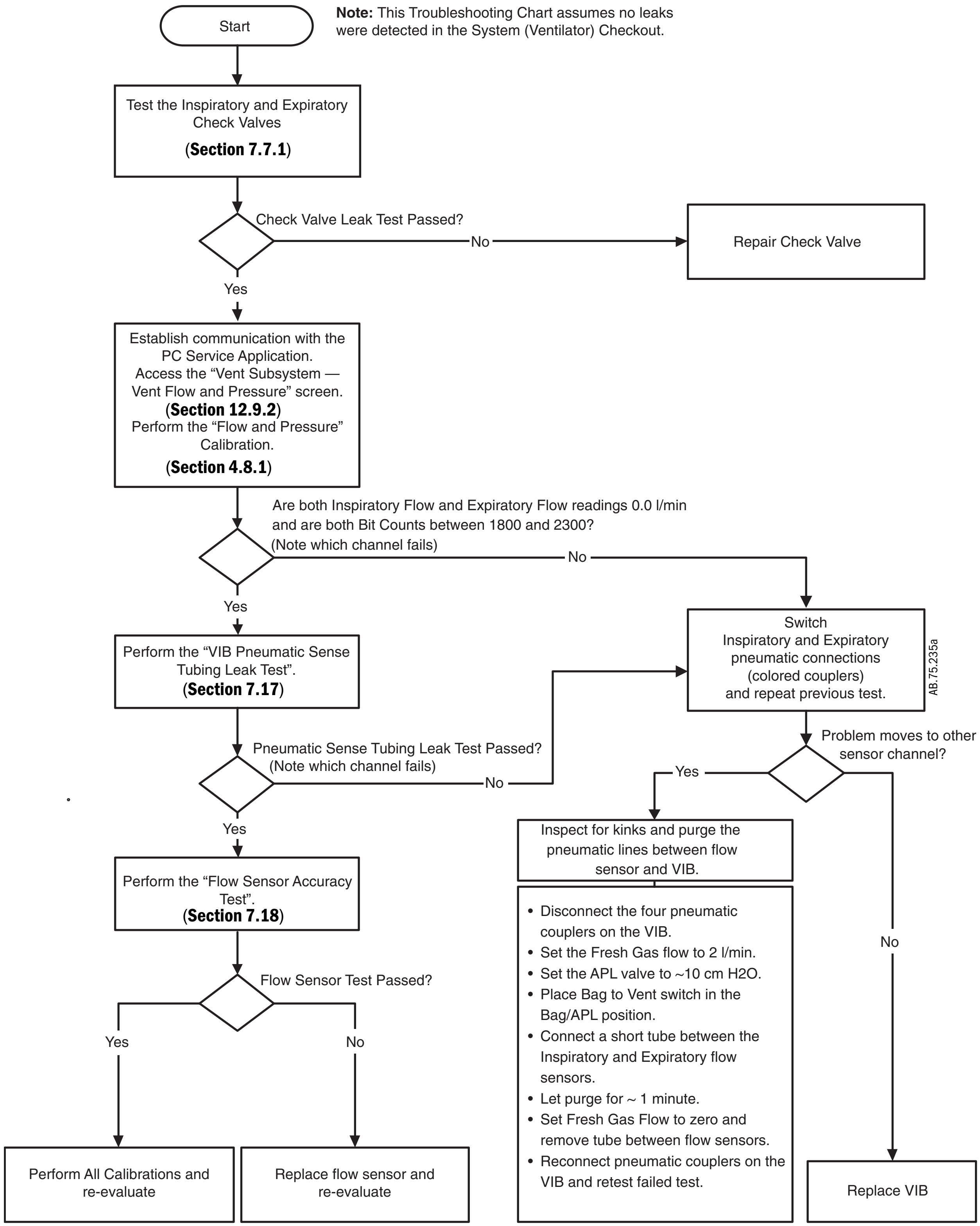
Flowchart 7

Display Troubleshooting



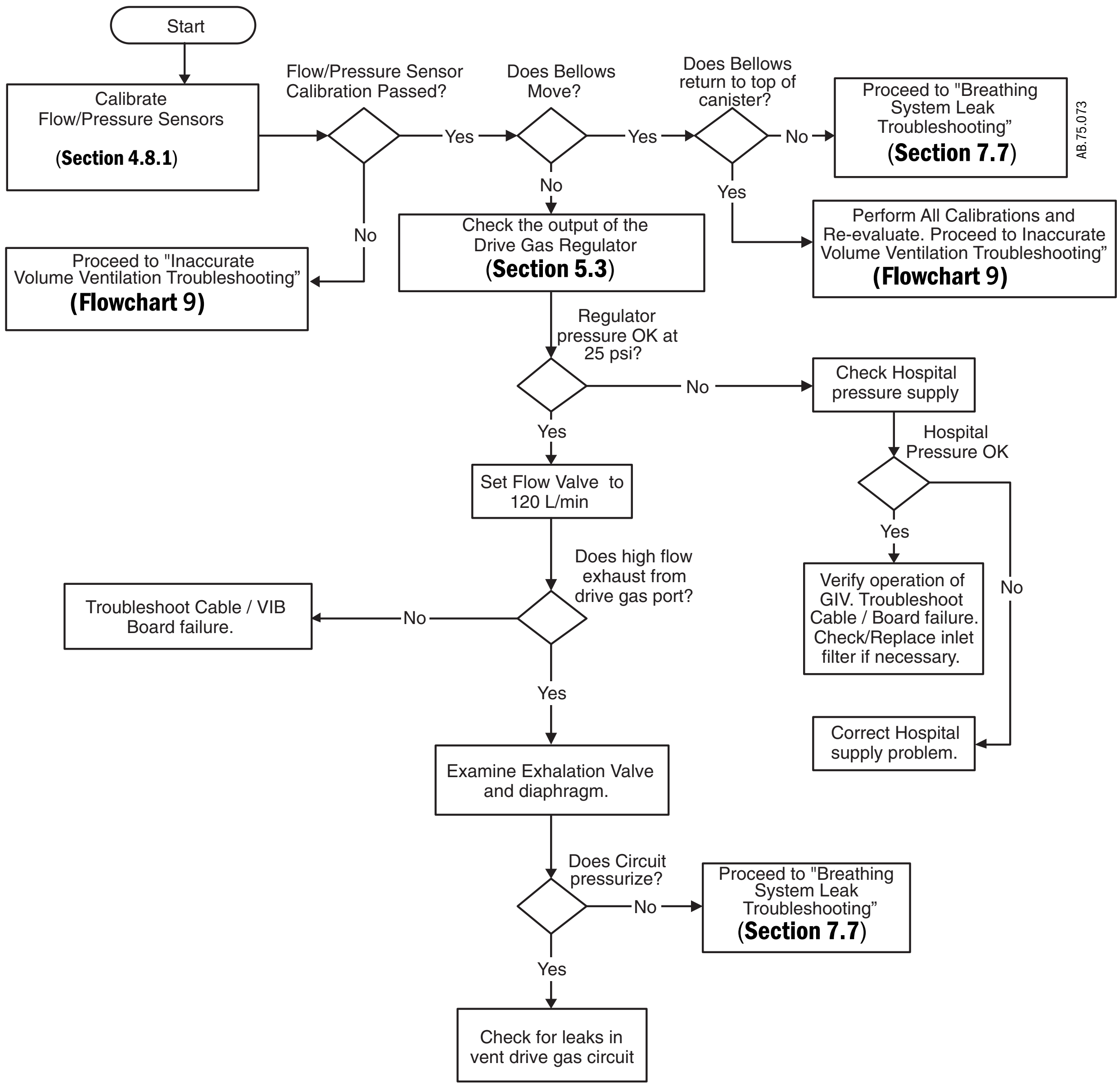
Flowchart **8**

Inaccurate Volume Ventilation Troubleshooting



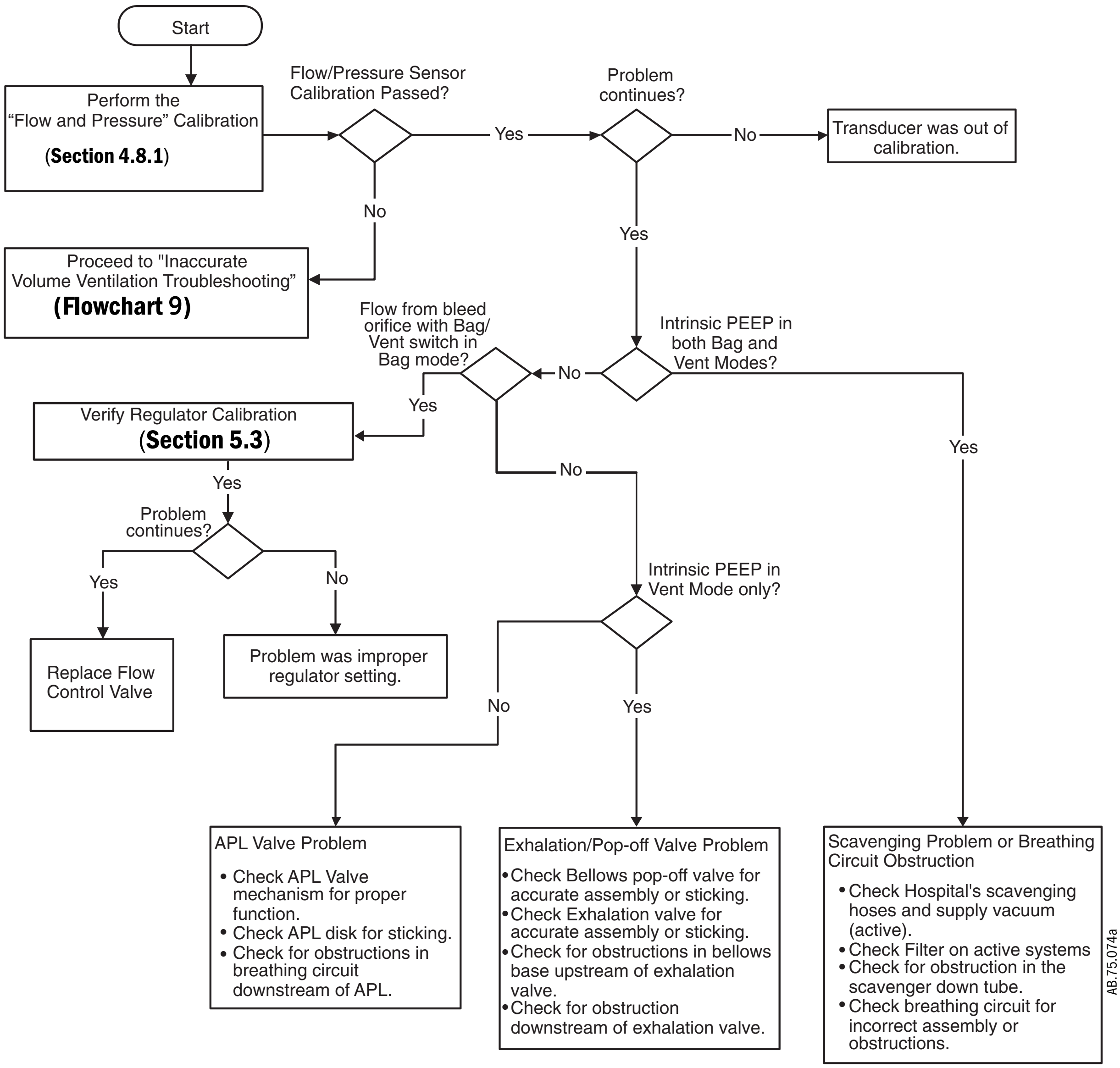
Flowchart **9**

No Ventilation Troubleshooting



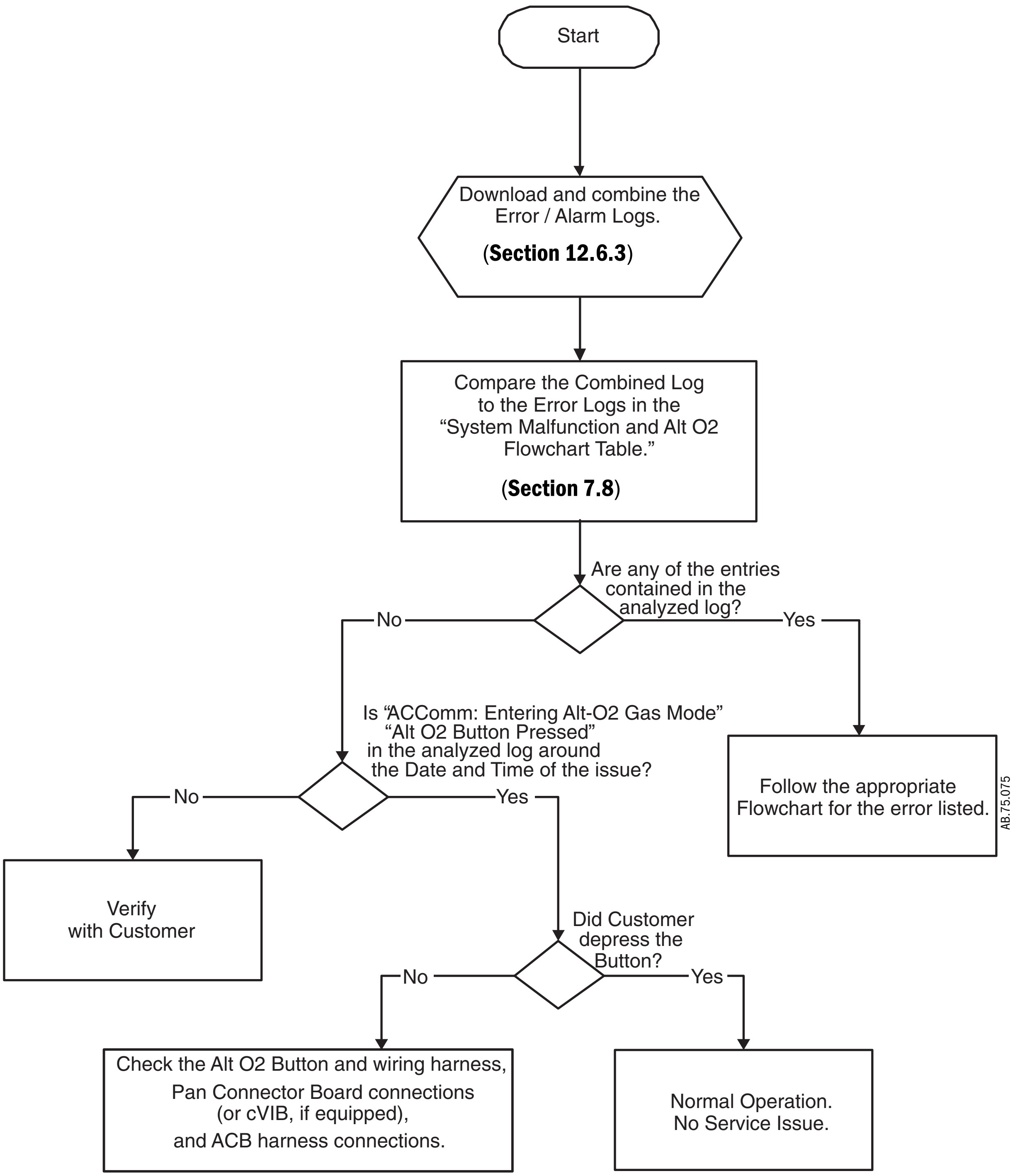
Flowchart **10**

High Intrinsic PEEP Troubleshooting



Flowchart **11**

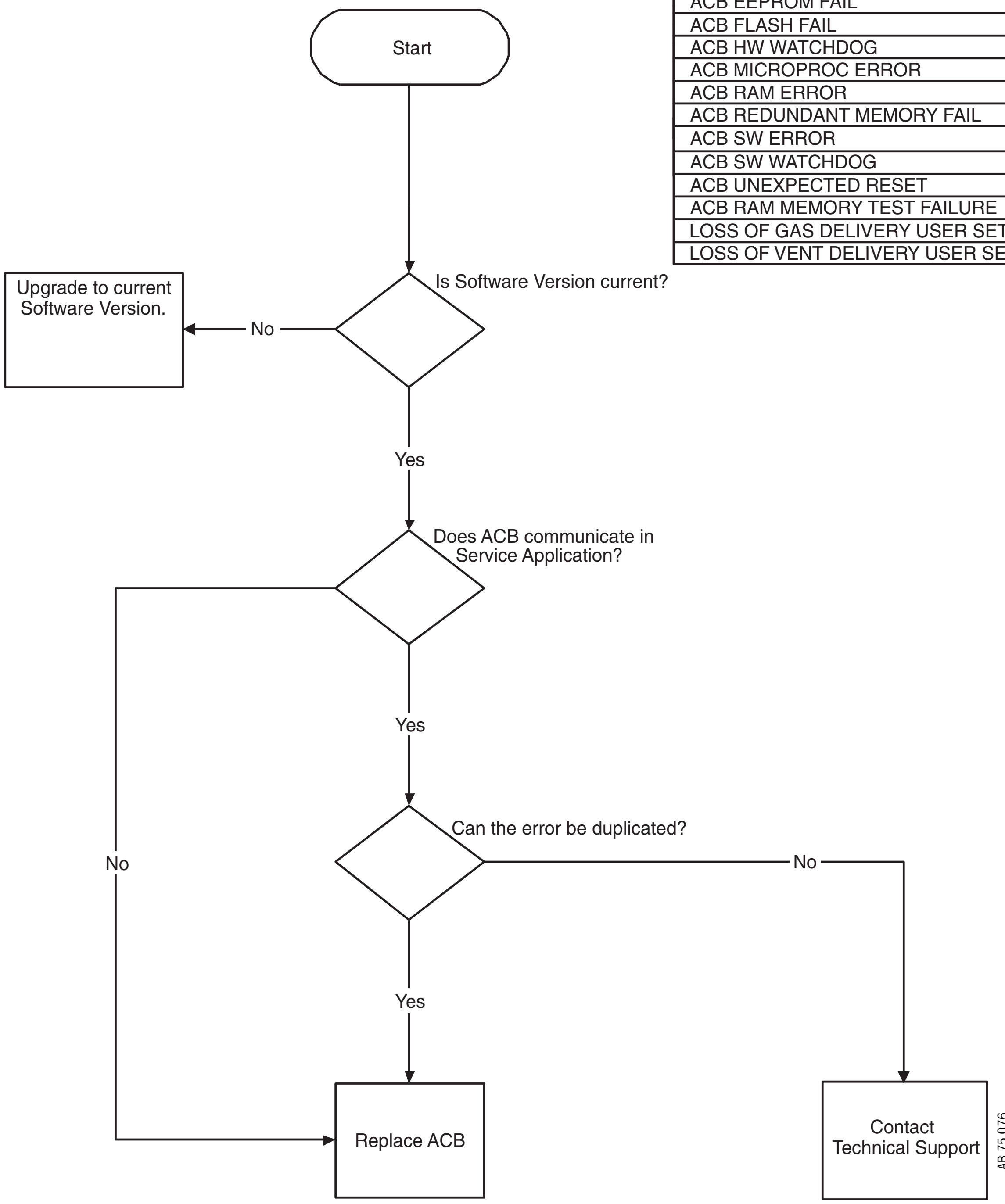
Alternate O_2 / System Malfunction Screen Troubleshooting



Flowchart **12**

Anesthesia Control Board Troubleshooting

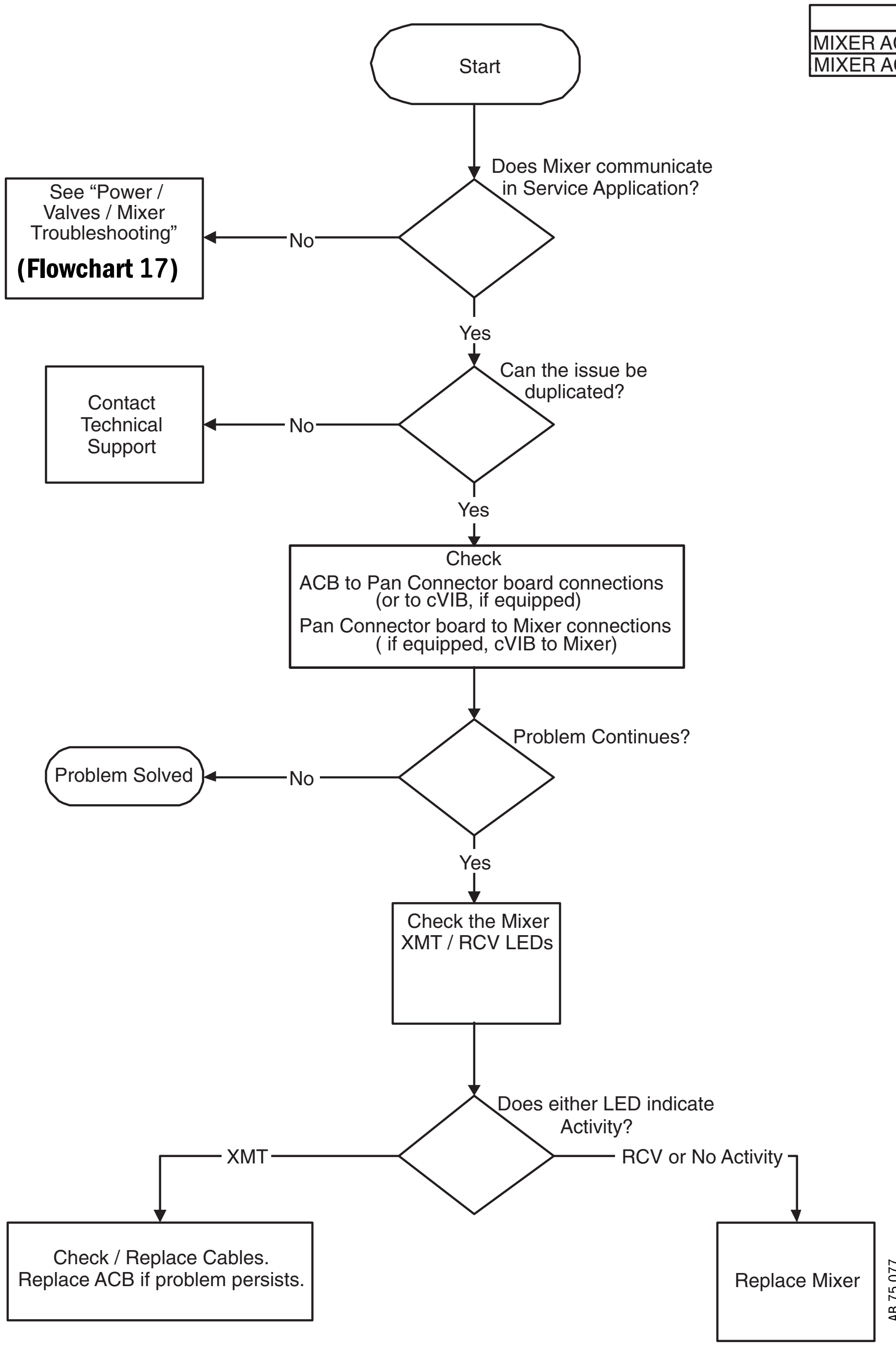
Error Entry
ACB CLOCK SPEED
ACB CPU TEST FAIL
ACB EEPROM FAIL
ACB FLASH FAIL
ACB HW WATCHDOG
ACB MICROPROC ERROR
ACB RAM ERROR
ACB REDUNDANT MEMORY FAIL
ACB SW ERROR
ACB SW WATCHDOG
ACB UNEXPECTED RESET
ACB RAM MEMORY TEST FAILURE
LOSS OF GAS DELIVERY USER SETTINGS
LOSS OF VENT DELIVERY USER SETTINGS



Flowchart **13**

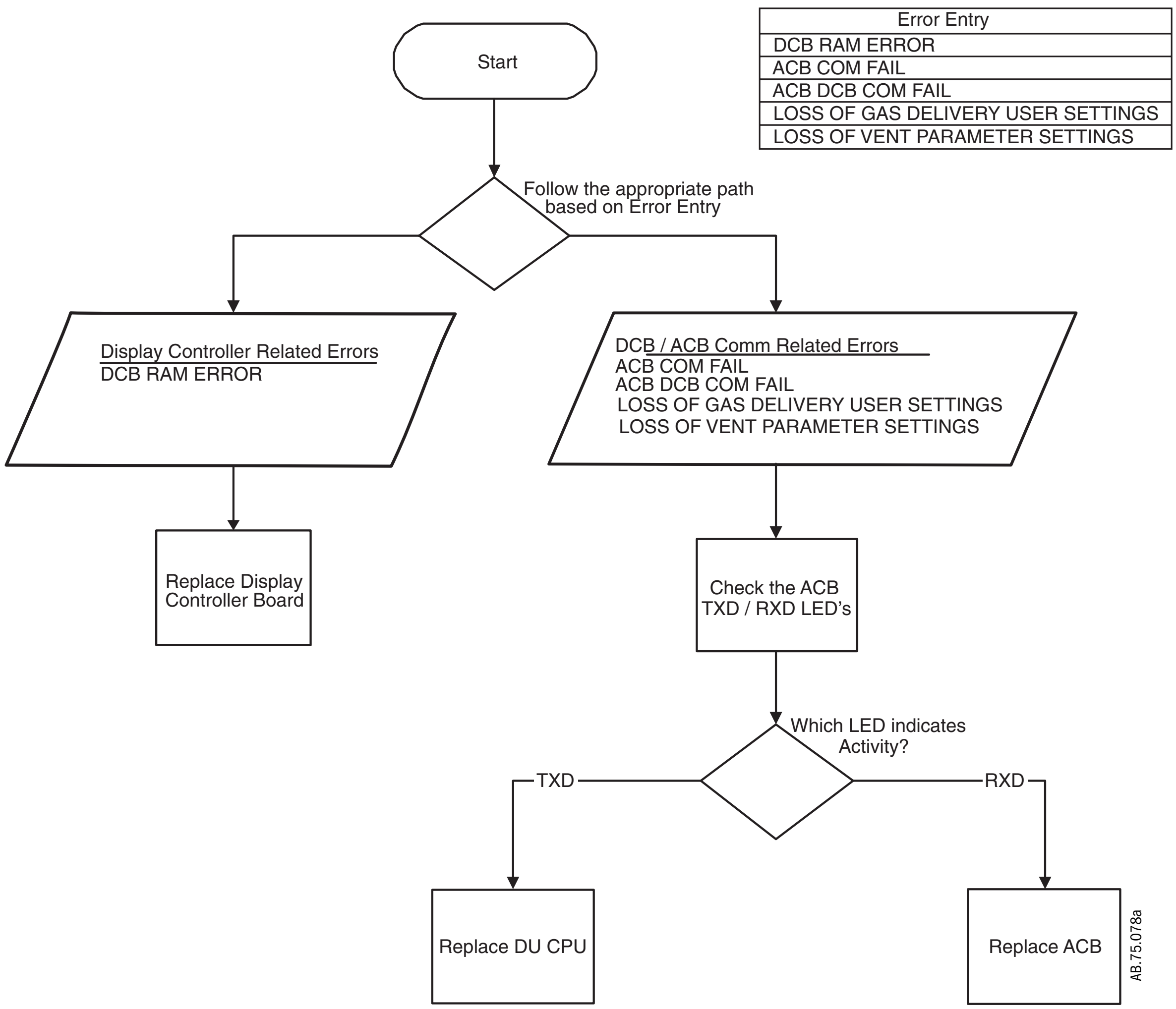
ACB - Mixer Troubleshooting

Error Entry
MIXER ACB COM FAIL
MIXER ACB COM FAILLOST CMD



Flowchart **14**

DU - ACB Communication Troubleshooting

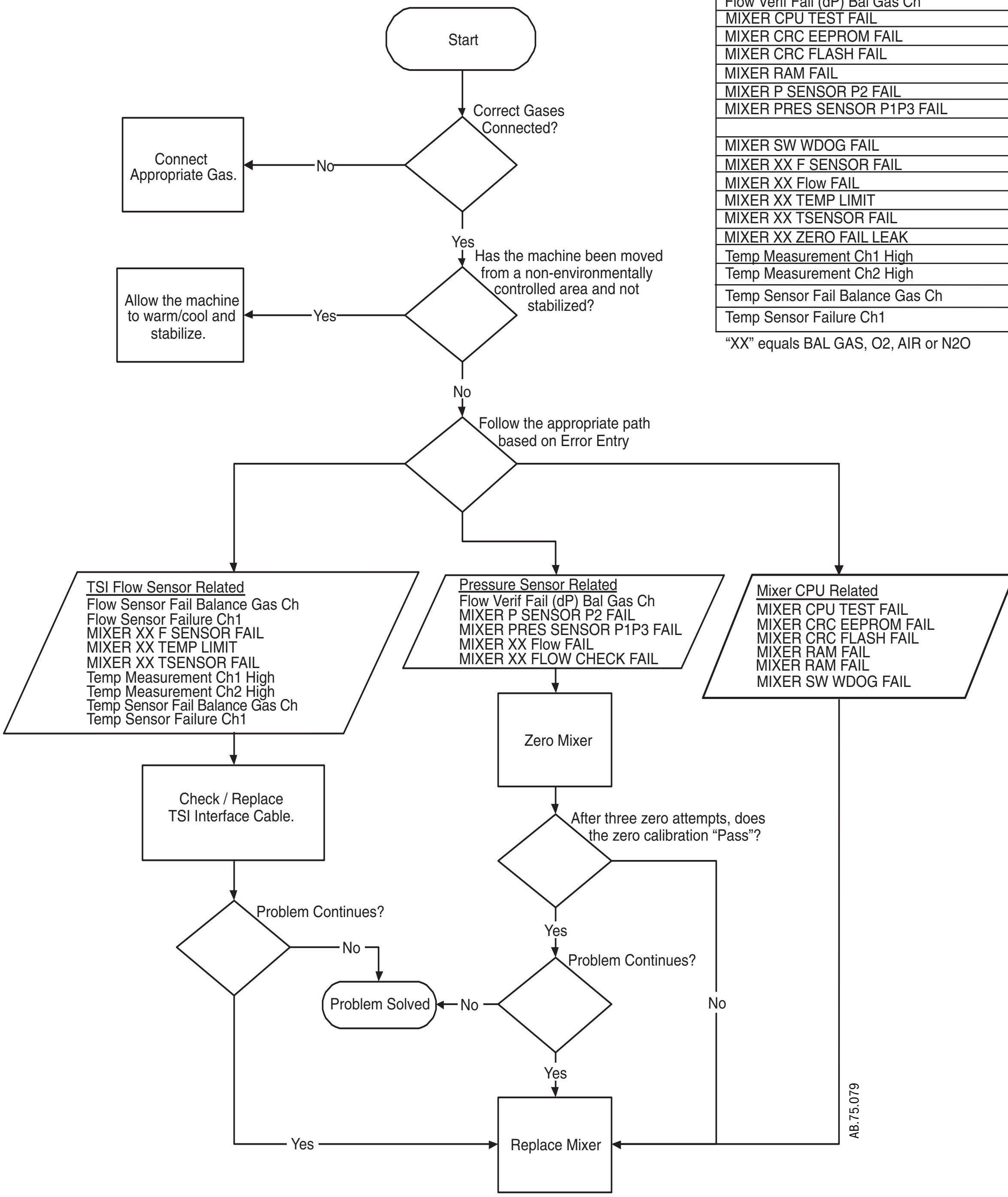


Flowchart **15**

Mixer Specific Troubleshooting

Error Entry
Flow Sensor Fail Balance Gas Ch
Flow Sensor Failure Ch1
Flow Verif Fail (dP) Bal Gas Ch
MIXER CPU TEST FAIL
MIXER CRC EEPROM FAIL
MIXER CRC FLASH FAIL
MIXER RAM FAIL
MIXER P SENSOR P2 FAIL
MIXER PRES SENSOR P1P3 FAIL
MIXER SW WDOG FAIL
MIXER XX F SENSOR FAIL
MIXER XX Flow FAIL
MIXER XX TEMP LIMIT
MIXER XX TSENSOR FAIL
MIXER XX ZERO FAIL LEAK
Temp Measurement Ch1 High
Temp Measurement Ch2 High
Temp Sensor Fail Balance Gas Ch
Temp Sensor Failure Ch1

“XX” equals BAL GAS, O2, AIR or N2O

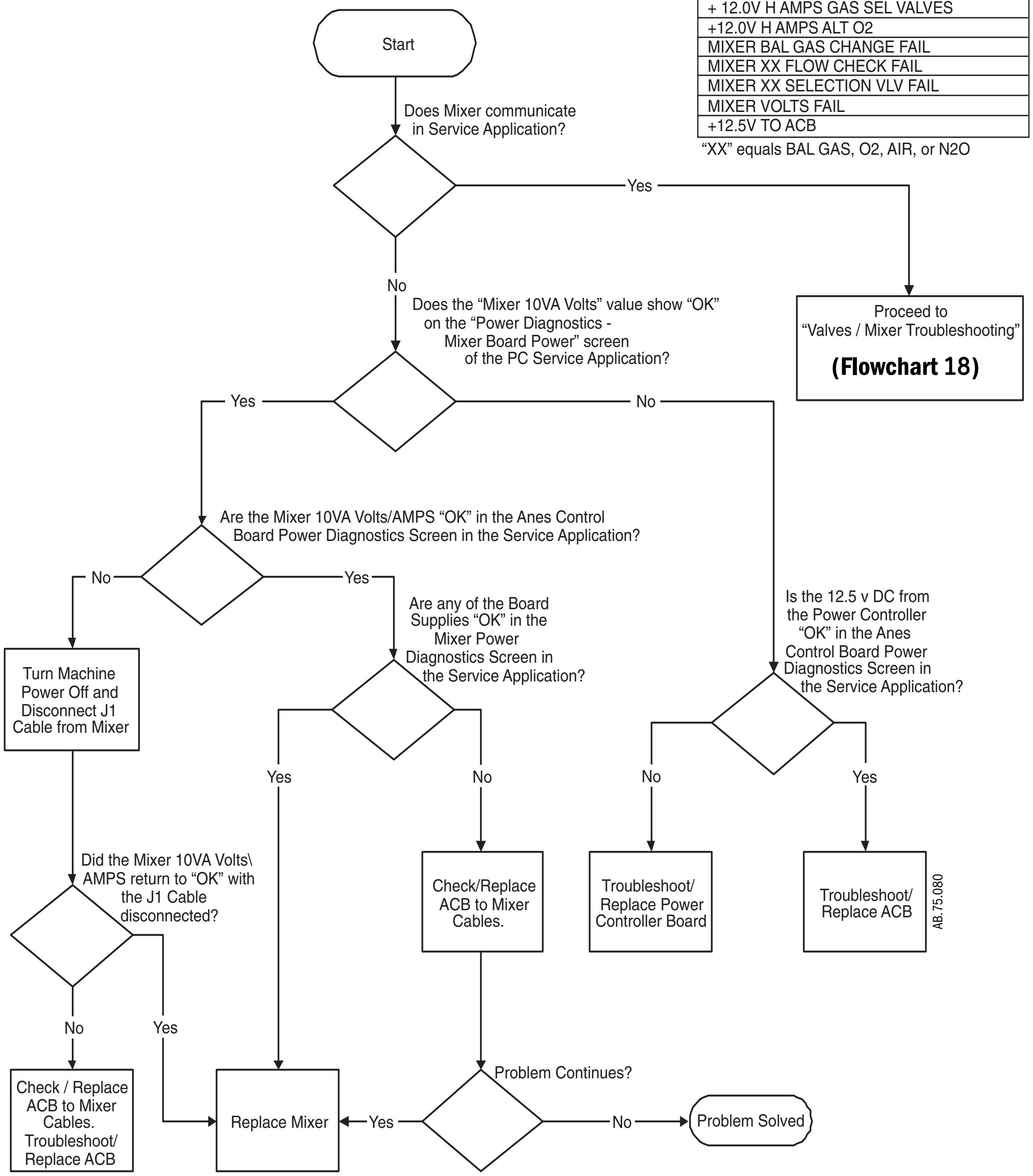


Flowchart **16**

Power - Valves - Mixer Troubleshooting

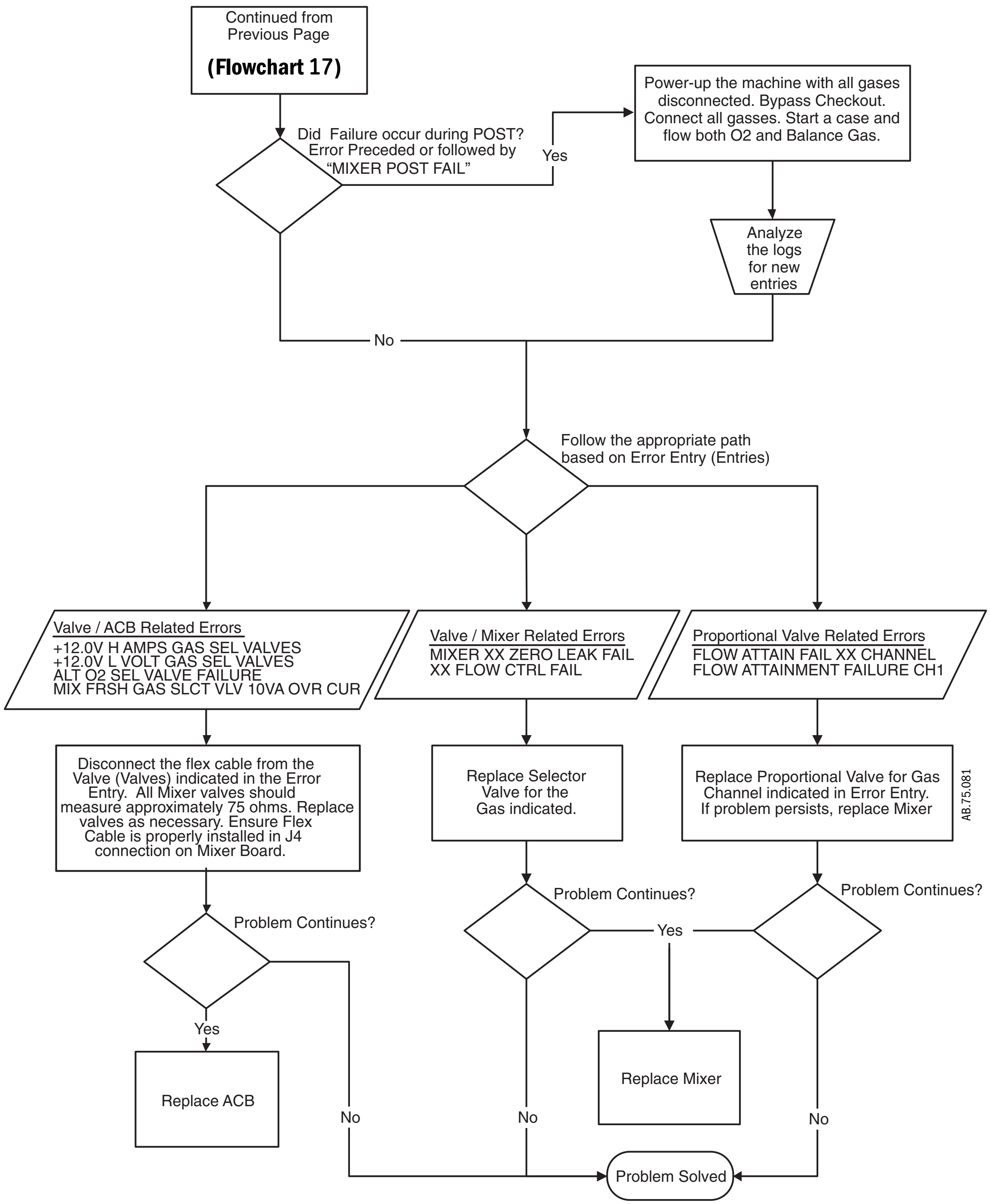
Error Entry
XX FLOW CTRL FAIL
XX PROP VALVE FAIL
Flow Attain Fail Bal Gas Channel
Flow Attainment Failure Ch1
+12.0V H AMPS MIXER
+ 12.0V H AMPS GAS SEL VALVES
+12.0V H AMPS ALT O2
MIXER BAL GAS CHANGE FAIL
MIXER XX FLOW CHECK FAIL
MIXER XX SELECTION VLV FAIL
MIXER VOLTS FAIL
+12.5V TO ACB

"XX" equals BAL GAS, O2, AIR, or N2O



Flowchart **17**

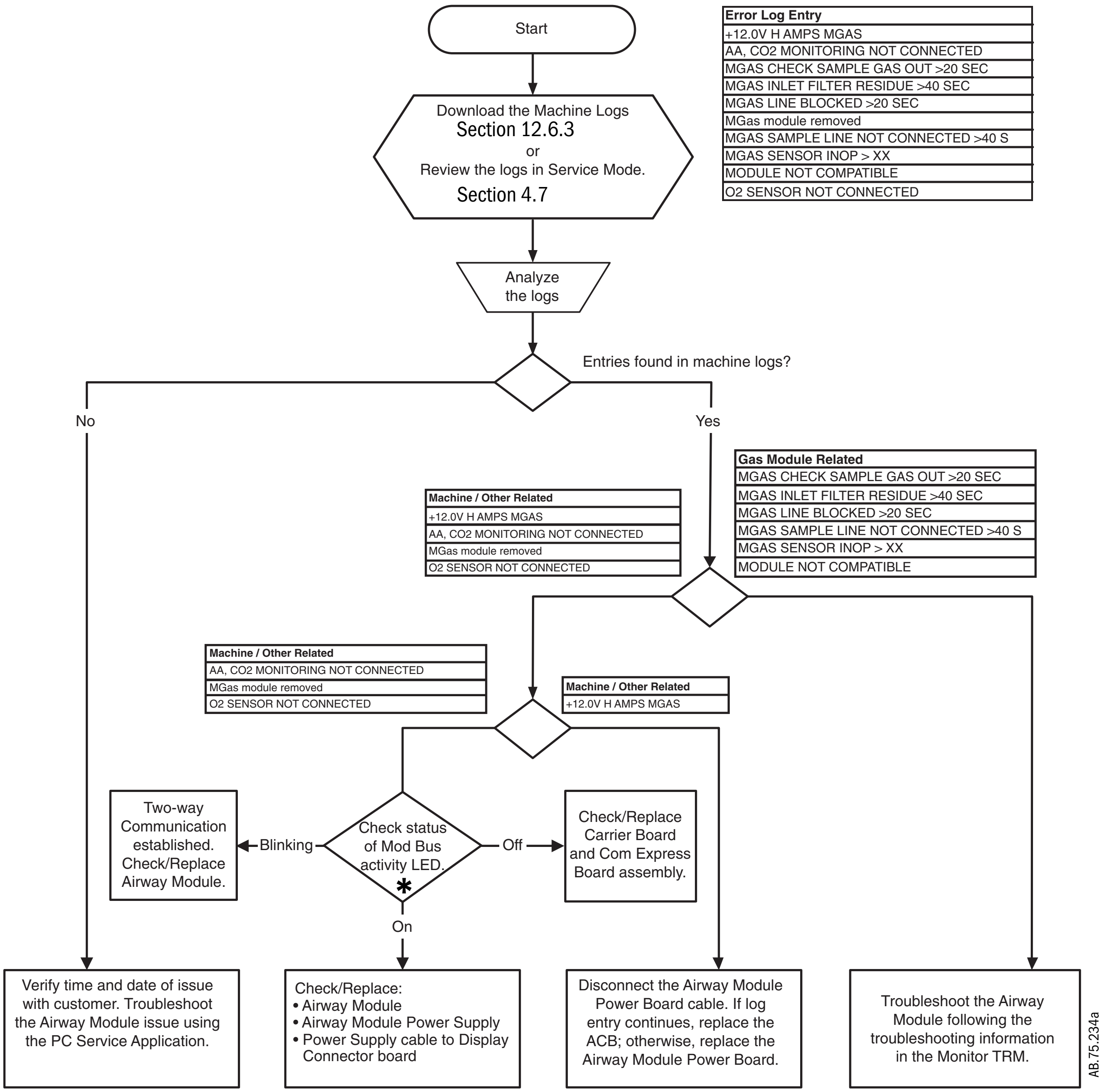
Valves - Mixer Troubleshooting



Flowchart **18**

Airway Module Troubleshooting

Note The "MGAS" error log entries refer to any Airway Module installed in the system.



* Refer to Section 2.4, "Display Unit".

Flowchart **19**

7.8 System Malfunction and Alt O_2 Flowchart Table

Error	Display Type	Flow Chart
+ 12.0V H AMPS GAS SEL VALVES +12.0V H AMPS ALT O2 +12.0V H AMPS MIXER +12.5V TO ACB	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 17)**
ACB CLOCK SPEED	System Malfunction	Anesthesia Control Board Troubleshooting **(Flowchart 13)**
ACB COM FAIL	System Malfunction	DU - ACB Communication Troubleshooting **(Flowchart 15)**
ACB CPU TEST FAIL	System Malfunction	Anesthesia Control Board Troubleshooting **(Flowchart 13)**
ACB DCB COM FAIL	System Malfunction	DU - ACB Communication Troubleshooting **(Flowchart 15)**
ACB EEPROM FAIL ACB FLASH FAIL ACB HW WATCHDOG ACB MICROPROC ERROR ACB RAM ERROR ACB REDUNDANT MEMORY FAIL ACB SW ERROR ACB SW WATCHDOG ACB UNEXPECTED RESET	System Malfunction	Anesthesia Control Board Troubleshooting **(Flowchart 13)**
ALT O2 SWITCH FAIL	Alternate O2 Screen	Check Alt O2 Switch Harness and Connections
DCB RAM ERROR	System Malfunction	DU - ACB Communication Troubleshooting **(Flowchart 15)**
Flow Attain Fail Bal Gas Channel Flow Attainment Failure Ch1	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 17)**
FLOW SENSOR FAIL BALANCE GAS CH FLOW SENSOR FAILURE CH1 Flow Verif Fail (Dp) Bal Gas Ch	Alternate O2 Screen	Mixer Specific Troubleshooting **(Flowchart 16)**
LOSS OF GAS DELIVERY USER SETTINGS LOSS OF VENT PARAMETER SETTINGS	System Malfunction	DU - ACB Communication Troubleshooting **(Flowchart 15)**
MIXER ACB COM FAIL MIXER ACB COM FAILLOST CMD	Alternate O2 Screen	ACB - Mixer Communication Troubleshooting **(Flowchart 14)**
MIXER BAL GAS CHANGE FAIL	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 17)**

Error	Display Type	Flow Chart
MIXER CRC EEPROM FAIL MIXER CRC FLASH FAIL MIXER RAM FAIL MIXER P SENSOR P2 FAIL	Alternate O2 Screen	Mixer Specific Troubleshooting **(Flowchart 16)**
MIXER POST FAIL	Alternate O2 Screen	See Related Errors in Error Logs
MIXER PRES SENSOR P1P3 FAIL MIXER SW WDOG FAIL	Alternate O2 Screen	Mixer Specific Troubleshooting **(Flowchart 16)**
MIXER VOLTS FAIL	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 17)**
MIXER XX F SENSOR FAIL	Alternate O2 Screen	Mixer Specific Troubleshooting **(Flowchart 16)**
MIXER XX Flow CHECK FAIL	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 17)**
MIXER XX FLOW FAIL	Alternate O2 Screen	Mixer Specific Troubleshooting **(Flowchart 16)**
MIXER XX SELECTION VLV FAIL	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 17)**
MIXER XX TEMP LIMIT MIXER XX TSENSOR FAIL MIXER XX ZERO FAILLEAK Temp Measurement Ch1 High Temp Measurement Ch2 High Temp Sensor Fail Balance Gas Ch Temp Sensor Failure Ch1	Alternate O2 Screen	Mixer Specific Troubleshooting **(Flowchart 16)**
XX FLOW CTRL FAIL XX PROP VALVE FAIL	Alternate O2 Screen	Power - Valves - Mixer Troubleshooting **(Flowchart 14)**

7.9 Electronic Vaporizer (eVap) Troubleshooting

As a general rule, proceed with electronic vaporizer fault isolation as follows:

1. Review the system error logs for vaporizer specific entries.
    - Refer to Section 7.14 for procedures related to the system error log entries.
2. Within the PC service application, perform the Vaporizer Test (Section 12.10.2).
    - Follow procedures below as directed by the vaporizer test results.
3. After servicing the vaporizer, rerun the Vaporizer Test to confirm any repairs made were successful.

7.9.1 Vaporizer Test Results

The Vaporizer Test will display extended diagnostic information upon completion.

If the test passes, the message **PASSED: Electronic Vaporizer Subsystem Check** is displayed along with the data used during the check. This indicates that the vaporizer is ready for use.

If the check encounters a problem, it will perform an automated fault isolation procedure. With most single fault failures the automated procedure will identify the failed component or a small set of possibilities.

In the event of a failure, a variety of messages are possible:

- Refer to the table in Section 7.9.2 for corrective actions.

7.9.2 Vaporizer Test Results troubleshooting procedures

Note 1: If a vaporizer alarm becomes active before or during the Vaporizer Test, the following message is printed along with the test results.

"CAUTION! Critical Vaporizer Alarm(s) Active. May Affect Results"

- Check the error log for vaporizer errors.
- Take any necessary corrective action.
- Repeat the test.

Note 2: If the Vaporizer Test results returned by Aisys CS2 are not supported by the Service Application the message below will be displayed.

"FAILED: Test results not supported by this version of Aisys CS2 Service Application"

- Upgrade Service Application to the latest version.

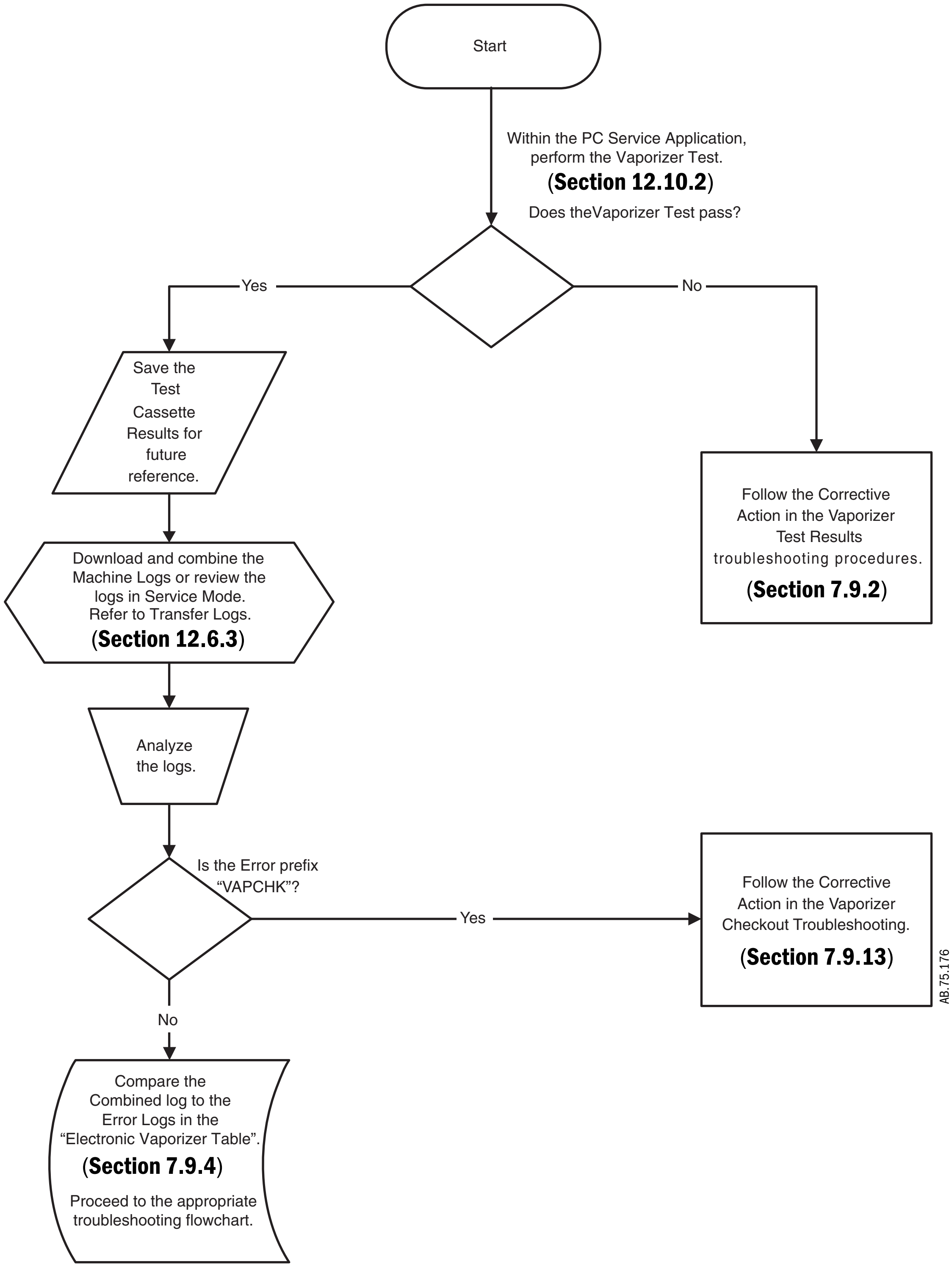
Vaporizer Test message	Corrective Action
Check Terminated: Test Cassette not detected.	Insert Test cassette.
Check Terminated: O2 supply or mixer flow failure.	Correct O_2 supply or Mixer flow function faults before proceeding with Vaporizer Test.
Check Terminated: Ventilator in bag mode or non-circle selected (ACGO).	Place Bag/Vent switch to Vent, select circle, and retest.
FAILED: Backpressure Valve: Low backpressure at 200ml/min flow.	Replace Backpressure Valve and retest.
FAILED: Cassette Circuit Flow Error	Identify the failing flow meter. Check the InputFlowAt500mlCheck and OutputFlowAt500mlCheck values in the printed results data. Whichever one deviates most from 500 (500 ml/min test flow) is the failing flow meter. If replacing the Zero Valve as suggested below, replace the zero valve of the failing flow meter. Replace and retest in the following order: • Backpressure Valve • Flowmeter Block • ADB
FAILED: Cassette Communications: Check Cassette Interface Board.	Check, replace, and retest in the following order: • All four magnets on Cassette Interface Board fingers draw down and make contact with Test Cassette contacts • Cassette Interface Board to Agent Delivery Board cable connections are secure • Cassette Interface Board • Agent Delivery Board
FAILED: Cassette Pressure Incorrect.	Replace and retest in the following order: • Both zero valves leaking/stuck open. • Flowmeter Block • ADB

Vaporizer Test message	Corrective Action
FAILED: Cassette: Leak detected.	Measured inflow is excessive when outflow and scavenging circuits are closed. If pre-use check also fails with a therapy cassette, replace and retest in the following order: • Missing, damaged, worn Mechanical Connector Valve o-rings. • Mechanical Connector Valves • Valve Block • Flowmeter Block NOTE: If pre-use test passes with a therapy cassette the Test Cassette may be leaking.
FAILED: Fault Detected. Invalid Outflow.	Replace and retest in the following order: • Outflow Zero Valve • Flowmeter Block • ADB
FAILED: Fault Detected. No cassette pressure rise.	Replace and retest in the following order: • Inflow Valve • Inflow Check Valve • Backpressure Valve • Flowmeter Block • ADB
FAILED: Fault Detected. No output flow.	Replace and retest in the following order: • Scavenging Valve • Flowmeter Block • ADB
FAILED: Flow Meter Block: Cassette pressure out of range.	If 'Reading' is significantly below ambient pressure, replace flowmeter block and retest. If 'Reading' is high, manually depressurize cassette and retest. If failure persists, replace and retest in the following order: • Flowmeter Block • ADB
FAILED: Flow Meter Block: Inflow/Outflow mismatch. (3000mL/min)	Replace and retest in the following order: • Check altitude setting (Section 4.4.1). • Flowmeter Block • ADB
FAILED: Flow Meter Block: Inflow/Outflow mismatch. (500mL/min)	Replace and retest in the following order: • Check altitude setting (Section 4.4.1). • Flowmeter Block • ADB
FAILED: Flow Meter Block: Mixer and cassette pressure sensors disagree. (High Pressure)	Mixer and Vaporizer measured pressures do not agree at the second of two test pressures (high pressure). Replace Flowmeter Block and retest. If problem persists, check troubleshooting procedures for Electronic Mixer. If mixer is not at fault, replace the ADB and retest.
FAILED: Flow Meter Block: Mixer and cassette pressure sensors disagree. (Low Pressure)	Mixer and Vaporizer measured pressures do not agree at the first of two test pressures (low pressure). Replace Flowmeter Block and retest. If problem persists, check troubleshooting procedures for Electronic Mixer. If mixer is not at fault, replace the ADB and retest.
FAILED: Flow Meter Block: Mixer/Inflow mismatch. (100mL/min)	Replace and retest in the following order: • Flowmeter Block • Mixer • ADB

Vaporizer Test message	Corrective Action
FAILED: Flow Meter Block: Mixer/Inflow mismatch. (3000mL/min)	Replace and retest in the following order: • Flowmeter Block • Mixer • ADB
FAILED: Flow Meter Block: Mixer/Inflow mismatch. (500mL/min)	Replace and retest in the following order: • Flowmeter Block • Mixer • ADB
FAILED: Flow Meter Block: Noisy cassette pressure signal.	Cassette Pressure Sensor signal is noisier than can be expected under normal conditions. Replace and retest in the following order: • Flowmeter Block • ADB
FAILED: Inflow Check Valve: Leaking/Stuck open.	Replace and retest in the following order: • Inflow Check Valve • ADB
FAILED: Inflow Read Failure	Replace and retest in the following order: • Inflow Zero Valve • Flowmeter Block • ADB
FAILED: Inflow Valve: Leaking/stuck open.	Replace and retest in the following order: • Inflow Valve • ADB
FAILED: Inflow Zero Valve: Failed closed.	Replace Inflow Zero Valve and retest.
FAILED: Maximum Cassette Circuit Flow Not Achieved.	Replace and retest in the following order: • Proportional Valve • Mechanical Connector Valves • Flowmeter Block • Outflow Valve • Inflow Valve • Scavenging Valve • ADB
FAILED: Mixer: Measured flow does not match set. (3000mL/min)	Mixer is not delivering commanded flow at a setting of 3000 mL/min. Check troubleshooting procedures for Electronic Mixer.
FAILED: Mixer: Measured flow does not match set. (500mL/min)	Mixer is not delivering commanded flow at a setting of 500 mL/min. Check troubleshooting procedures for Electronic Mixer.
FAILED: Outflow Read failure	Replace and retest in the following order: • Outflow Valve • Proportional Valve • Liquid Flow Prevention Valve • ADB

Vaporizer Test message	Corrective Action
FAILED: Outflow Valve: Leaking/stuck open.	Replace and retest in the following order: • Outflow Valve • ADB
FAILED: Outflow Zero Valve: Failed closed.	Replace Outflow Zero Valve and retest.
FAILED: Proportional Valve: Drive current error detected	Replace and retest in the following order: • Proportional Valve • ADB
FAILED: Proportional Valve: Erratic operation, sticking	Replace and retest in the following order: • Proportional Valve • ADB
FAILED: Proportional Valve: Leaking/stuck open.	Replace and retest in the following order: • Proportional Valve • ADB
FAILED: Scavenging Valve: Failed closed	Replace and retest in the following order: • Scavenging Valve • ADB

7.9.3 eVap Troubleshooting Flowchart

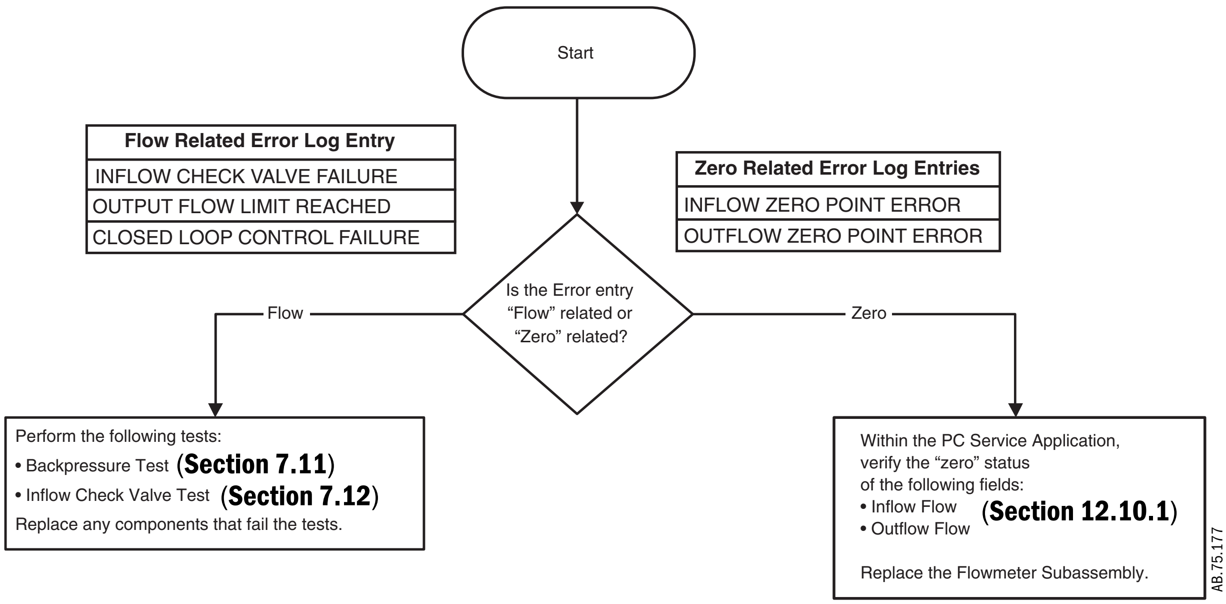


Flowchart **20**

7.9.4 eVap Error Log table

Symptom	**eVap Troubleshooting Flowchart**
Agent Delivery check failed.	See associated errors (Section 7.9.13)
Cassette Not Latching	**(Flowchart 25)** ADB Troubleshooting
Compatibility failure: DCB hardware	**(Flowchart 24)** ACB Comm
No Liquid Level Indicator	**(Flowchart 25)** ADB Troubleshooting
Error Log Entry	
ADB 10VA POWER ERROR	**(Flowchart 27)** Power and Valves Troubleshooting
ADB VOLTAGE ERROR	**(Flowchart 25)** ADB Troubleshooting
CASSETTE LEVEL LOW	See other associated errors
CASSETTE OVERFILL DETECTED	**(Flowchart 23)** Leak and Cassette Troubleshooting
CASSETTE PRESSURE ERROR	**(Flowchart 22)** Pressure Troubleshooting
CASSETTE TEMPERATURE EEPROM FAILURE	**(Flowchart 26)** Temperature Troubleshooting
CASSETTE TEMPERATURE FAILURE	**(Flowchart 26)** Temperature Troubleshooting
CLOSED LOOP CONTROL FAILURE	**(Flowchart 21)** Flow and Zero Troubleshooting
COM ERROR VENT TO ACB	**(Flowchart 24)** ACB Comm
CONDENSATION CONDITIONS EXIST	**(Flowchart 26)** Temperature Troubleshooting
DCB RAM ERROR	**(Flowchart 25)** ADB Troubleshooting
ENHANCED CASSETTE TEMPERATURE FAILURE	**(Flowchart 23)** Leak and Cassette Troubleshooting
INFLOW CHECK VALVE FAILURE	**(Flowchart 21)** Flow and Zero Troubleshooting
INFLOW OUTFLOW CROSSCHECK FAILURE	**(Flowchart 23)** Leak and Cassette Troubleshooting
INFLOW ZERO 10VA POWER ERROR	**(Flowchart 27)** Power and Valves Troubleshooting
INFLOW ZERO POINT ERROR	**(Flowchart 21)** Flow and Zero Troubleshooting
INSERT CASSETTE	**(Flowchart 25)** ADB Troubleshooting
INVALID CASSETTE ID	**(Flowchart 23)** Leak and Cassette Troubleshooting
LOSS OF VAPORIZER USER SETTINGS	**(Flowchart 15)** DU-ACB Communication
MAN CASS OVER UNDER TEMP	**(Flowchart 26)** Temperature Troubleshooting
MANIFOLD TEMPERATURE EEPROM FAILURE	**(Flowchart 26)** Temperature Troubleshooting
MANIFOLD TEMPERATURE FAILURE	**(Flowchart 26)** Temperature Troubleshooting
OUTFLOW SCAV 10VA POWER ERROR	**(Flowchart 27)** Power and Valves Troubleshooting
OUTFLOW ZERO POINT ERROR	**(Flowchart 21)** Flow and Zero Troubleshooting
OUTPUT FLOW LIMIT REACHED	**(Flowchart 21)** Flow and Zero Troubleshooting
PORT ZERO READ BACK FAIL	**(Flowchart 25)** ADB Troubleshooting
PRESSURE SENSOR EEPROM FAILURE	**(Flowchart 22)** Pressure Troubleshooting
PROP VALVE DRIVE SENSE	**(Flowchart 25)** ADB Troubleshooting
PROP VALVE HTR 10VA POWER ERROR	**(Flowchart 27)** Power and Valves Troubleshooting
VAP SENSOR ERROR	See other associated errors
VAP_CASSETTE_OVER_PRESSURE	**(Flowchart 22)** Pressure Troubleshooting
VAP_CONDENSATION_CONDITION EXISTS	**(Flowchart 26)** Temperature Troubleshooting
VAP ENHANCED CASSETTE TEMPERATURE FAILURE	**(Flowchart 23)** Leak and Cassette Troubleshooting
VAP PORT ZERO READ BACK FAIL	**(Flowchart 25)** ADB Troubleshooting
VAPORIZER LOST MIXER FLOW	**(Flowchart 24)** ACB Comm
VAPORIZER SENSOR ERROR	See other associated errors
VAPORIZER SUBSYSTEM COMM FAILURE	**(Flowchart 24)** ACB Comm

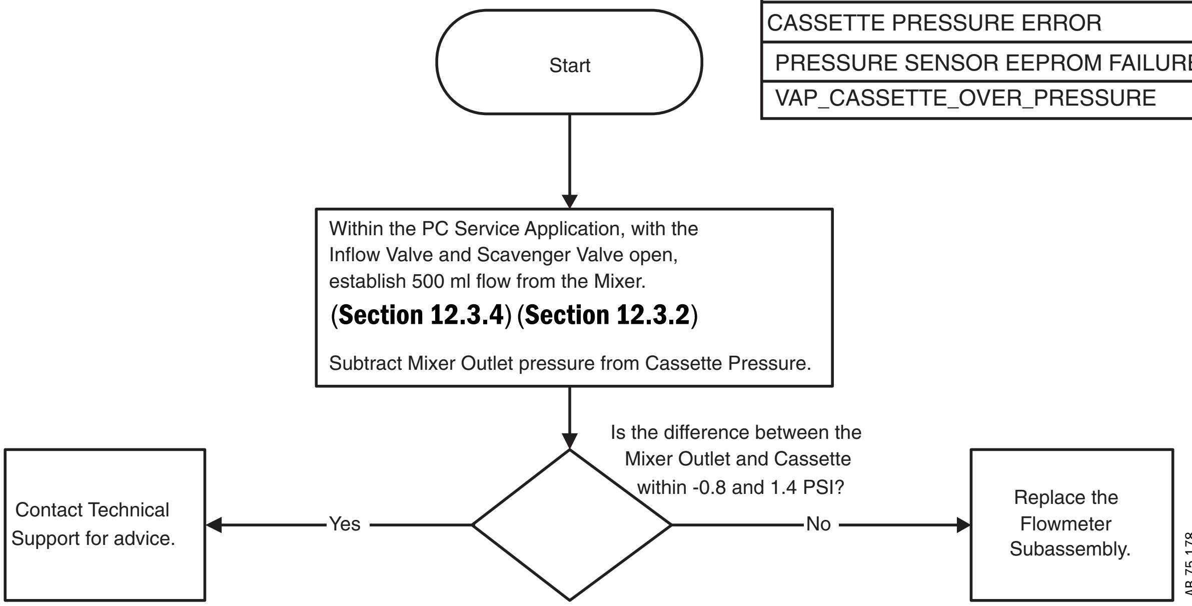
7.9.5 eVap Flow and Zero troubleshooting



Flowchart **21**

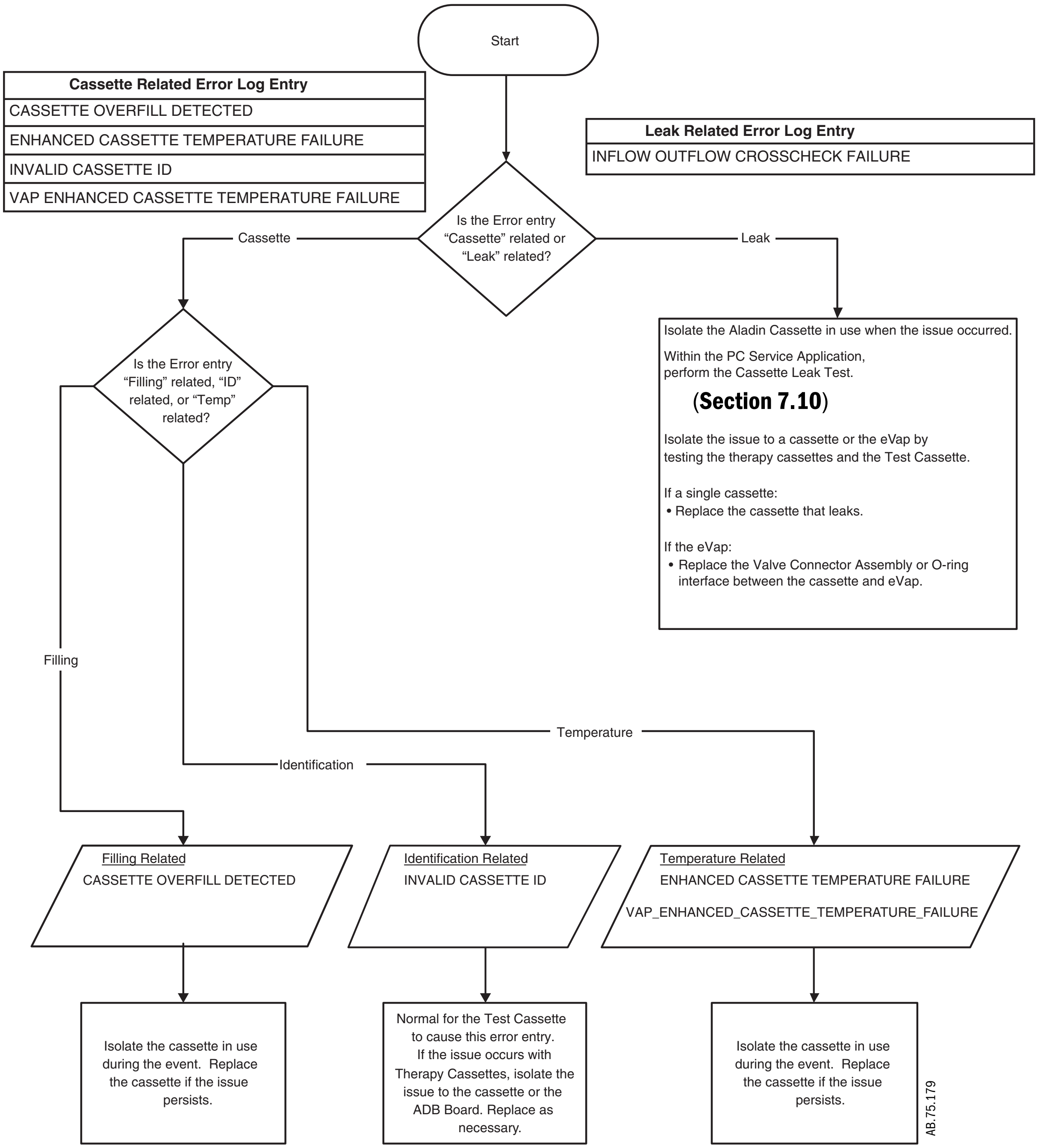
7.9.6 eVap Pressure troubleshooting

Error Log Entry
CASSETTE PRESSURE ERROR
PRESSURE SENSOR EEPROM FAILURE
VAP_CASSETTE_OVER_PRESSURE



Flowchart **22**

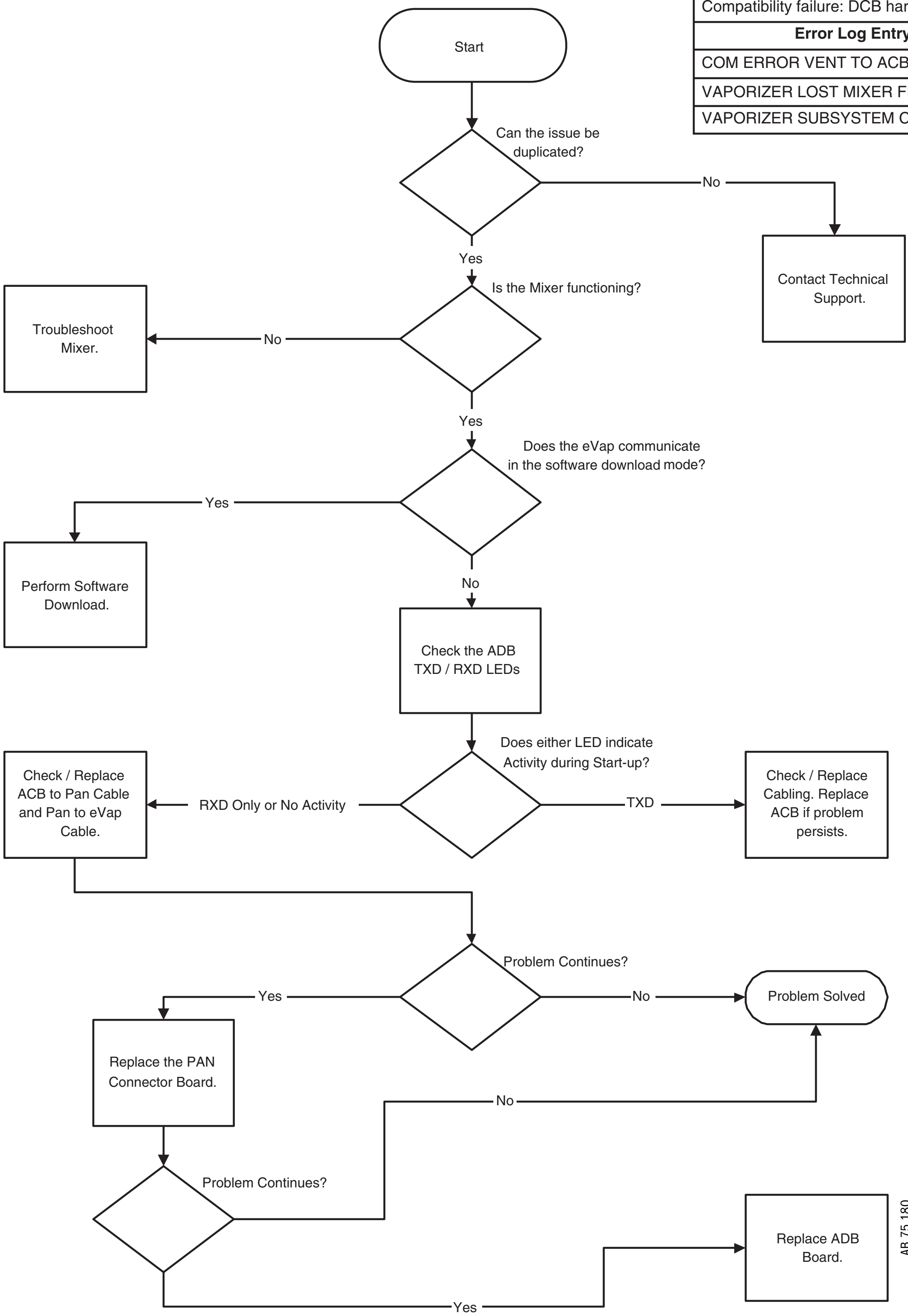
7.9.7 eVap Leak and Cassette troubleshooting



Flowchart **23**

7.9.8 eVap Communication troubleshooting

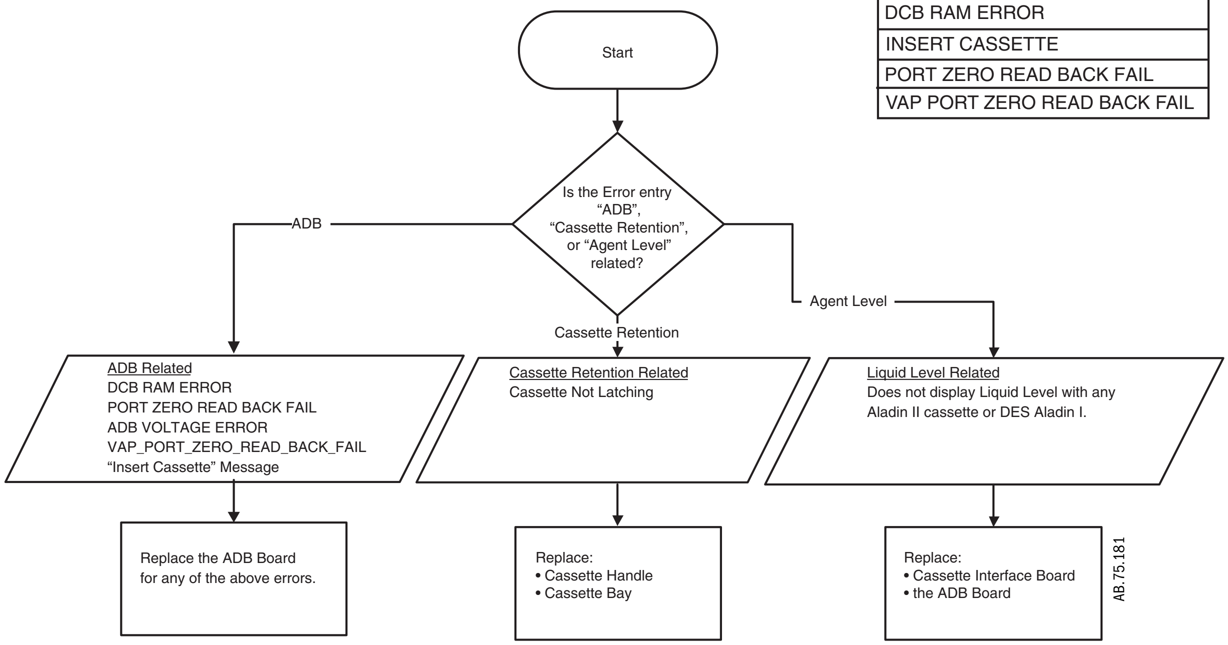
Symptom
Compatibility failure: DCB hardware
Error Log Entry
COM ERROR VENT TO ACB
VAPORIZER LOST MIXER FLOW
VAPORIZER SUBSYSTEM COMM FAILURE



Flowchart **24**

7.9.9 eVap ADB troubleshooting

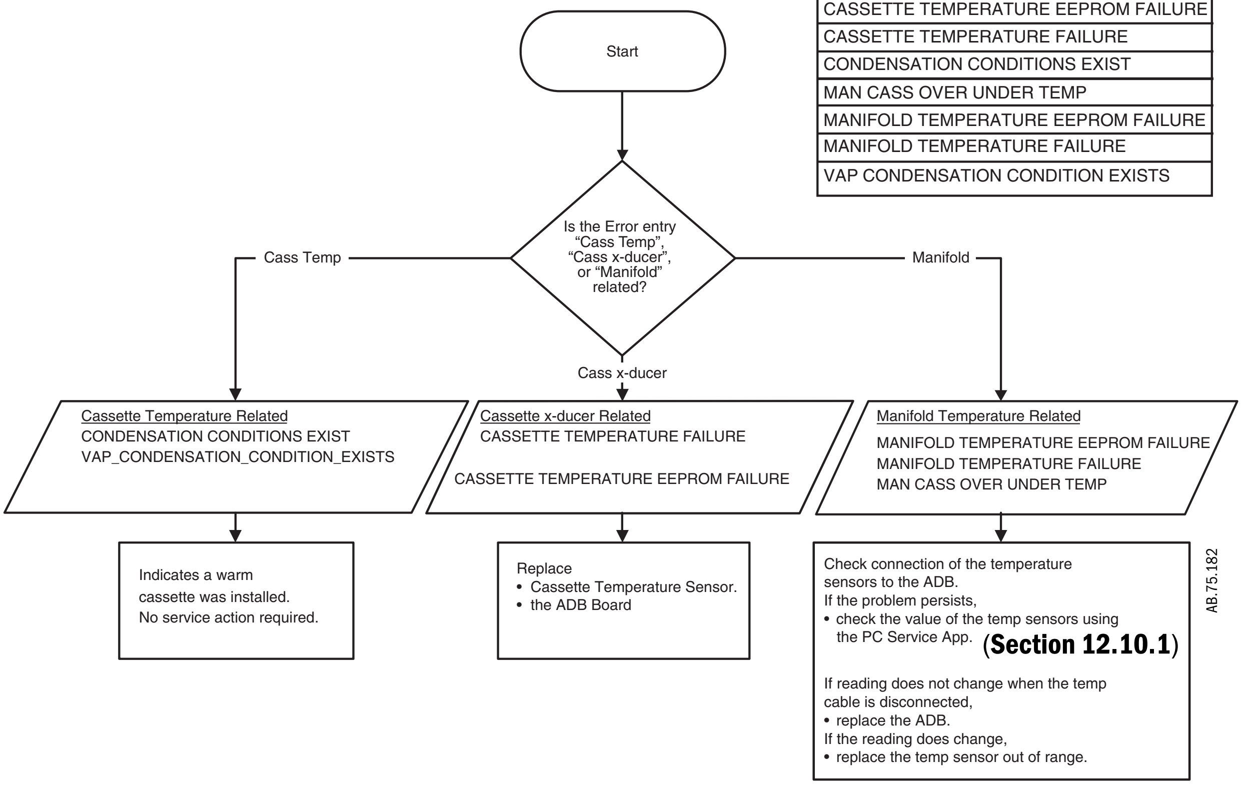
Symptom
Cassette Not Latching
No Liquid Level Indicator
Error Log Entry
ADB VOLTAGE ERROR
DCB RAM ERROR
INSERT CASSETTE
PORT ZERO READ BACK FAIL
VAP PORT ZERO READ BACK FAIL



Flowchart **25**

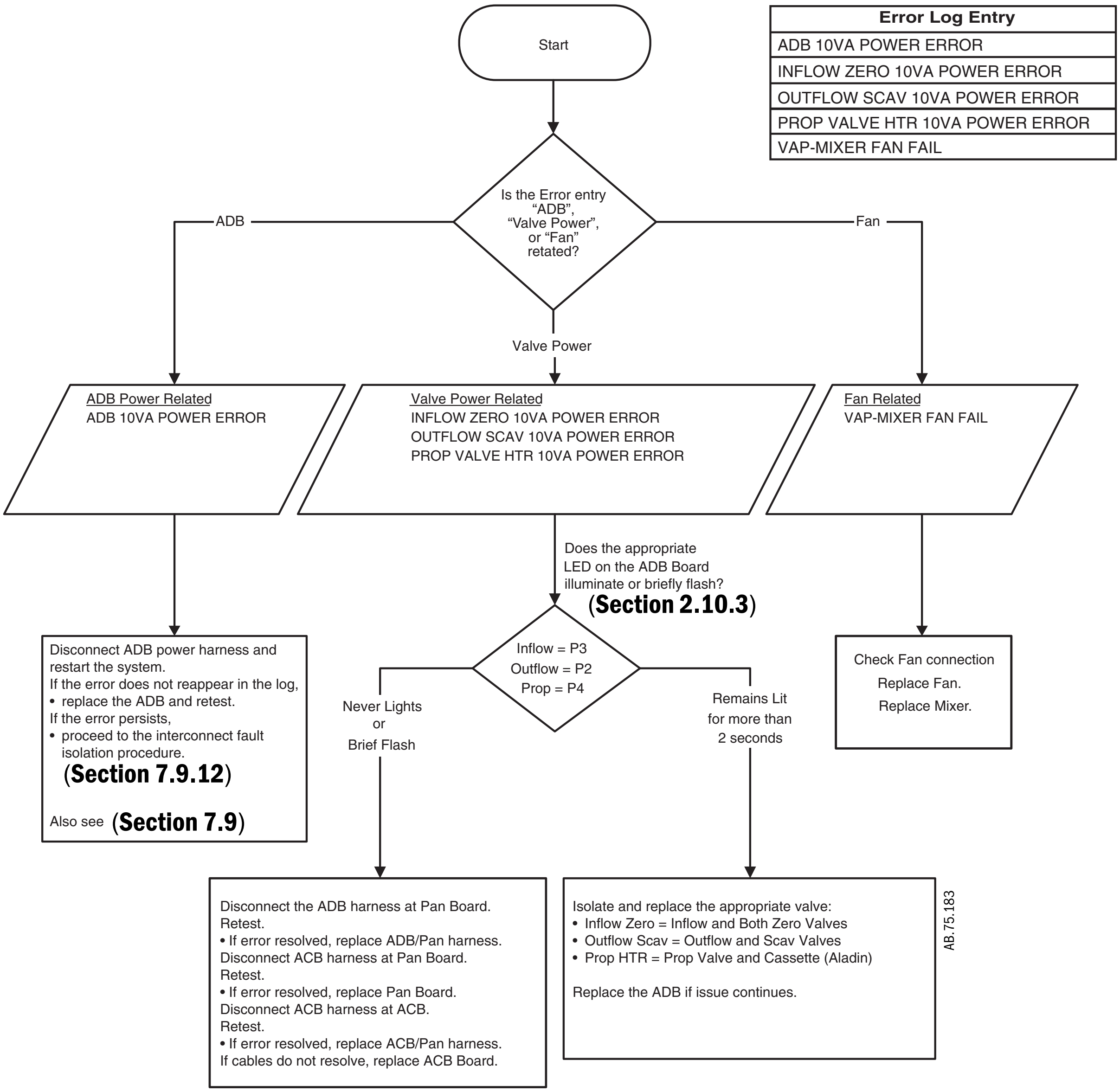
7.9.10 eVap Temperature troubleshooting

Error Log Entry
CASSETTE TEMPERATURE EEPROM FAILURE
CASSETTE TEMPERATURE FAILURE
CONDENSATION CONDITIONS EXIST
MAN CASS OVER UNDER TEMP
MANIFOLD TEMPERATURE EEPROM FAILURE
MANIFOLD TEMPERATURE FAILURE
VAP CONDENSATION CONDITION EXISTS



Flowchart **26**

7.9.11 eVap Power and Valves troubleshooting



Flowchart 27

7.9.12 Electronic vaporizer 10VA power interconnect fault isolation

Troubleshooting of the following Error Log Entries may lead you to further troubleshoot the problem as detailed below:

- ADB 10VA POWER ERROR
- INFLOW ZERO 10VA POWER ERROR
- OUTFLOW SCAV 10VA POWER ERROR
- PROP VALVE HTR 10VA POWER ERROR

10VA power interconnect fault isolation procedure:

Continue to disconnect harnesses in the following order and retest until problem resolved:

1. Disconnect the ADB harness at PCB.
   - If problem goes away, replace ADB-PCB harness.
2. Disconnect the ACB harness at PCB.
   - If problem goes away, replace PCB.
3. Disconnect the ACB harness at ACB.
   - If problem goes away, replace ACB-PCB harness.
4. If cable disconnects do not eliminate the failure, replace ACB and retest.

7.9.13 Vaporizer Checkout Troubleshooting

Error Log Entry	Condition / Test Configuration	Action/Troubleshooting
VAPCHK BACKPRESSURE	Pressure generated by the Backpressure Valve is too low. Mixer outlet pressure with 200 ml/min flow and Inflow Valve closed is below limit.	Replace: • Backpressure Valve
VAPCHK CASS LEAK	Cassette / eVap leak greater than limit. eVap Inflow flow reading greater than limit when cassette flow is off. Test: Mixer Flow: 2 l/min Inflow Valve: On Scav Valve: Off Outflow Valve: Off Prop Valve: 0	Retest with different cassette to determine if leak is in the cassette or eVap. If leak is in eVap, replace: • Connector Valves and Spring Seals • Tubing/fittings between eVap and Mixer • Scavenging Valve
VAPCHK CASSETTE COMM	Digital communication with Test Cassette Failed.	Check, replace, and retest in the following order: • All four magnets on Cassette Interface Board fingers draw down and make contact with Test Cassette contacts. • Cassette Interface Board to Agent Delivery Board cable connections are secure. • Cassette Interface Board. • Agent Delivery Board.
VAPCHK CASS PRESS RANGE	Ambient pressure as measured by Cassette Pressure Sensor outside limit. Reported pressure is outside the service altitude conditions with the Scavenging Valve open.	Disconnect the scavenging tube (blue). Restart test: • If the test passes, troubleshoot occlusion in scavenging circuit tubing. Look specifically for occluded Scavenging Downtube. If the test still fails, replace: • Flow Meter Block Assembly
VAPCHK CONFIG	Machine is ACGO and circuit selector switch is in the ACGO position OR Bag/Vent switch is in the Bag position	User training/information.
VAPCHK FLOW CONTROL	Unable to control eVap output flow.	Replace: • Proportional Valve • Backpressure Valve • Flow Meter Block Assembly • Agent Delivery Board

Error Log Entry	Condition / Test Configuration	Action/Troubleshooting
VAPCHK INCHECK LEAK	Inflow Check Valve leak exceeds limit. Test: Mixer Flow: 8 l/min Inflow Valve: On Scav Valve: Off Outflow Valve: Off Mixer Flow reduced to 2 l/min. Monitor eVap Inflow Flow for negative flow.	Replace: • Inflow Check Valve
VAPCHK INFLOW LEAK	Inflow Valve leak exceeds limit. Test: Mixer Flow:2 l/min Inflow Valve: Off Scav Valve: On Outflow Valve: On Prop Valve: 65534 Inflow flow values indicate flow equal to Inflow Valve leak rate.	Replace: • Inflow Valve (right side valve block assembly as viewed from front).
VAPCHK INFLOW OUTFLOW	Input and Output Flow Meters do not match to within limit Test: Mixer Flow: 0.5 l/min Inflow Valve: On Scav Valve: Off Outflow Valve: On Prop Valve: 65534	Replace: • Flow Meter Block Assembly • Agent Delivery Board
VAPCHK INFLOW ZERO	Inflow Meter Zero Valve fails to operate Test: Mixer Flow: 0.5 l/min Inflow Valve: On Scav Valve: Off Outflow Valve: On Prop Valve: 65534 Verify Inflow reads at or near 0.5 l/min Uncheck Zero Valves Auto and select Inflow Zero – On. Verify LED comes on, valve clicks, and Inflow reads at or near 0 ml.	Replace: If the test fails: • Input Flow Meter Zero Valve (right side of Flow Meter Block Assembly as viewed from the front) • Agent Delivery Board If the test passes: • Flow Meter Block Assembly
VAPCHK MAX FLOW	Unable to achieve required maximum eVap output flow	Replace: • Backpressure Valve • Proportional Valve • Flow Meter Block Assembly • Agent Delivery Board

Error Log Entry	Condition / Test Configuration	Action/Troubleshooting
VAPCHK MIX CASSP	Mixer outlet pressure and eVap cassette pressure do not match to within limit.	Replace: • Flow Meter Block Assembly • Agent Delivery Board • Mixer
VAPCHK MIX INFLOW	Delivered flow measured by Mixer does not agree with the eVap Inflow flowmeter within limit. Test: Mixer Flow: 0.5 l/min Inflow Valve: On Scav Valve: On Outflow Valve: ON Prop Valve: 65534	Check Mixer/eVap Inlet connection. Replace: • Backpressure Valve • Flow Meter Block Assembly • Agent Delivery Board • Mixer
VAPCHK MIXER SET	During eVap check: Mixer measured flow does not match set.	Troubleshoot Mixer.
VAPCHK MIXER TEST	Before start of eVap check: Mixer flow test failed. Mixer running 3 and 7 LPM test. All eVap valves off.	• Disconnect eVap Inlet tube. Restart test. If the VAPCHK MIXER TEST error recurs, troubleshoot mixer. • If a different error occurs, reconnect Inlet tube and disconnect outlet tube. Restart test. If the VAPCHK MIXER TEST recurs, replace backpressure valve.
VAPCHK OUTFLOW LEAK	Outflow valve leak exceeds limit Test: Mixer Flow: 2 l/min Inflow Valve: On Scav Valve: Off Outflow Valve: Off Prop Valve: 65534 Outflow flow values indicate Outflow Valve leak rate.	Replace: • Outflow Valve (rear valve on left side of valve block assembly as viewed from front)
VAPCHK OUTFLOW ZERO	Outflow Meter Zero Valve fails to operate Test: Mixer Flow: 0.5 l/min Inflow Valve: On Scav Valve: Off Outflow Valve: On Prop Valve: 65534 Verify Outflow reads at or near 0.5 l/min Uncheck Zero Valves Auto and select Outflow Zero – On. Verify LED comes on, valve clicks, and Outflow reads at or near 0 ml.	Replace: If the test fails: • Input Flow Meter Zero Valve (right side of Flow Meter Block Assembly as viewed from the front) • Agent Delivery Board If the test passes: • Flow Meter Block Assembly

Error Log Entry	Condition / Test Configuration	Action/Troubleshooting
VAPCHK PROP DRIVE	Proportional Valve drive current feedback does not match commanded current to within limit	Replace: • Proportional Valve • Agent Delivery Board
VAPCHK PROP LEAK	Proportional valve leak exceeds limit Test: Mixer Flow: 2 l/min Inflow Valve: On Scav Valve: Off Outflow Valve: On Prop Valve: 0 Outflow flow values indicate Prop Valve leak rate.	Replace: • Proportional Valve.
VAPCHK SCAV FAIL	Scavenging circuit not flowing gas / excessive restriction. Excessive pressure rise when flowing through scavenging circuit.	Disconnect eVap scavenging tube (Blue). Restart test: • If the test passes, troubleshoot occlusion in scavenging circuit tubing (Look specifically for occluded Scavenging Downtube.). If the test still fails, replace: • Scavenging Valve • Agent Delivery Board
VAPCHK VAP ALARM	Multiple Test Conditions	See additional eVap entries in error log. Address the cause of the alarm before continuing.

7.10 eVap Therapy Cassette Leak Test

1. Connect and establish communication with the PC Service Application.
2. On the **Gas Delivery Schematic**, set the following:
   - Mixer O2 Flow to ***2.0*** l/min.
3. On Vaporizer Schematic, set the following:
   - Inflow valve to ***On***
   - Outflow valve to ***Off***
   - Scavenging to ***Off***
   - Prop Flow Valve DAC Value to ***0***
   - Cassette Power to ***Off***
   - Zero Valves Auto box checked (☑)
4. After the readings stabilize, record the **eVap Inflow** flow value. It should be zero or near zero.
   - Note: Stable readings are defined as either a) not changing or b) shifting up and down through some minimum to maximum range. If shifting up and down, record the maximum inflow value displayed once the displayed flow range is neither increasing nor decreasing significantly. Disregard values during and immediately after flow meter zeroing.
5. Insert cassette under test.
6. Allow the **eVap Inflow** flow reading to stabilize and record flow.
   - Pass/Fail Criteria: Stable flow readings above 10 ml/min indicate a potential leak in the cassette or eVap Connection Valves.
7. Repeat steps 5 through 6 for each non-DES therapy cassette on the machine four to five times with varying insertion forces (gentle, normal, and aggressive).
8. If therapy cassette leak rate is greater than 10 ml/min, insert test cassette and confirm eVap leakage with test cassette is less than 10 ml/min.
   - Replace therapy cassette if therapy leak rate is greater than 10 ml/min and test cassette leak rate is less than 10 ml/min in same eVap unit.
9. Replace any cassette that exhibits leak rates above 10 ml/min.
10. If multiple (therapy and test) cassettes tested on one machine exhibit leaks, replace the Valve Connector Assembly or o-ring on the Valve Connector Assembly in the eVap subassembly.

7.11 eVap Backpressure Valve Test

1. Connect and establish communication with the PC Service Application.
2. In the **File**>**Preferences** menu set the Gas Supply Pressure Units to ***kPa***.
3. Install a Test Cassette in the eVap.
4. On the **Vaporizer Schematic**, set the following:
   - Prop Flow Valve DAC Value to ***65534***
   - Inflow valve to ***On***
   - Outflow valve to ***On***
   - Scavenging to ***On***
   - Cassette Power to ***Off***
   - Zero Valves Auto box checked (☑)
5. On the **Gas Delivery Schematic**, set the following:
   - Mixer O2 Flow to ***0.00*** l/min.
6. Record the following:
   - **Mixer Outlet** pressure
   - **Cassette Pressure**
   - and **eVap Inflow** flow readings
7. On the **Gas Delivery Schematic**, set the following:
   - Mixer O2 Flow to ***0.50*** l/min.
8. Record the following:
   - **Mixer Outlet** pressure
   - **Cassette Pressure**
   - and **eVap Inflow** flow readings
9. On **Vaporizer Schematic**, set the following:
   - Scavenging to ***Off***
10. Wait for the flow and pressure values to stabilize.
11. Record the following:
    - **Mixer Outlet** pressure
    - and **eVap Inflow** flow readings
12. On **Vaporizer Schematic**, reduce the Prop Flow Valve DAC Value to approximately ***23000*** counts. Observe the **eVap Outflow** flow reading.
    - Reduce or increase the Prop Flow Valve DAC Value setting until the **eVap Outflow** flow reading is between 150 to 250 ml.

13. Observe the **eVap Inflow** flow reading.
    - Ensure the **eVap Inflow** flow reading does not drop more than 10 ml from the value recorded in step 11 as the **Mixer Outlet** pressure increases 5 to 10 kPa above the **Mixer Outlet** pressure recorded in step 11.
14. When the **eVap Inflow** flow reading approximately matches the **eVap Outflow** flow reading (± 20 ml), record the **Mixer Outlet** pressure.
15. To calculate the leak rate of the Backpressure Valve, subtract the **eVap Inflow** flow reading recorded in step 8 from the **eVap Inflow** flow reading recorded in step 11.
    - Replace the Backpressure Valve if the flow rate difference is greater than 10 ml/min.
16. To calculate the pressure created by the Backpressure Valve, subtract **Mixer Outlet** pressure reading recorded in step 6 from the **Mixer Outlet** pressure reading recorded in step 14.
    - Replace the Backpressure Valve if the pressure created by the backpressure valve is less than 24 kPa.

    Note: A typical backpressure created by the Backpressure Valve is between 30 kPa and 50 kPa.

Record Values Here

Step 6	
Mixer Outlet (kPa)	
Cassette Pressure (kPa)	
Inflow flow (mL)	
Step 8	
Mixer Outlet (kPa)	
Cassette Pressure (kPa)	
Inflow flow (mL)	
Step 11	
Mixer Outlet (kPa)	
Inflow flow (mL)	
Step 14	
Mixer Outlet (kPa)	
Step 15 Backpressure Leak	
Inflow (Step 8) – Inflow (Step 11)	
Step 16 Backpressure Generated	
Mixer Outlet (Step 14) – Mixer Outlet (Step 6)	

7.12 eVap Inflow Check Valve Test

Test Equipment

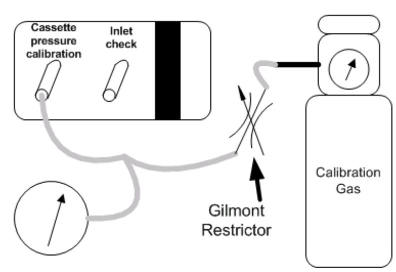
- Certifier 4070 or equivalent low-pressure measurement device (±1% of reading or better accurate)
- M-Gas/E-Gas Calibration Gas with Calibration Regulator (755530-HEL or M1006864)
  Note: If using the M1006864 calibration regulator, the tubing must be pushed on the hose barb past the bleed hole (bleed hole must be occluded) for the test to function correctly.
- ADU Test Cassette (8500006)
- Various tubing and Tee fittings (locally sourced)
- PC Service Application and Serial Cable (Section 10.1.1)
- Gilmont Flow Restrictor (6027-0000-126) or equivalent adjustable flow restrictor

Test Procedure

1. Move the dashboard forward to the service position or remove rear cover to access the eVap.
2. Connect and establish communication between the Aisys CS2 and the PC Service Application.
3. Insert the ADU Test Cassette in the eVap bay.
4. In Vaporizer Schematic, set the following valves to the following settings:
   - Inflow valve to “On”
   - Outflow valve to “On”
   - Scavenging valve to “Off”
   - Prop Flow Valve DAC Value to “65534”
   - Cassette Power to “Off”
   - Zero Valves Auto box checked

Note Ensure Outflow meter reading is zero. If non-zero, wait for the system to perform an Auto-zero cycle. When the eVap auto-zeros, an audible click can be heard and the LED (CR15) next to the zero valve connector temporally illuminates.

5. Connect the Calibration Gas Regulator output (without “Y” piece adapter) to the ADU Test Cassette port labeled “Cassette pressure calibration” as illustrated. Open the calibration regulator (on the non-adjustable) or set the regulator to approximately 3 PSI (on the adjustable regulator) and adjust the inline restrictor until the eVap Outflow flow reading on the PC Application reads 5ml (±1 ml). Re-adjustment of the regulator may be necessary after flow is established.

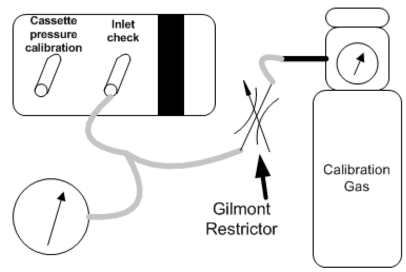


6. On the Gas Delivery Schematic:
   - Set the Total Flow to 15.00 LPM.
   - Then set the Total Flow to 0.00 LPM.
   - Then set the Total Flow to 15.00 LPM.
   - Then set the Total Flow to 0.20 LPM.

7. Disconnect the Mixer to eVap “Inlet” tubing from the back of the eVap.

Note Ensure Inflow meter reading is zero. If non-zero, wait for the system to perform an Auto-zero cycle. When the eVap auto-zeros, an audible click can be heard and the LED (CR17) next to the zero valve connector temporally illuminates.

8. Connect the Calibration Gas Regulator output to the ADU Test Cassette port labeled “Inlet Check”.
9. Observe the Inflow flow reading and the pressure on the pressure measurement device. After 20 seconds, record the readings for the flow and pressure.



10. Determine the Pass/Fail disposition of the valve using the table below:

Scenario	Pressure Response	Inflow Reading (ml/min)	Pass / Fail	Comments
1	Pressure sharply increases	0 flow	Pass	Inflow Check Valve is functioning properly.
2	Pressure sharply increases	Negative flow less than 4 ml/min	Pass	Inflow Check Valve is acceptable (leak below limit of 5 ml/min).
3	Pressure does not increase	Negative flow 4 ml/min or more	Fail	Inflow Check Valve is leaking. • Replace Inflow Check Valve.
4	Pressure sharply increases	Negative flow 4 ml/min or more	Possible test error or inflow meter not zeroed	Wait for Inflow meter auto zero cycle and re-record flow. • If flow goes to 0 (or less than -4 ml/min), Inflow Check Valve is acceptable. • If negative flow (greater than –4 ml/min) persists, troubleshoot for test pressure reading error or flowmeter reading error. Repeat test as needed.
5	Pressure does not increase	0 flow	Possible test error or test set-up leak	Possible adjustment of restrictor or leak in tubing. Check test setup and re-test.

11. Repeat steps 5 through 10 three times (reconnecting the Mixer to eVap “inlet” tubing to the back of the eVap).
12. If any of the three tests results indicate “Fail”, replace the Inflow Check Valve.
13. Re-connect all the machine tubing and re-install the dashboard.
14. Perform a post service checkout on the machine.

7.13 eVap Scavenger Path Testing

1. Connect and establish communication with the PC Service Application.
2. In the **File**>**Preferences** menu set the Gas Supply Pressure Units to ***kPa***.
3. On the **Gas Delivery Schematic**, set the following:
   - Mixer O2 Flow to ***0.50*** l/min.
4. Insert a de-pressurized Test Cassette.
5. On the **Vaporizer Schematic**, set the following:
   - Inflow valve to ***Off***
   - Outflow valve to ***Off***
   - Scavenging to ***On***
   - Prop Flow Valve DAC Value to ***0***
   - Cassette Power to ***Off***
   - Zero Valves Auto box checked (☑)
6. Record the **Cassette Pressure** value.
7. Set the Inflow valve to ***On***.
8. After the reading stabilizes, re-record the **Cassette Pressure**.
9. Subtract the second reading from the first reading.
   a. If the difference between the two readings is less than or equal to 1.00 kPa, there is no restriction in the scavenger path. No action is required.
   b. If the difference between the two readings is greater than 1.00 kPa, disconnect the eVap scavenger tubing (blue tubing) and repeat the test.
   c. With the scavenger tubing disconnected, if the pressure difference is less than 1.00 kPa, inspect the scavenger tubing for kinks and replace as necessary. If no kinks or restrictions are noted, inspect the Scavenger Downtube (1407-3904-000) for restrictions, replace as necessary.
   d. If the pressure gradient remains greater than 1.00 kPa, troubleshoot or replace the eVap.

7.14 Technical Alarms

The Error Log includes technical alarms and other error conditions reported by the system.

A technical alarm, as apposed to a parameter alarm, is an alarm condition that exists whether or not a patient is connected to the machine. Technical alarms include:

- Failed state alarms - internal problem prevents normal operation
- Ventilator failure alarms
- Vent Fail. Monitoring Only alarms
- Alternate O_2 state alarms - caused by electronic gas mixer failure

Alarms that do not fit into any particular category but are technical in nature are referred to as a Status alarms in this table.

Source table: AC = Anesthesia Computer
DC = Display Controller
EV = Electronic Vaporizer
Mixer = Electronic Gas Mixer
PC = Power Controller
Vent = Ventilator Interface

<table>
<tr><th>Error Log Entry</th><th>Alarm Text</th><th>Condition (Basic info)</th><th>Priority</th><th>Source</th><th>Enabling Criteria</th></tr>
<tr><th></th><th colspan="5">Action/Troubleshooting</th></tr>
<tr><td rowspan="2">+12.0V H AMPS GAS SEL VALVES</td><td>Alternate O_2 Screen.</td><td>AC detected high current to the Gas Select Valves.</td><td>Medium</td><td>AC</td><td>Fresh gas select valves +10VA is turned On.</td></tr>
<tr><td colspan="5">Disconnect the flex cable from each three-way and NC gas select valves.
Measure the resistance of each valve:
• should be approximately 75Ω.</td></tr>
<tr><td rowspan="2">+12.0V H AMPS ALT O2</td><td>Alternate O_2 Screen.</td><td>AC detected high current.</td><td>Medium</td><td>AC</td><td>Alternate O_2 valve +10VA turned On.</td></tr>
<tr><td colspan="5">Disconnect the flex cable from the NO Alternate O_2 valve.
Measure the resistance of the NO Alternate O_2 Bypass Valve:
• should be approximately 75Ω.</td></tr>
<tr><td rowspan="2">+12.0V H AMPS MIXER</td><td>Alternate O_2 Screen.</td><td>Status bit shows current high.</td><td>Medium</td><td>AC</td><td>Mixer +10VA turned On.</td></tr>
<tr><td colspan="5">On the Anesthesia Board Power window (Section 12.7.2) of the PC Service App, observe that Mixer 10VA Amps is reported as Fail.
Turn off power to the machine and disconnect the system interface harness from the Mixer.
If the Mixer 10VA Amps is now reported as OK,
• replace the Mixer.
If the Mixer 10VA Amps is still reported as Fail,
• inspect the harnesses from the ACB to PCB and PCB to Mixer for cross connections or damaged pins.
• replace the ACB.</td></tr>
<tr><td rowspan="2">+12.0V H AMPS VENTSIB</td><td>Ventilator failure!</td><td>Status bit shows current high.</td><td>High</td><td>AC</td><td>Ventilator Interface board 10VA is turned on.</td></tr>
<tr><td colspan="5">Reboot system.
If problem continues, replace cVIB.</td></tr>
<tr><td rowspan="2">+12.0V H AMPS MGAS</td><td>Gas monitoring not available</td><td>Status bit shows current high.</td><td>Medium</td><td>AC</td><td>MGAS 10 VA is turned on after 3 consecutive “ACB: +12.0V H AMPS MGAS” error log messages.</td></tr>
<tr><td colspan="5">Note: “+12.0V H AMPS MGAS” is not the same as “ACB: +12.0V H AMPS MGAS.”
Note: Single occurrences of “ACB: +12.0V H AMPS MGAS” require no action.
Remove Gas Module from the Module Bay.
If the problem continues, replace the M-Gas Monitoring board.
If the message disappears when module is removed, repair the M-Gas module:
• (see S/5 AM Technical Reference Manual for repair instructions).</td></tr>
<tr><td rowspan="2">+12.0V H AMPS VENT&OUTLET VALVES</td><td>Vent Fail. Monitoring Only.</td><td>Status bit shows current high.</td><td>Medium</td><td>AC
Vent</td><td>Ventilator valves +10VA is On.</td></tr>
<tr><td colspan="5">Disconnect the GIV and Insp Flow Valve.
Measure the resistance of each valve:
• should be approximately 25Ω for the GIV and 75Ω for the Insp Flow Valve.</td></tr>
</table>

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
+12.0V L VOLT ALT O2		Indicates Low Volts to the Mixer Alt O2 Valve.		ACB	
	This error can be falsely triggered. If no machine issues exist, ignore this entry. If machine issues exist, disconnect the flex cable from the NO Alternate O2 valve. Use a Multimeter to measure the resistance of the NO Alternate O2 Bypass Valve. It should be approximately 75Ω.				
+12.0V L VOLT VENT&OUTLET VALVES		Indicates the Gas Inlet Valve Solenoid or Inspiratory Flow Control Valve is drawing too much power.		ACB	
	Disconnect the GIV and Insp Flow Valve. Measure the resistance of each valve: • should be approximately 25Ω for each valve.				
+12.0V L VOLT VENTSIB		Indicates low voltage to the cVIB.		ACB	
	Use the Service Application to isolate cVIB from cable.				
+12.5V TO ACB	Alternate O_2	<11.9 or > 12.9 Vdc	High	AC - DC checks the service state.	
	Reboot system. If problem continues, replace the Power Controller board.				
+5V H AMP GAS SUPPLY XDUCERS	Cannot read gas supply pressures	Status bit shows current high.	Medium	AC	Pressure transducer +10VA turned On.
	Reboot system. If problem continues: 1. With system in Standby, disconnect all gas supply pressure transducers from ABS Filter board. 2. Reboot system. • If problem continues, replace the ACB. • If error is no longer present, set system to Standby and reconnect one pressure transducer at a time. 3. Reboot system and check for error with each transducer connected. Replace the transducer that causes the error to appear.				
12 HR TEST	Turn power Off and On for self tests	System has been operating for longer than 12 hours without a power up self test.	Low	AC - Vent DC checks enable criteria	System state is in Checkout.
	At next available time, move the system switch from the On position to the Off position, then back to the On position.				
ACB 4.096V ADC REF	Cannot monitor gas supplies	<4.018 or > 4.176 Vdc	Low	AC	
	Reboot System. If problem continues, replace the ACB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
ACB ADC FAIL	Cannot monitor gas supplies	ADC timeout on any MUX channel.	Low	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB CLOCK SPEED	System Malfunction	AC Clock frequency > 1.1* (expected value) or < 0.9* (expected value). AC Clock frequency incorrect.	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB COM FAIL	System Malfunction	After establishing initial communication, the DC does not receive any messages from AC in 10 sec.	High	DC	
	Reboot System. If problem continues, replace the ACB.				
ACB CPU TEST FAIL	System Malfunction	CPU instruction Test Failure	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB DCB COM FAIL	System Malfunction	The Anesthesia Computer receives no system state messages from the Display Computer for 10 seconds.	High	AC	Initial communications established.
	Reboot System. If problem continues, check the ACB to Mixer communication LED's (or cVIB communication LED's). If the RCV and XMT (or TXD and RXD) LED's indicate activity, check DU cable connections, replace Display Controller PCB if problem continues. If the RCV and XMT (or TXD and RXD) LED's indicate no activity, check the Anesthesia Control board connection, replace the Anesthesia Control board if problem continues.				
ACB EEPROM FAIL	Memory (EEPROM) failure	Read/Write failure or CRC failure of the EEPROM located on the Anesthesia Control Board.	Low	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB FLASH FAIL	System Malfunction	CRC Failure in code space.	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB HW WATCHDOG	System Malfunction	Hardware watchdog fails boot up test, times out, or detects an incorrect code sequence.	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB MICROPROC ERROR	System Malfunction	Unexpected microcontroller exception (bus error, address error, etc.).	High	AC	
	Reboot System. If problem continues, replace the ACB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
ACB PROCEDURE COM FAIL	System Malfunction	• The Display Computer receives no procedure messages from the Anesthesia Computer for 15 seconds +/- 1 second. • The Display Computer's procedure message does not match the Anesthesia Computer's procedure message for 15 seconds +/- 1 second.	High	DC	System in Therapy state
	Reboot system. If problem continues, check the ACB to Mixer communication LED's (or cVIB communication LED's). 1. If the RCV and XMT (or TXD and RXD) LED's indicate activity, • check DU cable connections. • replace Display Controller board if problem continues. 2. If the RCV and XMT (or TXD and RXD) LED's indicate no activity, • check the Anesthesia Control board connection. replace the Anesthesia Control board if problem continues.				
ACB RAM ERROR	System Malfunction	Memory Test Failure, Multiple bit errors detected.	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB REDUNDANT MEMORY FAIL	System Malfunction	A redundantly stored parameter could not be stored properly or was corrupted.	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB SW ERROR	System Malfunction	Unexpected software error	High	AC	
	Reboot System. If problem continues, reload ACB Software. If problem continues, replace the ACB.				
ACB SW WATCHDOG	System Malfunction	Software watchdog failed power-up test, timed out, or a software function was delinquent for too long.	High	AC	
	Reboot System. If problem continues, replace the ACB.				
ACB UNEXPECTED RESET	System Malfunction	Unexpected reset of AC	High	AC	
	Reboot system. If problem continues, replace the ACB.				
ACGO	Vol and Apnea monitoring off	Non Circle (ACGO) selected	Low	DC	System has ACGO
	No Service Action Required.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
ACMains POWER FAIL	Plug in power cable. On battery	ACMains_GOOD goes and stays low for at least 300 msec (3 software loops)	Medium	PC	30 minutes of battery power available.
	No Service Action Required.				
ADB 10VA POWER ERROR	Vaporizer Failure	Overcurrent condition detected by the AC. Circuit disabled.		AC	
	Disconnect ADB power harness and restart the system. If the error does not reappear in the log, • replace the ADB and retest. If the error persists, • proceed to the interconnect fault isolation procedure (Section 7.9.12). (Also see Section 7.9.)				
ADB VOLTAGE ERROR	Vaporizer Failure	One or more of the measured ADB voltages have failed. These include the ADC reference voltage, 12P1 power supply, and five volt supply.		AC	
	Replace ADB and retest. (Also see Section 7.9.)				
AGENT LEVEL LOST	Check agent level	Agent level reporting changes from being reported to agent level no longer available.	Low	AC	Cassette inserted And Agent level is reported And Agent ID is known (agent ID is not none).
	Check, replace, and retest as needed in the following order:· • All four magnets on Cassette Interface Board fingers draw down and make contact with Test Cassette contacts • Troubleshoot/Test cassette(s) • Cassette Interface Board to Agent Delivery Board cable connections are secure • Cassette Interface Board • Agent Delivery Board				
AGENT LEVEL OVER RANGE		Analog agent level (Aladin1 Desflurane) reading was valid but then went out of range (high).			
	Check, replace, and retest as needed in the following order:· • All four magnets on Cassette Interface Board fingers draw down and make contact with Test Cassette contacts • Troubleshoot/Test cassette(s) • Cassette Interface Board to Agent Delivery Board cable connections are secure • Cassette Interface Board • Agent Delivery Board				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
AGENT LEVEL UNDER RANGE		Analog agent level (Aladin1 Desflurane) reading was valid but then went out of range (low).			
	Check, replace, and retest as needed in the following order:· ▪ All four magnets on Cassette Interface Board fingers draw down and make contact with Test Cassette contacts ▪ Troubleshoot/Test cassette(s) ▪ Cassette Interface Board to Agent Delivery Board cable connections are secure ▪ Cassette Interface Board ▪ Agent Delivery Board				
AIR PIPE INVALID	Cannot monitor Air pipeline	Air Pipeline pressure is invalid.	Medium	DC	
	Check Air Pipeline Supply. Check/Replace Air Pipeline Pressure Transducer.				
AIR PRESS LOW	Air supply pressure low	Air pipeline pressure is less than 252 kPa and the air cylinder has a pressure less than 2633 kPa for one second.	Medium	AC, DC	Air is selected as the balance gas with a non zero flow of air or the ventilator uses air as the drive gas and mechanical ventilation is ON
	Check Air Supply. Check/Replace Air Pipeline/Cylinder Pressure Transducer.				
AIR PRESS LOW DURING 21% O2	Air pressure low. Increase O2%.	Air pipeline pressure is less than 252 kPa and the air cylinder has a pressure less than 2633 for one second.	High	AC DC	21% O2 (Air) is selected for fresh gas flow
	Check Air Supply. Check/Replace Air Pipeline/Cylinder Pressure Transducer.				
AIRWAY SENSOR CAL ERROR	Calibrate flow sensors	Airway Pressure Sensor zero offset out of range	Low	AC, Vent	Flow sensor detected
	In the Service Software, “Ventilation Flow and Pressure” (Section 12.9.2), verify the Airway Pressure counts is 800 ± 250. Disconnect the Black in-line connector in the Patient Airway. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the cVIB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
ALT O2 BUTTON PRESSED	Alternate O2 Screen	Alternate O2 button is selected	Medium	DC	Alt O2 button pressed
	No Service Action Required.				
ALT O2 SWITCH FAIL		Alternate O_2 switch status indicates Alt O_2 switch fault. The fault detection condition must persist for 1 second.	Medium	AC	
	Replace the Alt O_2 Switch.				
AUX OUTLET FAIL	No fresh gas flow?	The measured SCGO position does not match commanded position.	High	AC, Vent	
	In the Service Software / Ventilator Status (Section 12.9.1), view the Circuit Feedback status. If the feedback indicates “Fault”, toggle the Circuit. If the Status changes to match the Circuit setting, check/replace the SCGO/ACGO microswitches.				
BACKUP MODE ENTERED	Backup Mode active	No spontaneous breaths in set period of time (Backup Time (sec)) and 30 seconds has elapsed since starting PSVPro mode.	Low	DC	
	No spontaneous breaths in set period of time (Apnea time) and 30 seconds has elapsed since starting PSVPro mode. No Service Action Required.				
BAL CHANNEL PROP VALVE LEAK FAIL	Alternate O2	Likely caused by a leaky Balance Proportional Valve.		Mixer	
	Replace the proportional valve. Replace Mixer if issue continues.				
BAL FLOW CTRL FAIL		Mixer status bit STS_FLOW_CTRL_CH2_FAIL indicates flow attainment failure.	Medium	AC, Mixer	Balance gas supply pressure OK
	Reboot System. If problem continues, replace the Mixer.				
BAL PROP VALVE FAIL		Mixer status bit STS_CH2_PROPN VALVE FAIL indicates proportional valve failure (over current, etc.)	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
BATT V VERY LOW	Plug in power cable. On battery	Available battery power decreases to between 10 and 5 min	Medium	PC	AC Mains Power Failure in progress.
	Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
BATTERY CHARGE FAIL	No battery backup	The system is in standby and the battery charge current is >4.0 amps. **or** The system is powered on with a battery current >1.3 amps.	Medium	PC	
	Check the battery charge circuit in Service Software. Replace Battery.				
BATTERY EMPTY	System shutdown in <5 min	Available battery power is between 1 and 5 minutes	High	PC	AC Mains Power Failure in progress.
	Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				
BATTERY FAIL	No Battery Backup.	Battery voltage <10.5 V **or** While in bulk, over, or float charging battery is <10.5VDC **or** Battery has been bulk charging for >12 h in Standby or 24 h while powered on. **or** Voltage > 16.5V during bulk or over charging and normal current >0.25 Amps	Medium	PC	
	Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				
BATTERY LOW	Plug in power cable. On battery	Available battery power decreases to between 20 and 30 min	Medium	PC	Mains AC Mains Power Failure in progress.
	Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
BATTERY MISSING	No battery backup	Any battery voltage is between ±1.0 VDC.	Medium	PC	POST state
	Connect Battery. Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				
BATTERY REVERSED CONNECTIONS	No battery backup	Any battery voltage is less than –1.0 VDC	Medium	PC	
	Check Battery Connections.				
BATTERY V LOW	Plug in power cable. On battery	Available battery power decreases to between 10 and 20 minutes	Medium	PC	AC Mains Power Failure in progress.
	Leave the system plugged in to charge the battery. If problem continues, check the battery charge circuit in Service Software. Replace Battery.				
BELLOWS COLLAPSED	Unable to drive bellows	Manifold pressure > Paw + 10 + [0.25*(Inspiratory valve flow)]	Low	AC, Vent	In range Paw and manifold pressure data available and mechanical ventilation On.
	Check the breathing circuit for leaks or hose occlusions. Perform flow sensor calibration. Check drive gas check valve. Check cVIB cabling. Replace cVIB.				
BREATHING SYSTEM NOT LATCHED	Breathing system loose	Breathing system detection switch indicates breathing system not latched.	Low	AC, Vent	
	Check/replace ABS On switch. Check/replace harness (ABS switches to Filter board).				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
CARRIER BOARD OVERHEAT	Cooling fans may overheat	▪ Both Display Unit thermistors have a temperature reading >= 10 degrees C and < 85 degrees C, if Display Unit Thermistor 1 temperature reading is >= Display Unit Thermistor 2 temperature reading and Display Unit Thermistor 1 temperature reading is > 60 degrees C. ▪ Both Display Unit thermistors have a temperature reading >= 10 degrees C and < 85 degrees C, if Display Unit Thermistor 1 temperature reading is < Display Unit Thermistor 2 temperature reading and Display Unit Thermistor 2 temperature reading is > 60 degrees C. ▪ One of the Display Unit thermistors has a temperature reading >= 10 degrees C and < 85 degrees C, if the temperature reading for the Display Unit thermistor in the >= 10 degrees C and < 85 degrees C range is > 60 degrees C. ▪ Neither Display Unit thermistor has a temperature reading >= 10 degrees C and < 85 degrees C.	Medium	DU	
	1. Check Case Fan filter. 2. Check for proper operation of the Case and Com Express fans. 3. Replace fan(s). 4. Replace the Carrier and Com Express board assembly.				
CASE FAN SPEED FAIL	Cooling fans may overheat	Case fan speed is less than 800 RPM (50% of normal speed)	Medium	DU	
	1. Check the Case Fan filter.. 2. Check for proper operation of the Case Fan. 2. Replace the Case Fan. 3. Replace the Carrier and Com Express board assembly.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
CASSETTE LEVEL LOW	Check agent level. Do not fill vap while in use.	Cassette reporting a value of 'EMPTY'.	Low	AC	Cassette supports liquid level measurement
	After insertion, this error is logged the first time the cassette reports a level of 'EMPTY' or 'QUARTER FULL'.				
CASSETTE OVERFILL DETECTED	Cassette overfilled, replace cassette	Agent level sensor indicates overfilled condition.	Medium De-escalating	AC	
	After insertion, this error is logged the first time the cassette reports a level of 'OVERFILLED'.				
CASSETTE PRESSURE ERROR	Check cassette. Set agent.	Cassette pressure out of range.	Medium De-escalating	AC	
	Check all connections of the Flowmeter Block to the ADB. If the cassette is DES and the problem persists, bleed and retry. Otherwise, run the Vaporizer Test (Section 12.10.2). (Also see Section 7.9.)				
CASSETTE REMOVED DURING DELIVERY	Insert cassette	Cassette removal was detected during active delivery.	Low	AC	System state is Therapy
	Reported whenever the cassette is removed while the vaporizer is actively delivering agent.				
CASSETTE TEMPERATURE FAILURE	Try another cassette. Schedule service.	Temperature difference between dual cassette temperature sensors greater than limit.	Medium De-escalating	AC	
	See Section 7.9.10.				
CASSETTE TEMPERATURE EEPROM FAILURE	Try another cassette. Schedule service.	Cassette temperature sensor calibration data EEPROM read error or cassette temperature sensor hardware revision data EEPROM read error or software compatibility failure.	Medium De-escalating	AC	
	Check connection of Cassette Temperature Sensor to the ADB. Cycle power. If the problem persists replace and retest, in the following order (Also see Section 7.9.): • Cassette temp sensor • ADB				
CAL DATA FAILURE IN EEPROM	Service calibration advised	Default cal data is being used due to corrupt data in cal region.	Low	AC	
	Perform complete service level calibrations (ventilator).				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
CHECK FLOW SENSOR	Check flow sensors	During Mechanical breaths, the measured flow for 6 consecutive breaths, to and from the patient, does not meet certain criteria. No or negative flow on Insp flow sensor during inspiration or negative flow on Exp flow sensor.	Medium	AC, Vent	In-range flow data available during mechanical ventilation
	Check flow sensor connections. Check the breathing circuit. Check cVIB sensor tubing for leaks. Perform flow sensor calibration. Check Insp/Exp check valves. Check/Replace flow sensors.				
CLOSED LOOP CONTROL FAILURE	Check cassette. Set agent.	Closed loop controller was unable to control output flow from the cassette.	Medium De-escalating	AC	System state is Therapy
	Run PC Service App Vaporizer Test (Section 12.10.2) to verify hardware performance. Replace and retest in the following order (Also see Section 7.9.): • Proportional Valve • ADB This error can also be caused by the following: • Liquid Flow Prevention Valve actuated. Look for occurrences of CONDENSATION CONDITIONS EXIST and CASSETTE OVERFILL DETECTED errors preceding this error. • Cassette held in place, but not latched, during agent delivery. It is possible to hold the cassette in a position such that the cassette ID is recognized but the cassette valves are not open, preventing flow. • Check cassette travel to ensure deformation or under sizing of cassette bay is not causing undue restriction.				
Circuit check failed.		A message or failure displayed during the system checkout.		DU	
	Perform suggested action and repeat the system Checkout.				
Circuit O2 check skipped.		A message or failure displayed during the system checkout.		DU	
	Perform suggested action and repeat the system Checkout.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
COM ERROR VENT TO ACB	System Malfunction	After regular communications has been established between the Ventilator boundary object and the Vent SIB CPU, a total loss of communications shall be declared if the Ventilator boundary object receives no messages from the Vent SIB CPU for 35 milliseconds.	High	AC Vent	
	Reboot System. If problem continues: 1. Check cabling. 2. Replace cVIB. 3. Replace ACB.				
Compatibility failure: No version info in file for subsystem 0.		Indicates a subsystem did not report compatibility information to the Display Unit.		DU	
	Look for other entries in the Error Logs. i.e. “Self-tests Failed”. Perform Software Download.				
Compatibility failure: Software Error		Indicates a subsystem did not report compatibility information to the Display Unit.		DU	
	Look for other entries in the Error Logs. i.e. “Self-tests Failed”. Perform Software Download.				
Compatibility incomplete: No versions from Vent SIB		Indicates the Compatibility information for the Ventilator Interface Board does not match the Compatibility Table created during the last software download or the GIV Test did not pass.		DU	
	Check for other errors (Self-tests Failed). Perform Download New to rebuild Compatibility Table. If persists, replace cVIB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
Compatibility incomplete: No versions received from Vent SIB		Indicates the Compatibility information for the Ventilator Interface Board does not match the Compatibility Table created during the last software download or the GIV Test did not pass.		DU	
	Look for other entries in the Error Logs. i.e. “Self-tests Failed”. Replace the GIV Solenoid. Check the operation of the Gas Inlet Valve operation. Perform Software Download.				
COOLING FAN CURRENT LOW FAILURE		Indicates the Pan Fan is drawing too little current.		Mixer	
	Replace Fan. Replace Mixer.				
CPU FAN SPEED FAIL	Cooling fans failed. May overheat.	CPU fan speed less than 50% of nominal speed	Medium	DC	
	This message relates to the CPU heatsink fan in the HPDU. • Turn on unit with back cover removed and verify CPU fan is not working. • Verify fan connector is plugged in. • Replace CPU fan.				
CPU OVERHEAT	Cooling fans failed. May overheat.	Temperature reading of either DU thermistor > 60 degrees C	Medium	DC	
	This message relates to the case fan in the HPDU. • With unit running, remove the fan filter from back of unit and feel if fan is working. • Open case and check that fan connector is plugged in. • Replace case fan.				
CPU OVERHEAT	Cooling fans may overheat.	Temperature reading of either DU thermistor > 70 degrees C	Medium	DC	
	This message relates to the case fan in the DU. • With unit running, remove the fan filter from back of unit and feel if fan is working. • Open case and check that fan connector is plugged in. • Replace case fan.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
DCB PROCEDURE COM FAIL	System Malfunction	• The Anesthesia Computer receives no procedure messages from the Display Computer for 15 seconds +/- 0.5 second. • The Anesthesia Computer's procedure message does not match the Display Computer's procedure message for 15 seconds +/- 0.5 second.	High	AC	System in Therapy state
	Reboot system. If problem continues, check the ACB to Mixer communication LED's (or cVIB communication LED's). 1. If the RCV and XMT (or TXD and RXD) LED's indicate activity, • check DU cable connections. • replace Display Controller board if problem continues. 2. If the RCV and XMT (or TXD and RXD) LED's indicate no activity, • check the Anesthesia Control board connection. replace the Anesthesia Control board if problem continues.				
DCB RAM ERROR	System Malfunction	Self test failure or multi bit error detected.	High	DC	
	Reboot System. If problem continues, replace the Display Controller Board.				
DC COMMANDED AC TO FAILURE		Indicates the Display Controller detected issues and commanded the Anesthesia Controller to safe state.		DC	
	Check for other errors in the error logs (Compatibility failure, Compatibility incomplete, etc.).				
DRIVE GAS LOST	Ventilator has no drive gas	O_2 supply low if O_2 is selected drive gas **or** AIR supply low if Air is selected drive gas.	High	AC DC checks enable criteria	Mechanical Ventilation is ON.
	Connect O_2 or AIR supply. See Action/Troubleshooting for O_2 PRESS LOW or AIR PRES LOW.				
EXP FLOW SENSOR CAL ERROR	Calibrate flow sensors	Exp Flow Sensor zero offset out of range	Low	AC, Vent	Flow sensor detected
	In Service Software, under "Vent Flow and Pressure" (Section 12.9.2), verify the Expiratory Flow counts is 2050 ± 250. Disconnect the Blue and Yellow in-line connectors. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the cVIB.				
EXP FLOW SENSOR EEPROM FAILURE	Replace exp flow sensor	EEPROM cal data read failure	Low	AC, Vent	
	Replace Exp Flow Sensor.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
EXPIRED GAS CONTROL AUTO EXITED	Et Control stopped. Adjust settings.	Expired Gas Control algorithm communicates Exited EGC state.	Medium	DC	Expired Gas Control is On.
	Review Error Logs for EGC (Et Control) related Error Messages. Refer to Section 7.15 for Et Control Troubleshooting.				
EXPIRED GAS CONTROL FALLBACK	Increase flow. Check Gas Setup menu.	In EGC Fallback Submode due to EGC_SUSPEND_SAMPLE_ LINE_LEAK. **or** In EGC Fallback Submode for greater than 30 seconds.	Medium	DC	Expired Gas Control is On.
	Review Error Logs for EGC (Et Control) related Error Messages. Refer to Section 7.15 for Et Control Troubleshooting.				
EXPIRED GAS CONTROL SAMPLE LINE LEAK	Sample line leak. Check sample line.	In EGC Fallback Submode due to EGC_SUSPEND_SAMPLE_ LINE_LEAK **or** In EGC Fallback Submode due to EGC_SUSPEND_EGC_SYS_ CHECK_FAILED.	Medium	DC	Expired Gas Control is On.
	Review Error Logs for EGC (Et Control) related Error Messages. Refer to Section 7.15 for Et Control Troubleshooting.				
FAN FAIL	Cooling fan needs service. System OK	Fan Power Status Bit is Low (FAN1_GOOD).	Medium	PC	Communication between Power Controller and Display Computer.
	Connect cooling fan. Replace cooling fan.				
FANS FAIL	Cooling fans failed. May overheat.	Both of the Fan Power Status Bits are Low (FAN1_GOOD, FAN2_GOOD)	Medium	PC	Communication between Power Controller and Display Computer.
	Connect cooling fans. Replace cooling fans. Replace PCB.				
Flow Attainment Failure Ch1		Indicates the commanded flow through the O2 Gas channel does not match the measured flow via the flow sensor and the differential pressure transducers.		Mixer	
	Replace the O2 Proportional Valve. Replace the Mixer.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
FLOW MANIFOLD EEPROM FAILURE	Vaporizer Failure	Cassette pressure and flow meter calibration data EEPROM read error or cassette pressure and flow meter hardware revision data EEPROM read error or software compatibility failure.		AC	
	Check all connections of the Flow Meter Block to the ADB. Cycle power. If the problem persists replace and retest, in the following order (Also see Section 7.9.): • Flowmeter Block • ADB				
FLOW SENSOR CAL ERROR	Calibrate flow sensors	Insp or Exp flow sensor or the airway or manifold pressure sensor zero offset out of range (flow calibration failure)	Low	AC, Vent	Flow sensor detected
	See associated Errors. i.e. “EXP FLOW SENSOR CAL ERROR” or “AIRWAY SENSOR CAL ERROR”.				
FLOW VALVE CURRENT FAILURE		Indicates the current feedback from the Insp Flow Valve was incorrect for seven consecutive readings.		ACB	
	In Service Software, under “Vent Flow and Pressure” (Section 12.9.2), increase the Flow Valve counts and view the Flow Valve Current mA and Counts.				
FLOW VALVE DAC FAILURE		Indicates the current feedback from the Insp Flow Valve was incorrect for seven consecutive readings.		ACB	
	In Service Software, under “Vent Flow and Pressure” (Section 12.9.2), increase the Flow Valve counts and view the Flow Valve Current mA and Counts.				
Flow Verification Failure (dP) Ch1		Indicates the commanded flow through the O2 Gas Channel and the flow measured by the Hot-wire anemometer agrees but the flow as measured by the pressure transducers does not agree.		Mixer	
	Perform the Mixer zero. Replace Mixer.				
FRONT PANEL COM FAIL	Display panel controls failure	Key pad controller fails to send “life tick” for greater than 10 Sec.	Medium (Yellow)	DC	
	Reboot system. If problem continues, replace Display Controller Board.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
FRONT PANEL KEY STUCK		Indicates a stuck Keypad or encoder on the Display.		DU	
	Replace the Keypad / Encoder.				
FRONT PANEL VOLTAGE OUT OF RANGE		Out of range voltage detected from the front panel controls.		DC	
	Reboot system. If problem continues, replace Display Controller Board.				
GAS INLET VALVE BOOT UP TEST FAIL	Vent Fail. Monitoring Only	Boot-up test failed.	High	AC, Vent	
	1. Check GIV solenoid connection. 2. Replace GIV. 3. Rebuild the GIV components. 4. Replace cVIB.				
INFLOW CHECK VALVE FAILURE	Vaporizer Failure	Negative flow in the cassette inflow limb greater than limit.		AC	
	Replace Inflow check valve. (Also see Section 7.9.)				
INFLOW OUTFLOW CROSSCHECK FAILURE INFLOW OUTFLOW CROSSCHECK FAILURE RECOVERABLE	Vaporizer Failure	Output concentration measured by the output and input flowmeter disagree by more than limit.		AC	
	Check eVap and cassettes used with the machine for leaks. Replace and retest in the following order (Also see Section 7.9.): • Zero Valve (Inflow or Outflow depending on Vaporizer Test results). • Flowmeter Block • ADB				
INSP FLOW SENSOR CAL ERROR	Calibrate flow sensors	Insp Flow Sensor zero offset out of range.	Low	AC, Vent	Flow sensor detected
	In Service Software, under "Vent Flow and Pressure" (Section 12.9.2), verify the Inspiratory Pressure counts is2050 ± 250. Disconnect the Black and White in-line connectors. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the cVIB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
INFLOW ZERO 10VA POWER ERROR	Vaporizer Failure	Overcurrent condition detected by the AC. Circuit disabled.		AC	
	If the P3 indicator never lights or lights only briefly, • proceed to the interconnect fault isolation procedure (Section 7.9.12). If the P3 indicator remains lit for more than 2 seconds, • isolate the failed valve (Inflow, Inflow zero or Outflow zero) circuit with manual valve controls. Replace and retest in the following order (Also see Section 7.9.): • Valve • ADB				
INFLOW ZERO POINT ERROR	Vaporizer Failure	Input flowmeter measured value during zeroing is out of range.		AC	
	Replace and retest in the following order (Also see Section 7.9.): • Inflow Zero Valve • Flowmeter Block • ADB				
INSP FLOW SENSOR EEPROM FAILURE	Replace insp flow sensor	EEPROM cal data read failure	Low	AC, Vent	
	Replace the Inspiratory Flow Sensor.				
INSERT CASSETTE		The system does not detect a vaporizer cassette	Low	AC	Agent delivery not on (agent Off or state is checkout)
	Occurs whenever a cassette is not inserted.				
INVALID CASSETTE ID	Cannot identify cassette	Invalid cassette ID code	Medium De-escalating	AC	
	If failure occurs with multiple cassettes of the same type (agent), • insert test cassette and verify test cassette is identified in the PC Service App. Remove test cassette and verify PC Service App indicates 'NONE'. If either PC Service App test fails, • replace ADB. (Also see Section 7.9.)				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
LOSS OF GAS DELIVERY USER SETTINGS LOSS OF VAPORIZER USER SETTINGS LOSS OF VENT PARAMETER SETTINGS	 Vaporizer Failure Vent Fail. Monitoring Only	After regular communications has been established between the AC and the Display Computer, this alarm is declared if the system is in the Therapy State and the AC determines the Gas Delivery User Setting (Vaporizer User Settings) (Ventilator Parameter Settings) from the Display Computer arrived more than 10 seconds ago.		AC	
	Reboot system. If problem continues, check the ACB to Mixer communication LED's (or cVIB communication LED's). 1. If the RCV and XMT (or TXD and RXD) LED's indicate activity, • check DU cable connections. • replace Display Controller board if problem continues. 2. If the RCV and XMT (or TXD and RXD) LED's indicate no activity, • check the Anesthesia Control board connection. • replace the Anesthesia Control board if problem continues.				
Low Pressure Leak check failed.		Indicates the LowP Leak section of the System Checkout Failed.		DU	
	Troubleshoot the Low Pressure Leak.				
Low Pressure Leak check fails.		A message or failure displayed during the system checkout. Low Pressure Leak Check with SCGO failed automated check. Leak measured is greater than 50 ml/min.		DU	
	Check Vaporizer for leaks. Check integrity of low-pressure circuit (Mixer outlet to SCGO / Insp Flow Sensor).				
MAN CASS OVER UNDER TEMP	Check cassette. Set agent.	Either manifold temperature reading or cassette temperature reading outside of limit.	Medium De-escalating	AC	
	Operating temperature as measured by one of the Electronic Vaporizer temperature sensors was out of allowed operating range.				
MANIFOLD PAW SENSOR FAIL	Vent Fail. Monitoring Only	Calibration failure at bootup.	Medium	AC, Vent	
	In Service Software, under "Vent Flow and Pressure" (Section 12.9.2), verify the Manifold Flow counts is 800 ± 250. Disconnect the White in-line connector in the Manifold Pressure. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the cVIB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MANIFOLD PRESSURE SENSR FAILURE		Indicates a calibration failure at bootup.		ACB	
	In Service Software, under "Vent Flow and Pressure" (Section 12.9.2), verify the Manifold Flow counts is 800 ± 250. Disconnect the White in-line connector in the Manifold Pressure. If the counts return within specified range, check for occlusions in the Bulkhead harness. If the counts do not return within the specified range, replace the cVIB.				
MANIFOLD SENSOR CAL ERROR		Indicates the Manifold Pressure zero failed.		ACB	
	Could be caused by bad span calibration or leaky vent Insp Flow Valve.				
MANIFOLD TEMPERATURE EEPROM FAILURE	Agent output not accurate. Schedule service.	Manifold Temperature sensor calibration data EEPROM read error.	Medium De-escalating	AC	
	Check connection of Manifold Temperature Sensor to the ADB. Cycle power. If the problem persists, replace and retest in the following order (Also see Section 7.9.): • Manifold temp sensor • ADB				
MANIFOLD TEMPERATURE FAILURE	Agent output not accurate. Schedule service.	Temperature difference between dual manifold temperature sensors greater than limit.	Medium De-escalating	AC	
	See Section 7.9.10.				
MGAS CHECK SAMPLE GAS OUT >20 SEC	Check sample gas out	MGAS SPEC. Continuous Occlusion Bit set.	Medium	MGAS	MGAS present and MGAS communicates continuous occlusion for 20 seconds
	Replace sample line. See AM TRM for further Troubleshooting.				
MGAS INLET FILTER RESIDUE >40 SEC	Replace D-Fend	MGAS SPEC (Residue build-up on the water trap membrane. This decreases air flow).	Medium	MGAS	MGAS present and MGAS communicates this the Replace Trap alarm bit for 40 seconds
	Replace D-Fend. See AM TRM for further Troubleshooting.				
MGAS LINE BLOCKED >20 SEC	Sample line blocked	MGAS SPEC states The sample tubing inside or outside the monitor blocked, or the water trap is occluded.	Medium	MGAS	MGAS present and MGAS communicates this the continuous occlusion alarm for 20 seconds
	Replace sample line. See AM TRM for further Troubleshooting.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MGAS SAMPLE FLOW DEVIATION	Low gas sample flow	Sample flow is less than 80% of the Airway Module's specific nominal flow value for 10 consecutive seconds. (nominal flow value for E/M airway modules = 200 ml/min) (nominal flow value for E-s airway modules = 120 ml/min).	Low	DU (**for E/M modules**) Module (**for E-s module**)	MGAS present and MGAS communicates valid sample flow data
	Troubleshoot Airway Module flow issues using released documentation for the specific type of Airway Module.				
MGAS SAMPLE LINE NOT CONNECTED >40 S	Check D-Fend	MGAS SPEC states The sample tubing or the D-Fend module is not installed.	Medium	MGAS	MGAS present and MGAS communicates this the OpenGasCircuit alarm for 40 seconds
	Replace D-Fend. See AM TRM for further Troubleshooting.				
MGAS SENSOR INOP > XX	Module fail. No CO_2, AA, O_2 data	MGAS SPEC Mgas communicates hardware failure (RAM failure; ROM checksum error; Error in CPU eeprom; Error O_2 preamp eeprom; Error in SSS board eeprom; Voltage error; Lamp control failure.) or UPI does not initialize.	Medium	MGAS	
	See AM TRM for further Troubleshooting.				
MIXER BAL GAS CHANGE FAIL	Alternate O_2 Screen	Mixer Status Bit: STS_BALGAS_CHANGE_OVER_FAIL After the mixer commanded a change to the balance gas, the status of the selector valve shows the old balance gas is still connected.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER BALGAS Flow FAIL		Mixer error bit STS_CH2_DELTAP_FLOW_FAIL Pressure difference between P3 and P2 differs from the drop expected at the measured flow for channel 2 (Balance Gas).	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MIXER O2 Flow FAIL	Alternate O_2 Screen	Mixer error bit STS_CH1_DELTAP_FLOW_FAIL Pressure difference differs from the drop expected at the measured flow for Channel 1 (O_2).	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER ACB COM FAIL	Alternate O_2 Screen	Five seconds pass without measured flow data from the mixer.	Medium	AC	Communication has been established between mixer and AC.
	Reboot System. If problem continues, • check/replace Pan Connector to Mixer cable. • replace the Mixer.				
MIXER ACB COM FAILLOST CMD	Alternate O_2 Screen.	Mixer status Bit STS_LOSS_OF_SETFLOW_CMD. Mixer has lost AC flow commands for 5 sec or received “illegal” commands.(hypoxic mix, settings not allowed)	Medium	AC, Mixer	
	Reboot System. If problem continues, • check/replace Pan Connector to Mixer cable. • replace the Mixer.				
MIXER AIR SELECTION VLV FAIL	Alternate O_2 Screen.	Mixer Status Bit: STS_SELV_VAIR_NOTIFY_FAIL The status of the air selector valve does not match the commanded state.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER BAL GAS F SENSOR FAIL	Alternate O_2 Screen.	Mixer error bit STS_F2_SENSOR_FAIL Balance gas flow sensor failure.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER BAL GAS TSENSOR FAIL		Mixer error bit STS_T2_SENSOR_FAIL (Balance Gas). Balance gas temperature sensor failure.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MIXER BAL GAS FLOW CHECK FAIL		Mixer status bit 1LPM_FLOW_TEST_FAIL. Bal gas proportional valve fails flow check STS_FLOW_TEST_BAL_CHAN_FAILshows balance gas proportional valve failed self test.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER BAL GAS TEMP LIMIT		Mixer error bit STS_CH2_TEMP_LIMIT (Balance Gas). Balance gas temperature exceeds 50 °C.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER BAL GAS ZERO FAILLEAK		Mixer status bit STS_CH2_ZERO_FLOWPROPN_V_CH2_LEAK_FAIL_TEST_FAIL. Bal gas proportional valve fails zero flow check shows flow while closed.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER CPU TEST FAIL	Alternate O2 Screen	Mixer error bit STS_CPU_TEST_FAIL indicates a failure	Medium	AC Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER CRC EEPROM FAIL	Alternate O_2 Screen	Runtime CRC check on EEPROM failed. Mixer Status Bit STS_EEPROM_CRC_FAIL.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER CRC FLASH FAIL	Alternate O_2 Screen	Runtime CRC check on Flash failed. Mixer Status Bit STS_FLASH_CRC_FAIL	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER N2O SELECTION VLV FAIL		Mixer Status Bit: STS_SELV_VN2O_NOTIFY_FAIL The status of the N_2O selector valve does not match the commanded state.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER O2 TSENSOR FAIL	Alternate O_2 Screen.	Mixer error bit STS_T1_SENSOR_FAIL O_2 temperature sensor failure	Medium	AC, Mixer	
	Reboot System. If problem continues, Replace the Mixer.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MIXER O2 F SENSOR FAIL	Alternate O_2 Screen	Mixer error bit STS_F2F1_SENSOR_FAIL (O_2). O_2 flow sensor fail.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER O2 FLOW CHECK FAIL	Alternate O_2 Screen	Mixer status bit STS_FLOW_TEST_CH1_FAIL1LPM_FLOW_TEST_FAIL. O_2 proportional valve fails flow check.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER O2 SELECTION VLV FAIL	Alternate O_2 Screen	Mixer Status Bit: STS_SELV_VOXY_NOTIFY_FAIL The status of the O_2 selector valve does not match the commanded state.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER O2 TEMP LIMIT	Alternate O_2 Screen	Mixer error bit STS_CH1_TEMP_LIMIT (O_2). O_2 temperature exceeds 50 °C.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER O2 ZERO LEAK FAIL		Mixer status bit STS_CH1_ZERO_FLOW_TESPROPN_V_LEAK_FAILT_FAIL. O_2 proportional valve fails zero flow checks for leaks when it should be closed.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER P SENSOR P2 FAIL		Mixer error bit STS_PRESS_SENSOR_FAIL_P2 Pressure sensor 2 in the mixer has failed.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER POST FAIL	Alternate O_2 Screen	Mixer tells AC that Power Up Self Test Fail	Medium	AC, Mixer	
	See associated Error in Error Log. i.e. “MIXER O_2 FLOW CHECK FAIL” or “Mix: FLOW VERIFICATION FAILURE (dP) CH1”.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MIXER PRES SENSOR P1P3 FAIL		Mixer error bit STS_PRESS_SENSOR_FAIL_ P1P3 One of the pressure sensors in the Mixer has failed (P1 or P3).	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER RAM FAIL	Alternate O2 Screen	Mixer status bit STS_RAMPATTERN_FAIL indicates a failure	Medium	AC Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER SW WDOG		Indicates the Mixer Watchdog has been activated.		Mixer	
	See associated Error in Error Log. i.e. “MIXER O2 FLOW CHECK FAIL” or “Mix: FLOW VERIFICATION”.				
MIXER SW WDOG FAIL	Alternate O_2 Screen	Mixer status Bit STS_SW_WDOG_FAIL.	Medium	AC, Mixer	
	Reboot System. If problem continues, replace the Mixer.				
MIXER VOLTS FAIL	Alternate O_2 Screen	Mixer power supply (on board) is out of tolerance. Status bit STS_VOLT_REF_FAIL.	Medium	AC, Mixer	+12.5 V (10 VA) to mixer OK.
	In Service Software, under “Mixer Board Power” (Section 12.7.3), view the “Mixer 10VA Voltage” from Anes Cntrl Bd: If “Mixer 10VA Volts” reads “OK, and +12.5 Vdc reads “Fail”, replace the Mixer. If “Mixer 10VA Volts” reads “Fail”, • check cabling between ACB and Mixer. • replace ACB.				
MIX O2 BYPASS VLV 10VA OVER CURR		Indicates the current feedback from the O2 Bypass Selector was incorrect for seven consecutive readings.		ACB	
	Measure the O2 Bypass Selector Valve. Should be approximately 75 Ω. Replace ACB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
MODULE NOT COMPATIBLE	Module not compatible	The Monitoring Module detected is not compatible with system software. System is designed to work with the following Compact Airway Module versions: M-CaiO (HW rev 00 and above, SW rev 3.2 and above) and M-CaiOV (HW rev 00 and above, SW Rev 3.2 and above).	Low	DC	
	Replace M-Gas module with compatible module.				
MONITOR BATT CURRENT FAIL	No battery backup for monitor	Battery backup current to monitor is active while AC supply is OK.	Low	PC	
	Check AC power connection to anesthesia monitor and circuit breaker. If problem continues, replace anesthesia monitor.				
MONITOR BATT CURRENT HIGH	No battery backup for monitor	Battery backup current to monitor is too high.	Low	PC	
	Reboot System. If problem continues, replace anesthesia monitor.				
MONITOR BATT CURRENT REVERSED	No battery backup for monitor	Battery backup current to monitor is reversed.	Low	PC	
	Reboot System. If problem continues, replace anesthesia monitor.				
N2O PRESS LOW	N_2O supply pressure low	N_2O pipeline pressure is less than 252 kPa and the N_2O cylinder pressure is less than 2633 kPa.	Low	AC	N_2O is selected as the balance gas with a non zero flow of N_2O
	Check N_2O Supply. Check / Replace N_2O Pipeline/Cylinder Pressure Transducer.				
NO EXPIRATORY FLOW SENSOR	No exp flow sensor	No Expiratory sensor connected and not calibrating	Medium	A, Vent	
	Connect Expiratory flow sensor. Check/Replace Bulkhead harness. Replace cVIB Board.				
NO INSPIRATORY FLOW SENSOR	No insp flow sensor	No inspiratory sensor connected and not calibrating.	Medium	AC, Vent	AC -Vent
	Connect Inspiratory flow sensor. Check/Replace Bulkhead harness. Replace cVIB Board.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
O2 CAL ERROR	Calibrate O_2 sensor	Offset, slope, or cell voltage not in range or O_2 > 110%	Low	AC, Vent	Galvanic O_2 sensor connected
	Calibrate O_2 Sensor. If calibration fails, replace O_2 Sensor. If calibration continues to fail, wait 90 minutes and repeat calibration. If calibration fails after 90 minute, replace cVIB.				
O2 FLOW CTRL FAIL		Mixer status bit STS_FLOW_CTRL_CH1_FAIL indicates flow control failure.	Medium	AC, Mixer	O_2 gas supply pressure OK
	Reboot System. If problem continues, Replace the Mixer.				
O2 FLUSH FAILURE	O_2 flush stuck on?	Switch is detected “on” continuously > 30 sec.	Low	AC, Vent	
	Alarm condition becomes false for 2 consecutive switch readings.				
O2 PIPE INVALID	Cannot monitor O_2 pipeline	O_2 Pipeline pressure is invalid.	Medium	DC	
	Check O_2 Pipeline Supply. Check / Replace O_2 Pipeline Pressure Transducer.				
O2 PRESS LOW	O_2 supply pressure low	O_2 pipeline pressure is less than 252 kPa and the O_2 cylinder has a pressure less than 2633 kPa for one second.	High	AC, DC	N_2O flow stops on threshold detection and Air continues to flow if selected.
	Check O_2 Supply. Check / Replace O_2 Pipeline/Cylinder Pressure Transducer.				
O2 PROP VALVE FAIL		Mixer status bit STS_CH1_PROPN VALVE FAIL indicates proportional valve failure.	Medium	AC, Mixer	
	Reboot System. If problem continues, Replace the Mixer.				
O2 SENSOR FAILURE	Replace O_2 sensor	O_2 < 5%	Low	AC, Vent	Galvanic O_2 sensor connected
	Calibrate O_2 Sensor. If calibration fails, replace O_2 Sensor. If calibration continues to fail, wait 90 minutes and repeat calibration. If calibration fails after 90 minute, replace cVIB.				
ON/STANDBY SWITCH TO STANDBY	Turn switch on to continue use	On/Standby switch transitions from On to Standby.	High	PC	System state is Therapy and Power Controller is communicating with DC
	No Service Action Required.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
OUTFLOW SCAV 10VA POWER ERROR	Vaporizer Failure	Overcurrent condition detected by the AC. Circuit disabled.		AC	
	If the P2 indicator never lights or lights only briefly, • proceed to interconnect fault isolation procedure (Section 7.9.12). If the P2 indicator remains lit for more than 2 seconds, • isolate the failed valve (outflow or scavenging) circuit with manual valve controls. Replace and retest in the following order (Also see Section 7.9.): • Valve • ADB				
OUTFLOW ZERO POINT ERROR	Vaporizer Failure	Output flowmeter measured value during zeroing is out of range.		AC	
	Replace and retest in the following order (Also see Section 7.9.): • Outflow Zero Valve • Flowmeter Block • ADB				
OUTPUT FLOW LIMIT REACHED	Cannot deliver agent setting at set flow	Commanded cassette flow >= 6.0 L/min for > 10 seconds OR Commanded flow >= 4.0 L/min and flow valve is at max for > 10 seconds.	Low	AC	Agent delivery on
	Indicates commanded agent flow could not be achieved because the vaporizer reached its maximum flow capability. This occurs at high flow and agent settings, primarily with Sevoflurane. The user sees an alarm message advising them to reduce flows and the agent monitor may show an under delivery.				
PATIENT VOLUME MISMATCH OCCURRED	Calibrate, dry, or replace flow sensors	PATIENT VOLUME MISMATCH alarm occurred.	Low	AC, Vent, DC checks enable criteria	System state is in Checkout.
	1. Check flow sensor connections. 2. Replace flow sensors. 3. Check the cVIB tubing for moisture. 4. Replace cVIB.				
PCB Alarm Off: AC Mains failure		Indicates AC Power Removed.		PCB	
	No Service Action Required.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria	Action/Troubleshooting
PCB Alarm Off: DC-DC power module failure		Indicates the AC supply is OK (AC GOOD HIGH) but the system reports using the battery (BATT STAT 1 and 2 LOW).		PCB		Check U-frame wiring. Set system switch to Standby; remove mains; wait 20 seconds; power up system. If problem continues, replace PCB.
PCB Alarm Off: Monitor Current Active w/AC Mains		Indicates the Battery backup current to monitor is active while AC supply is OK.		PCB		Check AC power connection to anesthesia monitor and circuit breaker. If problem continues, replace anesthesia monitor.
PCB Alarm On: 1 min time left		A message or failure displayed during the system checkout.		PCB		Leave the system plugged into AC Mains for 24 hours. If issue persists, replace batteries.
PCB Alarm On: AC mains failure		Indicates AC Power Removed.		PCB		No Service Action Required.
PCB Alarm On: Bulk charge time exceeded in stdby		Indicates the batteries were being Bulk Charged for a period greater than 12 hours while the system was in the Standby state.		PCB		Replace Batteries. Replace the Power Controller Board.
PCB Alarm On: Monitor Current Active w/AC Mains		Indicates the Battery backup current to monitor is active while AC supply is OK.		PCB		Check AC power connection to anesthesia monitor and circuit breaker. If problem continues, replace anesthesia monitor.
PCB Saved Alarm Off: 1 min time left		A message or failure displayed during the system checkout.		PCB		Leave the system plugged into AC Mains for 24 hours. If issue persists, replace batteries.
PCB Saved Alarm Off: AC Mains failure		Indicates AC Power Removed.		PCB		No Service Action Required.

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
PCB Saved Alarm Off: Blk chrg time exceed in stdby		Indicates the batteries were being Bulk Charged for a period greater than 12 hours while the system was in the Standby state.		PCB	
	Replace Batteries. Replace the Power Controller Board.				
PCB Saved Alarm Off: DC-DC power module failure		Indicates greater than 0.25 amps current draw out of the batteries for 2 minutes while AC Mains is connected to the machine.		PCB	
	Replace Batteries. Replace the Power Controller Board.				
PCB Saved Alarm On: 1 min time left		A message or failure displayed during the system checkout.		PCB	
	Leave the system plugged into AC Mains for 24 hours. If issue persists, replace batteries.				
PCB Saved Alarm On: AC Mains failure		Indicates AC Power Removed.		PCB	
	No Service Action Required.				
PCB Saved Alarm On: DC-DC power module failure		Indicates greater than 0.25 amps current draw out of the batteries for 2 minutes while AC Mains is connected to the machine.		PCB	
	Replace Batteries. Replace the Power Controller Board.				
PCB Saved Alarm On: DU to PSC Comm Error		Indicates a the Power Controller to Display Unit communication was lost. The Power Controller “saved” the error and communicated the error to the Display Unit when communication was next established.		PCB	
	No Service Action Required.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
PCB Saved Error: POWER CNTRL COM FAIL		Indicates communication between the Display Unit computer and the Anesthesia Controller Board (ACB) was lost and a Power Controller error occurred. The error was stored until communication could be re-established and written to the Display Unit computer.		PCB	
	Check the Anesthesia Controller Board (ACB) to Display Unit communication cable.				
PEEP PCV NOT AVAILABLE	Vol vent only. No PEEP or PSV	Paw data is in range but the Pmanifold <= -15 cmH_2O	Medium Or Low	DC	None
	Perform flow sensor calibration. If calibration fails: In Service Software, under “Vent Flow and Pressure” (Section 12.9.2), check the transducer precision. Use the Flow valve control to compare linearity of the Manifold transducer to the Paw transducer.				
PORT PLUG POST FAIL	Vent Fail. Monitoring Only	Paw > 100 cmH2O for 1 second in POST state	Medium	AC Vent	In-range Paw data available
	Remove occlusion from Inspiratory port.				
PORT ZERO READ BACK FAIL		Read back of a latch storing valve state did not match the commanded state of the valves indicating internal Agent Delivery Board failure.		EV	
	Replace ADB. (Also see Section 7.9.)				
POWER CONTROLER COM FAIL	Internal failure. System may shut down	Communications with PC and DC cannot be established for ten seconds.	Medium	DC	
	Reboot system. If problem continues: 1. Check DU cable connections. 2. Check the Display Connector board cable connections. 3. Replace the Power Controller board.				
POWER CONTROLLER SELF TEST	Internal failure	Power Controller fails self-tests.	High	PC	
	Replace Power Controller board.				
POWER SUPPLY 75C	Circuitry >75C shutdown possible	Power supply temperature exceeds 75C.	Medium	PC	
	Check / Clean cooling fan.				
PRESS SNSOR1 PRESS SNSOR2 PRESS SNSOR3 FAILURE		Indicates (P1)(P2)(P3) pressure transducer on the Mixer is out of specification.		Mixer	
	Zero the Mixer pressure transducers. Replace Mixer.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
PROP VALVE DRIVE SENSE		Monitored Proportional Valve drive current did not match the commanded value indicating failure of the proportional valve, connection, or drive circuit.		EV	
	Replace and retest in the following order (Also see Section 7.9.): • Proportional valve/check connection • ADB				
PROP VALVE HTR 10VA POWER ERROR	Vaporizer Failure	Overcurrent condition detected by the AC. Circuit disabled.		AC	
	If the P4 indicator never lights or lights only briefly, • remove the Cassette Interface Board jumper at the Cassette Interface Board and retest. If the problem persists, • remove the jumper completely and retest. If the problem is still present, • proceed to interconnect fault isolation procedure (Section 7.9.12). If the P4 indicator remains lit for more than 2 seconds, • check for a failed Proportional valve circuit with manual valve controls. If the Proportional valve does not generate the failure, • evaluate cassettes that have been used in the machine to determine if any of the cassettes in use are faulty. Replace and retest in the following order (Also see Section 7.9.): • Proportional Valve • Cassette • ADB				
PWR CNTRL DC-DC FAIL	Using battery. PC fail	AC supply is OK (AC GOOD HIGH) but the system reports using the battery (BATT STAT 1 and 2 LOW).	Medium	PC	
	Check U-frame wiring. Set system switch to Standby; remove mains; wait 20 seconds; power up system. If problem continues, replace PCB.				
Quick check fails.		A message or failure displayed during the system checkout.		DU	
	Check for other errors in the error logs.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
REVERSE EXPIRATORY FLOW	Reverse exp flow. Check valves OK?	Flow towards the patient (volume >= 20 mL) on expiratory sensor and flow towards the patient (volume >= 5 mL) on the inspiratory sensor during inspiration for 6 consecutive mechanical breaths.	Medium	AC Vent	In-range flow data available, mechanical ventilation on
	Check flow sensor connections for "No Flow Sensor" alarm. Check the breathing circuit. Perform flow sensor calibration. Check Insp/Exp check valves. Replace the flow sensors. Check for kinked cVIB tubing. Check the cVIB cabling.				
SCGO	Vol and Apnea monitoring off	Non Circle SCGO selected.	Low	DC	System has SCGO
	No service action required.				
SEVERE SUSTAINED PAW		Indicates the measures airway pressure was greater than 100 cm H2O for 10 seconds.		ACB	
	No Service Action. Reboot system. If problem continues, check Airway Pressure signal in Service Mode.				
STANDBY PATIENT DETECTION	No fresh gas flow!	3 volume breaths are detected within 30 seconds or 3 CO_2 breaths are detected within 30 seconds	High	DC	System in Checkout: General or Checkout: Start Case
	No service action required.				
System Self-tests failed		Indicates the Power-on tests failed. Look for other entries for clarification.		DU	
	Check for other errors in the error logs (Compatibility failure, Compatibility incomplete, etc.).				
TOUCHSCREEN FAILURE	Touchscreen Failure	Alarm is activated if the touch panel controller fails the communications POST test.	Medium	DU	
	Reboot system. If problem continues: 1. Replace the Touch Controller board. 2. Replace the LCD Touch Bezel assembly.				
Valve Ch1 Leak Tests Not Done		Indicates the O2 Leak Test skipped. Can be caused by no O2 supply connected at power-up.		Mixer	
	No Service Action Required.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
VAP CASS TEMP SENSOR COMPAT FAIL		Vap Cassette Temperature Sensor revision not supported by Aisys CS2 System Software.			
	Correct system configuration by updating Cassette Temperature Sensor hardware or Aisys CS2 System Software.				
VAPCHK - - - - - - - - (various messages)	Vaporizer Failure	Vaporizer fault detected during system checkout.			
	Refer to Vaporizer Checkout Troubleshooting *(Section 7.9.13 on page 7-72)*.				
VAP CONDENSATION CONDITIONS EXIST		Measured cassette temperature is at least 5 degrees warmer than Flowmeter Block temperature. Extreme condensation of agent vapor in the Flowmeter Block can result in erratic delivery and/or CLOSED LOOP CONTROL FAILURE due to closure of the Liquid Flow Prevention valve.		EV	
	Advise user to avoid storage of cassettes in warm environments that could result in warm cassettes being placed in relatively colder machines.				
VAP ENHANCED CASSETTE TEMPERATURE FAILURE		The two independent temperature sensing elements in the $Aladin_2$ cassette disagree by more than the allowed amount indicating that one has failed. Cassette temperature sensing reverted to legacy Cassette Temperature Sensor at the time this was logged.		EV	
	$Aladin_2$ cassette failure. Replace cassette and retest.				
VAP FLOW METER BLK COMPAT FAIL		Flow Meter Block revision not supported by Aisys CS2 System Software.			
	Correct system configuration by updating Flow Meter Block / Vap hardware or Aisys CS2 System Software.				
VAPORIZER LOST MIXER FLOW	Vaporizer Failure	Five seconds pass without valid measured flow data from the mixer.		AC	
	Check trouble shooting procedures for Electronic Mixer.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
VAPORIZER SUBSYSTEM COMM FAILURE	Vaporizer Failure	Anesthesia Computer and Agent Delivery Subsystem communication lost or error for greater than 1 second.		AC	
	Verify harnesses from ACB to PCB and ACB to ADB are connected. Replace and retest, in the following order (Also see Section 7.9.): • ADB • ACB • PCB/Harnesses				
VAP SENSOR ERROR	Vaporizer Failure	One or more of the vaporizer sensors is grossly out of range (indicating electrical fault or disconnect).		AC	
	Check all temp/pressure/flow sensors connections to the ADB. Cycle power. If problem persists, • run PC Service App Vaporizer Test (Section 12.10.2). (Also see Section 7.9.)				
Vent check stage 1 failed.		A message or failure displayed during the system checkout.		DU	
	Checkout failed. Check for other errors in the error logs.				
Vent check stage 1 fails.		A message or failure displayed during the system checkout.		DU	
	Checkout failed. Check for other errors in the error logs.				
Vent check stage 2 failed.		A message or failure displayed during the system checkout.		DU	
	Checkout failed. Check for other errors in the error logs.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
Vent check stage 2 fails.		A message or failure displayed during the system checkout.		DU	
	Checkout failed. Check for other errors in the error logs.				
VENT FLOW VALVE FAIL DAC	Vent Fail. Monitoring Only	Incorrect DAC feedback for 3 consecutive readings	Medium	AC, Vent	
	Reboot System. If problem continues: In Service Software, under “Vent Flow and Pressure” (Section 12.9.2), increase the Flow Valve counts and view the Flow Valve Feedback mV and Counts. Verify the settings match.				
VENT +12.5V FAIL	Vent Fail. Monitoring Only	Nominal 12.5V <11.3 Vdc or >13.13 Vdc	Medium	AC, Vent	
	In Service Software, under “Vent Interface Board Power” (Section 12.7.4), view the “Vent Int Bd 10VA Voltage” from Board Supplies: • If “Vent Int Bd 10VA Voltage” reads “OK, and +12.5 Vdc reads “Fail”, replace the cVIB. • If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and cVIB.				
VENT +6V FAIL	Vent Fail. Monitoring Only	VSIB +6V out of range<5.51 Vdc or > 6.5 Vdc	High	AC, Vent	Vent +12.5 V (10 VA) is OK
	In Service Software, under “Vent Interface Board Power” (Section 12.7.4), view the “Vent Int Bd 10VA Voltage” from Board Supplies: • If “Vent Int Bd 10VA Voltage” reads “OK, and +6.0Vdc reads “Fail”, replace the cVIB. • If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and cVIB.				
VENT 1.22V FAIL	Vent Fail. Monitoring Only	Voltage < 1.074Vdc or Voltage > 1.367 Vdc	Medium	AC, Vent	Vent +12.5 V (10 VA) is OK
	In Service Software, under “Vent Interface Board Power” (Section 12.7.4), view the “Vent Int Bd 10VA Voltage” from Board Supplies: • If “Vent Int Bd 10VA Voltage” reads “OK, and 1.22 Vdc reads “Fail”, replace the cVIB. • If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and cVIB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
VENT -6V FAIL	Vent Fail. Monitoring Only	VSIB -6V out of range<-6.72 Vdc or > -5.28 Vdc	High	AC, Vent	Vent +12.5 V (10 VA) is OK
	In Service Software, under “Vent Interface Board Power” (Section 12.7.4), view the “Vent Int Bd 10VA Voltage” from Board Supplies: • If “Vent Int Bd 10VA Voltage” reads “OK, and -6.0Vdc reads “Fail”, replace the cVIB. • If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and cVIB.				
VENT ADC VREF FAIL	Vent Fail. Monitoring Only	VSIB ADC3.200V ref voltage out of range <3.179 or >3.221 Vdc	High	AC, Vent	Vent +12.5 V (10 VA) is OK
	In Service Software, under “Vent Interface Board Power” (Section 12.7.4), view the “Vent Int Bd 10VA Voltage” from Board Supplies: • If “Vent Int Bd 10VA Voltage” reads “OK, and 3.2 Vdc reads “Fail”, replace the cVIB. • If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and cVIB.				
VENT AIRWAY OVERPRESS SIGNAL	Inspiration stopped	High airway overpressure signal set.	Medium	AC, Vent	Mechanical Ventilation On
	No Service Action. Reboot system. If problem continues, check Airway Pressure signal in Service Mode.				
VENT AIRWAY OVERPRESS SIGNAL FAIL	Vent Fail. Monitoring Only	Ventilator SIB indicates the High Airway overpressure signal was set and Paw < 90 cmH_2O and Pmanifold <80 cm H_2O.	Medium	AC, Vent	Mechanical Ventilation On
	No Service Action. Reboot system. If problem continues, check Airway Pressure signal in Service Mode.				
VENT FLOW VALVE FAIL CURRENT	Vent Fail. Monitoring Only	Incorrect current feedback for 7 consecutive readings.	Medium	AC, Vent	
	Reboot System. If problem continues: In Service Software, under “Vent Flow and Pressure” (Section 12.9.2), increase the Flow Valve counts and view the Flow Valve Current mA and Counts.				
VENT SIB 10VA OVER CURRENT		Indicates the current feedback from the cVIB was incorrect.		ACB	
	Disconnect cVIB power harness and restart the system. If the error does not reappear in the log, • replace the cVIB and retest. If the error persists, • replace the ACB.				

Error Log Entry	Alarm Text	Condition (Basic info)	Priority	Source	Enabling Criteria
	Action/Troubleshooting				
VENT SIB COMMUNICATION FAILURE		Indicates a loss of communication between the Anesthesia Controller Board (ACB) and the consolidated Ventilator Interface Board (cVIB) after communication has been established.		ACB	
	Check cabling. Replace Pan Connector Board. Replace cVIB. Replace ACB.				
VENT SUSTAINED PAW SDOWN	Vent Fail. Monitoring Only	Paw > 100 cmH_2O for 10 seconds.	Medium	AC, Vent	In-range Paw data available
	No Service Action. Reboot system. If problem continues, check Airway Pressure signal in Service Mode.				
VENT VALVE 10VA OVER CURRENT		Indicates the current feedback from the Insp Flow Valve was incorrect for seven consecutive readings.		ACB	
	In Service Software, under “Vent Flow and Pressure” (Section 12.9.2), increase the Flow Valve counts and view the Flow Valve Current mA and Counts.				
VENT VALVE POWER FAIL	Vent Fail. Monitoring Only	Nominal 12.5V <11.3 V or >13.13Vdc	Medium	AC, Vent	
	In Service Software, under “Vent Interface Board Power” (Section 12.7.4), view the “Vent Int Bd 10VA Voltage” from Board Supplies: • If “Vent Int Bd 10VA Voltage” reads “OK, and the Vent Valve 10VA Volts reads “Fail”, disconnect the cVIB to Pan connector harness. If the Vent Valve 10VA Volts continues to read “Fail”, replace the cVIB. • If “Vent Int Bd 10VA Voltage” reads “Fail” and the “Vent Int Bd 10VA Voltage” from the Anes Cntrl Bd reads “OK”, Check cabling between ACB and cVIB.				
Vlv Bal Gas Ch Leak Tests Not Done		Indicates the Bal Gas Leak Test skipped. Can be caused by no Bal Gas connected at power-up.		Mixer	
	No Service Action Required.				

7.15 Et Control Troubleshooting

For the following symptoms, the user is instructed to try several actions to correct the problem. If the condition continues, they are instructed to contact a Datex-Ohmeda trained service representative. Follow the suggested service actions to troubleshoot the symptoms.

Symptom	**Help Message**	**Problem** ▪ **User Action**	**Service Troubleshooting** **If symptom continues:**
Et Control has stopped. Help information shows fresh gas module is required.	Et Control requires a Fresh Gas Module. Check gas module connections.	The fresh gas module used with M-Gas or E-Gas modules has become disconnected. ▪ Check that the fresh gas module is properly connected.	▪ Use PC Service App to check that electrical and pneumatic connections for the Fresh Gas Module are properly hooked up and FGM is working correctly. This test also checks for proper functionality to the Fresh Gas Relief valve. ▪ Replace Fresh Gas Module. ▪ Replace Fresh Gas Relief Valve.
Et Control has stopped. Help information indicates Fresh Gas Sample Check failure.	Use Fresh Gas Control. Calibrate gas module when possible.	The fresh gas sample check failed. ▪ Check the airway module sample line for kinks. ▪ Calibrate the airway module.	**For machines with M-Gas or E-Gas modules** ▪ Use PC Service App to check that electrical and pneumatic connections for the Fresh Gas Module are properly hooked up and FGM is working correctly. This test also checks for proper functionality to the Fresh Gas Relief valve. ▪ Check Vaporizer for proper operation. ▪ Check Mixer for proper operation. ▪ Check MGAS for proper operation. ▪ Replace Fresh Gas Module. ▪ Replace Fresh Gas Relief Valve.
			For machines with CARESCAPE E-sGas modules ▪ Use PC Service App to check that E-sGas fresh gas valve is properly connected and working correctly. ▪ Check Vaporizer for proper operation. ▪ Check Mixer for proper operation. ▪ Replace Fresh Gas Relief Valve. ▪ Replace E-sGas module or follow E-sGas module service instructions to repair the fresh gas valve.

Symptom	Help Message	Problem ▪ User Action	Service Troubleshooting If symptom continues:
Et Control has stopped. Help information indicates Supervisor failure.	Target settings not achieved. Use Fresh Gas Control.	Target EtO2 and target EtAA were not achieved. ▪ The case conditions may not allow the use of Et Control. Try Et Control during another case.	This should be rare. If it occurs many times then most likely there is a bigger system problem. ▪ Check Vaporizer for proper operation. ▪ Check Mixer for proper operation. ▪ Check for leaks, proper scavenging connections, other normal checks.
Et Control has stopped. Help information indicates enter Et Control again.	Enter Et Control again.	Multiple possible causes. ▪ Re-enter Et Control.	▪ Reinstall Et Control software. ▪ Replace the Compact Flash Card in the DU.
Gas module valve malfunction. Et Control will not be available. Install a different gas module to use Et Control.	Unable to enter Et Control or Et Control has stopped. Help information indicates gas module valve malfunction	The CARESCAPE E-sGAs airway module fresh gas sampling valve failed to function. Install a different gas module to use Et Control	▪ Use PC Service App to check that electrical and pneumatic connections for the Fresh Gas Module are properly hooked up and FGM is working correctly. This test also checks for proper functionality to the Fresh Gas Relief valve. ▪ Replace Fresh Gas Module. ▪ Replace Fresh Gas Relief Valve.

7.16 Steps and Messages displayed during the System Checkout

Stage 1: Step 1: “Bag/Vent Switch” - Verify the Bag/Vent switch is set correctly.

- If the switch is set to Ventilator Mode, continue with next step.
- If the switch is set to Manual Mode, fail with “Wrong circuit selected”.

Step 2: “O2 Pressure” - Is O_2 available and working?

- If O_2 Supply is adequate and mixer passes a mixer flow test of 250 ml/min of O_2, continue with the next step.
- If not, fail with “Low O2 supply pressure” or with mixer failure.

Step 3: “Ventilator Drive Pressure” - Make sure ventilator has drive gas pressure.

- If drive gas pressure (as measured by the Manifold Pressure Transducer), continue with the next step.
- If no drive gas pressure, fail with “Ventilator has no drive gas”.
- If all of the steps above pass, the ventilator will be commanded to flow 18 L/min. Before selecting “Continue” on the next menu, “Make sure the bellows are fully collapsed” before you “Occlude the Patient Y”.

Stage 2: Step 1: “Verify the Bellows Empty” - Check to make sure bellows is collapsed.

- If Airway pressure increases to or above 30 cm H_20 in 5 seconds, fail the test with “Can not empty bellows”.
- If not, continue with next step.

Step 2: “Circuit Leak Test” - Attempt to find the leak of the ventilator mode system.

Note The Leakage Limits (Acceptance - Fail) are set in the Service Installation menu (refer to Section 4.4.3).

- Flow 1 l/min O_2 until pressure increases to 20 cm H_20.
- If pressure does not increase to 20 cm H_20 within in 15 seconds, fail with “Cannot pressurize circuit”. If it does reach 20 cm H_20, change flow to 100 ml/min.
- If a flow of "Acceptance Limit" reaches 30 cm H_20 or greater, display “Circuit leak is less than ## ml/min” and continue to next step. If it does not, gradually increase flow until pressure reaches 30 cm H_20.
- If a flow is found that reaches 30 cm H_20 and that flow is less than "Fail Limit", continue to next step but indicate that, “Ventilator circuit leak is ## ml/ min”.
- If the circuit pressure does not increase to 30 cm H_20 with "Fail Limit" flow, fail with “Ventilator circuit leak is greater than ## ml/min”.

Step 3: “Agent Delivery” – Tests the electronic vaporizer by comparing Mixer flows and pressures to the eVap flows and pressures. Des and non-Des cassettes are tested differently due to the nature of Des. This means it is possible for the check to pass with Des and fail with a different agent cassette. The cancel button is rejected if pushed between the start of agent delivery and the end of the circuit purge.

- If the “Agent Delivery” test fails, the actual failure is detailed in the logs preceded with “VAPCHK”. See Section 7.9.13, “Vaporizer Checkout Troubleshooting”.

Step 4: “Mechanical Ventilation” - Tests the Mechanical Ventilation by delivering small Pressure Controlled breaths and look for alarms:

- If alarm condition is detected, it will be stated in final menu.
- Continue to next step.

Step 5: “Circuit Compliance” - Tests the circuit compliance by delivering small (15 cm H_2O) Pressure Controlled breaths, measures the circuit volume via the expiratory flow sensor, and looks for alarms:

- If the measured volume is less than 15 ml (either due to small patient circuit or flow sensor issues) a “Check Flow Sensor” alarm may be generated that prohibit the calculation of circuit compliance, state that “Can not measure circuit compliance”.
- If alarms did not occur, calculate compliance and state “Circuit Compliance XXX ml/ cm H20”

Step 6: “O_2 Flow” - Run the mixer tests on O_2 channel (Check gas supply and run a 3L and 10L flow delivery test and leak test):

- If O_2 pressure is low, fail with “Low O2 Supply pressure”.
- If mixer does not fail the 3L, 10L and the leak test, continue with the next step.
- If mixer fails the 3L, 10L or the leak test, fail with the mixer failure.

Step 7: "AIR Flow" – Run the mixer tests on AIR channel (Check gas supply and run a 3L and 10L flow delivery test and leak test):

- If O_2 is drive gas and air supply is low, continue with next step and indicate "Could not test air".
- If Air is the drive gas and air supply is low, continue with next step and indicate "Ventilator has not drive gas".
- If mixer does not fail the 3L,10L and the leak test, continue with the next step.
- If mixer fails the 3L,10L or the leak test, fail with the mixer failure.

Step 8: "N_2O Flow" – Run the mixer tests on N_2O channel (Check gas supply and run a 3L and 10L flow delivery test and leak test):

- If N_2O is disabled, continue with next step.
- If N_2O supply is low, continue with next step and indicate "Could not test N_2O".
- If mixer does not fail the 3L,10L and the leak test, continue with the next step.
- If mixer fails the 3L,10L or the leak test, fail with the mixer failure.

Step 9: "Battery and Electrical" – Are the AC/Mains connected and the battery charged?

- If AC/Mains failed, indicate "Power cord disconnected. Using battery".
- If Battery failed, indicate "Battery failure".
- If Battery charging with 20 - 30 minutes available, indicate "Battery still charging."
- If Battery charging with 10 - 20 minutes available, indicate "Battery still charging".
- If battery charging with 0-10 minutes available, indicate "Battery still charging".
- If battery fully charged, pass step.

7.16.1 Machine Check - Circuit

Step1: Check to make sure Bag/Vent switch is set correctly; check ACGO switch set correctly; make sure CO_2 bypass is Off.

- If switches are set to the correct position, continue with the next step. If set to the incorrect position, the test will fail with “Wrong circuit selected”.

Step2: Is O_2 available and working?

- If O_2 Supply is Not low and mixer passes a mixer flow test of 250 ml/min of O_2, continue with the next step. If not, fail with “Low O2 supply pressure” or with mixer failure.

Step3: Is circuit (airway) pressure too high? Check the circuit (airway) pressure is less than 30 cm H_20; continue with the next step.

- If airway pressure greater than 30 cm H_20 fail with “Circuit pressure too high”.

Step4: Find manual circuit leak: Increase flow to find the manual circuit leak.

- If pressure does not increase to 30 cm H_20, fail with “Cannot pressurize circuit”.
- If flow required to maintain pressure at 30 cm H_20 is greater than 250 ml/min, state “Manual circuit leak is XXX ml/min at 30 cm H20”.
- If flow required to maintain pressure at 30 cm H_20 is less than or equal to 250 cm H_20, continue with the next step.

Step 5: Test the Alt O_2 flow part: Close the Alt O_2 Flow Control Valve (allow flow through the Alt O_2 flow path).

- If the measured flow is greater than 400 ml/min, pass the test and transition to the Start Case screen. If the measured flow is less than 400ml/min, transition to the “Accept” screen.

7.17 cVIB Pneumatic Sense Tubing Leak Test

1. On the Gas Delivery Schematic in the PC Service Application, set the Set Fresh gas flow to 2 l/min.
2. Perform the following:
   - Open the APL valve (0 cm H_2O).
   - Place the Bag-to-Vent switch in the Bag/APL position.
   - Connect a short tube between the inspiratory and expiratory flow sensors.
3. On the Vent Subsystem menu, select “Vent Flow and Pressure”.
   - The airway pressure should read near zero.
   - The Inspiratory Flow and Expiratory Flow should read near zero (between +0.5 and -0.5 l/min flows).
4. Remove the tabletop (Section 9.5) to access the flow sensor tubes.
5. Occlude the bag port. Adjust the APL to read approximately 10 cm H_2O on the Airway Pressure readout. The flow may jump briefly, but should stabilize to read between +0.5 and -0.5 l/min. Very gently push the tubes coming from the flow sensors slightly in all directions. Observe to see if the flow measurements jump.

⚠ **Caution** If either sensor reads more than 2 l/min, STOP. This indicates a possible leak in the flow sensor pneumatic circuit. Skip steps 3 and 4, go directly to step 5. If the pressure is increased further, the cVIB may be damaged.

6. Adjust the APL to read 20 cm H_2O on the Airway Pressure readout. The flows may jump briefly, but should stabilize to read between +0.5 and -0.5 l/min.
7. Adjust the APL to read 40 cm H_2O on the Airway Pressure readout. The flows may jump briefly, but should stabilize to read between +0.5 and -0.5 l/min.
8. If the flow measurements on the PC Service Application stay near zero, the sense lines are leak free. If either sensor indicates a flow, there may be a leak. Note which sensor channel indicates flow (fails the leak test).

Troubleshooting

To troubleshoot, reduce the circuit pressure back to zero. Reverse the flow sensor connections at the cVIB interface panel and repeat the above tests.

- If the problem follows the sensor, discard the sensor; it has a leak.
- If the problem stays with the same side of the circuit, it is likely the leak is in the tubing, not with the sensor.

7.18 Flow Sensor Accuracy Test

The test device used in the following procedure must have an accuracy to ± 2.5% or better (refer to Section 10.1.5). Ensure the test device is set to measure appropriate drive gas (O_2 or Air).

This procedure checks the raw velocity measurement made by the flow sensor; therefore, any error inherent in the conversion to volume is eliminated. This is true for both the ventilator flow sensors and the test device.

1. Remove the bellows housing.
2. Remove and set aside the bellows assembly and the pressure relief (pop-off) valve.
3. Reinstall the bellows housing.
4. Remove the flow sensor module and take off the cover.
5. Remove the expiratory flow sensor from the flow sensor module.
6. Reinstall the flow sensor module with the Expiratory Flow sensor connected but not seated in the circuit module.
7. Ensure both sensors are plugged into the bulkhead connector.
8. Connect a test flow device in series with the Inspiratory Flow sensor (ensure the correct flow direction).
9. Connect a short piece of patient tubing between the Inspiratory Flow sensor and the removed Expiratory Flow sensor.
10. Connect and establish communication with the PC Service Application.
11. Set the Bag/Vent switch to Vent.
12. Go to the Vent Schematic screen and adjust the Insp Flow Valve to the following settings:
    - Set the Gas Inlet Valve to On.
    - Select flows of 5, 10, 20, 30, and 50.
13. At each flow, record the absolute value of the Inspiratory and Expiratory flow sensors.

    (Inspiratory and Expiratory flows will have different signs (+ and -); these are flow direction indicators only.)
    - The flow sensor readings should be within 10% of the test device.
14. Switch the position of the Inspiratory and Expiratory flow sensors.

    (This will reverse the flow through the sensors and give an indication of aging on the internal flapper. As the flapper gets older and is subjected to repeated cleaning, it tends to harden and lose its original shape.)
15. Repeat step 12.
    - The flow sensor readings should be within 10% of the test device.s

Notes

8 Software Download

In this section

8.1 Overview

This section covers the functions of the USB Media used to download system software.

To run the application:

- Set the system switch to Standby and set the AC Inlet power switch to Off.
- Insert the USB Media into the open (right-hand) USB port of the display unit.
- Set the AC Inlet power switch and the system switch to On. The application will load and display the Main Menu along with the System Information page.

8.1.1 Main Menu and System Information

The Main Menu appears on the left-hand side of the screen and the System Information appears on the right-hand side of the screen and displays the system information as shown below:

Software Loader for Aisys CS2, Ver X.XX **(Date)(Time)**

System Serial Number
ABCDXXXXXXXXX

Main Menu
Software Download
. . .

Aisys CS2 System Information

___________Currently Installed___________

Subsystem	HW Rev	Serial #	SW Ver	BootVer
Front Panel Cntl	n/a	n/a	XX.XX	XXbXX
Power Controller	XXXX/A /XX	ABCXXXXX	XX.XX	XXbXX
Electronic Mixer	XXXX/A /XX	ABCXXXXX	XX.XX	XXbXX
Vent Intface Bd	XXXX/A /XX	ABCXXXXX	XX.XX	XXbXX
Vaporizer	XXXX/A/XXX	ABCXXXXX	XX.XX	XX.XX
Vap Flow Meter	XXXX/A/XXX	ABCXXXXX	n/a	n/a
Vap Temp Sensor	XXXX/A/XXX	ABCXXXXX	n/a	n/a
Anes Control Bd	XXXX/A /XX	ABCXXXXX	XX.XX	XX.XX
Dsply Unit BIOS	XXXX/XX/XX	ABCXXXXX	XX.XX	n/a
Dsply Unit App	XXX/XX/XX	n/a	XX.XX	n/a

If a subsystem is not communicating, the message "(Not communicating)" will be shown instead of the information fields.

If the system is running on battery power instead of AC power, the warning message "Running on battery" will be displayed in the bottom row of the Menu area on the left side of the screen.

8.2 Software Download

Use the ComWheel to select ***Software Download*** to bring up the Software Download menu.

Software Download	Remarks
Download New	Downloads only new software versions not found on the system and compatible with installed subsystem hardware.
Download All	Downloads all software subsystems.

Since downloading all the subsystem software can take up to 30 minutes, you should normally choose "Download New" to install only the updated subsystem software or software required for newly installed subsystems.

Software Loader for Aisys CS2, Ver X.XX **(Date)(Time)**

System Serial Number
ABCDXXXXXXXXX

Software Download
Download New
Download All

Loading Aisys CS2 Product Software Version XX.XX

	___ Installed ___		__New__	
Subsystem	**HW Rev**	**SW Ver**	**SW Ver**	**Status**
Front Panel Cntl	n/a	XX.XX	XX.XX	Xxxxxxx
Power Controller	XXXX/A /XX	XX.XX	XX.XX	Xxxxxxx
Electronic Mixer	XXXX/A /XX	XX.XX	XX.XX	Xxxxxxx
Vent Intface Bd	XXXX/A /XX	XX.XX	XX.XX	Xxxxxxx
Vaporizer	XXXX/A/XXX	XX.XX	XX.XX	Xxxxxxx
Anes Control Bd	XXXX/A /XX	XX.XX	XX.XX	Xxxxxxx
Dsply Unit BIOS	XXXX/XX/XX	XX.XX	XX.XX	Xxxxxxx
Dsply Unit App	XXX/XX/XX	XX.XX	XX.XX	Xxxxxxx
ModBus Controllr	n/a	XX.XX	XX.XX	Xxxxxxx
Dsply Unit FontC	n/a	XX.XX	XX.XX	Xxxxxxx
Dsply Unit FontJ	n/a	XX.XX	XX.XX	Xxxxxxx

Note Whenever a Software Download is completed, a software compatibility table is written to internal media. This file is used by the DU applicatin software to ensure that the system remains in an approved configuration when the application software is started.

Notes about downloading software

To ensure that all software versions on the system are compatible, the end result of “Download All” or “Download New” will be the same. The software loaded on the machine will exactly match what is on the USB Media. Be sure to have the latest/correct version of software before attempting a download to avoid inadvertent overwrites of newer software with an older version.
If, during the “Download New” process, the compatibility checker detects a newer version of software component on the system, a “Notice” appears on the screen that asks you to confirm the downgrade.
“Download All” will download all compatible software from the USB media to the system. If the compatibility checker detects a newer version of software component on the system, a “Notice” appears on the screen that asks you to confirm the downgrade.

Download process

The USB Media includes only the latest software for each subsystem.

As each subsystem software segment is being downloaded, the following status messages note the state of each subsystem and the result of the download:

- ***Waiting*** - Attempting to establish communications with the subsystem.
- ***No Comms*** - Communications with the subsystem have not been established.
- ***In App*** - System is running its application code; not ready for download.
- ***Ready*** - System is in its boot code; ready for download.
- ***Loading*** - System is accepting download data.
- ***Done*** - Software download has completed successfully.
- ***Skipped*** - Software download was bypassed.
- ***Fail*** - Software download did not complete successfully. A “Fail” message will require reloading of the software; or repair of the system may be necessary.

If the subsystem is communicating but the HW Rev or current SW Rev are not known, dashes will appear for those values.

Download complete

When all the required subsystem software is download, the following message appears on the screen. You must shut down the system to exit the download function.

DOWNLOAD IS COMPLETE.
Remove AC mains power. Turn on/standby switch to Standby. Then remove external USB Media. Wait 20 seconds before restoring power to the system.

Note

After powering down the system, be sure to wait at least 20 seconds before restarting the system.

8.3 Software Compatibility Check

If Software Download detects an incompatible subsystem, an error message noting the incompatible subsystem is displayed.

ERROR!! INCOMPATIBLE SOFTWARE. The software version on the USB Media is not compatible with the installed XXX subsystem. Installed part #: **(Stock Number) (Rev X)**, swver XX.XX USB Media part #: **(Stock Number) (Rev X)**, swver XX.XX

Notes

9 Repair Procedures

In this section

⚠ **WARNING** To prevent fires:

- Use lubricants approved for anesthesia or O_2 equipment, such as Krytox.
- Do not use lubricants that contain oil or grease; they burn or explode in high O_2 concentrations.
- All covers used on the system must be made from antistatic (conductive) materials. Static electricity can cause fires.

⚠ Obey infection control and safety procedures. Used equipment may contain blood and body fluids.

⚠ A movable part or a removable component may present a pinch or a crush hazard. Use care when moving or replacing system parts and components.

⚠ Before servicing the system, disconnect the power cord from the AC mains supply. The detachable power cord is the means for isolating the system's circuits from the supply mains on all poles simultaneously.

⚠ Some internal parts have sharp edges and can cause cuts or abrasions. Use care when servicing internal components.

⚠ Replace damaged parts with components manufactured or sold by GE Healthcare. Then test the unit to ascertain that it complies with the manufacturers's published specifications.

⚠ After repairs are completed, always perform the checkout procedure. Refer to Section 3 of this manual.

⚠ Do not use the brake while moving the anesthesia system. This could cause the machine to tip over. Only use the brake to keep the system in place.

⚠ Maintain system balance. When using rails or dovetails, distribute equipment on each side of the system. Uneven system balance could cause the system to tip.

⚠ **CAUTION** Electrostatic discharge through circuit boards may damage the components on them. Wear a static control wrist strap before touching the circuit boards. Handle all circuit boards by their non-conductive edges. Use anti-static containers when transporting them.

9.1 Circuit board replacement precautions

The Aisys CS2 anesthesia system has processors on several boards. On three of these boards, information such as the machine serial number and optional ventilation modes (PCV, SIMV, and PSVPro) are stored redundantly.

During power-up, the machine serial number and installed options information stored on the boards are compared. If one board differs, information from the two agreeing boards will be written to the new board. If three boards differ (in the case of two boards replaced) the system defaults to “NO OPTIONS” and default machine serial number.

To retain the installed options, **install only one replacement board at a time**.

If multiple boards are to be installed, install the first board, load software on the new board, and power-up the machine in normal mode. Repeat this procedure for each board installation.

The following table lists the actions required after replacing printed circuit boards:

Board Name (Short Name)	Required Action After Installation
Display Unit Carrier Board and Com Express Assembly	Load Software (see **Note** below). Check / Re-Configure Machine Configurations. [**Most user configuration settings are stored on the Compact Flash card and are retained when the CF card is transferred to the new board assembly.**] Affix the new Key Code and Board ID Label to the back of the display unit. Preoperative Checkout.
Anesthesia Control Board (ACB)	Load Software. Check / Re-Configure Machine Configurations. User Calibrations (O2 Cell, Flow Sensor, etc.). Gas Transducer Zero. All Ventilator Calibrations. Preoperative Checkout.
Power Controller (PCB)	Load Software. Preoperative Checkout.
Consolidated Ventilator Interface Board (cVIB)	Load Software. User Calibrations (O2 Cell, Flow Sensor, etc.). All Ventilator Calibrations. Preoperative Checkout.
Electronic Mixer (Mixer)	Load Software. Zero Mixer Pressure Sensors. Preoperative Checkout.
Agent Delivery Board (ADB)	Load Software. Do Agent Delivery test with Test Cassette (Section 3.4.6). Preoperative Checkout.
All Others	Preoperative Checkout.
Note: Flash software starts loading immediately when the Download Application first boots. Do not interrupt the Flash download. Allow the download to complete before proceeding.	

9.2 KEY/BID label (Key Code)

Note For the Aisys CS2 system, the "Control Board" reference is to the "Carrier Board and Com Express Assembly" in the Display Unit.

The KEY/BID code for the replacement Control board is appropriate for machines that do not include any optional features. If the serviced machine included optional features, access the Key Code Generator web site to obtain the appropriate optional features Key Code.

1. Gather the following information (* denotes Required Information):

Requestor Information	
* Email Address	
* Full Name	
* Organization	
End User Information	
Hospital Name	
Address 1	
Address 2	
City	
Postal Code	
Country	
Telephone	
Information from the EXISTING Control Board being REMOVED	
* Control Board ID number	
* Control Board Key Code	
Information from the REPLACEMENT Control Board being INSTALLED	
* Control Board ID Number	

2. Access the Key Code Generator on the following web site.
   - http://www.docodes.com
3. Enter the required information and Submit the Request.

An e-mail with the replacement Control Board Key Code will be immediately sent to the e-mail address provided (*due to delays in some firewalls and internet traffic, responses can take up to 24 hours to receive*).

9.3 How to bleed gas pressure from the machine

Before disconnecting pneumatic fittings, bleed all gas pressure from the machine.

1. Close all cylinder valves and disconnect all pipeline supplies from the source.
2. Set the system switch to On.
3. Ensure that all cylinder and pipeline pressures read zero.
4. Establish a flow for the affected gas to bleed down the pressure.
5. Set the system switch to Standby.

9.4 How to remove the rear panels

To access components in the upper electronic enclosure from the rear of the machine, you must remove the rear cosmetic panel and an inner enclosure cover.

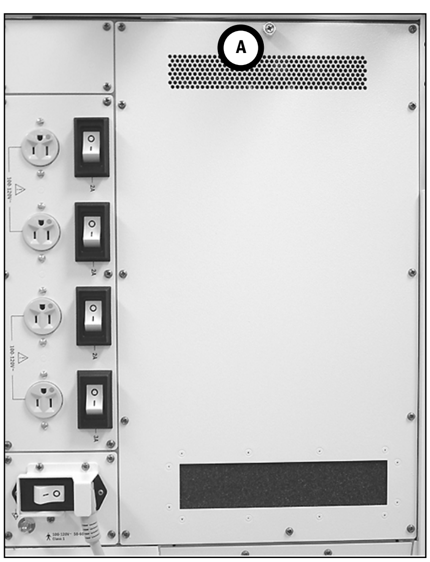
To access components in the lower electronics enclosure, you must remove the lower access panel.

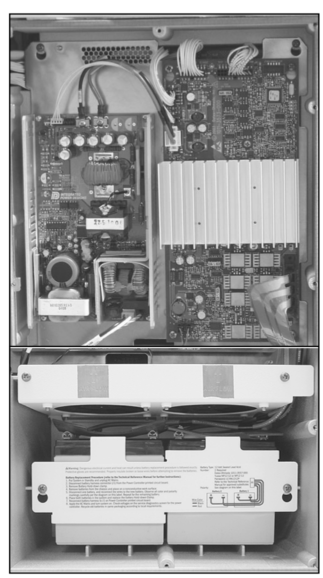
9.4.1 To remove the rear upper panels

1. Bleed all gas pressure from the machine (Section 9.3).
2. Ensure that all cylinder and pipeline pressures read zero before proceeding.
3. Disconnect all electrical cables.
4. To remove the rear cosmetic panel, fully loosen the five captive screws that hold the panel in place. Remove the panel.
5. To remove the inner access panel, remove the 18 mounting screw around the periphery of the panel. Disconnect the fan cable to remove the panel.

9.4.2 To remove the lower access panels

1. Disconnect the power cord from the AC mains supply.
2. Bleed all gas pressure from the machine (Section 9.3).
3. Ensure that all cylinder and pipeline pressures read zero before proceeding.
4. If present, remove the inboard cylinders.
5. To remove the lower access panel, remove the 11 mounting screws around the periphery of the panel.
6. Loosen the thumbscrew (**A**) at the top edge of the panel to remove it.



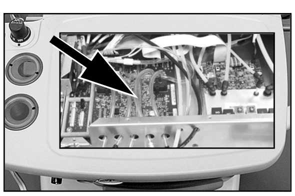


9.5 How to remove the tabletop

The tabletop is held in place with four captive screws along the periphery of the pan assembly (accessed from below the rim of the tabletop).

- Two screws (**A**) are at the front of the tabletop: one screw is at the right corner of the tabletop, one is near the O_2 Flush button.
- To access the remaining two screws (**B**), you must remove the ABS: one screw is at the left corner of the tabletop, one is near the APL Valve.

9.6 Servicing the pan electrical enclosure components



The pan electrical enclosure includes the following components (Section 10.10):

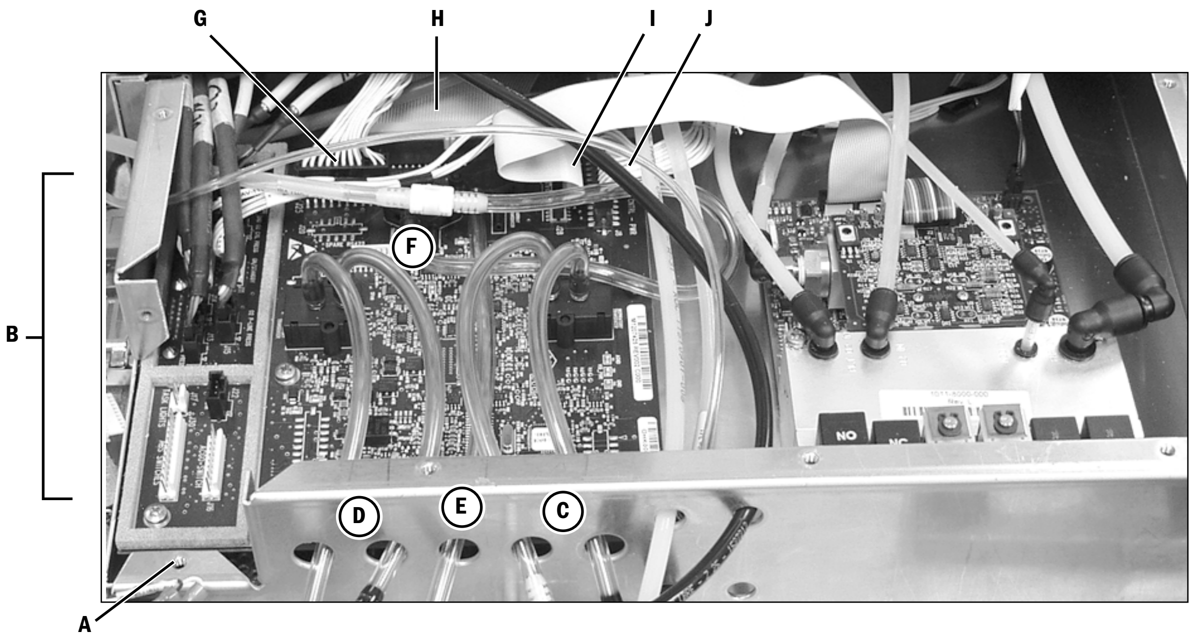
- Electronic Gas Mixer assembly
- Consolidated Ventilator Interface board (cVIB)
- O_2 Flush Regulator

To replace these components, remove the tabletop (Section 9.5) and the pan enclosure cover. Access to some of these components require further disassembly for replacement.

9.6.1 Consolidated Ventilator Interface board (cVIB)

The following procedure describes how to replace the Consolidated Ventilator Interface board (cVIB).

1. Remove the pan enclosure lower cover (**A**).
2. Disconnect the harnesses along the left edge of the cVIB (**B**).
3. Before disconnecting the following tubing, note how each tube passes through the openings in the electrical enclosure.
   - Disconnect the white and black inline tubing fittings from the Inspiratory pressure transducer (**C**).
   - Disconnect the blue and yellow inline tubing fittings from the Expiratory pressure transducer (**D**).
   - Disconnect the black inline tube fitting from the Airway pressure transducer (**E**).
   - Disconnect the white inline tube fitting from the Manifold pressure transducer (**F**).

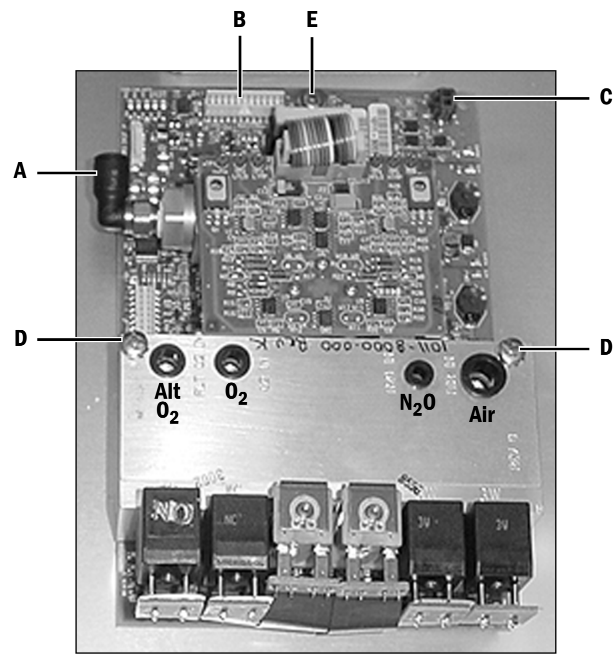


4. Disconnect the harness (**G**) coming from the eVap.
5. Disconnect the ribbon cable (**H**) coming from the lower electrical enclosure.
6. Disconnect the ribbon cable (**I**) coming from the Mixer.
7. Disconnect the harness (**J**) coming from the lower electrical enclosure.
8. Remove the mounting screws that hold the board to the enclosure.
9. To replace the cVIB, reassemble in reverse order.
   - Ensure that the tubing fittings are connected to like color fittings and that the tubing will not kink when the cover is replaced.
10. Load Software.
11. Perform User Calibrations (Section 4.8.1).
12. Perform all Ventilator Calibrations (Section 5.4).

9.6.2 Electronic Gas Mixer assembly

The following procedure describes how to replace the Electronic Gas Mixer assembly.

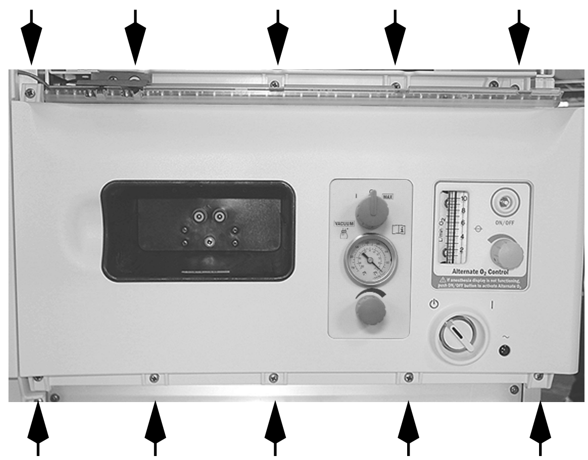
1. Bleed all gas pressure from the machine (Section 9.3).
2. Ensure that all cylinder and pipeline pressures read zero before proceeding.
3. Loosen the mounting screws and move the dashboard to the service position (Section 9.7).
4. Disconnect the inlet tubing or fittings from the manifold. If the machine does not include N_2O, transfer the plug from the N_2O inlet to the replacement assembly.
5. Disconnect the tubing from the elbow outlet fitting (**A**).



6. Disconnect the ribbon cable from the Pan Connector board (**B**).
7. Disconnect the fan harness (**C**).
8. Remove the two screws (**D**) that hold the manifold to the enclosure.
9. Remove the mounting screw (**E**) at the front edge of the main circuit board.
10. Temporarily remove the Ventilator Interface board to provide clearance to slide the mixer forward and out of the pan enclosure.
11. Replace the Electronic Gas Mixer assembly and reassemble the removed components in reverse order.
12. Load Software.
13. Zero Mixer Pressure Transducers (Section 4.8.7).

9.7 How to access dashboard components

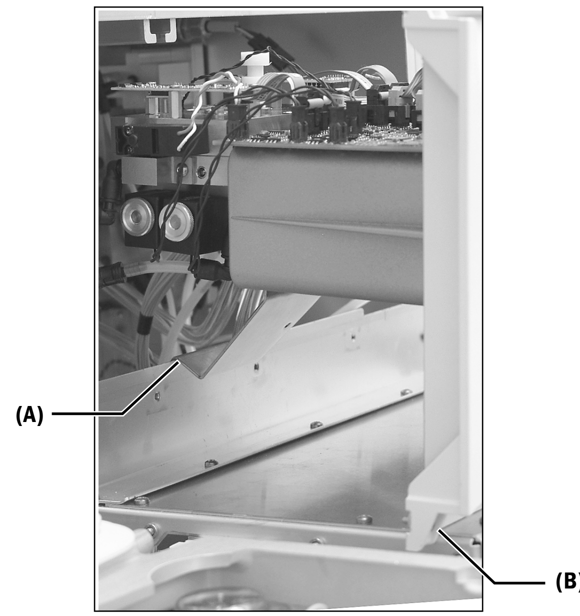
1. Bleed all gas pressure from the machine (Section 9.3).
2. Ensure that all cylinder and pipeline pressures read zero before proceeding.
3. Remove the tabletop (Section 9.5).
4. Remove the upper bezel located above the dashboard.
5. Loosen 10 captive dashboard mounting screws and move the dashboard forward to the stop position.



⚠ **CAUTION** When replacing the dashboard back into the machine, take care not to trap, kink, or snag any tubing or wiring harnesses.

9.8 Replace electronic vaporizer and components

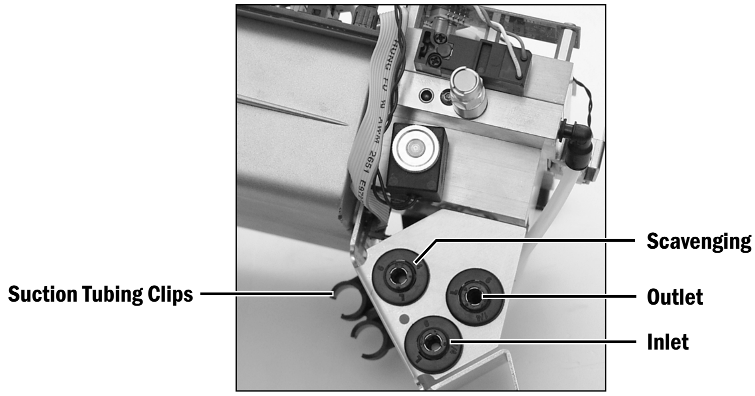
1. Move the dashboard forward to the service position (Section 9.7).
2. Lift the assembly slightly to release the hanging pin from the rail.



3. Position the dashboard so that the eVap support bracket (**A**) rests on the edge of the chassis and the bottom edge of the dashboard (**B**) straddles the pan electronic enclosure.
4. In the forward position, the following eVap components can be replaced without removing the eVap from the machine. Refer to the following sections for details.
   - Flowmeter subassembly
   - Flowmeter inflow and outflow zero valves
   - Manifold temperature sensor board
   - Agent delivery board
   - Cassette interface board
5. To replace the eVap, or components not mentioned above, remove the eVap from the machine as detailed in the following section.

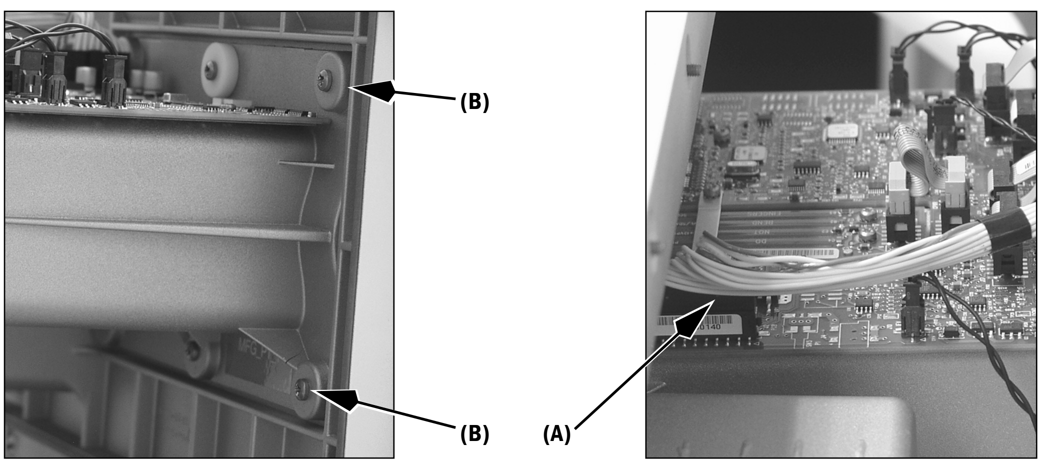
9.8.1 Remove the electronic vaporizer

1. If the eVap is equipped with bulkhead fittings on the eVap support bracket, disconnect the inlet, outlet, and scavenging tubing from the bulkhead fittings. Remove the suction tubing connectors (if equipped) from the clips on the bottom of the eVap support bracket.



   If the eVap is not equipped with bulkhead fittings, disconnect the tubing directly from the inlet, outlet, and the scavenging ports of the eVap.

2. Disconnect the pan connector harness (**A**) from the Agent Delivery board.
3. Clip the tie-wrap holding the pan connector harness to the eVap support bracket.
4. Remove the six screws (**B**) holding the eVap to the dashboard.



5. **Note**: The eVap assembly weighs approximately 5 kg (11 lb). Most of the weight of the eVap is at the rear.

⚠ **CAUTION** When handling the eVap, be careful not to damage the Flow Control Valve at the back of the flowmeter block.

6. To remove the eVap:
   - Firmly take hold of the eVap at the rear with one hand without touching any boards.
   - Support the front of the eVap with the other hand.
   - Raise the rear of the eVap tilting the dashboard forward.
   - When clear, remove the eVap from the machine.

9.8.2 Replacing eVap components

Do not remove any components on the eVap flowmeter subassembly that are fastened with Torx head fasteners. The components are not serviceable items.

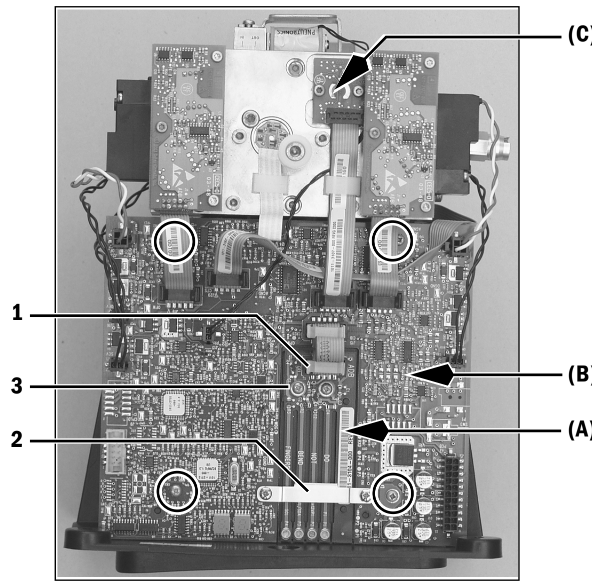
Most components can be replaced by disconnecting associated wiring, removing mounting hardware and remounting the replacement component in place. Where applicable, note the additional comments for specific components detailed below.

Cassette Interface board (A)

- Disconnect jumper cable (**1**).
- Remove retaining bracket (**2**).
- Remove mounting screws or nuts and washers (**3**). When replacing boards with nuts, tighten the nuts by hand, then torque to 0.6 Nm. Do not overtighten!
- Be careful not to bend fingers.

Agent Delivery board (B)

- Remove cover if installed.
- Remove the cassette interface board retaining bracket and jumper cable as above.
- Disconnect harnesses and ribbon cables.
- Remove mounting screws/standoffs (circled).
- Raise the rear edge of the board to free it from the assembly.



Manifold Temperature Sensor board (C)

- The bottom of the board includes two thermistors that contact a thermal transfer pad. When removing the board, ensure that the pad remains with the manifold. If required, reposition the pad before replacing the board.

Cassette Temperature subassembly (D)

- Do not overtighten the mounting screws. Tighten the screws until just snug.

Flow Control valve (E)

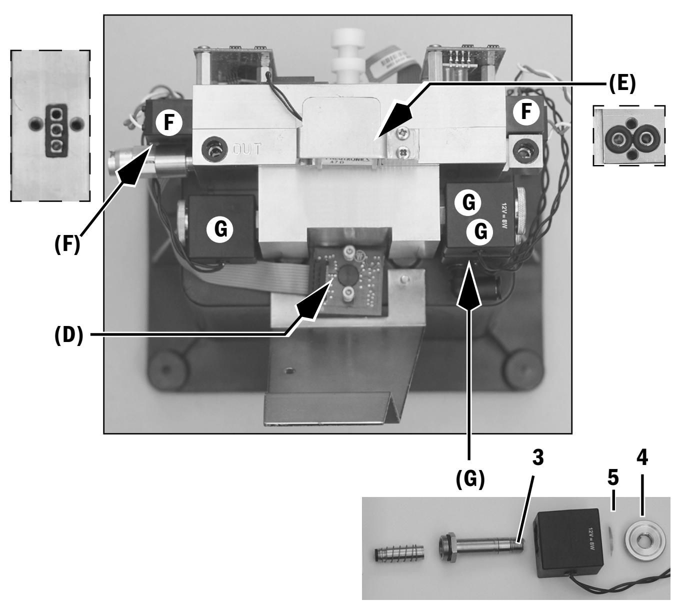
- Inspect o-rings; replace as necessary.

Inflow/Outflow zero valves (F)

- Inspect gasket; replace as necessary.
- Be sure gasket is fully seated in cavity before installation.

Inflow/Outflow/Scavenging solenoid valves (G)

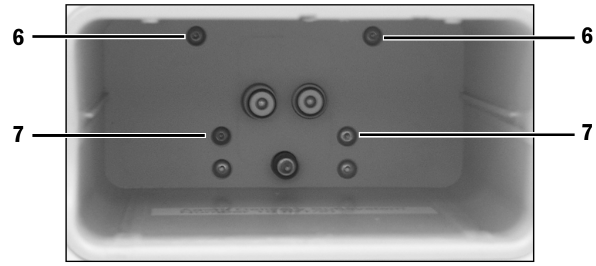
- Apply thin coat of silicone sealant (Refer to section 10.1.6) to the threads of the mounting post (**3**) after mounting the solenoid but before securing the thumb nut (**4**). Install washer (**5**) with dome facing outward (toward nut). The raised surface of the thumb nut should bear on the washer.

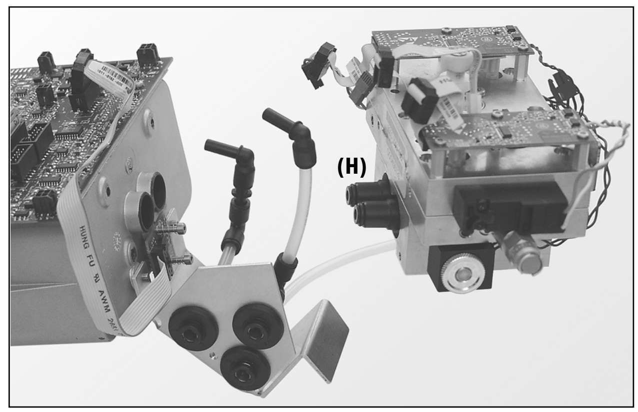


Access mechanical connector valves (H)

You can access the connector valves by removing the flowmeter and valve block subassemblies from the cassette bay as a unit.

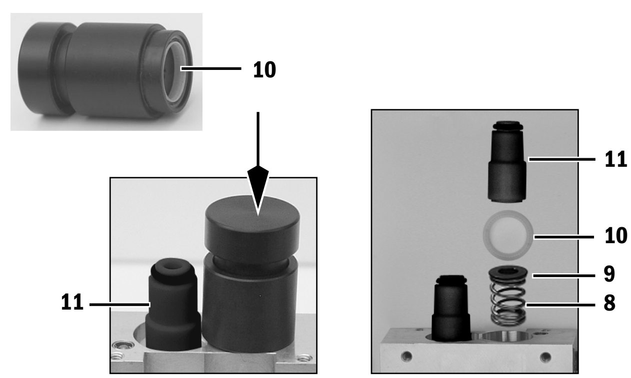
- Disconnect harnesses and ribbon cables from the agent delivery board.
- If applicable, disconnect the tubing from the inlet, outlet, and the scavenging ports of the eVap.
- Remove the top two screws (**6**) and middle two screws (**7**) from inside the cassette bay to release the flowmeter and valve block subassemblies.





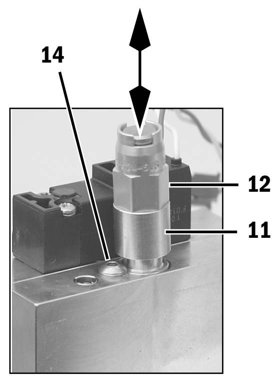
Replace connector valve assembly

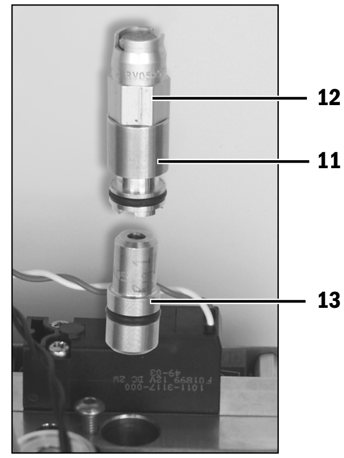
- Place a spring (**8**) and alignment bushing (**9**) into the valve block.
- Insert a spring energized seal (**10**) into the insertion tool (spring surface facing out).
- Position the insertion tool into the valve cavity.
- Press the seal in place to retain the spring.
- Position the connector valve (**11**) into the valve block cavity. (*Note: Pressing the connector valve in too far will cause the seal to be ejected by the spring.*)



Replace the relief valve

- Hold the backpressure plug (**11**) with non-marring pliers while turning the relief valve (**12**) counterclockwise to remove it.
- If you are replacing the relief valve and the backpressure valve (**13**), remove the relief valve and the backpressure plug as a unit before replacing the relief valve.



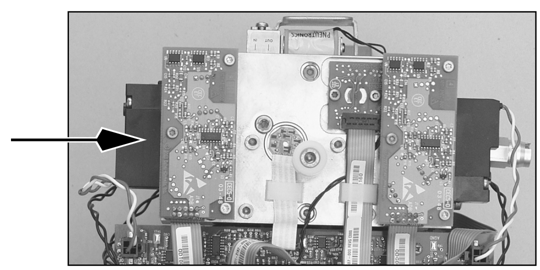


Replace the backpressure valve

- Loosen the mounting screw (**14**).
- Pull on the backpressure plug as you continue to loosen the mounting screw until both the screw and plug come loose.
- Use an angled probe to grab the backpressure valve (**13**) and pull it out of the manifold. (*If the machine is on, hold a hand over the backpressure valve bore and push the alternate O_2 button; the backpressure valve may pop out. Push the alternate O_2 button again to disable flow.*)
- Inspect and replace the plug o-ring if required.
- Insert the backpressure valve into the manifold; note the direction (flow arrow should point out of the manifold).
- Using only a finger, push the backpressure valve into the bore.
- Position the plug assembly and the mounting screw together in place.
- Tighten the mounting screw while pushing down on the plug assembly until it is fully seated.

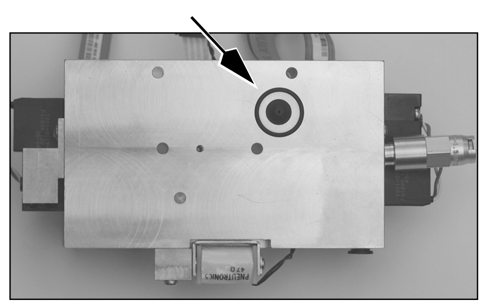
To replace the Flowmeter subassembly

- Refer to the Installation Instructions included in the Flowmeter Subassembly Kit.



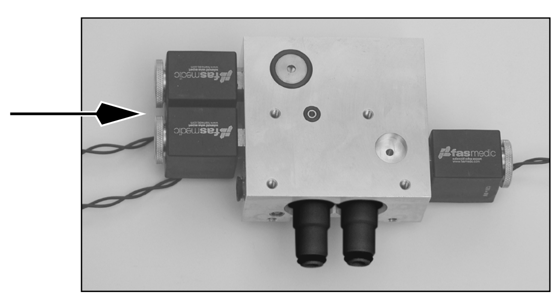
Replace the inflow check valve assembly

- Refer to the Installation Instructions included in the Inflow Check Valve Assembly Kit.



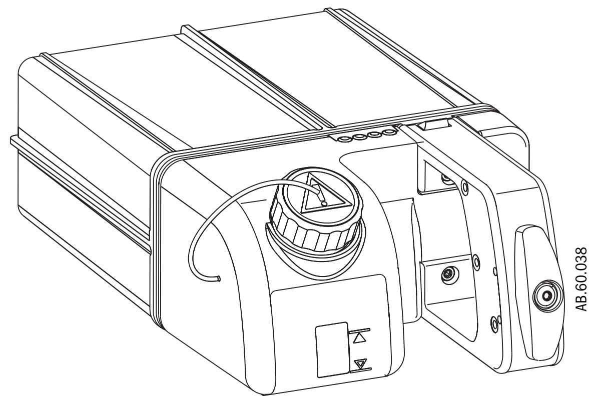
To replace the valve block subassembly

- Refer to the Installation Instructions included in the Valve Block Subassembly Kit.



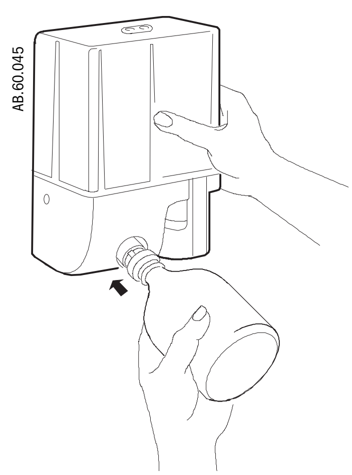
9.9 Servicing $Aladin_2$ cassettes

Note Before service or returning a cassette to the manufacturer, make sure that the cassette is empty. All $Aladin_2$ cassettes must be emptied before shipping. Package and ship the cassettes in a suitable container.



9.9.1 Emptying an $Aladin_2$ cassette

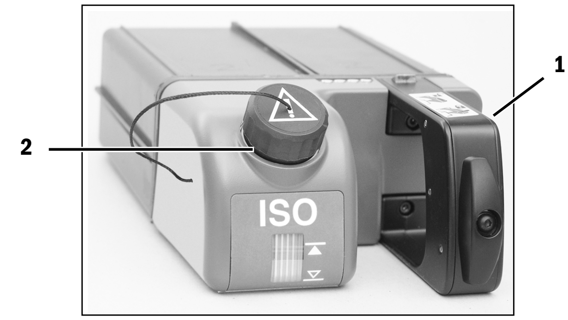
1. Connect an empty bottle to the filling system and hold it tight.
2. Turn the $Aladin_2$ cassette so that agent flows into the bottle and wait until the cassette is empty.



3. To get the maximum amount of agent out, rock the cassette from left to right and tip it forward and back several times.
4. Remove the bottle before returning the cassette to the horizontal position.

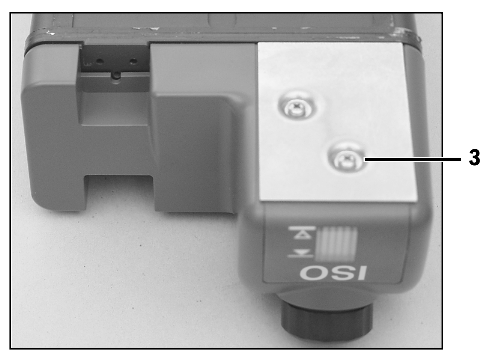
9.9.2 $Aladin_2$ cassette parts replacement

You can replace the handle assembly (**Item 1**) and the o-ring (**Item 2**) for the filler cap without disassembly. To prevent scratching the cap sealing surface, use caution when removing the o-ring.

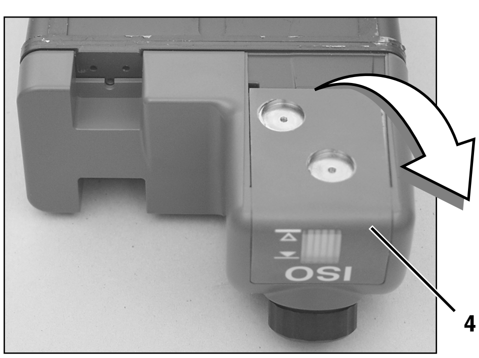


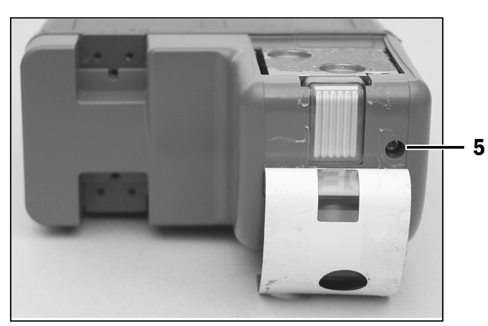
For the remaining components, follow the outlined sequence to access the individual components.

1. Ensure that the cassette is empty of agent (refer to Section 9.9.1).
2. Remove the handle assembly.
3. For non-DES cassettes, remove the filler cap.
4. Turn the cassette over and remove the bottom plate (**Item 3**).
   - Note that the Saf-T-Fil DES cassette does not use a bottom plate.



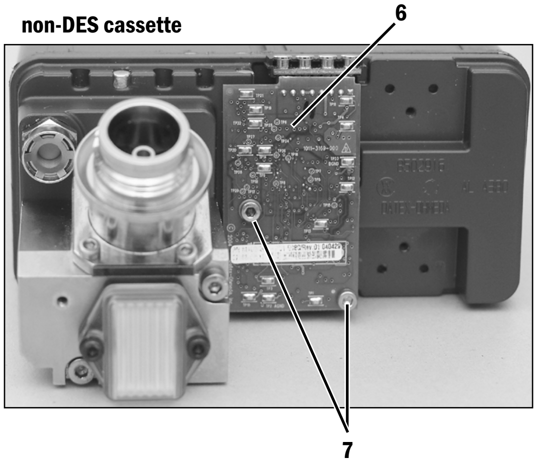
5. Remove the label (**Item 4**) to access the mounting screw (**Item 5**) for the mask.



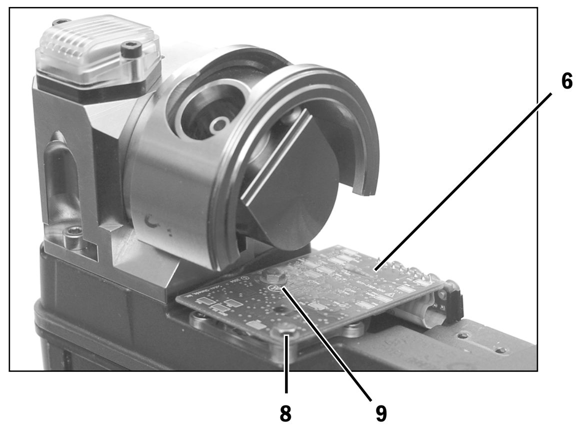


6. To replace the Agent Cassette board (**Item 6**) remove the two mounting screws.
   - For a non-DES cassette,
     use a2.5-mm hex wrench to remove the mounting screws (**Item 7**).
   - For a DES cassette,
     use a 5.5-mm socket to remove the fully exposed mounting screw (**Item 8**).
     To remove the screw under the filler assembly (**Item 9**), use a 5.5-mm open end wrench or a small size adjustable open end wrench to loosen the screw to the point where you can spin it out with your fingers. When mounting the board, ensure that you include the insulating washer under the screw head to prevent board damage when tightening this fastener. Place the hardware into the board mounting hole prior to positioning the board on the DES cassette.

non-DES cassette

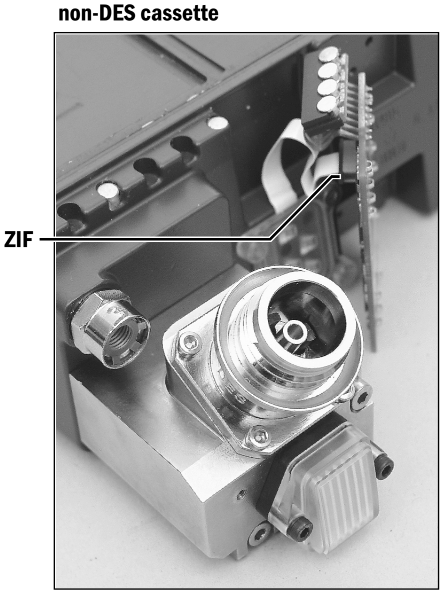


DES cassette (Saf-T-Fil shown)

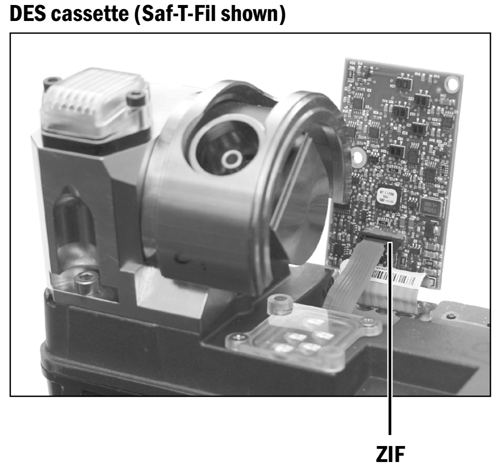


7. Note that the ribbon cable attached to the Agent Cassette board uses a **ZIF** (zero insertion force) connector; pull tabs toward ribbon cable to release (push down after inserting cable). The conductors on the ribbon cable face the top of cassette.
   - Cassettes without enhanced temperature sensing do not include this ribbon cable.

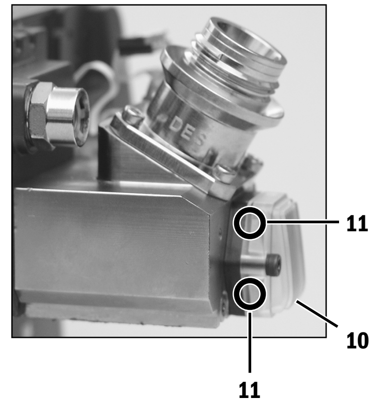
non-DES cassette



DES cassette (Saf-T-Fil shown)

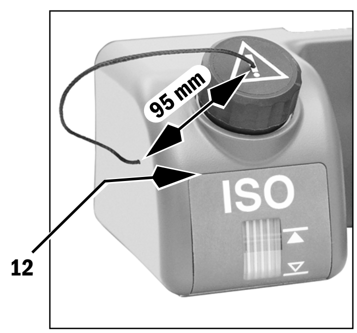


8. When replacing the sight glass (**Item 10**), orient it so that the rounded edge is facing down. Ensure that the two o-rings (**Item 11**) are seated in the sight glass before tightening the mounting screws.

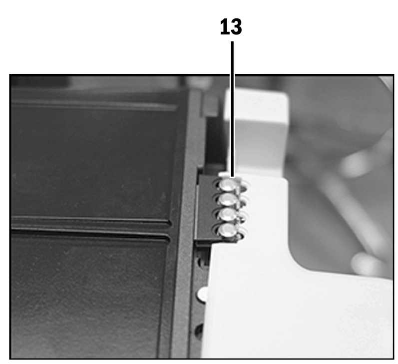


9. When replacing the filler cap, thread the cord through the hole in the mask and tie a knot so that **at least 95 mm** of cord remains external.

10. When replacing the label (**Item 12**), be sure to align the top of the label with the top edge of the recess in the mask. Be careful to apply the correct label with regards to whether the cassette has an enhanced temperature sensor or not.

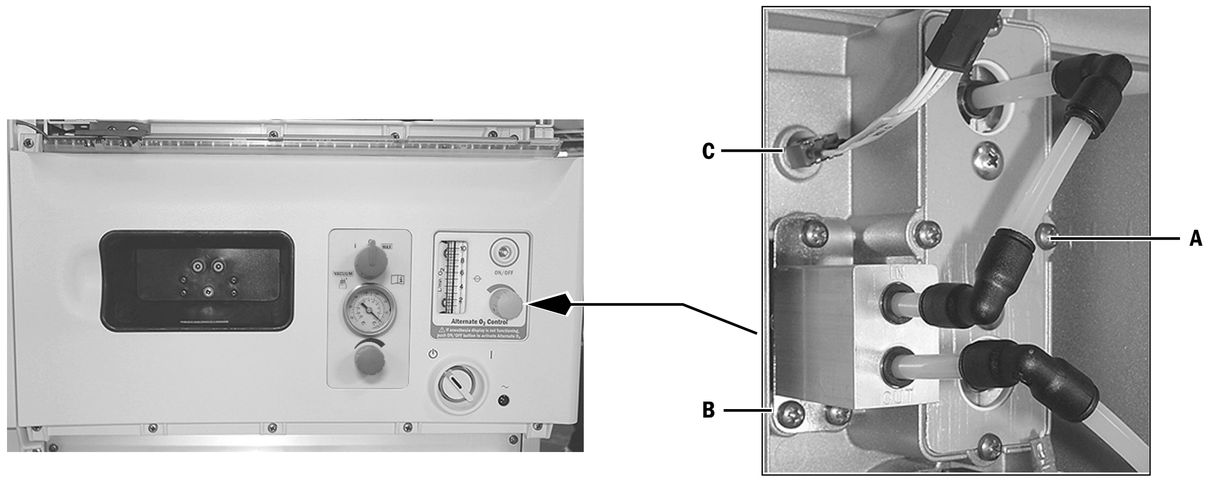


11. When reattaching the mask, be sure that the contact retainer (**Item 13**) engages the slot in the mask.



9.10 Replace Alt O_2 components

1. Move the dashboard forward to the service position (Section 9.7).



Alt O_2 Flowmeter (A)

Disconnect the tubing from the flowmeter.
Remove the four screws that hold the flowmeter mounting bracket to the dashboard.
Transfer the mounting bracket to the new flowmeter.

Needle Valve Assembly (B)

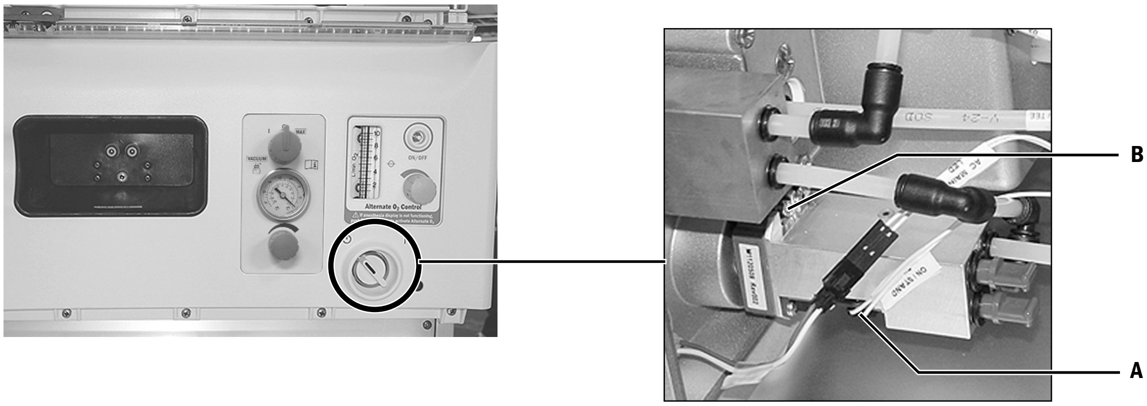
Loosen the set screw that holds the knob to the needle valve; remove knob.
Disconnect the tubing from the needle valve assembly.
Remove the three screws that hold the needle valve assembly to the dashboard.
Transfer the mounting plate to the new needle valve assembly.

Alt O_2 Switch (C)

Disconnect the switch harness.
When replacing the switch, face the tab on the washer toward the switch body (tab not used for positioning).

9.11 Replace system switch assembly

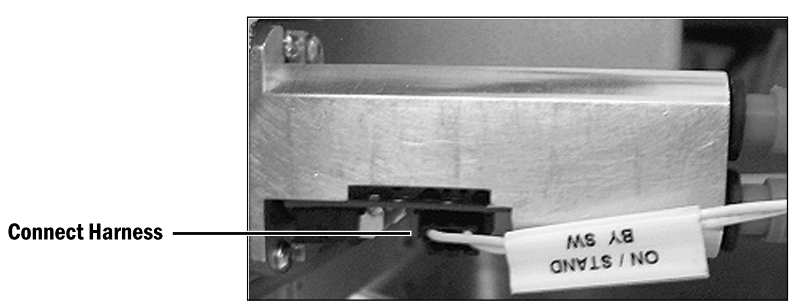
1. Move the dashboard forward to the service position (Section 9.7).



2. Disconnect the wire harness (**A**) from the switch.
3. Back out the system switch mounting screws (**B**) just enough to allow the knob collar to be released.
4. While holding the switch assembly, push in the knob and turn it counterclockwise.
5. Pull the knob and collar out from the front and remove the switch assembly.

9.11.1 Install replacement switch

1. Transfer the 8-mm plugs from the old system switch to the new system switch on the pneumatic module (pull on the plug to ensure that it is locked into the module).
2. Turn back the system switch mounting screws until their tips recede.
3. Orient the switch with the circuit board in the 6 o'clock position (facing down).
4. Install the switch assembly through the dashboard.
5. Push the knob collar in with the indicator up and turn it clockwise until it locks.
6. Tighten the mounting screws. Make sure that the top edge of the switch assembly is parallel to the top edge of the dashboard.
7. Connect the switch harness to the circuit board connector as shown.
   - Gently pull on the wire to ensure there is a good connection.

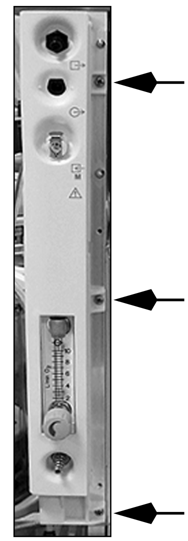


8. Transfer the tubing from the old system switch to the new system switch on the pneumatic module (pull on the tubing to ensure that it is locked into the module).

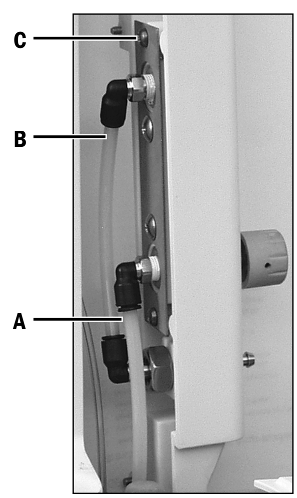
9. Test the replacement switch assembly:
   a. Connect an O_2 supply.
   b. Connect the power cable to an electrical outlet.
   c. Set the system switch to On.
   d. Make sure that the display comes On.
   e. Select Alt O_2 flow.
   f. Increase the Alt O_2 flow. Make sure that gas flows.
   g. Make sure that you do not feel or hear any leaks.
   h. Set the system switch to Standby.
   i. Make sure all gas flow stops and the display turns Off.
10. Reinstall the dashboard, the upper cosmetic panel, and the tabletop.
11. Perform the checkout procedure (Section 3).

9.12 Replace auxiliary O_2 flowmeter

1. Bleed all gas pressure from the machine (Section 9.3).
2. Ensure that all cylinder and pipeline pressures read zero before proceeding.
3. Remove the ABS breathing system and set it aside.
4. Remove the tabletop (Section 9.5).
5. Remove the upper bezel located above the dashboard.
6. Loosen 10 captive dashboard mounting screw and move the dashboard forward to the service position.
7. Remove the bezel assembly from the machine.
   - Loosen the three mounting screws that hold the assembly to the machine chassis.
   - Move the assembly forward.
   - Move the bezel forward to access the Aux O_2 flowmeter components.



8. Disconnect the tube (**A**) from the inlet fitting.
9. Disconnect the tube (**B**) from the outlet fitting.
10. Remove the two screws (**C**) that hold the flowmeter mounting bracket to the bezel; remove the flowmeter assembly from the bezel.
11. Transfer the mounting bracket to the new flowmeter.



12. If required, transfer the fittings to the new flowmeter (apply Teflon tape).
13. Reassemble in reverse order.
14. Perform the checkout procedure (Section 3).

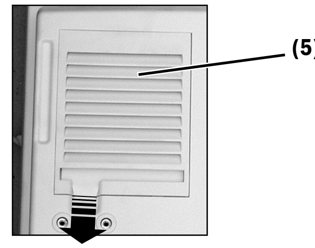
9.13 Servicing the Display Unit

Note The item numbers appearing in parenthesis in this section refer to items in the parts list in Section 10.42.11.

The fan filter (5) can be replaced with the Display Unit in place.

To replace the filter, slide the filter downward to remove it from the Display Unit.

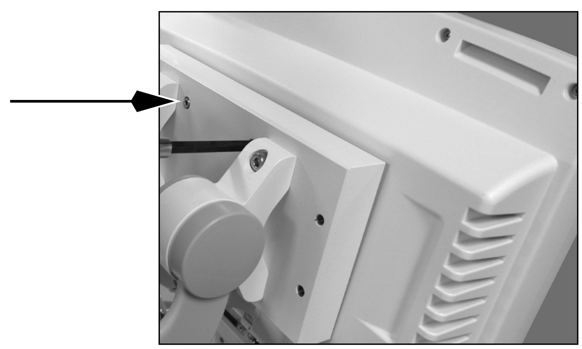
To service other components of the Display Unit, you must first remove the Display Unit from the machine.



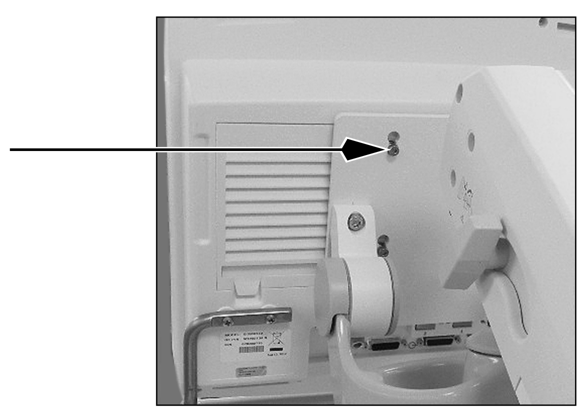
9.13.1 Remove the Display Unit

The Display Unit is mounted to the wrist assembly on the display arm. It is held in place with four screws.

1. Disconnect the cables from the Display Unit.
2. Before removing the display, move the display arm to its highest position and lock it in place.
3. Remove the DU from the display arm.
   - If the DU is the only display, it is mounted to a counterweight that is attached to the wrist assembly. Remove the four screws that hold the DU to the counterweight.



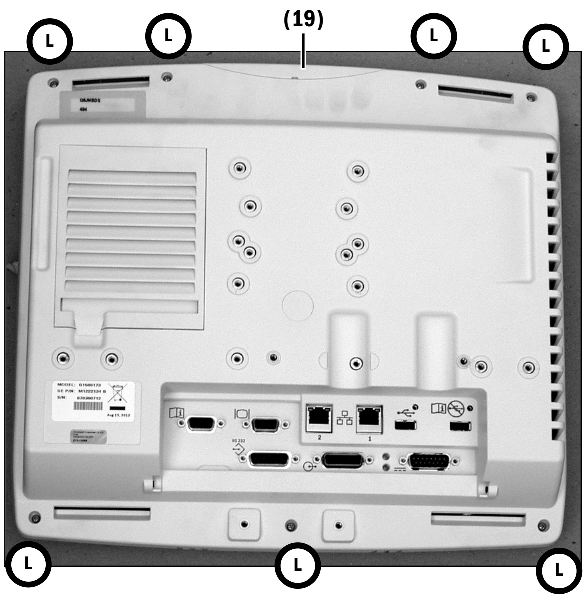
   - If the display arm also supports an optional monitor display, the DU is attached to a vertical or horizontal mounting plate through four keyhole slots. Loosen the four screws that hold the DU to the mounting plate.

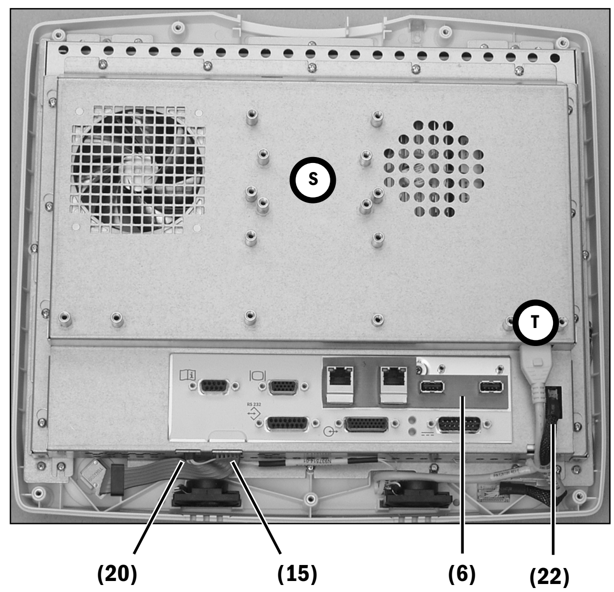


9.13.2 Disassemble the Display Unit

Place the display unit face down on an anti-static pad (wear static control wrist strap).

1. Remove the two upper mounting screws.
2. Remove the fan filter to aid in replacing the rear housing later.
3. Using a small bladed screwdriver, gently pry the light-bar cover (**19**) from the display unit.
4. Loosen the seven captive screws (**L**) that hold the rear housing.
5. Remove the rear housing.





At this point, you can replace the following items (the item numbers refer to the parts list in Section 10.43):

- the **Encoder assembly** (**15**)
- the **Speaker assembly** (**20**)
- the **Ethernet and USB Connectors gasket** (**6**)
- the **Carrier Board to Keyboard harness** (**22**)
- the **Keypad assembly** (**2**)
  (refer to Section 9.13.6, "*To replace the Keypad assembly*").

To access the remaining items you have to remove the carrier board shield (**S**).

- Cut the cable tie holding the two cables at the lower right side.
- Disconnect the touch controller cable (**T**).
- Disconnect the Keyboard harness at the Carrier Board (**22**).
- Disconnect the encoder harness from the Carrier Board (**15**).
- Disconnect the speaker harness from the Carrier Board (**20**) and set the speakers aside.

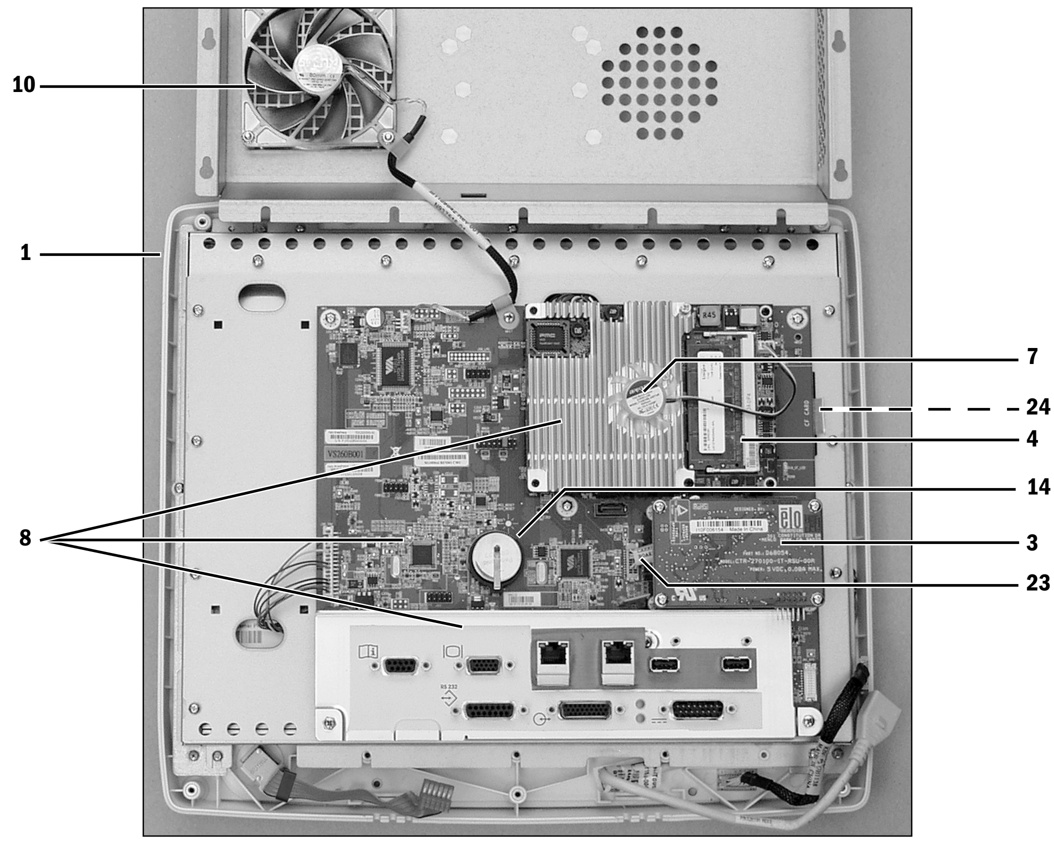
Note Do not loosen any screws that are dabbed with sealing compound.

- Loosen five screws at top edge of shield.
- Loose four screws (keyhole) along each side of the shield.
- Remove four screws at bottom edge of shield.
- Slide the shield toward the bottom edge of the display to disengage the touch controller harness connector (**T**) and flip it over the top edge of the display.

9.13.3 To replace components

At this point, you can replace the following items (the item numbers refer to the parts list in Section 10.43):

- the **Case fan** (**10**)
- the **Battery** (**14**) - refer to Section 9.13.7 for details.
- the **Com Express fan** (**7**)
- the **Touch Controller board** (**3**)
- the **Touch Controller harness** (**23**)
- the **CF Card** (**24**)
- the **Memory Module**(**4**)

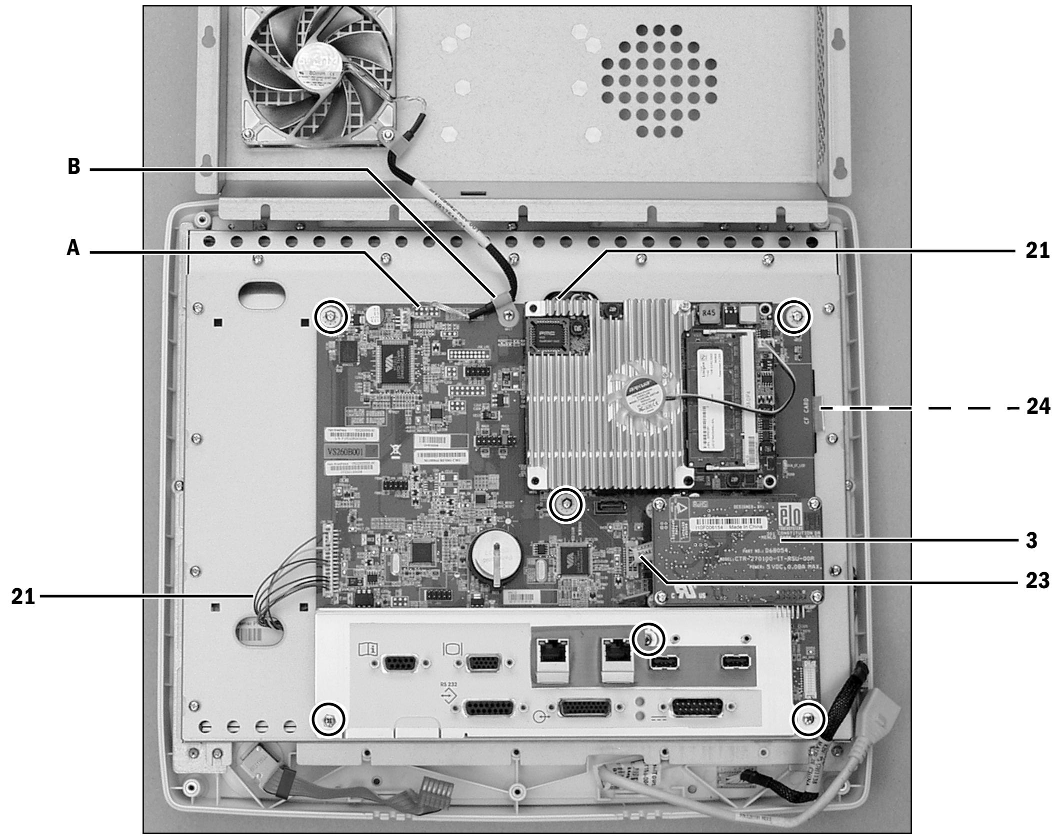


To replace the Carrier board and Com Express board assembly (**8**), refer to Section 9.13.4.

To replace the LCD/Touch Bezel assembly (**1**), refer to Section 9.13.5

9.13.4 To replace the Carrier board and Com Express board assembly

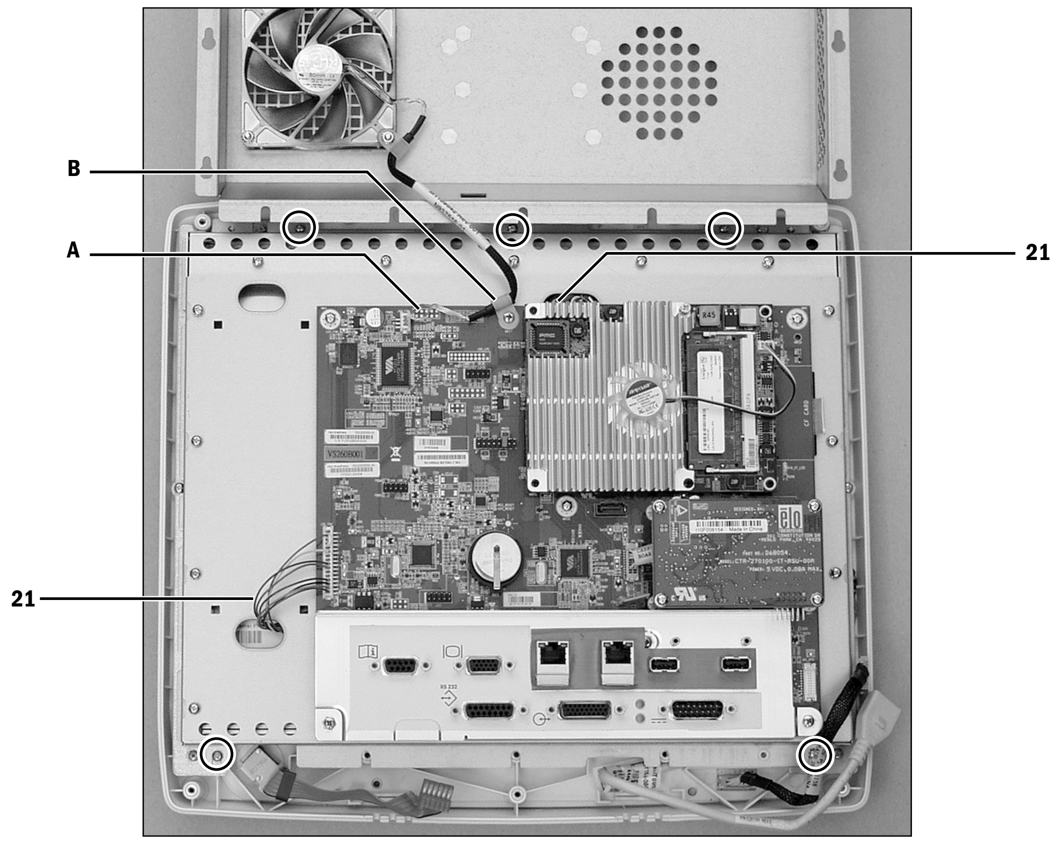
1. Disconnect the following cables:
   - Case fan cable (**A**); remove the p-clip (**B**) holding the harness to the Carrier board.
   - Carrier board to LCD LVDS harness (**21**) - two connectors.
   - Carrier board to Touch Controller board harness (**23**)



2. Remove the Touch Controller board (**3**) - remove the standoffs.
3. Remove six Carrier board mounting screws (**circled**).
4. Remove the Carrier board and Com Express board assembly.
5. Transfer the CF Card (**24**) to the new Carrier board and Com Express board assembly.
6. Install the new Carrier board and Com Express board assembly.
   - Secure the assembly with the six screw (**circled**).
   - Install the Touch Controller board standoffs; attach the Touch Controller harness (**23**); secure the Touch Controller board to the standoffs.
   - Attach the Carrier board to LCD LVDS harness (**21**) - two connectors.
   - Attach the Case fan cable (**A**); secure the p-clip (**B**) holding the harness to the Carrier board.
7. Reassemble in reverse order.
8. Perform the checkout procedure (Section 3).

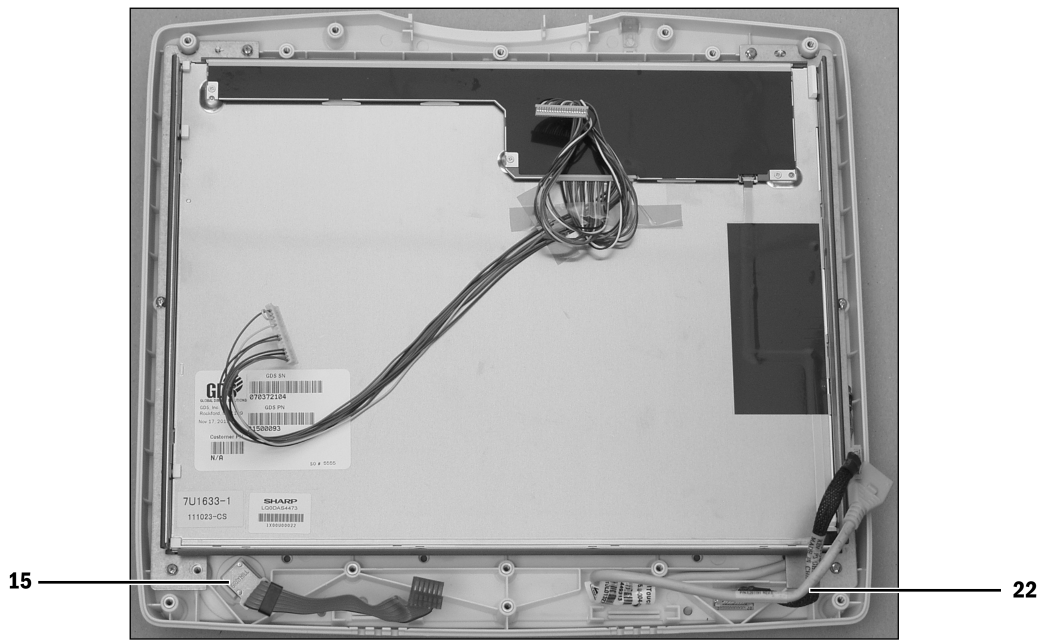
9.13.5 To replace the LCD/Touch and front bezel assembly

1. Disassemble the display unit as detailed in the previous sections.
2. Disconnect the Case fan cable (**A**); remove the p-clip (**B**) holding the harness to the Carrier board.
3. Disconnect the Carrier board to LCD LVDS harness (**21**) - two connectors.
4. Remove five LCD shield mounting screws (**circled**).
   - Do not loosen any screws that are dabbed with sealing compound.



5. Remove the LCD shield and Carrier board assembly from the LCD Touch Bezel assembly.

6. The Keypad assembly from the existing bezel assembly can not be reused, affix a replacement Keypad assembly to the new LCD Touch Bezel assembly (refer to Section 9.13.6, “*To replace the Keypad assembly*”).
7. Transfer the following components to the new LCD Touch Bezel assembly.
   - Carrier Board to Keyboard harness (**22**).
   - Encoder assembly (**15**).

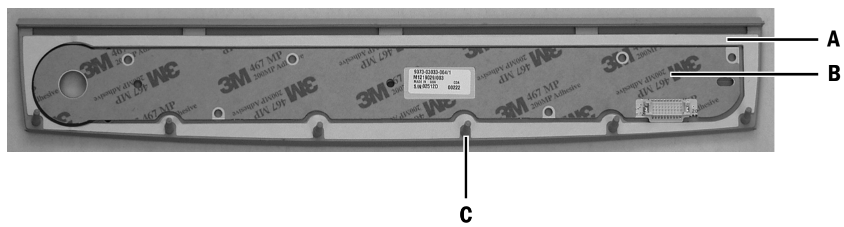


8. Mount the LCD shield and Carrier board assembly to the bezel assembly.
   - Guide the LCD harness connectors through the slots in the shield.
   - Secure the shield to bezel assembly.
   - Connect the LCD harness connectors to the Carrier board.
9. Attach the Case fan cable; secure the p-clip holding the harness to the Carrier board.
10. Reassemble in reverse order.
11. Calibrate the Touch screen (Section 4.9, “*Display Diagnostics*”).
12. Perform the checkout procedure (Section 3)

9.13.6 To replace the Keypad assembly

Note: The encoder mounting hardware holds the keypad's rubber overlay in place to help prevent liquid from entering the display unit.

1. Remove the encoder knob and mounting hardware.
   - If required, remove the lockwasher from the keypad.
2. Remove the cable connector from the keypad assembly.
3. Remove existing Keypad:
   - Pull it away from the front Bezel assembly.
4. Clean mounting surface with isopropyl alcohol.
5. Remove all backing from new Keypad assembly to expose adhesive:
   - from the pad (**A**) and from the circuit board (**B**).



6. Engage top edge of Keypad with front Bezel assembly. Pockets in keypad are meant to engage with protrusions on top edge of bezel and must be fully seated before the next step.
7. Rotate the bottom edge of the Keypad onto the bezel so that the pull tabs align with the mounting holes in the bezel.
8. From the back of the bezel, pull the six tabs (**C**) through to secure the Keypad.
9. Press the Keypad down onto the bezel so that it is completely affixed to the bezel. Apply pressure to all areas of the keypad to assure proper adhesion.
10. Replace the encoder mounting hardware and the encoder knob. The lockwasher should be under the nut, in contact with the keypad.
11. Connect the cable to the keypad assembly.

9.13.7 To replace the CPU "coin" battery

The Lithium 3-volt "coin" battery on the Carrier Board maintains the system Date and Time and certain configurations of the BIOS setup. If the battery is removed or becomes disconnected, the Time and Date needs to be restored.

To replace the battery:

1. Gently lift battery until it can be removed from holder.
2. Touching only the sides of the battery, place the battery under the retaining clip.

⚠ **CAUTION** When replacing the battery be careful to only touch the sides of the battery, not the top or bottom, as corrosion may occur.

3. Configure the Time and Date for the device.
4. Perform the checkout procedure (Section 3).

9.14 Servicing the lower electrical enclosure components

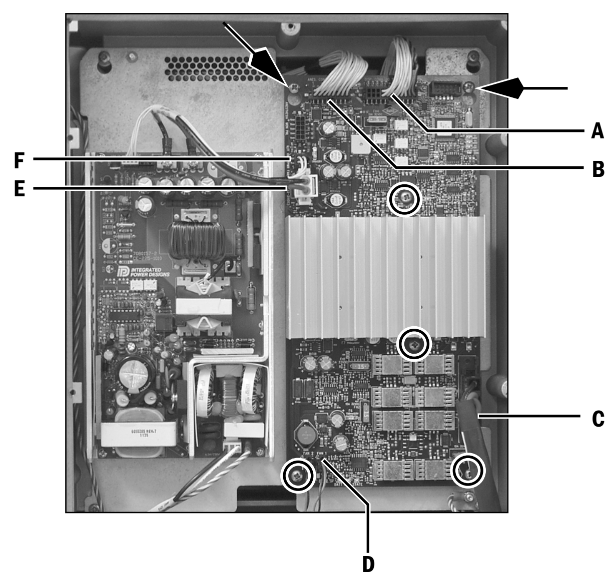
The lower electrical enclosure includes the following components (Section 10.9):

- the Power Controller board
- the universal Power Supply
- the Anesthesia Control board
- the Display Connector board
- the backup batteries and the lower enclosure fans.

To replace these components, remove the access panel at the rear of the machine (Section 9.4).

9.14.1 Power Controller board

1. Disconnect the cables coming from the following components:
   - the Display Connector board (**A**),
   - the Anesthesia Control board (**B**),
   - the batteries (**C**),
   - the fans (**D**),
   - the power supply (**E**) and (**F**).
   - the auxiliary connector board (**G**), if present.

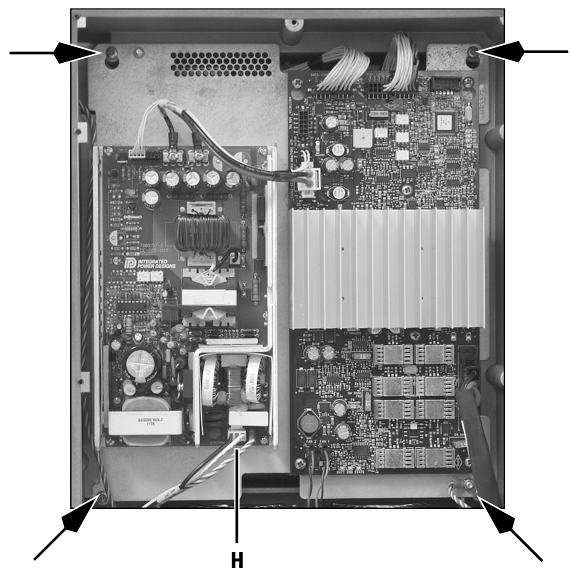


2. Remove the four screws (**circled**) that hold the Power Controller to the mounting plate.
3. Loosen the two screws (**arrows**) at the top edge of the Power Controller.
4. Lift the Power Controller slightly to release it from the keyhole slots.
5. To replace the Power Controller board, reassemble in reverse order.
6. Load Software.

9.14.2 Power Supply

The power supply is secured to the mounting plate with hardware from the back side of the plate. To replace the power supply, you must remove the plate assembly (power supply and controller board) from the electrical enclosure.

1. Disconnect the cables from the power controller board as described in the previous section.
2. Also disconnect the AC power input harness (H) from the power supply.

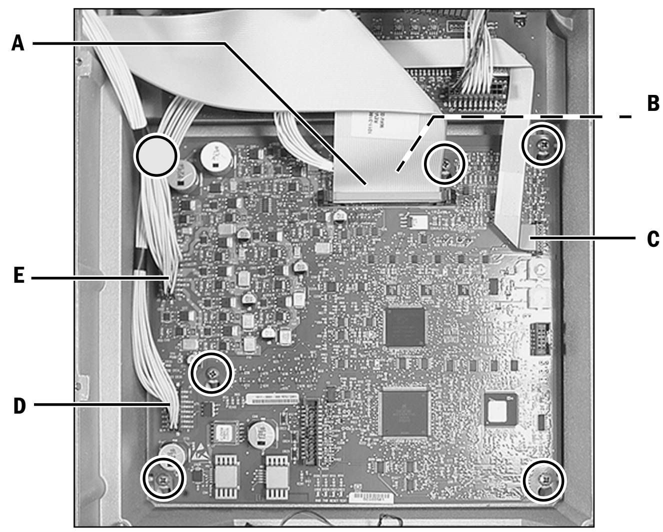


3. Loosen the four screws (**arrows**) at each corner of the mounting plate.
4. Lift the assembly slightly to release it from the keyhole slots.
5. Note that the assembly is still attached to a ground wire at the lower right-hand corner of the mounting plate.
6. Lower the assembly to a convenient position and replace the power supply.
7. Transfer the power supply output harness to the new power supply.
8. Reassemble in reverse order.

9.14.3 Anesthesia Control board

To replace the Anesthesia Control board, first remove the Power Supply/Power Controller board assembly (Section 9.14.2). Then, follow the procedure below:

1. Disconnect the cables coming from the following components:
   - the large ribbon cable from the Pan Connector board (**A**),
   - the harness from the Display Connector board (**B**),
   - the small ribbon cable from the Display Connector board (**C**),
   - the harness from the Power Controller board (**D**),
   - the harness from the Pan Connector board (**E**).

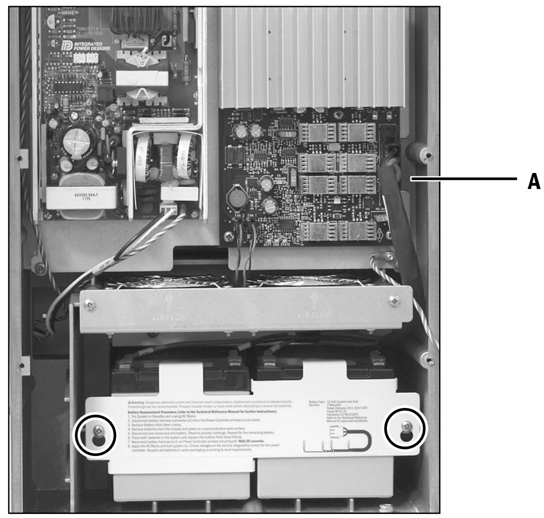


2. Loosen the six screws (**circled**) that hold the Anesthesia Control board to the enclosure.
3. Lift the Anesthesia Control board slightly to release it from the keyhole slots.
4. To replace the Anesthesia Control board, reassemble in reverse order.
5. Load Software.
6. Check/Reconfigure the Machine Configurations (Install/Setups).
7. Perform User Calibrations (Section 4.8.1).
8. Zero Gas Transducers (Section 4.8.7).
9. Perform all Ventilator Calibrations (Section 5.4).

9.14.4 Backup batteries

To remove the batteries

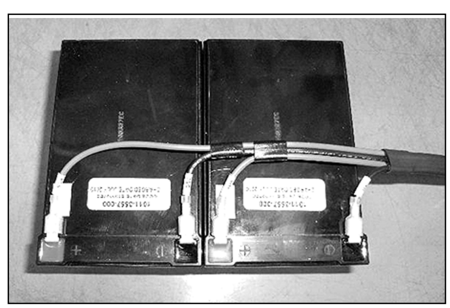
1. Loosen the two screws (**circled**) that hold the battery retainer to the enclosure.
2. Remove the retainer.
3. Disconnect the battery cable from the Power Controller board (**A**).



4. Remove both batteries simultaneously as a unit from the machine.

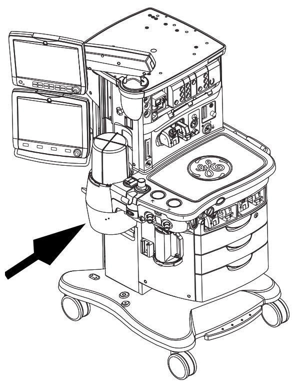
To replace the batteries

1. Transfer the battery cable to the new batteries.



2. To replace the batteries, reassemble in reverse order
3. Allow the batteries to charge.
4. Recycle old batteries in same packaging according to local requirements.

9.15 Servicing the Vent Engine

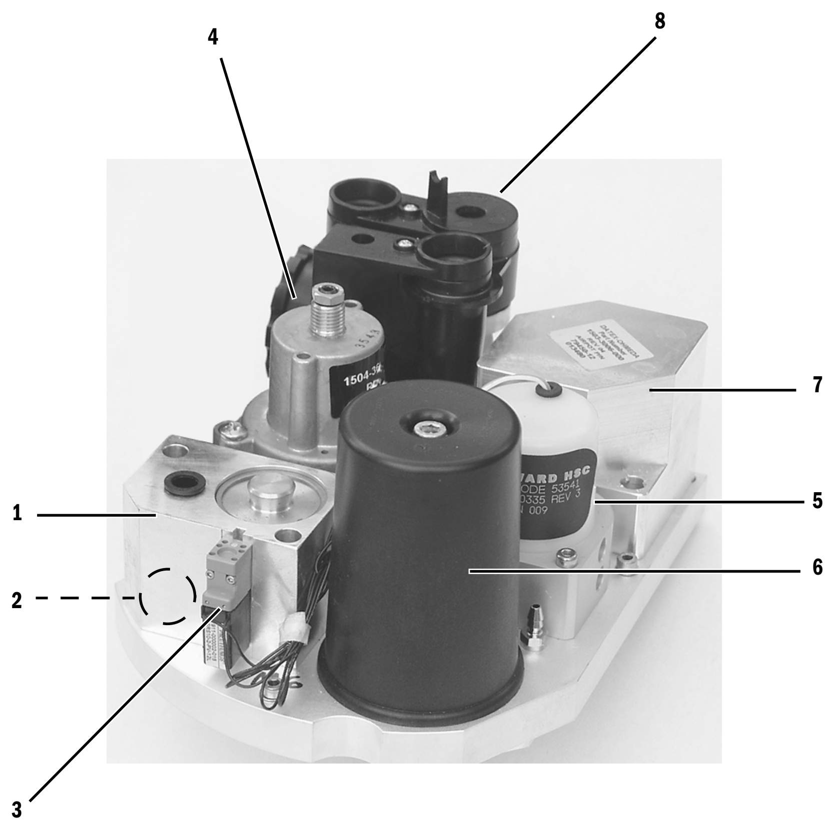


The Vent Engine is found in a housing located below the breathing system bellows assembly.

The Vent Engine includes the following subassemblies.

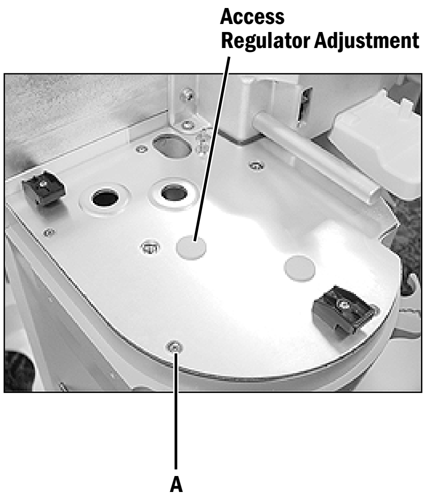
- Gas Inlet Valve Assembly (**1**)
- Inlet Filter (**2**) - located under the gas inlet valve
- Inlet Valve Solenoid (**3**)
- Drive Gas Regulator (**4**)
- Flow Control Valve (**5**)
- Reservoir (**6**)
- Drive Gas Check Valve (**7**)
- Interface Manifold (**8**)

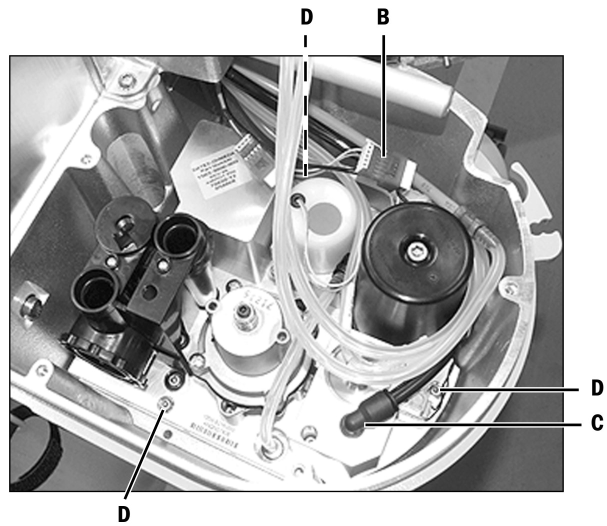
To replace any of the Vent Engine components, you must first remove the Vent Engine from the housing (refer to Section 9.15.1).



9.15.1 To remove the Vent Engine

1. Disconnect pipeline supplies; close cylinder valves; bleed off pressure.
2. Remove the ABS breathing system.
3. Remove the Exhalation valve.
4. Remove the scavenging downtube.
5. Loosen the captive screws (**A**) that hold the Vent Engine cover to the housing. Raise the cover to access the Vent Engine.

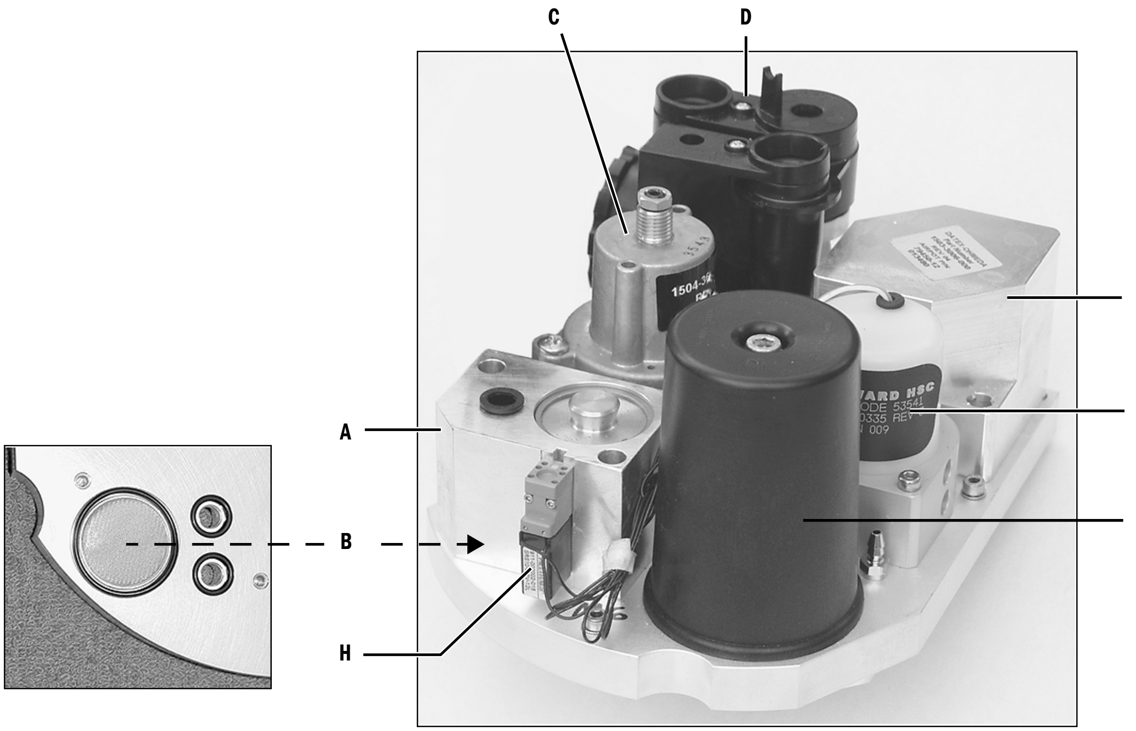




6. Disconnect the Vent Engine harness (**B**).
7. Disconnect the white tube-coupler — inline with tube to manifold pressure transducer on the Consolidated Ventilator Interface Board.
8. If present, disconnect the black tube-coupler, inline with tube to AGSS flow indicator.
9. Disconnect the drive gas hose (**C**).
10. Loosen the three captive screws (**D**) that hold the engine manifold to the housing.
11. Lift the Vent Engine out of the housing.
12. To replace the Vent Engine, reassemble in reverse order.

9.15.2 Replacing Vent Engine components

Refer to Section 13for Vent Engine components that are to be serviced under regular maintenance. Most of the components on the Vent Engine can be replaced by removing the mounting screws and reusing them to secure the replacement part.



Gas Inlet Valve (A)
Inspect the two o-rings that seal it to the manifold. Replace as necessary.
To replace GIV shuttle valve components, refer to Section 9.15.3.

Inlet Filter (B)
Install the filter with the smooth side facing up.
Inspect the o-ring. Replace as necessary.

Regulator (C)
Inspect the two o-rings that seal it to the manifold. Replace as necessary.
Perform the Drive Gas Regulator calibration in Section 5.3.

Interface Manifold (D)
Inspect the two o-rings that seal it to the manifold. Replace as necessary.
Lubricate o-rings sparingly with Krytox.

Drive Gas Check Valve (E)
Inspect the o-ring that seals it to the manifold. Replace as necessary.
Clean the seat on the manifold and the seal on Drive Gas Check Valve with isopropyl alcohol.

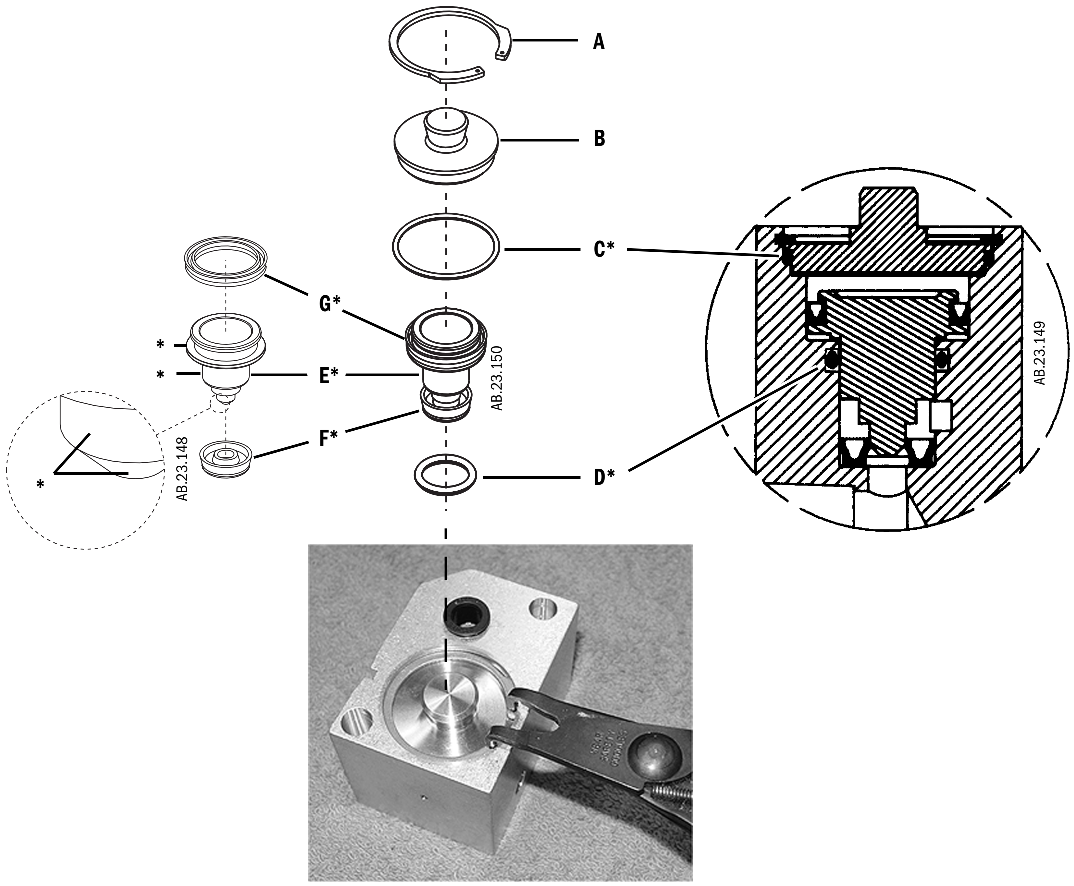
Inspiratory Flow Valve (F)
Note orientation of the flow valve. Inspect the two o-rings that seal it to the manifold. Replace as necessary.
Perform the Inspiratory Flow Valve calibration in Section 5.4.3.

Reservoir (G)
Inspect the two o-rings: reservoir to manifold, reservoir to screw head.
Replace as necessary.

Inlet Valve Solenoid (H)
Inspect seal between solenoid and GIV body.
Replace as necessary (included with solenoid).

9.15.3 Replacing GIV components

Lubricate items marked with an asterisk (*) sparingly with Krytox.



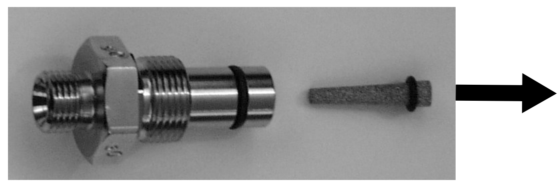
1. Remove the retaining ring (**A**) and the GIV cap (**B**).
2. Use pneumatic pressure to remove the shuttle. Cover the shuttle with a cloth and briefly apply pressure (connect the drive gas hose or use pipeline pressure) through the drive gas inlet.
3. Remove the upper o-ring (**C**) and the lower o-rings (**D**).
4. Install the lower o-ring (**D***).
5. Lubricate the shuttle (**E**) at the three areas (*) shown: the circumference of the shuttle where the upper and lower u-cup seals are placed and the body part of the shuttle that slides along the lower o-ring.
6. Install the lower u-cup seal (**F***) and the upper u-cup seal (**G***) on the shuttle.
7. Press the shuttle assembly into the GIV manifold.
8. Install the upper o-ring (**C***).
9. Install the cap (**B**) and the retaining ring (**A**).
10. Reassemble in reverse order.

9.16 Servicing the pipeline inlet manifold components

The pipeline inlet filter and the inlet check valve can be replaced without removing the pipeline manifold from the machine. To replace the pressure transducer, you have to remove the manifold.

9.16.1 Replace pipeline inlet filter

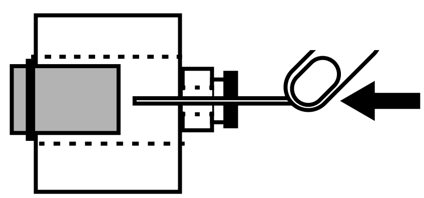
1. Bleed all gas pressure from the machine (Section 9.3).
2. Remove the pipeline inlet fitting.
3. Pull the pipeline inlet filter out of the fitting. The o-ring should come out with the filter.



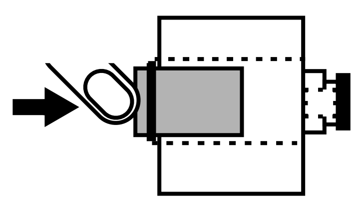
4. Install the new pipeline inlet filter in the pipeline inlet fitting. The new filter comes with an o-ring.

9.16.2 Replace pipeline inlet check valve

1. Remove the rear panel (Section 9.4).
2. Remove the pipeline inlet fitting.
3. The Air and O_2 pipeline manifolds include a drive gas connection at the back of the manifold. Remove the drive gas tube or plug to access the check valve.
4. From the back of the pipeline manifold, use a thin tool to push out the check valve. (For an N_2O manifold, you will have to carefully apply pressure at the outlet of the manifold — with a syringe for example — to gently force the check valve out of the manifold).



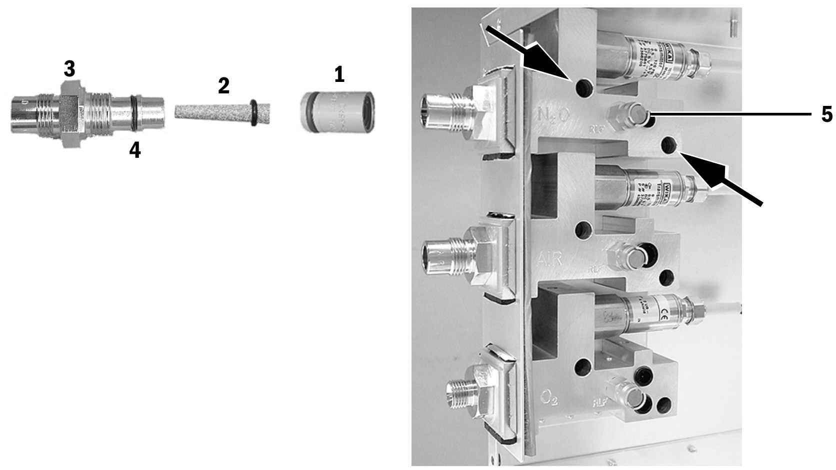
5. Push the new check valve into the opening, using the same thin tool. The new check valve includes an o-ring — orient the o-ring toward the pipeline inlet. **Note:** Make sure to push the new check valve all the way back into the opening until it bottoms out on the shoulder.



6. Install the pipeline inlet fitting.
7. Perform the checkout procedure (Section 3).

9.16.3 Replace the inlet manifold

1. Bleed all gas pressure from the machine (Section 9.3).
2. Remove the rear panel (Section 9.4).
3. Disconnect the tubing from the manifold outlet(s).
4. Disconnect the transducer harness.
5. Remove the two screw that hold the manifold to the side extrution.



6. Transfer the following items to the replacement manifold or install new as required.
   - pipeline check valve (1)
   - inlet filter (2)
   - inlet fitting (3) and o-ring (4)
   - relief valve (5)
7. Transfer the pressure transducer to the new supply (Section 9.18).
   - Ensure the o-ring is in place.
   - Install the transducer.
8. To reassemble, perform the previous steps in reverse order.
9. Perform the checkout procedure (Section 3).

9.17 Service the cylinder supply modules

⚠ WARNING Be careful not to expose internal components to grease or oil (except Krytox or equivalent).

9.17.1 Tightening procedure for high-pressure tube fittings

The regulator for an outboard cylinder supply is connected to the high pressure hose assembly through a copper tube with fittings at both ends. Use the following tightening procedure whenever you are replacing the regulator or the high pressure hose assembly.

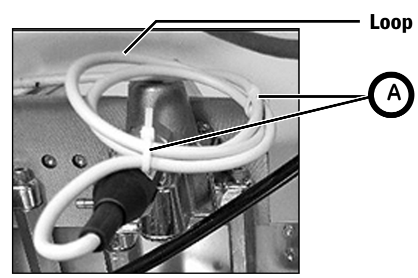
1. Insert the tubing into the fitting until the ferrule seats in the fitting.
2. Tighten the nut by hand.
3. Continue tightening the nut with a wrench until it reaches the original position (about 1/4 turn). You will feel an increase in resistance at the original position.
4. After reaching the original position, tighten the nut just slightly.

Note If you are installing a new tube that has not been tightened before, tighten the nut with a wrench an additional 3/4 of a turn after the nut is finger tight.

9.17.2 Replace primary regulator module (complete replacement)

⚠ **WARNING** Be careful not to expose internal components of the cylinder supply, the elbow, or the pressure transducer to particles, grease, or oil.

1. Bleed all gas pressure from the machine (Section 9.3).
2. Ensure that all cylinder and pipeline pressures are at zero before proceeding.
3. Remove the rear upper panels (Section 9.4.1).
4. Disconnect the output tube fitting from the regulator.
5. Disconnect the transducer cable connector from the wire harness.
6. Remove the three mounting screws and lockwashers.
7. Remove the copper tube elbow fitting from the replacement gas supply.
8. Transfer the pressure transducer and transducer elbow fitting to the new supply (Section 9.18).
   - Remove any teflon tape remnants from the transducer mounting threads (transducer, elbow, and module).
   - Apply 1-1/4 turns of new teflon tape around the treads. Verify that the first few threads are free of tape.
   - Install the elbow.
   - Install the transducer.
9. To reassemble, perform the previous steps in reverse order.
   - Pull on the cylinder output fitting to ensure it is locked in place.
10. Connect the transducer cable to the cVIB.
    - Loop the excess cable length and secure it with cable ties (**A**) as shown.



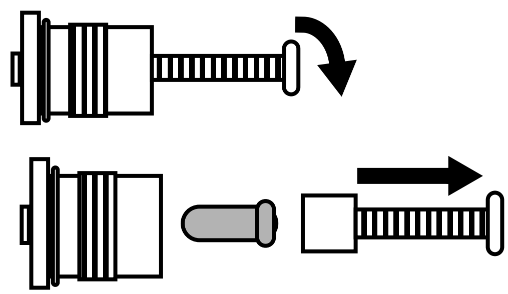
11. Check the output of the regulator BEFORE you install the rear panel. Adjust if necessary (Section 5.1).
12. Perform the checkout procedure (Section 3).

9.17.3 Replace cylinder inlet filter

1. Bleed all gas pressure from the machine (Section 9.3).
2. Open the cylinder yokes.
3. Remove the inlet adapter from the cylinder yoke, using a 4 mm hex wrench.

   Note: A brass retaining ring keeps the filter inside the inlet adapter.
4. Thread a 6-mm screw (two turns only) into the brass retaining ring and pull it out.

⚠ **CAUTION** Be careful not to crush the filter. Do not thread in the screw more than two full turns.



5. Remove the filter.
6. Install the new filter and brass retaining ring.
7. Install the inlet adapter in the cylinder yoke.
8. Perform the checkout procedure (Section 3).

9.17.4 Replace cylinder check valve

The cylinder check valve is not a replaceable item. If the check valve is defective, you must replace the complete cylinder supply module.

9.18 Replace gas-supply pressure transducers

The gas-supply pressure transducer includes an integral cable that connects to the cVIB in the pan electronic enclosure. The transducer itself is mounted directly to the supply module. To replace a pressure transducer (pipeline or cylinder) you have to remove the module from the machine.

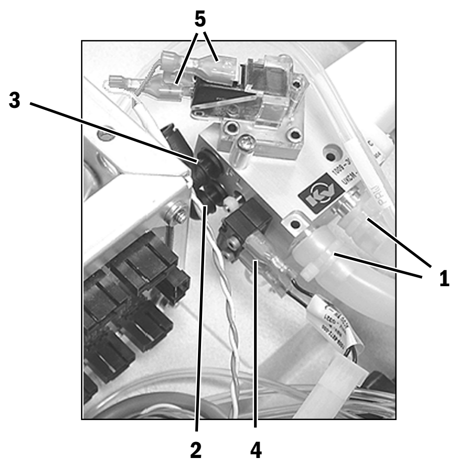
1. To access the cVIB, remove the tabletop (Section 9.5) and the cover of the pan electronic enclosure.
2. Disconnect the transducer cable from the cVIB.
3. Remove the supply module to access transducer.
   - For cylinder supplies, refer to Section 9.17.
   - For pipeline supplies, refer to Section 9.16.
4. Remove the transducer from the module.
5. Install the new transducer.
   - For pipeline transducers:
     - Be sure that an o-ring is in place.
   - For cylinder transducers:
     - Remove any teflon tape remnants from the module.
     - Apply 1-1/4 turns of teflon tape around the treads of the transducer. Verify that the first few threads are free of tape.
     - Install the transducer.

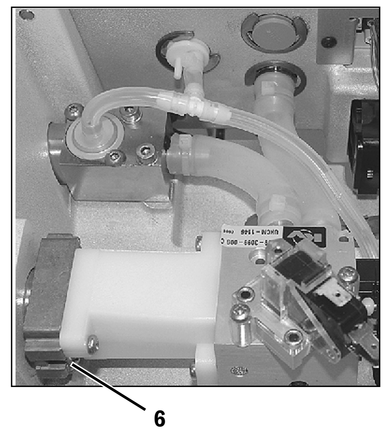
6. To reassemble, perform the previous steps in reverse order.
7. Perform the checkout procedure (Section 3).

9.19 Replace ACGO selector switch

Removal

1. Remove the tabletop (Section 9.5).
2. Clip the tie wraps (**1**) from the outlet barb fittings at the side of the switch.



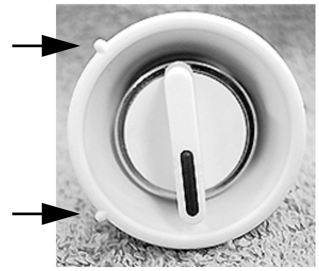


3. Disconnect the fresh gas (**2**) and flush (**3**) tubes at the back of the switch.
4. Disconnect the wires from the ACGO mode microswitch (**4**) at the back of the selector switch.
5. Disconnect the wires from the flush pressure switch (**5**) on top of the selector switch.
6. Set the ACGO selector switch to ABS.
7. Back out the selector switch mounting screws (**6**) until the tips are flush with the face of the mounting casting.
8. While pushing the selector knob toward the machine and holding it steady, push the valve body toward the knob and rotate it counterclockwise to separate the valve body from the knob assembly.
9. Remove the knob assembly and protective shroud from the machine.
10. Remove the valve from the silicone output tubes.

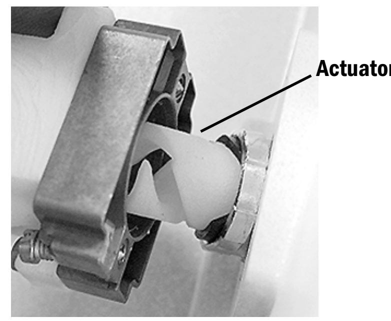
Replacement

1. Remove the knob assembly from the valve body.
2. Back out the selector switch mounting screws until the tips are flush with the face of the mounting casting.
3. Guide the outlet fittings of the valve body into their respective silicone tubes.
4. Hold the selector knob with the indicator mark facing down. Turn the chrome collar to its maximum counterclockwise position (as viewed from the front).

5. Place the shroud over the knob and guide the assembly into the pan opening.
6. Ensure that the indicators on the shroud align with label on the pan and the alignment tab mates with the alignment hole in the pan.



7. While holding the knob assembly steady against the pan, place the valve assembly over the knob actuator. Using moderate force press the two assemblies together. The knob should rotate to the ACGO position.



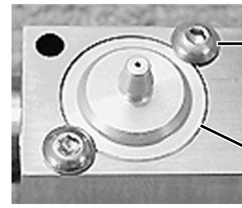
8. While continuing to force the assemblies together, rotate the knob assembly to the ABS position. The assemblies should snap into place.
9. Verify proper alignment of the knob with the setting indicators. Tighten the mounting screws evenly to secure the switch assembly to the pan.
10. Secure the outlet tubing with tie wraps.
11. Connect the fresh gas and flush gas tubing. Pull on the tubing to ensure that it is locked in the fitting.
12. Reconnect the wires to the ACGO mode microswitch at the back of the valve (top two terminals).
13. Reconnect the wires to the flush pressure switch at the top of the valve (upper and lower terminals).
14. Replace the tabletop.

Test procedure

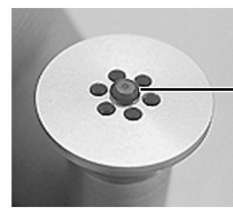
1. Confirm that flush flow and 5 L/min fresh gas flow are diverted to the ACGO port and the ABS in the respective knob positions.
2. Confirm that the ventilator display indicates ACGO mode when the valve is set in the ACGO position.
3. Test the function of the flush pressure switch (Service Application - “Ventilation Status” — Section 12.9.1).
4. Perform the low-pressure leak test (Section 3.4.5).
5. Perform the checkout procedure (Section 3)

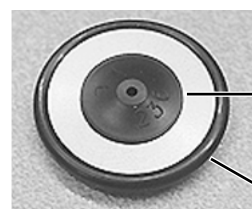
9.20 Clean or replace ACGO port flapper valve

1. Remove the tabletop (Section 9.5).
2. Remove the ACGO cap mounting screws.
3. Remove the cap.

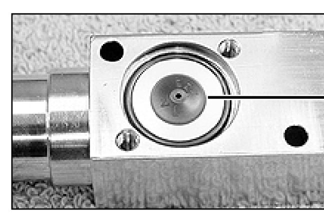


4. Examine the flapper and disk for obstructions or debris. Clean with isopropyl alcohol if necessary; retest (Section 3.4.5, "Low P Leak test on an ACGO equipped system").
5. If leak persists, replace the flapper.
   - Remove the flapper from the check valve disk.
   - Clean the new flapper with isopropyl alcohol.
   - Apply a drop of isopropyl alcohol to the center hub of the new flapper.
   - Before the alcohol evaporates, align the center hub of the new flapper with the center hole of the check valve disc.
   - While pressing the flapper against the disc, use your fingernail to help pull the hub through the disc from the other side.





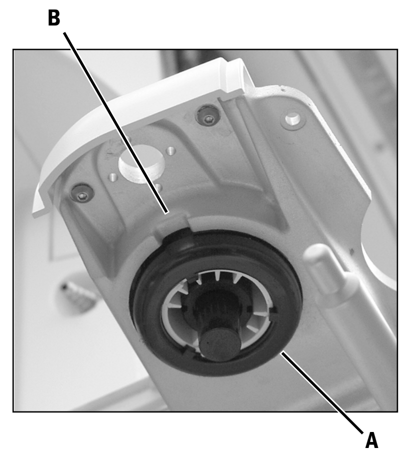
6. Lubricate the o-ring sparingly with Krytox (do not get Krytox on the flapper).
7. Insert the flapper assembly into the ACGO outlet with the flapper up.
8. Replace the cap.
9. Reassemble the machine.
10. Perform the checkout procedure (Section 3).



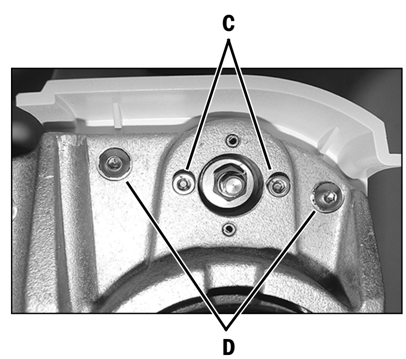
9.21 Replace the APL valve

The current APL Valve includes the cover as an integral component (Refer to section 10.42.2).
To replace the APL Valve assembly you must remove the cover retaining screws (as shown in Steps 4 and 5) in addition to releasing the APL Valve retainer (shown in Step 3).

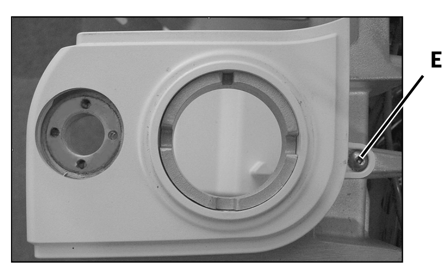
1. Remove the ABS breathing system.
2. Remove the Tabletop.
3. Remove the Existing APL Valve:
   - The APL Valve is held in place with a spring and a retainer (**A**) that snaps into a recess in the lower body of the APL valve.
   - To release the retainer, place an appropriately sized straight blade screwdriver into the housing cutout (**B**). Twist the screwdriver to release the retainer.
   - Remove the APL Valve.



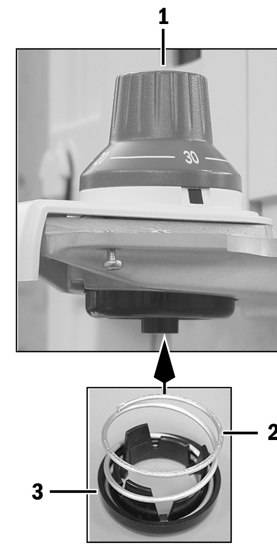
4. Remove the Bag Support Arm or Patient Tubing Clip:
   - From the underside of the casting, remove the hardware (**C**) that holds the Bag Support Arm or Patient Tubing Clip in place.
   - Set aside the Bag Support Arm or Patient Tubing Clip.



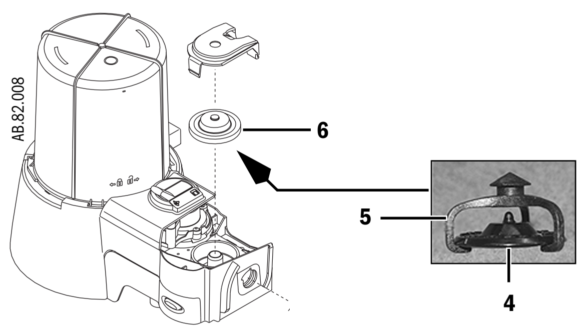
5. Remove the APL Valve Cover:
   - Loosen and remove the two screws from the underside (**D**) and the screw from the top (**E**) that holds the APL Valve Cover in place.



6. Install the new APL Valve and Cover assembly (**1**).
   - Replace the three screws removed in step 5.
   - Place the spring (**2**) into the retainer (**3**).
   - While holding the APL valve, snap the spring and retainer onto the valve body from below.



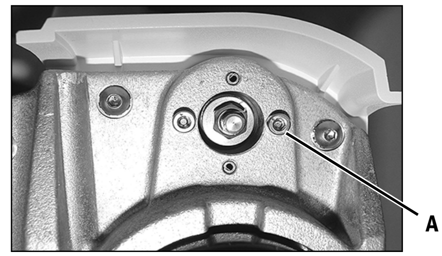
7. Reinstall the Bag Support Arm or Patient Tubing Clip removed in step 4.
   - Apply Loctite 242 to the Bag Support Arm mounting screws.
8. Replace the remaining APL components:
   - Poppet (**4**)
   - Cage (**5**)
   - Diaphragm (**6**)



9. Reinstall the Tabletop.
10. Reinstall the ABS breathing system.
11. Perform the checkout procedure (Section 3).

9.22 Replace the bag support arm

1. Remove the ABS breathing system from the machine.
2. From the underside of the casting, remove the hardware (**A**) that holds the arm in place.
   - If either of the pins (see below) remain in the casting, remove them from the casting.

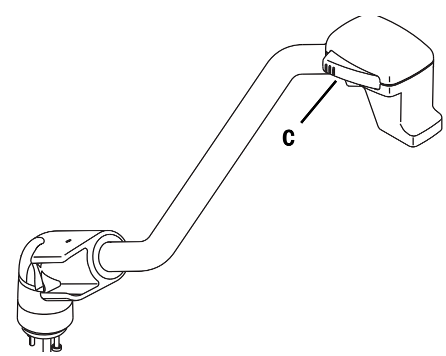


3. Install the new bag support arm assembly.
   - Position the bag arm over mounting pattern of 4 small holes in the support casting. The arm should extend towards the front of the machine. Align the two pins (**B**) extending from the base of the bag arm assembly, with two of the small holes in the casting that are in line with the APL valve.

   - Lower the bag arm, pushing the two pins into the holes.
   - From the underside of the casting, secure the bag arm with two M3x20 socket head screws (apply Loctite 242) and flat washers.
4. Test the force required to swing the bag arm from side to side and adjust if necessary.

Note: The adjustment nut is initially set so that 4 of exposed threads extend from the adjusting nut (internal to lower assembly). With use, the force required to move the arm increases and may require readjustment.

   The force is adjusted by turning the lock nut mounting screw (4-mm hex) which is accessible from underneath the support casting. Turn clockwise to increase the force and counterclockwise to reduce the force.



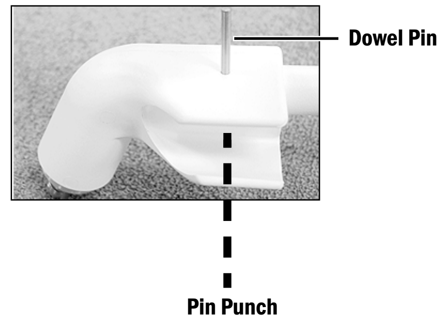
   - Swing the bag arm sideways through the 90 degree arc permitted by its internal stop.
   - Adjust to just enough friction to prevent the bag arm from swinging sideways as the bag height is being changed. The bag arm height is changed by squeezing the lock release lever (**C**) at the free end of the bag arm and rotating it to the desired position.
5. Reinstall the ABS breathing system.

9.22.1 Servicing the bag support arm

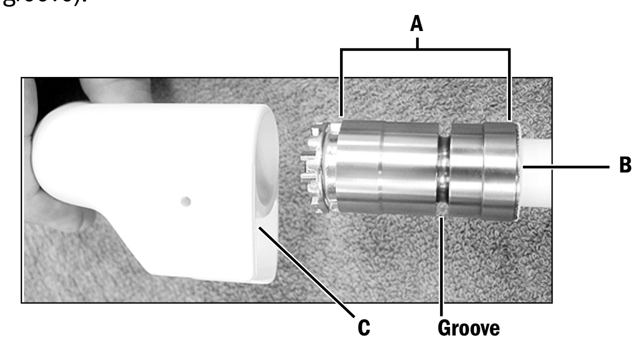
Service parts for the bag support arm include the upper and lower assemblies.

To replace either assembly:

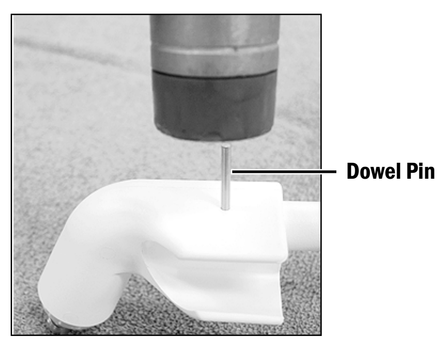
1. Remove the bag support arm from the machine (Section 9.22).
2. To separate the upper assembly from the lower assembly, use a small (2.5-mm) pin punch from the bottom to drive the dowel pin up and out.



3. To assemble the bag arm, apply a light coat of Krytox to the area of the upper arm (**A**) that extends into the lower arm (including the dowel pin groove).

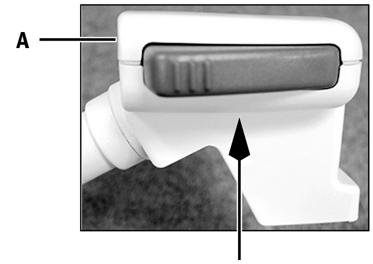


4. Insert the upper assembly into the lower assembly. Align the surface (**B**) of the upper assembly with the surface (**C**) of the lower assembly.
5. Insert the dowel pin into the hole (from the top side as shown). Drive the dowel pin into the bag arm until it is flush with the top surface.

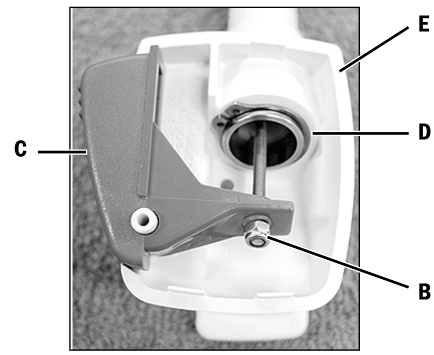


9.22.2 Replace bag port housing

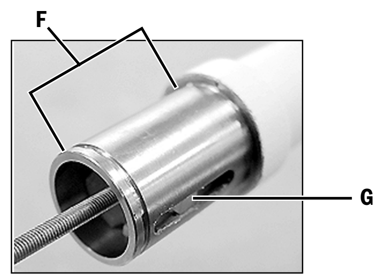
1. Remove the bag support arm cover (**A**) – screw and lockwasher from below.



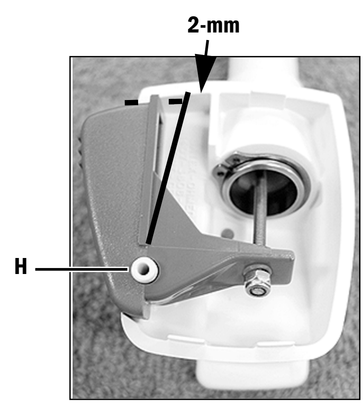
2. Remove nut (**B**) to remove the release lever (**C**).
3. Remove the retaining ring (**D**).
4. Slide the bag port housing (**E**) off the end of the bag support arm.



5. Before installing the new bag port housing, clean and lubricate sparingly with Krytox the exposed metal end (**F**) and the guide slot (**G**) of the bag support arm.

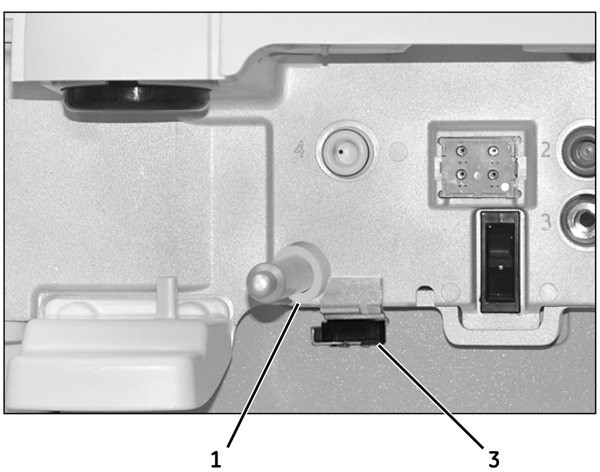


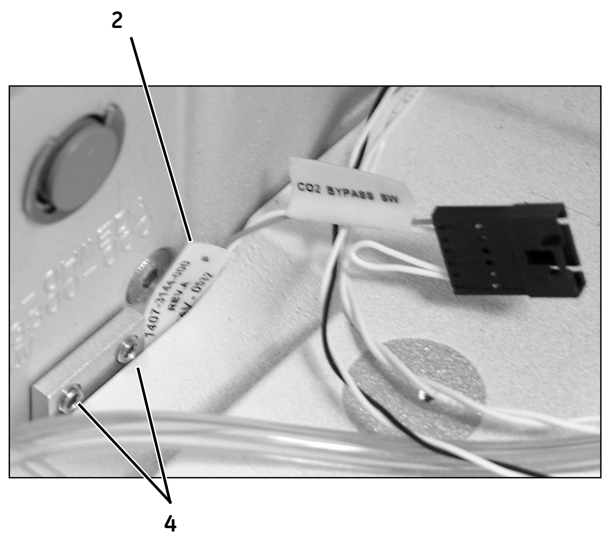
6. Slide the new bag port housing onto the bag arm. Secure it with the retaining ring.
7. Lubricate sparingly with Krytox the pivot boss (**H**) before replacing the release lever.
8. After replacing the release lever, adjust the mounting nut so that a 2-mm gap remains between the lever and housing when the release lever is fully depressed.
9. Reinstall the bag arm cover.



9.23 Replace the canister release (CO_2 bypass) switch

1. Remove the ABS and the tabletop to gain access to the switch components.
2. To replace any of the components (Refer to section 10.41), remove the switch assembly from the bulkhead.
3. After repair, remount the assembly as follows to ensure proper operation.
   - Place the spacer ring (**1**) over the guidepost (Refer to section 10.1.4).
   - Feed the connector end of the switch harness (**2**) into the pan. Position the harness toward the rear of the pan in the gap behind the guidepost.
   - Place the switch assembly over the bottom edge of the ABS bulkhead. If required, adjust the mounting setscrews to allow the switch assembly to slide into place (**3**).
   - Position the switch assembly so that it rests against the spacer and the bottom edge of the bulkhead.
   - Ensure that the wires are not pinched and that they do not obstruct the action of the switch level.
   - Reconnect the switch harness.
   - Tighten the setscrews (**4**) to hold the assembly in place.
   - Remove the spacer from the guidepost.



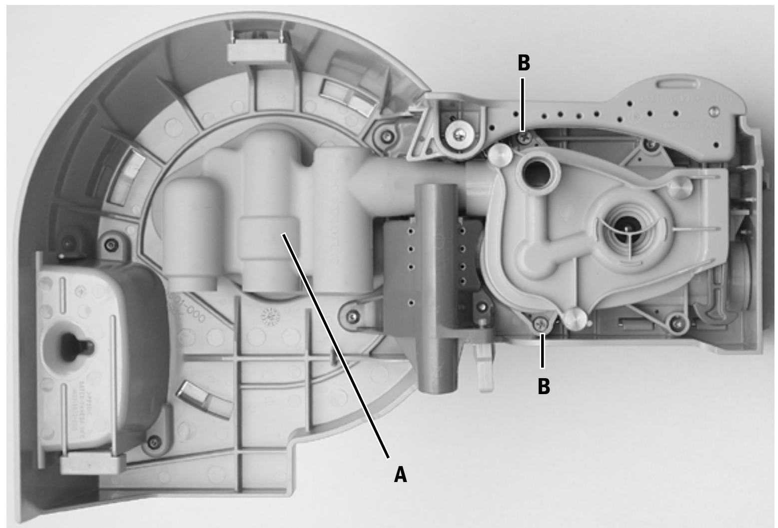


4. Replace the tabletop and the ABS.
5. Perform the checkout procedure (Section 3).

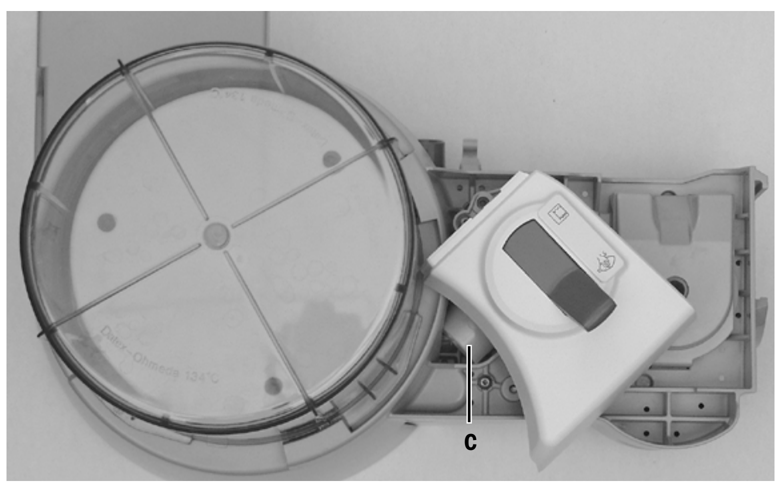
9.24 Replace ABS breathing system components

9.24.1 Replace Bag/Vent switch assembly

1. Remove the ABS breathing system.
2. From the underside, remove the bellows base manifold (**A**) and fully loosen the two captive screws (**B**) at the bag port side of the APL/BTV manifold.



3. From the topside, pull up and rotate the Bag/Vent switch cartridge counterclockwise until the Bag/Vent switch outlet port (**C**) clears the bellows housing.

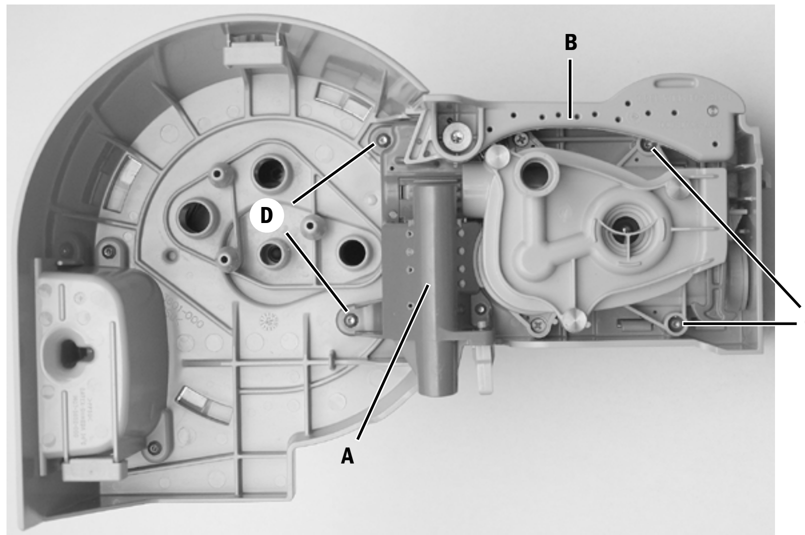


4. Lift out the Bag/Vent switch cartridge from the housing.
5. Replace the Bag/Vent switch cartridge in reverse order.
6. Reinstall the ABS breathing system.
7. Perform the checkout procedure (Section 3).

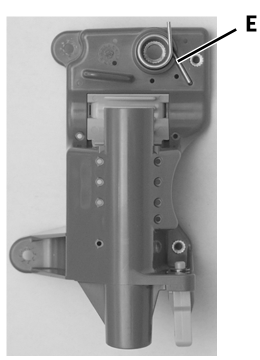
9.24.2 Replace bellows base latch assembly

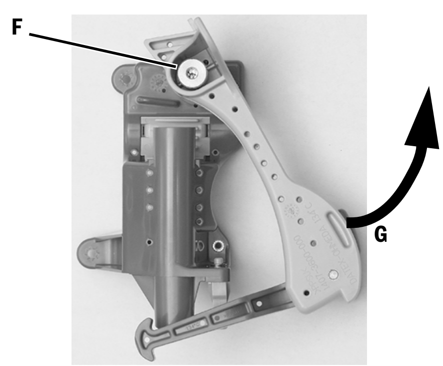
To replace the latch assembly, you must disassemble the bellows base assembly to the point where you can remove the guide (**A**) and latch assembly (**B**) as a unit.

1. Remove the Bag/Vent switch cartridge (Section 9.24.1).
2. Remove the two remaining screws (**C**) that hold the APL/BTV manifold to the bellows base assembly. Remove the APL/BTV manifold.



3. To remove the guide/latch assembly, remove two mounting screws (**D**) from the underside. Remove two additional mounting screws from the topside. Remove the guide/latch assembly from the bellows base assembly.
4. Separate the latch assembly from the guide assembly.
5. To install the new latch assembly, put the spring (**E**) into place in the guide assembly (long leg down).
6. Place the latch assembly on the guide assembly so that the latch engages the short leg of the spring. Secure the latch assembly (**F**) to the guide assembly.

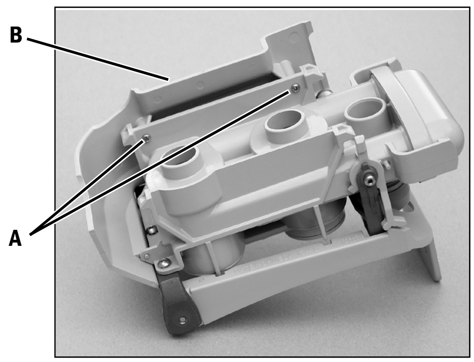


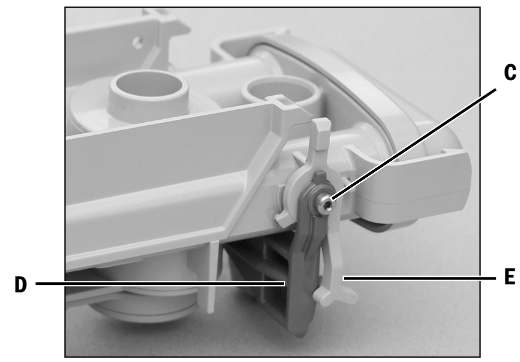


7. Mount the guide/latch assembly into the bellows base assembly.
   - Extend the latch (**G**) while placing the assembly into the base.
8. Reassemble the breathing system in reverse order.
9. Perform the checkout procedure (Section 3).

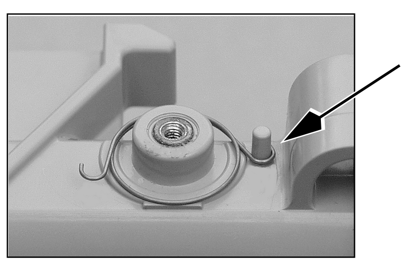
9.24.3 EZchange Canister spring replacement

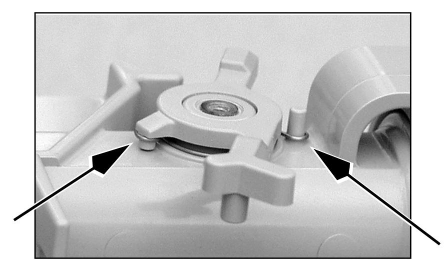
1. Detach the EZchange module from the machine.
2. Remove the two M3 screws (**A**) that hold the module cover (**B**); set the cover aside.





3. Remove the two M3 shoulder screws (**C**) that fasten the canister latch lever (**D**).
4. Remove the latch lever, the switch actuator lever (**E**) and the spring; discard the spring.
5. Place the new spring on the module (as shown below). Position the switch actuator lever over the spring. Ensure the spring hooks are fully engaged into the posts on the manifold and the actuating lever.





6. Clean any residual Loctite debris from the M3 shoulder screws removed in Step 3.
7. Place the canister latch lever in position. Apply Loctite 242 to the threads of the two M3 shoulder screw threads and secure the canister latch lever.
8. Check the switch actuator lever to ensure free movement. If sticking is observed, loosen the M3 shoulder screw approximately 1/8 of a turn until free movement of the switch actuator lever is observed.
9. Install the module cover.
10. Install the EZchange module.
11. Verify that the following message appears on the screen when the absorber canister is released.
    - 'CO2 Absorber Out of Circuit'
12. Perform the checkout procedure (Section 3).

9.25 Replace Casters

⚠ **WARNING:** Replacing a caster requires at least two people to maneuver and tip the machine. Personal injury and/or machine damage is possible if one person attempts this procedure alone.

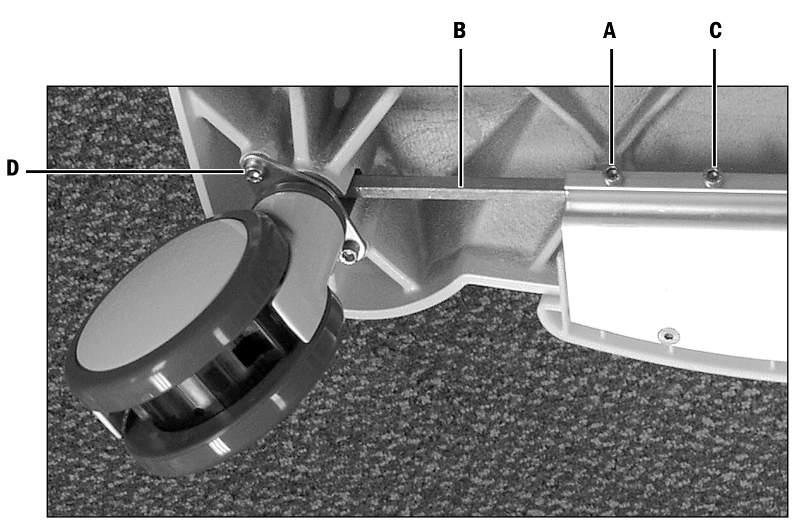
1. Disconnect all pipeline hoses from the wall and the machine, close all gas cylinders, unplug the power cord, and set the system switch to standby.
2. Remove the vaporizers, gas cylinders, drawers and all auxiliary equipment.

⚠ **CAUTION:** To prevent damage, do not tip the machine more than 10 degrees from vertical.

9.25.1 Replace front caster

1. Block the rear wheels; then, block up the machine until there is enough room to remove the caster.

   To block up the machine, tip and slide blocks under the base casting. Raise both sides evenly until the unit is high enough to remove the defective caster.
2. Release the brake.
3. Loosen the screw (**A**) that holds the brake actuator rod (**B**) to the brake pedal.
4. Back out the rod “stop” screw (**C**) to allow the rod to move into the brake assembly.
5. Slide the brake rod toward the center of the machine until it no longer engages caster.
6. Remove the screws (**D**) that holds caster to the base casting.
7. Remove the damaged caster.



8. Mount the replacement caster into position so that the hex opening in the stem faces the hex rod.
9. Slide brake rod through the caster until it hits the outer frame wall.

10. Secure the caster to the base casting.
11. Tighten the hex rod “stop” screw (**C**); ensure that it does not engage the hex rod.
12. Tighten the hex rod retaining screw (**A**).
13. Make sure brake operates smoothly and casters turn freely with brake released.
14. Lock the brake. Make sure casters remain in place and do not turn.
15. Remove the support blocks.
16. Carefully lower the unit to the floor.
17. Unblock the rear wheels.
18. Remount equipment.
19. Perform the checkout procedure (Section 3).

9.25.2 Replace Back Casters

1. Block the front wheels; then, block up the machine until there is enough room to remove the defective caster.

   To block up the machine, tip and slide blocks under the base casting. Raise both sides evenly until the unit is high enough to remove the caster.
2. Remove the screws that holds caster to the base casting.
3. Remove the damaged caster.
4. Mount the replacement caster into position.
5. Secure the caster to the base casting.
6. Make sure the caster turns freely.
7. Remove the support blocks.
8. Carefully lower the unit to the floor.
9. Unblock the rear wheels.
10. Remount equipment.
11. Perform the checkout procedure (Section 3).

9.26 Change drive gas

⚠ **CAUTION** If you change the drive gas, you must also change the drive gas selection on the ventilator service setup screen. Refer to Section 4 of the ventilator Technical Reference manual.

- If the drive gas selection and the actual drive gas do not agree, volumes will not be correct.

The ventilator will alarm with the message "Low Drive Gas Press" if the selected drive gas pressure, either O_2 or Air, is lost.

1. Remove the rear panel (Section 9.4).

Note: The O_2 and Air pipeline manifolds have a drive gas connection at the back. The connection not in use is plugged.

2. Remove the plug from the new connection.
3. Disconnect the drive gas hose from the present connection.
4. Install the plug in this connection (pull on the plug to ensure that it is locked into the fitting).
5. Reroute the drive gas hose so that it does not cause kinks in other tubing.
6. Connect the drive gas hose to the new connection (pull on the hose connector to ensure that it is locked into the fitting).
7. Do a high-pressure leak test (Section 3.6).
8. Enter the service mode and select the correct drive gas.
9. Test the primary regulator. Verify that it functions within specifications now that it will be supplying drive gas to the ventilator (Section 5.1).
10. Perform the checkout procedure (Section 3).

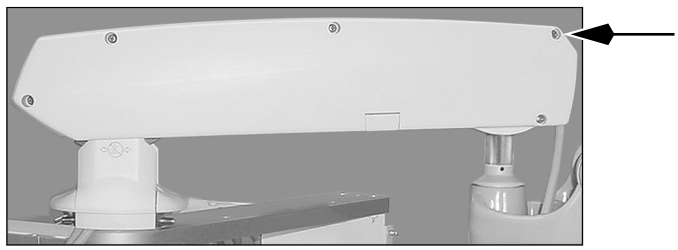
9.27 Display arm adjustments

Install any Display Arm mounted Patient Monitors before adjusting the display arm Counterbalance and Tilt movements. Adjustments can be made to the following components to maintain proper positioning of the displays:

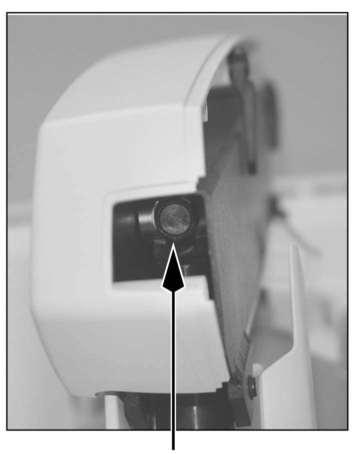
- Counterbalance of the display arm (up and down movement)
- Wrist casting (side to side movement of displays)
- Clutch bearings (tilt position of the displays)

9.27.1 Display arm counterbalance adjustment

1. Remove the display arm cover by loosening the five captive screws.



2. Ensure that the displays are not positioned over the top shelf.
3. Access the counterbalance adjustment nut at the back of the display arm; it is approximately 6.5 cm inside the metal frame of the arm.

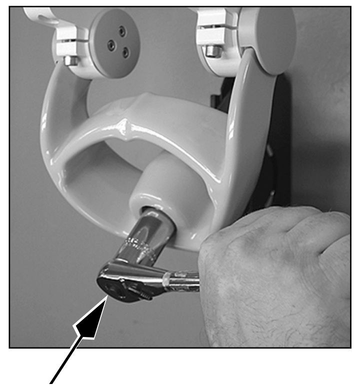


4. Using a 13-mm socket and at least a 8-cm extension, turn the adjustment nut clockwise to add more counterbalance or counterclockwise to remove counterbalance.
5. Adjust the counterbalance to the desired setting.
   - The display arm should move up or down freely when assisted but remain in position after moving it to the desired vertical position.
   - The arm should not fall or rise independently when the counterbalance is correctly adjusted.
6. Reinstall the display arm cover.

9.27.2 Wrist Casting adjustment

The mounting hardware for the wrist casting includes a thrust bearing and several friction washers that control the resistance to side movement (swivel) of the displays.

1. Using a 3/4-inch (19-mm) socket, tighten (clockwise) or loosen (counterclockwise) the mounting nut to adjust the resistance.



2. Adjust the resistance to the desired setting.
   - The display should swivel from side to side freely but remain in position after moving it to the desired position.
   - The display should not move out of position when front panel controls on the display are used.

9.27.3 Clutch bearing adjustment

The clutch bearings provide resistance when tilting the displays forward but have no effect when tilting the displays backward. To ensure that each bearing is adjusted to a relatively equal torque, adjust each bearing in small increments while testing for the proper resistance.

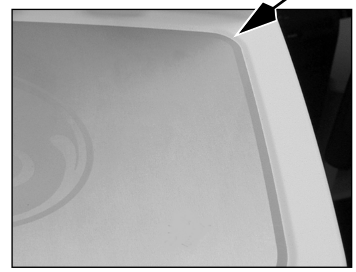
1. Using a 5-mm hex wrench, turn the adjustment screw on each clutch bearing incrementally clockwise to increase forward resistance or counterclockwise to decrease forward resistance.

2. Adjust the resistance to the desired setting.
   - When tilted backward, the display should move up freely but remain in position at the desired position.
   - The display should not move out of position when front panel controls on the display are used.
   - The display should move with minimal resistance when being tilted forward.

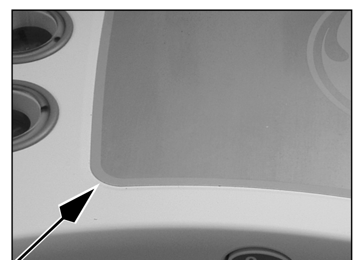
9.28 Replace the work surface overlay

⚠ **CAUTION** It is very important to precisely align the overlay before affixing it to the work surface. Once mounted and removed, the work surface overlay cannot be reused.

1. To replace the work surface overly, carefully lift a corner of the aluminum overlay with a small screwdriver.
2. Remove the overlay from the work surface.
3. Remove any residual adhesive and clean the work surface with isopropyl alcohol prior to applying a new work surface overlay.



4. Remove the protective paper from the bottom of the new overlay.
5. Position the overlay slightly above the work surface.
6. Align the rear-right and the front-left corners of the overlay with the work surface.
7. Keeping the overlay aligned with the work surface, carefully lower the overlay onto the work surface and press it into place.
   - Wipe the overlay with a soft cloth to press it in place and remove any air bubbles.

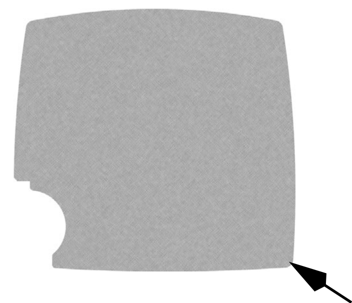


8. Remove the protective film from the top surface of the overlay.

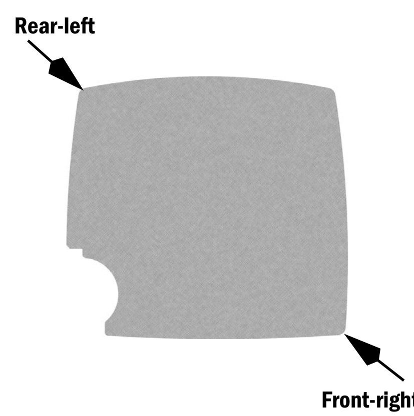
9.29 Replace the top shelf inlay

⚠ **CAUTION** It is very important to precisely align the inlay before affixing it to the top shelf. Once mounted and removed, the top shelf inlay cannot be reused.

1. To replace the top shelf inlay, carefully lift a corner of the aluminum inlay with a small screwdriver.
2. Remove the overlay from the work surface.
3. Remove any residual adhesive and clean the top shelf with isopropyl alcohol prior to applying a new top shelf inlay.



4. Remove the protective paper from the bottom of the new inlay.
5. Position the inlay slightly above the top shelf.
6. Align the rear-left and the front-right corners of the inlay with the top shelf.
7. Keeping the inlay aligned with the top shelf, carefully lower the inlay onto the top shelf and press it into place.
   - Wipe the inlay with a soft cloth to press it in place and remove any air bubbles.
8. Remove the protective film from the top surface of the inlay.



Notes

10 Illustrated Parts

In this section

10.1 Service tools

10.1.1 Software tools

Item	Description	Version	Stock Number
1	Aisys CS2 System Software, Service USB Flash Media	10.00	2068899-001
2	Aisys CS2 Service Application, PC based		2063832-001
3	Cable, Display Unit serial port to PC serial port		1011-3984-000
4	If required, RS-232 to USB adapter (V1.1 compliant)		obtain locally

As one option, we have functionally tested the KeySpan (Tripp-Lite) USA-19HS Serial Adapter and found it to be an acceptable alternative. It can be purchased locally or on the Internet (http://www.tripplite.com/en/products/keyspan-products.cfm).

4

10.1.2 Test Devices

Note There are many types of flow and pressure test devices available that can be used to complete the test procedures specified in this manual. Unless otherwise specified, the flow and presssure test devices should have an accuracy of ± 2.5% or better.

GE Healthcare assumes that the trained service person using these devices is knowledgeable about their use; therefore, specific test device instructions are not included in this manual.

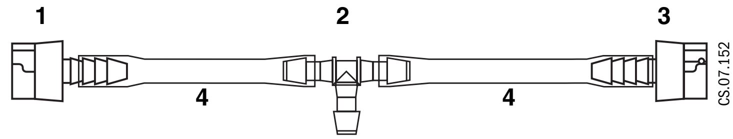
If a check does not pass a test, verify that the test device and setup to the measuring point are correct before starting to calibrate or change parts.

Test Devices (obtain locally)	Where Used
• Pressure test device capable of measuring 689 kPa (100 psi) **Test Range (207 to 400 kPa) (30 to 58 psi)**	Refer to Section 5.1.1 "*Test setup for Primary Regulators*"
• Pressure test device (pressure gauge or digital manometer) **Test Point (241 ± 7 kPa) (35 ± 1 psi)**	Refer to Section 5.2 "*O_2 Flush Regulator*"
• Pressure test device (pressure gauge or digital manometer) **Test Point (172 ± 1.72 kPa) (25 ±0.25 psi)**	Refer to Section 5.3 "*Adjust Drive Gas Regulator*"
• Pressure test device (pressure gauge or digital manometer) **Test Point (100 cmH20)**	Refer to Section 5.4.2 **or** Refer to Section 5.4.5 "*Manifold P Span*" **or** "*Paw Span*"
• Pressure test device (pressure gauge or digital manometer) **Test Point (200 mmHg)** • Flow test device **Test Range (0.45 to 11 sl/min)**	Refer to Section 6.6 "*Mixer test*"
• Flow test device capable of measuring 0–15 l/min with an accuracy of ±2% of reading **Test Range (0.5 to 13 l/min)**	Refer to Section 6.7 **or** Refer to Section 6.8 "*Alternate O_2 flowmeter tests*" **or** "*Auxiliary O_2 flowmeter tests*"
• Vacuum test gauge capable of measuring 0 to 550 mm Hg with an accuracy of ±1% of reading **Test Range (62 to 538 mmHg) (8.3 to 71.7 kPa)** • Flow test device capable of measuring 0–30 L/min **Test Point (20 l/min)**	Refer to Section 6.9 "*Integrated Suction Regulator tests*"
• Leakage current test device	Refer to Section 3.13 "*Electrical safety tests*"

10.1.3 Manifold pressure test adapter

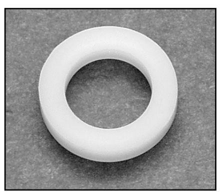
The manifold pressure test adapter is used to tee into the manifold pressure line for the Manifold P Span calibration (Section 5.4.2).

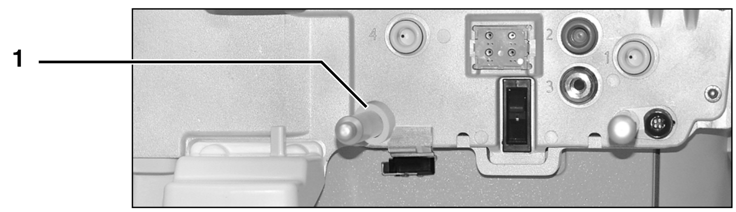
Assemble the adapter using the parts shown.



Item	Description	Stock Number
1	Coupler, male - white	1503-3236-000
2	Tee (male barb)	1009-3011-000
3	Coupler, female - white	1503-3119-000
4	Tubing (low-pressure) 1/4 inch	1605-1001-000

10.1.4 Canister release switch (CO_2 bypass) spacer tool



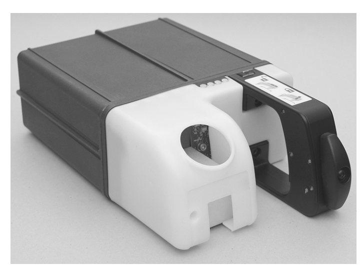


Item	Description	Stock Number
1	Spacer Ring - switch assembly guide (Refer to Section 9.23).	M1052886

10.1.5 Electronic vaporizer (eVap) service tools

1

2



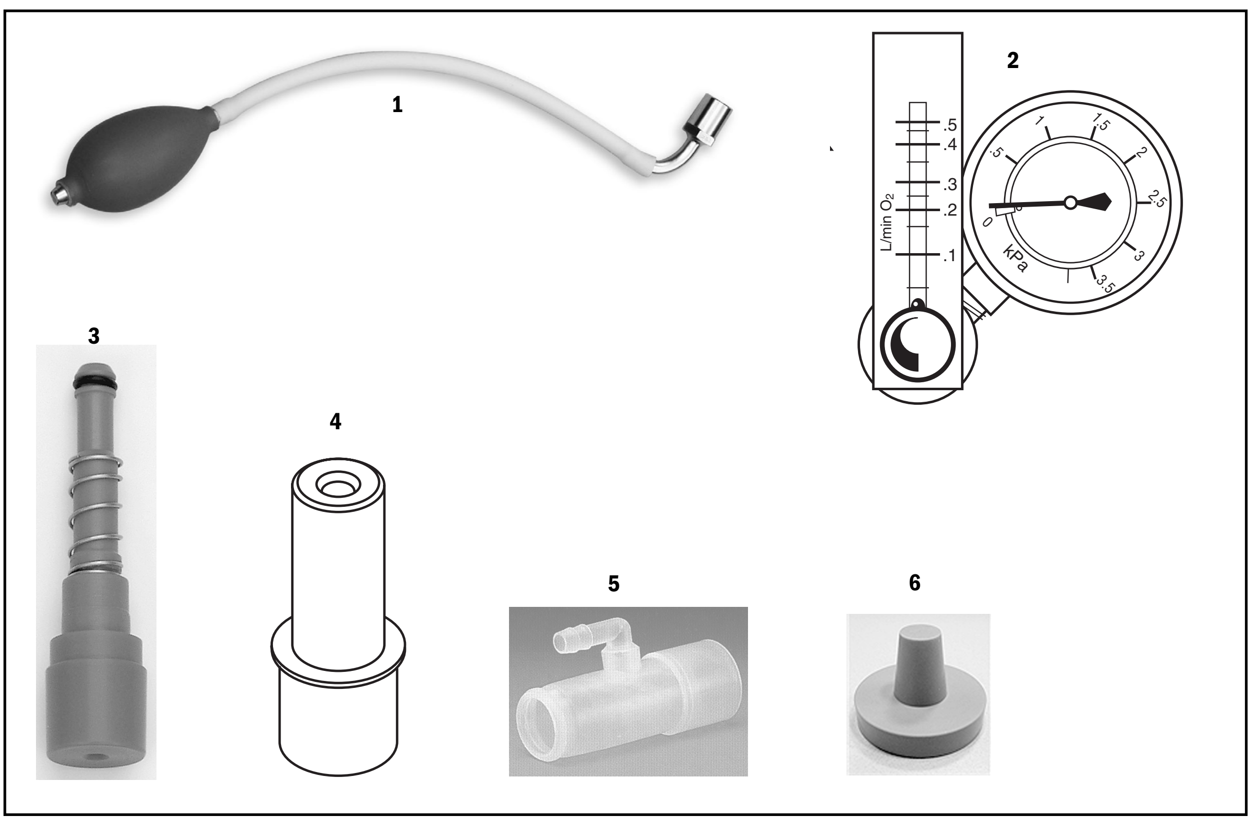
Item	Tool	Stock Number
1	Spring seal insertion tool, eVap	1011-8004-000
2	Test cassette, Aisys CS2 eVap	1011-8006-000

10.1.6 Lubricants and Adhesives

Item	Description	Stock Number
1	Lubricant, Krytox GPL 205, 2 oz	1001-3854-000
2	Lubricant, Dow 111, 5.3 oz (Refer to Section 10.19.2)	6700-0074-200
3	Thread Lock, Loctite No 24221, 10 ml	0220-5017-300
4	Thread Lock, Loctite No 243 (Refer to Section 10.2)	1011-3851-000
5	Silicone sealant (Refer to Section 10.28.2)	0220-5251-300

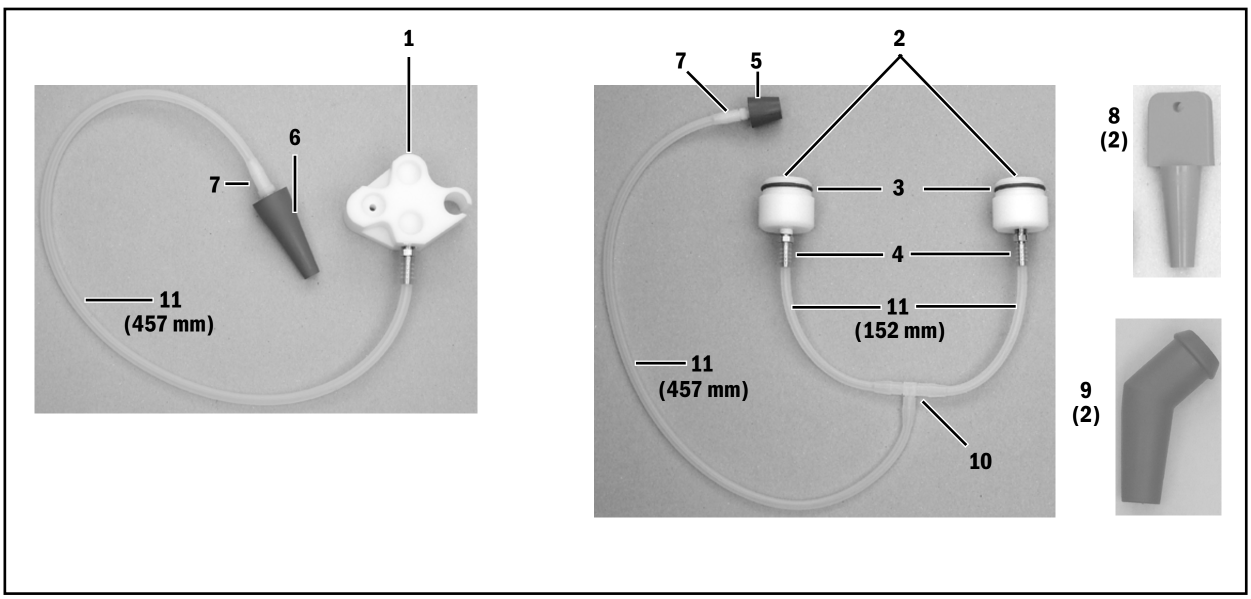
10.1.7 Test Tools

Item	Tool		Stock Number
1	Low-pressure Leak Test Device	(negative pressure)	0309-1319-800
2	Low-pressure Leak Test Device - 3.5 kPa Low-pressure Leak Test Device - 25 kPa	(positive pressure - ISO) (positive pressure - BSI)	1001-8976-000 1001-8975-000
3	Adapter, positive low-pressure leak test		1009-3119-000
4	PEEP/INSP Calibration Flow Orifice		1504-3016-000
5	Airway Pressure Sensing Tee		1504-3011-000
6	Plug, stopper		M1210946
Not Shown			
	Tool to help disconnect tubing from Legris fittings		2900-0000-000
	Test Lung		0219-7210-300
	Leak detection fluid, Snoop		obtain locally
	Airway module exhaust line		8004463
	Airway module calibration gas		755583
	Calibration gas regulator		755534
	Airway module calibration gas (U.S. variant only)		755571
	Calibration gas regulator (U.S. variant only)		M1006864

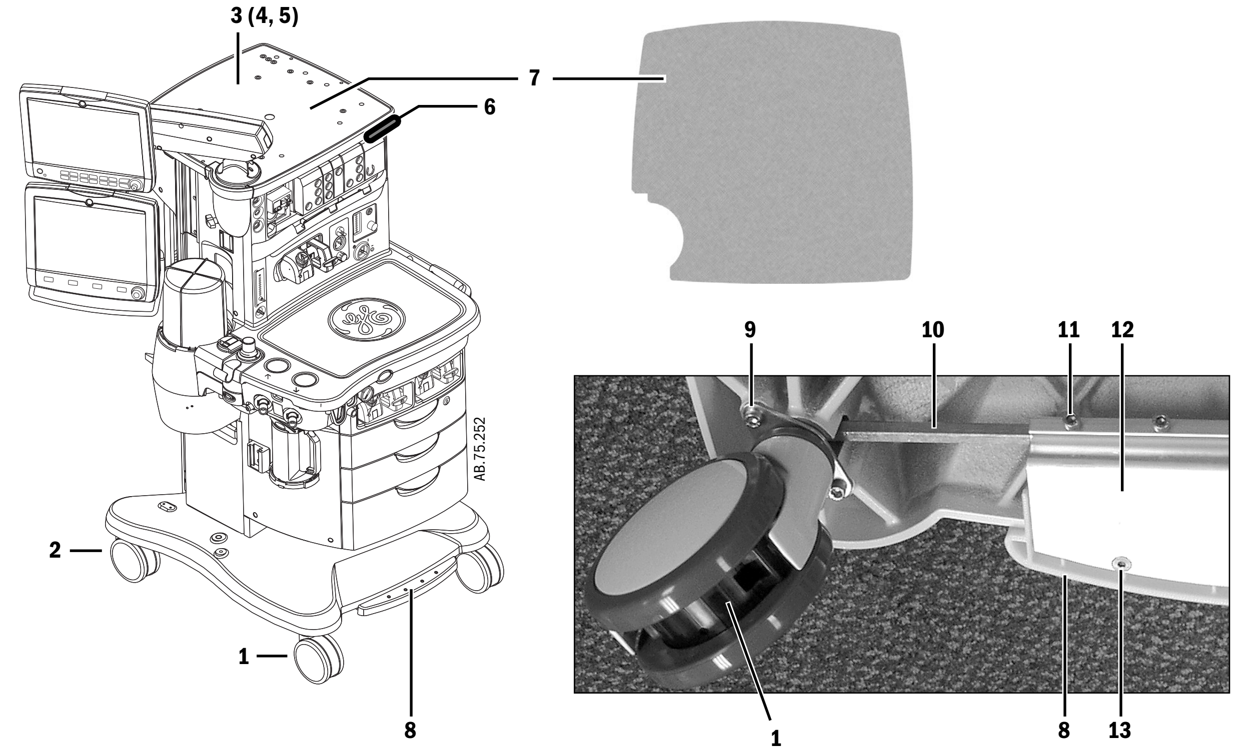


10.1.8 Leak Test Tool Kit

Item	Tool	Stock Number
	Leak Test Tool Kit, ABS breathing system	1407-7013-000
1	Test Tool, bulkhead	1407-8500-000
2	Test Tool, circle module (2 each)	1407-8502-000
3	O-ring, OD 30 x ID 22	1407-3104-000
4	Fitting, 1/4 HB x 1/8 NPTM	0206-5128-300
5	Plug, tapered 24x18 mm	1407-8506-000
6	Plug, tapered 27x12 mm	1407-8505-000
7	Connector, 1/4 x1/4 tube	0204-8892-300
8	Plug, service B/S 11 mm (2 each)	1407-8504-000
9	Plug, service BTV 18 mm (2 each)	1407-8503-000
10	Tee, hose barbs	1406-3595-000
11	Tubing, silicone (457 mm - 152 mm)	1006-3666-000



10.2 Components - front view - left side

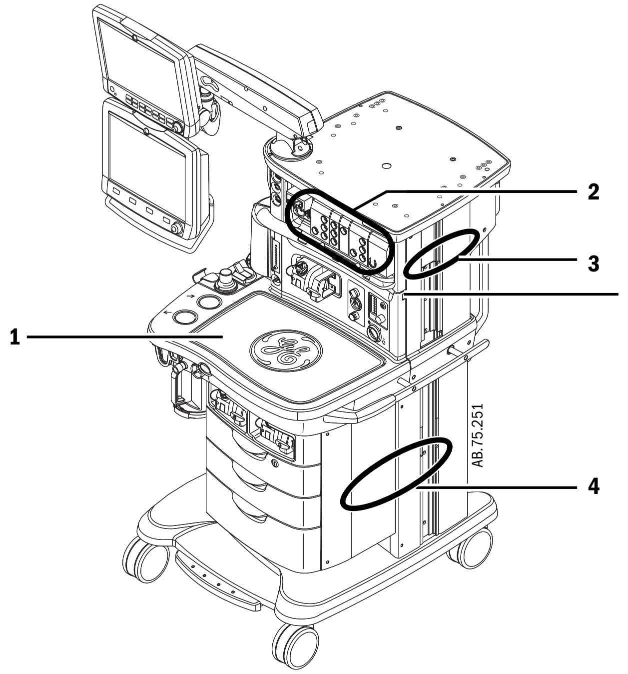


Item	Description	Stock Number
1	Caster, 125-mm (locking)	M1218615
2	Caster, 125-mm (free swivel)	M1218617
3	Shelf, top	1011-3304-000
4	Screw, M6x14 (3 front) Screw, M6x35 (3 each side)	0144-2131-922 0144-2131-912
5	Lockwasher, M6 internal	0144-1118-130
6	Label, Aisys CS2	2067023-001
7*	Inlay, Top Shelf	2066693-S
8	Pedal, Central Brake (molded cover)	M1218611
9	Screw, M6x20 SHCS	0144-2131-921
10	Hex Rod	M1239055
11	Screw, M5x12	0144-2131-915
12	Extrusion, Central Brake	M1239054
13**	Screw, M6x16 SHCS	9211-0960-167
14	CASTrGARDs, 12.7 cm / 5 inch , set of four	1001-3269-000

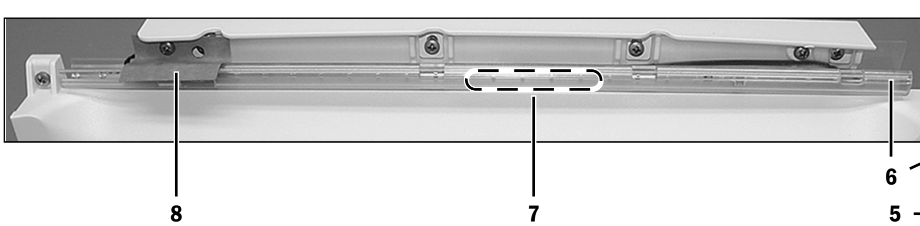
* The overlay is not designed to be removed and reused after it has been installed. When removed, replacement of the overlay may be required.

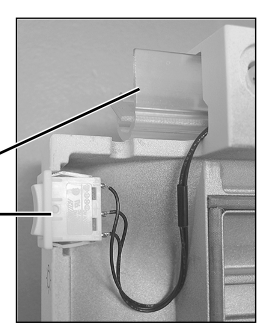
** Apply Loctite 243.

10.3 Components - front view - right side

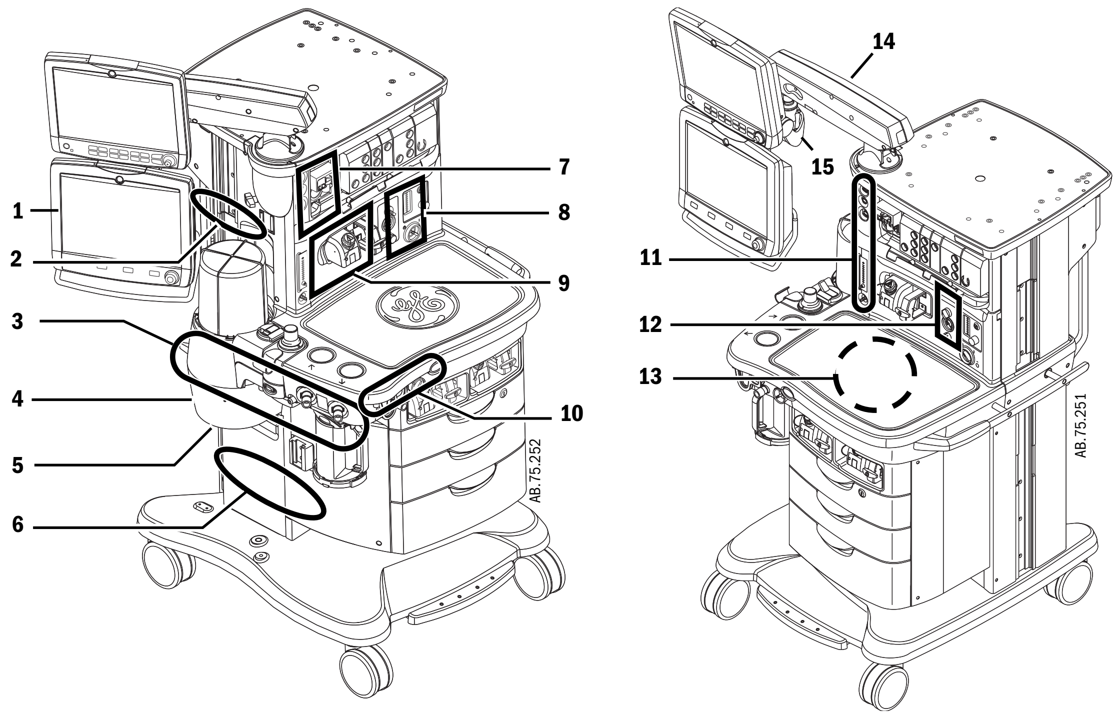


Item	Description	Stock Number
1	Tabletop components	Refer to Section 10.31
2	Components - upper bay	Refer to Section 10.48
3	Panel, cosmetic upper right-side	Refer to Section 10.23
4	Panel, cosmetic lower right-side	Refer to Section 10.24
5	Harness, Task Light switch (includes switch)	1011-3545-000
6	Lens, light package	1011-3374-000
7	Light Board	1011-3180-000
8	Guard, fish paper	1011-3623-000



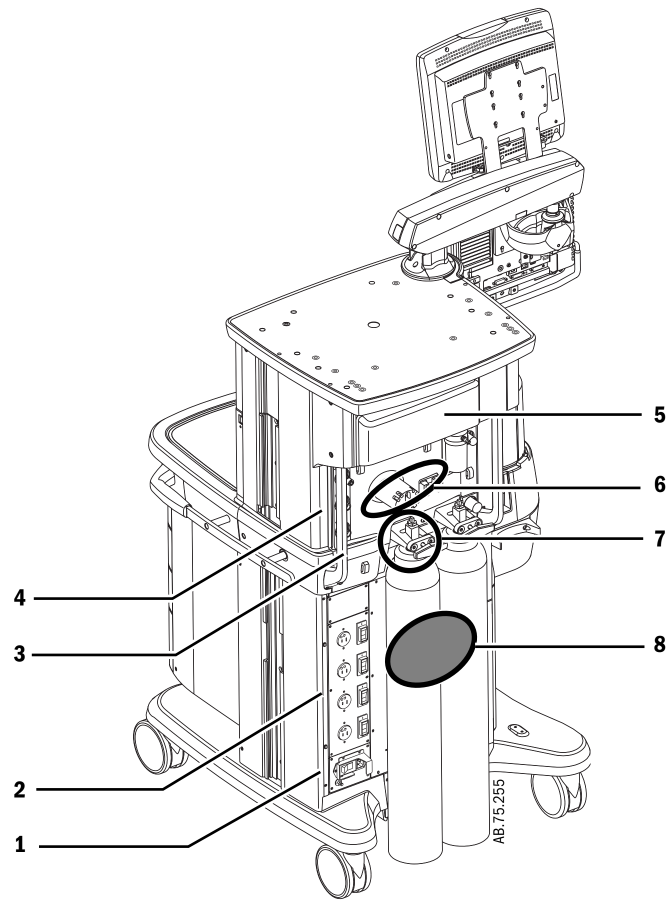


10.4 Components - front view references



Item	Description	Section number
1	Condenser	Refer to Section 10.42.11
2	Panel, cosmetic upper left-side	Refer to Section 10.25
3	Breathing System	Refer to Section 10.42
4	Vent Engine Housing	Refer to Section 10.17
5	Anesthetic Gas Scavenging System — AGSS	Refer to Section 10.30
6	Panel, cosmetic lower left-side	Refer to Section 10.26
7	Airway module components	Refer to Section 10.40
8	Front panel, Alt O2, and system switch	Refer to Section 10.6
9	Electronic Vaporizer	Refer to Section 10.28
10	ABS to machine Interface Components (SCGO) ABS to machine Interface Components (ACGO) O2 Flush Valve	Refer to Section 10.14 Refer to Section 10.15 Refer to Section 10.16
11	Aux O2 Flowmeter, Et Control, and Sample Gas Return	Refer to Section 10.20
12	Integrated Suction Regulator	Refer to Section 10.19
13	Pan electronic enclosure components	Refer to Section 10.10
14	Display arm	Refer to Section 10.45
15	Wrist casting assembly mounting	Refer to Section 10.46

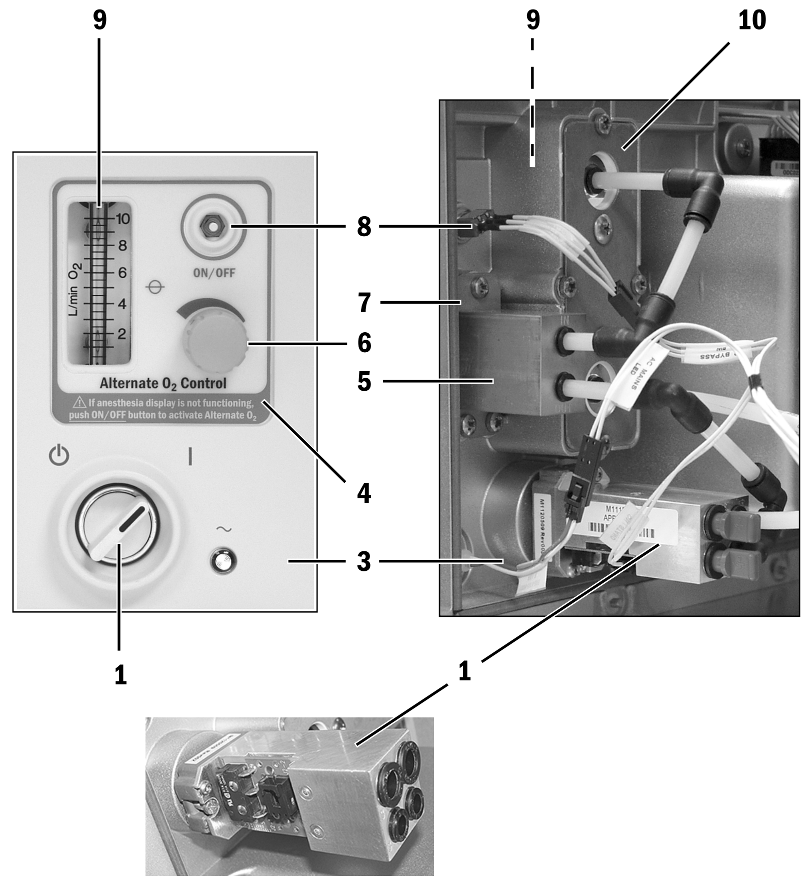
10.5 Components - rear view

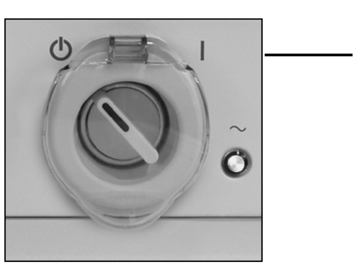


Item	Description	Stock Number
1	AC Inlet	Refer to Section 10.7
2	AC Outlets	Refer to Section 10.8
3	Handle, Rear	1011-3381-000
4	Pipeline Inlets	Refer to Section 10.12
5	Panel, cosmetic upper rear	Refer to Section 10.48
6	Rear panel components Upper enclosure panel items	Refer to Section 10.21 Refer to Section 10.22
7	Cylinder Gas Supplies	Refer to Section 10.13
8	Lower electronic enclosure components Enclosure panel	Refer to Section 10.9 Refer to Section 10.22

10.6 Front panel, Alt O2, and system switch

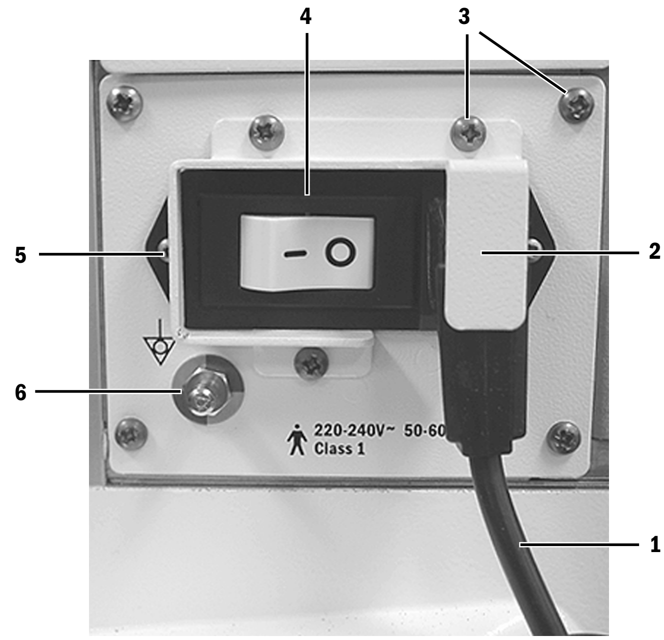
Table 1:	
Language	**Alt O_2 Label**
Bulgarian	M1233593
Chinese	1011-3913-000
Croatian	M1217824
Czech	1011-3939-000
Danish	1011-3949-000
Dutch	1011-3931-000
English	1011-3567-000
Estonian	M1090083
Finnish	1011-3932-000
French	1011-3929-000
German	1011-3930-000
Greek	1011-3943-000
Hungarian	1011-3944-000
Indonesian	2068953-001
Italian	1011-3936-000
Japanese	1011-3933-000
Korean	M1093583
Latvian	2068954-001
Lithuanian	M1215707
Norwegian	1011-3941-000
Polish	1011-3940-000
Portuguese	1011-3938-000
Romanian	M1233595
Russian	1011-3912-000
Serbian	M1233591
Slovakian	2068951-001
Spanish	1011-3937-000
Swedish	1011-3945-000
Turkish	1011-3942-000
Vietnamese	2068952-001

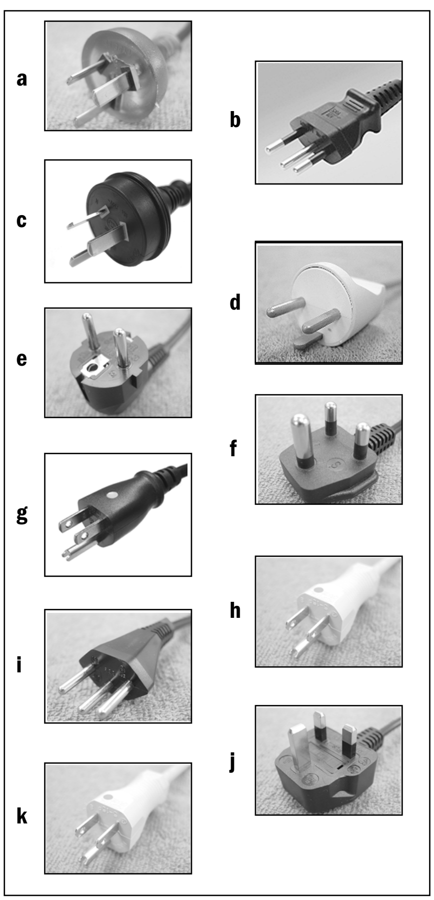




Item	Description	Stock Number
1	Switch, system On/Standby, Kit	M1115795-S
2	Switch Cover Kit	M1202240-S
3	LED assembly, mains green	1009-5514-000
4	Label, Alt O_2	See Table 1
5	Needle Valve assembly, flow control	1011-3429-000
6	Knob (set screw not included) - Soft Teal	M1213259
	Set screw	9211-0830-053
7	Plate, needle valve	1011-3639-000
	Screw, M4x8	1006-3178-000
8	Switch, Alt O_2 (includes harness)	1009-5517-000
9	Flowmeter, Alt O_2	1011-3428-000
10	Plate, flowmeter	1011-3270-000
	Screw, 10-32x3/8 (bracket to flowmeter - 2 each)	0140-6631-107
	Screw, M4x8 (assembly to front panel - 4 each)	1006-3178-000

10.7 AC Power cords and AC Inlet





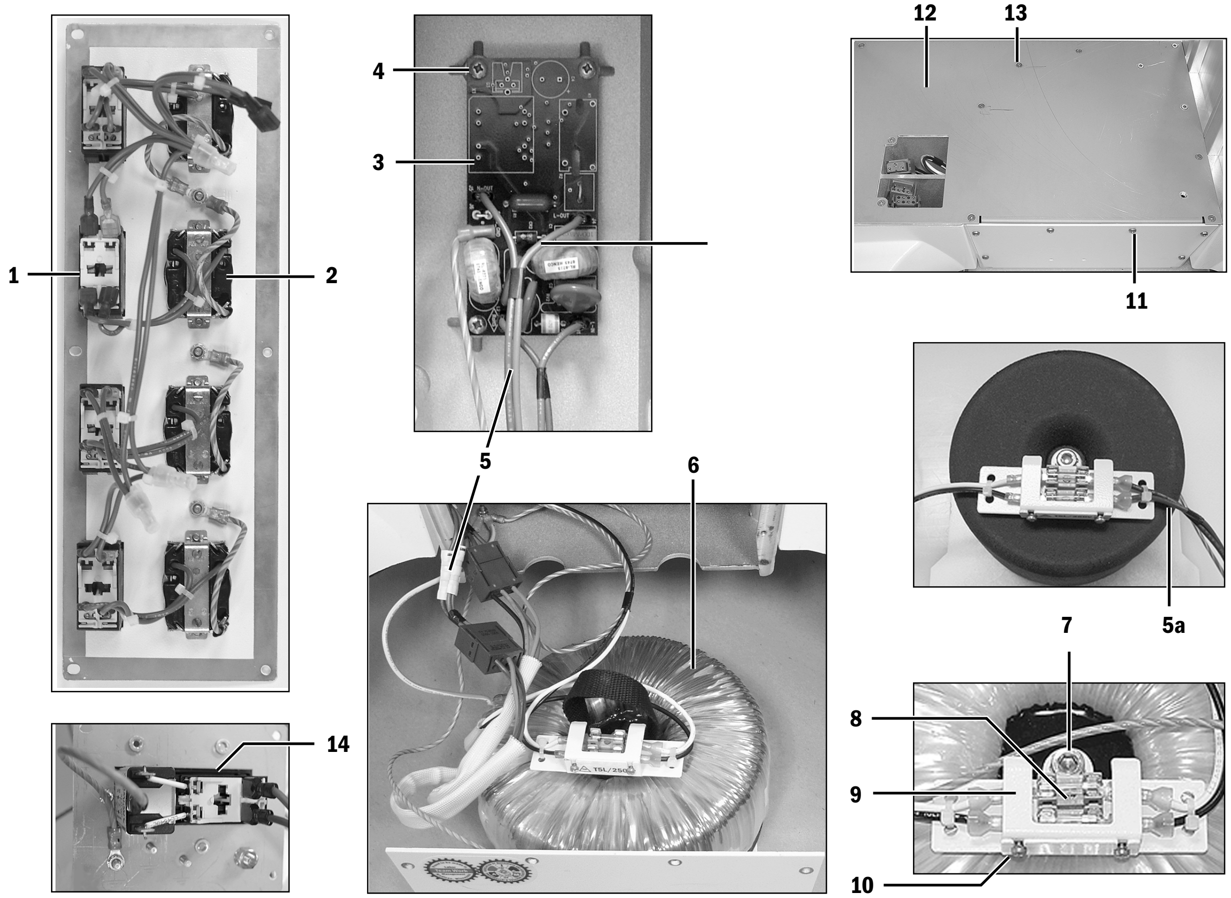
Item		Description	Stock Number
1		Power Cord	
	a	Australia, 220-240 VAC AS 3112 outlets	1006-3888-000
	b	*Brazil, 120V~/220-240V~ NBR 14136	M1213612
	c	*China, 220-240 VAC AS GB2099	M1053942
	d	Danish, 220-240 VAC	1011-3696-000
	e	EURO and France, 220 VAC with CEE 7/7	1001-3380-000
	f	India and South Africa, 220-240 VAC BS546 (Kit includes retainers)	M1233910
	g	Japan, 100-120 VAC JIS-C3306	M1142139
	h	Peru, 220-240 VAC NEMA	1006-3882-000
	i	Swiss, 220-240 VAC SEV 1011	1006-3889-000
	j	UK, 220-240 VAC BS1363	1006-3884-000
	k	US, 100-120 VAC NEMA	1006-3907-000
2		Guard, power cord retainer	1011-3221-000
		*Guard, power cord retainer (Low Profile)	M1054218
3		Screw, M4x8 Pozidriv	1006-3178-000
4		AC Inlet	Refer to Section 10.8
5		Screw, M3x6 Pozidriv Sems	0140-6219-128
		Stud, 6mm Equipotential	0208-0070-300

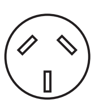
* **Note**: These power cords use the Low Profile retainer.

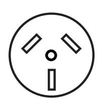
10.8 AC Inlet/Outlet Components

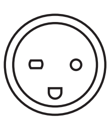
Item	Description	Stock Number
1	Circuit Breaker, 1A, Rocker	1009-5722-000
	Circuit Breaker, 2A Rocker	1009-5721-000
	Circuit Breaker, 3A Rocker	1009-5720-000
	Circuit Breaker, 4A Rocker	1009-5719-000
2	Outlet Receptacle, Australia, AS 3112	1001-3305-000
	Outlet Receptacle, China, AS 3112 (CCC)	M1061131
	Outlet Receptacle, Danish, AFSNIT 107-2-D1	1011-3910-000
	Outlet Receptacle, EURO, CEE 7/7	1202-3551-000
	Outlet Receptacle, France, CEE 7/5	1006-4421-000
	Support Frame, snap in	1006-4422-000
	Outlet Receptacle, India and South Africa, BS 546	1006-3805-000
	Outlet Receptacle, Japanese	1006-3578-000
	Outlet Receptacle, NA, Nema 5-15	1006-3555-000
	Outlet Receptacle, Swiss, SEV 1011	1006-3807-000
	Outlet Receptacle, UK, BS1363	1001-3309-000
3	Circuit board, Universal Surge	M1077081
4	Screw, M4x8 Pozidriv Sems	0140-6226-113
5	Harnesses	Refer to Section 10.37
5a	Harness, Surge board to fuses (120/220/240 - Brazil)	M1216688
6	Toroid Kit, Low Inrush 100-240V (**includes Universal Surge board - Item 3**)	M1186636-S
7*	Screw, M8x70	1006-3905-000
	Lockwasher, M8 external	0144-1118-225
	Washer, M8	9213-0180-006
8	Fuse, 5A - 5x20mm	1202-3345-000
	Fuse holder	1009-5674-000
	Screw, M2x6	0140-6712-102
9	Guard, fuse holder	1011-3622-000
10	Screw, M3x6 Pozidriv Sems	0140-6219-128
11	Screw, M4x8 DIN84	1006-3178-000
12	Cover, transformer	1011-3371-000
13	Screw, M4x8 FLAT HD	0140-6226-107
14	Inlet, 100-120A~, with line filter and 15 A circuit breaker	1009-5698-000
	Inlet, 220-240A~, with line filter and 8 A circuit breaker	1009-5757-000

* Apply Loctite 242.




AS 3112
Australia


AS 3112/GB2099
China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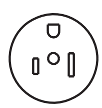
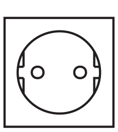
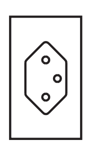
Danish,


JIS-C3306
Japanese


CEE 7/7
EURO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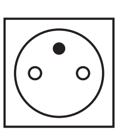
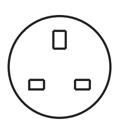
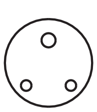
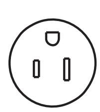
Swiss,

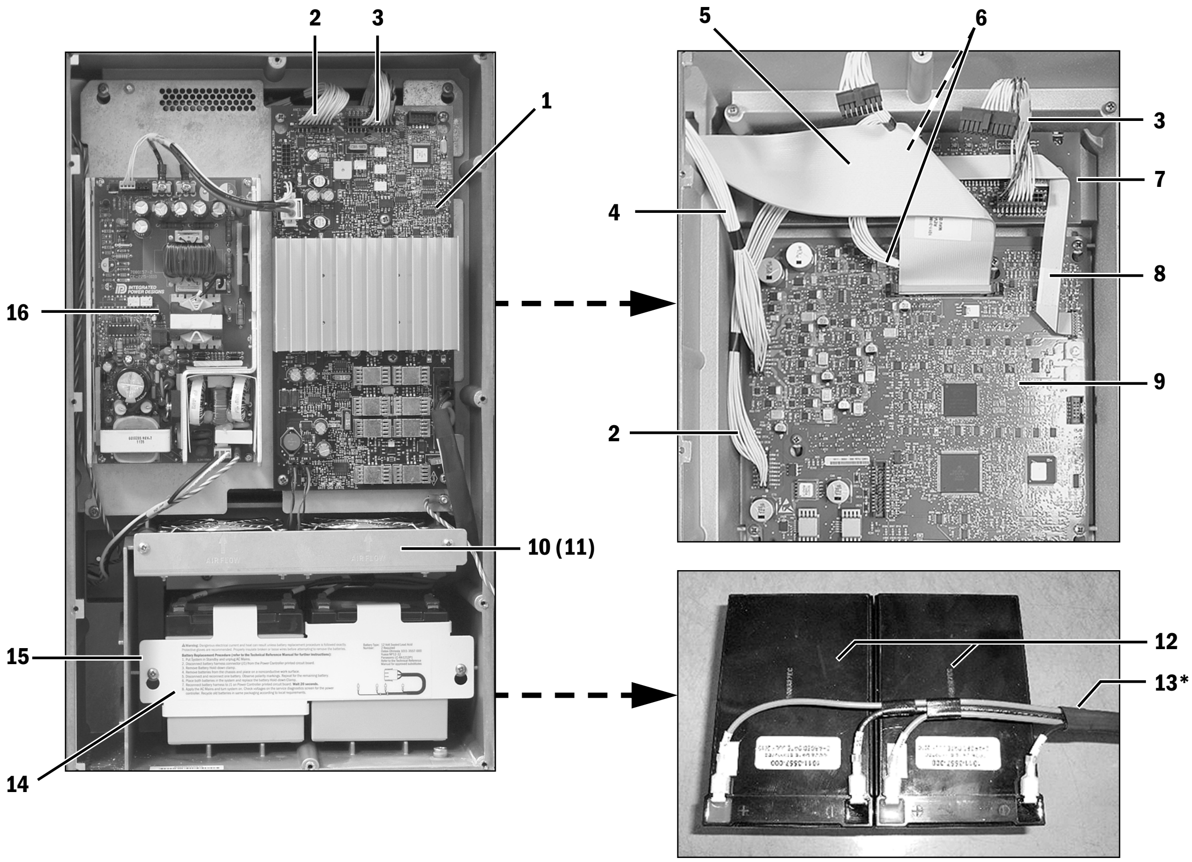

CEE 7/5
France


BS1363
UK


BS 546
India and South Africa

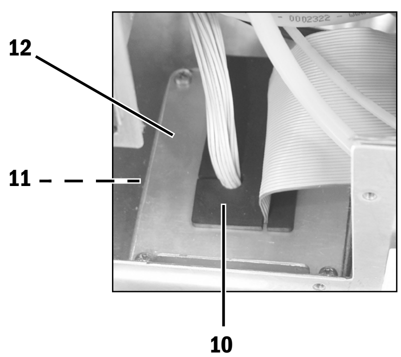

Nema 5-15
NA

10.9 Lower electronic enclosure components

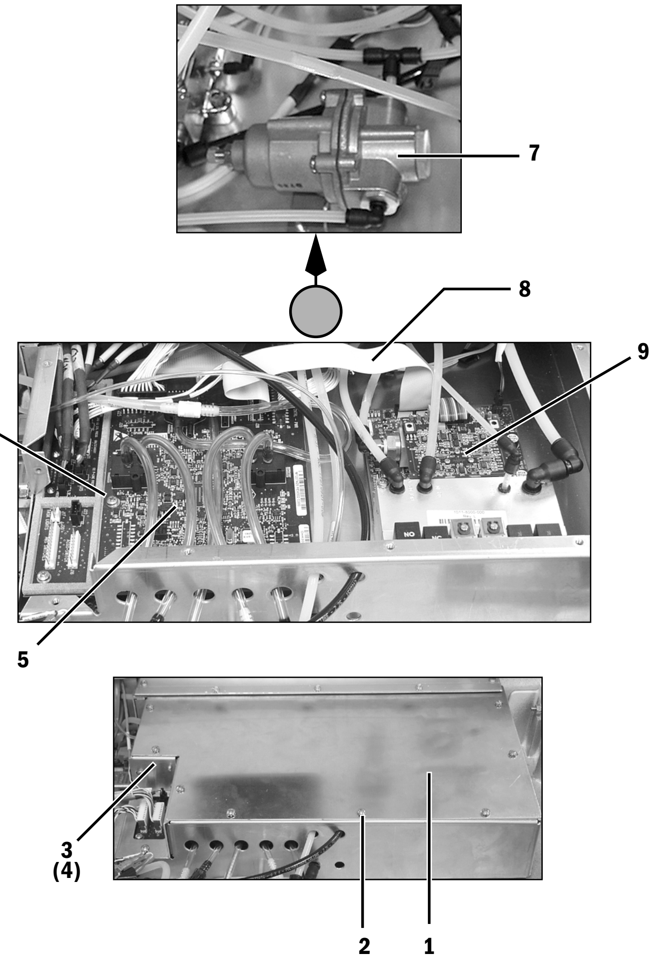


Item	Description	Stock Number
1	Power Controller board (Tested)	1011-3572-000-S
2	Harness, J4-ACB to J4-PCB	1009-5551-000
3	Harness, J3-PCB to J5-DCB	1009-5552-000
4	Harness, J3-ACB to cVIB	M1220574
5	Cable, ribbon J1-ACB to cVIB	M1220571
6	Harness, J7-ACB to J6-DCB	1009-5556-000
7	Display Connector Board	1009-3005-000
8	Cable, ribbon J2-ACB to J9-DCB	1009-5561-000
9	Anesthesia Control board (tested)	1011-3004-000-S
10	Fan (flow upward)	1009-5697-000
11	Guard, fan wire form	0208-2737-300
12	Battery, sealed lead acid, 12V 12AH (two required)	1011-3557-000
13	Harness, battery to PCB (includes service label, **Item 14**)	M1198968-S
14	Label, battery service instructions	M1191139
15	Bracket, battery restraint	1011-3212-000
16	Power Supply, universal 225W	1011-3832-000

10.10 Pan electronic enclosure components



Rear View

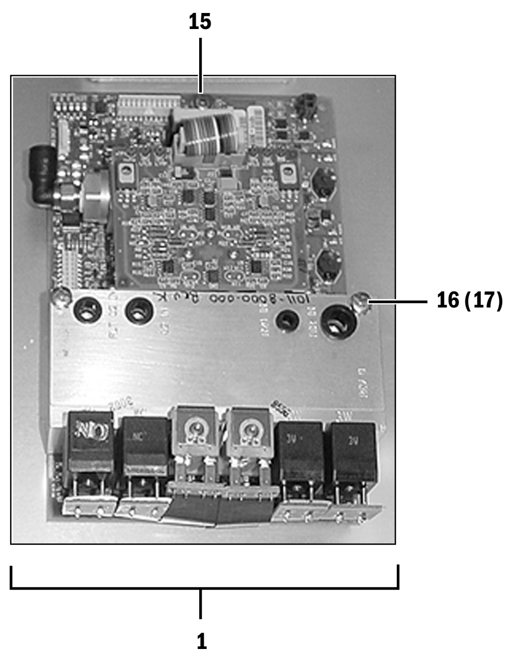


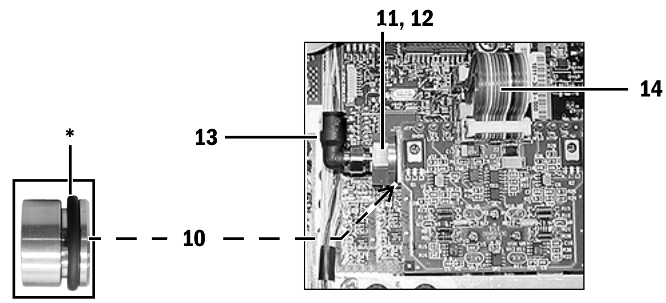
Front View

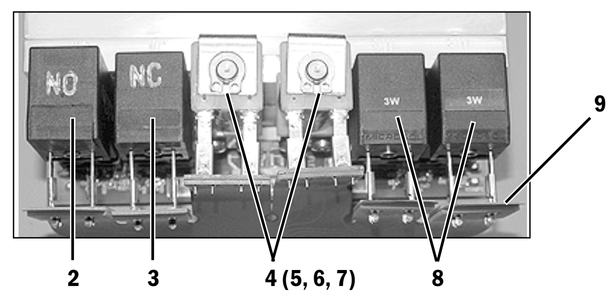
Item	Description	Stock Number
1	Cover, upper electronic enclosure	M1219104
2	Screw, M4x8 DIN84	1006-3178-000
3	Cover, side	M1219106
4	Gasket, EMI Kit	M1230977
5	Consolidated Ventilator Interface Board (**cVIB**), Calibrated	M1223654
6	Screw, M4x16	9211-0440-163
7	Regulator, O_2 Flush	1011-3168-000
8	Cable, cVIB to Mixer	M1220557
9	Gas Mixer Assembly, complete	Refer to Section 10.11
10	Cable raceway	M1228076
11	Gasket, cable raceway plate	1009-3418-000
12	Plate, cable raceway	1009-3417-000
Not Shown		
	Et Control components	Refer to Section 10.20

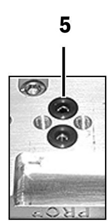
10.11 Electronic Gas Mixer

⚠ **CAUTION** Ensure a clean environment when servicing the gas mixer.





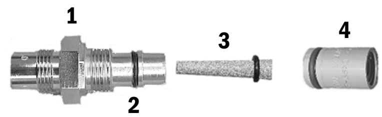


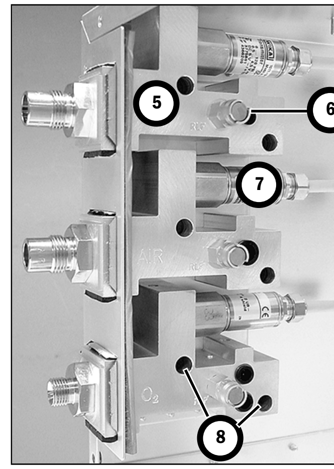


Item	Description	Stock Number
1	Mixer Assembly - complete	1011-8000-000-S
2	Valve, 2-way NO (includes screws and gasket)	1009-3014-000
3	Valve, 2-way NC (includes screws and gasket)	1009-3013-000
4	Valve, proportional	1011-3560-000
5	O-ring (2 used with each proportional valve)	6027-0000-165
6	Screw, M3x16 (2 used for mounting each valve)	1504-3003-000
7	Lockwasher, M3 external	9213-0530-003
8	Valve, 3-way NC (includes screws and gasket)	1009-3346-000
9	Flex-cable, valve interface	1009-3359-000
10	Outlet check valve, replacement kit (includes o-ring and flapper valve)	1009-8246-000
11	Retainer, flapper valve	1011-3516-000
12	O-ring, retainer	1011-3518-000
13	Elbow, 1/4 inch tube to 1/8 inch NPT	1011-3071-000
14	Cable, TSI interface	1011-3082-000
Mounting Hardware		
15	Screw, M4x6	1009-3283-000
16	Screw, M4x40	0140-6226-128
17	Lockwasher, M4 external	9213-0540-003

* Lubricate sparingly with Krytox.

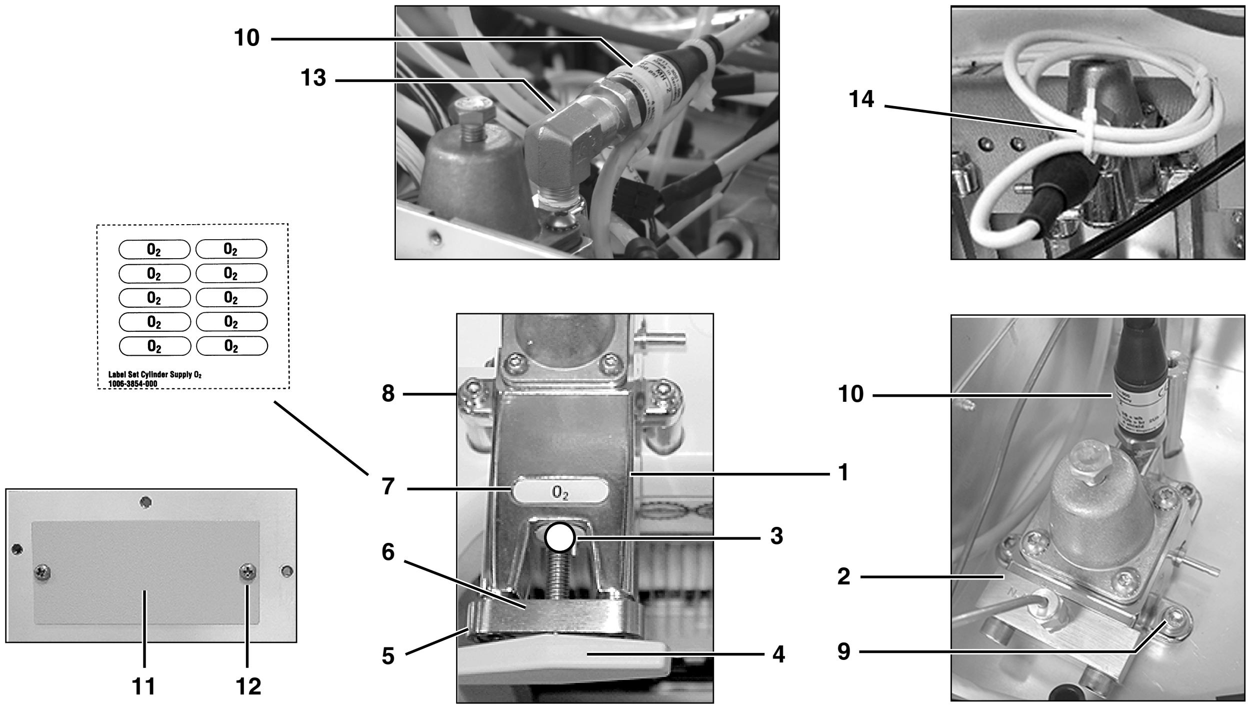
10.12 Pipeline inlet fittings





Item	Description	Stock Number
1	**Pipeline inlet - O_2 fittings**	--------------------
	Body, O_2 DISS	1006-5149-000
	Body, O_2 NIST	1006-5158-000
	Body, O_2 G 3/8 BSPP	1006-5170-000
	Pipeline inlet assembly O_2 - France (S90-116)	1006-8363-000
	Pipeline inlet assembly O_2 - Canada (DISS Female)	1006-8360-000
	Pipeline inlet assembly O_2 - Australia (G 1/4 BSPP)	1006-8396-000
1	**Pipeline inlet - N2O fittings**	--------------------
	Body, N_2O DISS	1006-5150-000
	Body, N_2O NIST	1006-5159-000
	Body, N_2O G 3/8 BSPP	1006-5171-000
	Pipeline inlet assembly N_2O - France (S90-116)	1006-8362-000
	Pipeline inlet assembly N_2O - Canada (DISS Female)	1006-8359-000
	Pipeline inlet assembly N_2O - Australia (G 1/4 BSPP)	1006-8397-000
1	**Pipeline inlet Air fitting**	--------------------
	Body, Air DISS	1006-5151-000
	Body, Air NIST	1006-5160-000
	Body, Air G 3/8 BSPP	1006-5172-000
	Pipeline inlet assembly Air - France (S90-116)	1006-8361-000
	Pipeline inlet assembly Air - Canada (DISS Female)	1006-8358-000
	Pipeline inlet assembly Air - Australia (G 1/4 BSPP)	1006-8398-000
2	O-ring, bore seal	---------------------
	O_2 and N_2O	0210-0479-300
	Air	0210-0539-300
3	Sintered metal filter with o-ring	1006-8351-000
4	Pipeline check valve with o-ring	1505-3273-000
5	Gas Inlet Manifold (replacement) O_2	1009-8066-000
	N_2O	1009-8067-000
	Air	1009-8068-000
6	Relief valve, 689/758 kPa (100/110 psi)	1011-3049-000
7	Transducer, pipeline pressure	1011-3000-000
8	Screw, M4x20	0144-2124-218
	Lockwasher, M4	0144-1118-128

10.13 Cylinder Gas Supplies

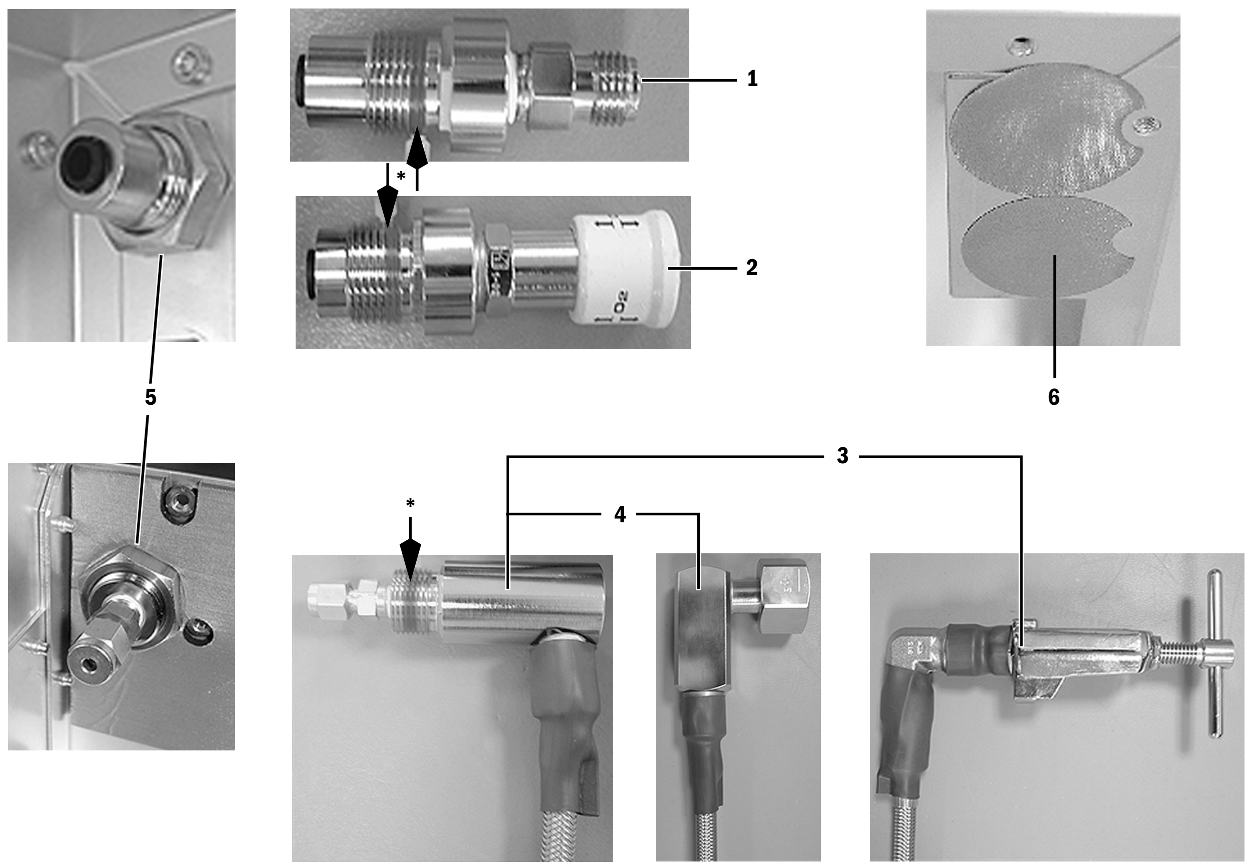


Item	Description	Pin Index	DIN
1	Gas supply O_2	1006-3201-000	1006-3207-000
1	Gas supply N_2O	1006-3225-000	1006-3208-000
1	Gas supply Air	1006-3203-000	1006-3209-000
		Third Cylinder	
2	Gas supply O_2	1011-8150-000	
	Gas supply N_2O	1011-8154-000	

Item	Description	Stock Number
3	Cylinder inlets (Pin Index or DIN for external cylinder)	Refer to Section 10.13.2
4	Tee handle beige	0219-3372-600
5	Spacer, gas block (2)	1001-4077-000
	Screw, M8 x 25 long socket head cap (2)	9211-0680-253
6	Clamp, yoke	1001-4076-000
7	Label Set, cylinder supply, O_2	1006-3854-000
	Label Set, cylinder supply, N_2O	1006-3855-000
	Label Set, cylinder supply, Air	1006-3856-000
8	Screw M6x25 socket head cap	9211-0660-254
	Lockwasher, M6 internal	0144-1118-130
	(*) Spacer, standoff	1011-3241-000
9	Screw M6x25 socket head cap	9211-0660-254
	Lockwasher, M6 internal	0144-1118-130
10	Transducer, cylinder pressure (includes cable)	1011-3001-000
11	Cover (vacant cylinder)	1006-4655-000
12	Screw, M4x8 DIN84	1006-3178-000
13	Elbow, 1/4-inch NPTM x 1/4-inch NPTF	M1132378
14	Cable Tie, 4-inch	0203-5915-300

* Apply Loctite 242.

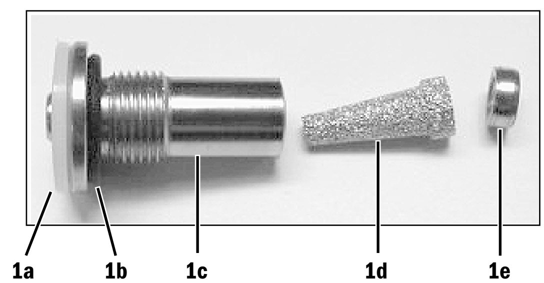
10.13.1 Power outlets and third cylinder high-pressure hoses

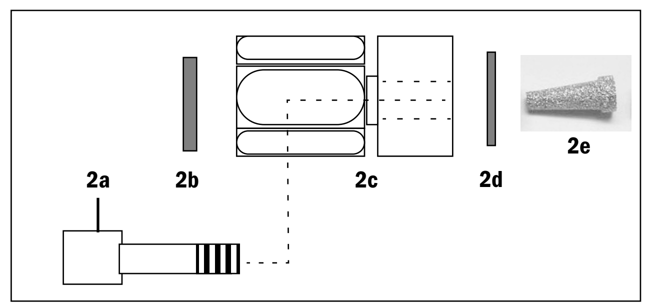


Item	Description		Stock Number
1*	Outlet, pneumatic power - DISS (Field Upgrade Kit)		1011-8075-000
2*	Outlet, pneumatic power - Euro (Field Upgrade Kit)		1011-8077-000
3*	Hose assembly, high pressure, Pin Index	O_2 -	1011-3869-000
		N_2O -	1011-3870-000
4*	Hose assembly, high pressure DIN	O_2 -	1011-3871-000
		N_2O -	1011-3872-000
5	Nut, M20x1.5 Brass		1006-5065-000
6	Plug, cover		1011-3813-000

* Apply Loctite 242.

10.13.2 Cylinder inlet fittings

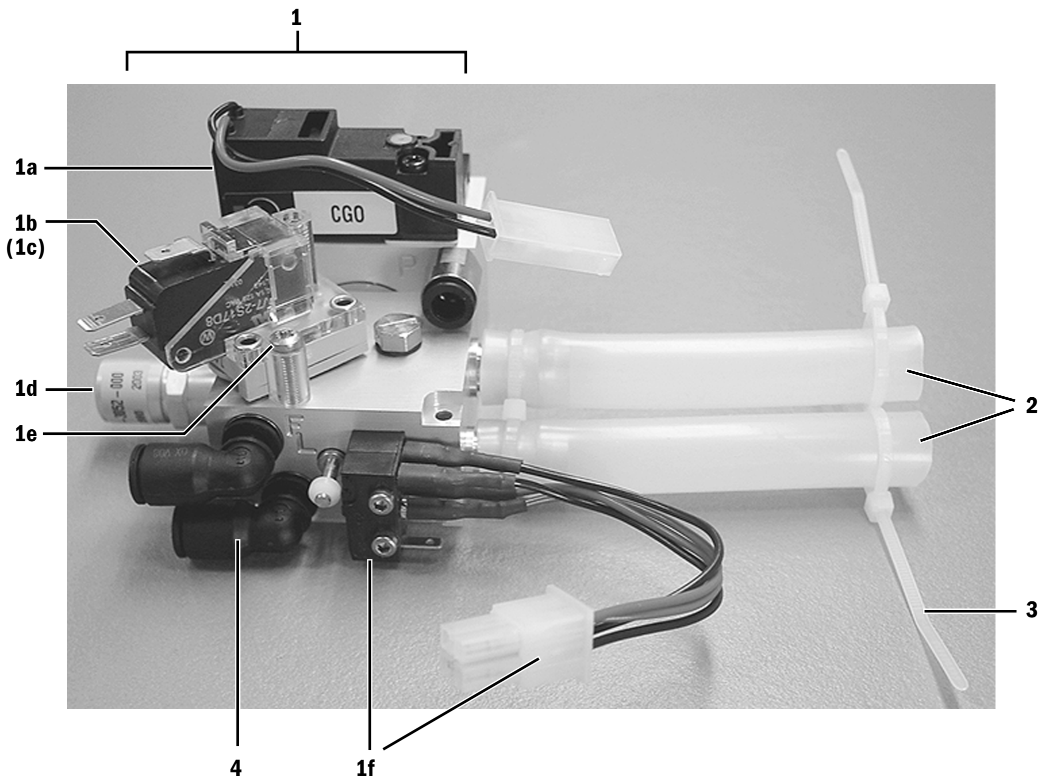




Item	Description	Stock Number
1	**Cylinder inlets (Pin Index)**	---------------------
1a	Gasket	0210-5022-300
1b*	O-ring	9221-3013-116
1c	Adapter, inlet	1001-4075-000
1d	Filter, sintered bronze	9914-6380-000
1e	Retaining ring, filter	1001-5954-000
2	**Cylinder inlets (DIN)**	---------------------
2a	Screw, M8x16	0144-2140-242
2b	Sealing ring (DIN)	1009-3356-000
2c	DIN Adapter (O_2)	1006-4000-000
	DIN Adapter (N_2O)	1006-4001-000
	DIN Adapter (Air)	1006-4002-000
2d	O-ring, 0.687 ID, 0.812 OD	0210-0544-300
2e	Filter, sintered bronze	9914-6380-000

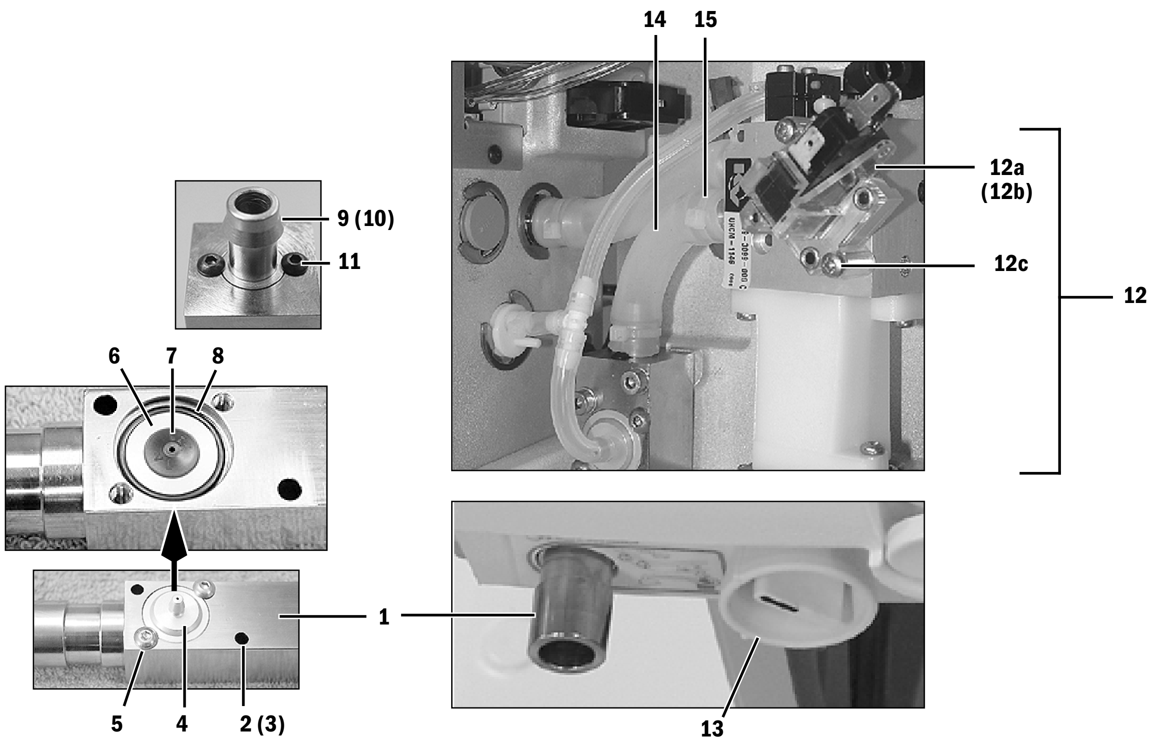
* Lubricate sparingly with Krytox

10.14 ABS to machine Interface Components (SCGO)



Item	Description	Stock Number
	SCGO Field Conversion Kit (parts to convert machine from ACGO to SCGO)	1011-8073-000
1	SCGO Selector Module, complete	1009-3098-000
1a	Solenoid kit CGO	1009-3279-000
1b	Flush pressure switch (includes o-ring)	1006-3972-000
1c	O-ring	1006-3213-000
1d	Valve, relief 150 cmH2O	1009-3052-000
1e	Screws, M3x20	0144-2124-201
1f	Switch, mode (CGO/SCGO), kit	1009-3282-000
2	Tubing, silicone (75 mm, 75 mm)	1009-3164-000
3	Cable Tie	0203-5915-300
4	Elbow, Legris 1/4 inch	1006-3737-000

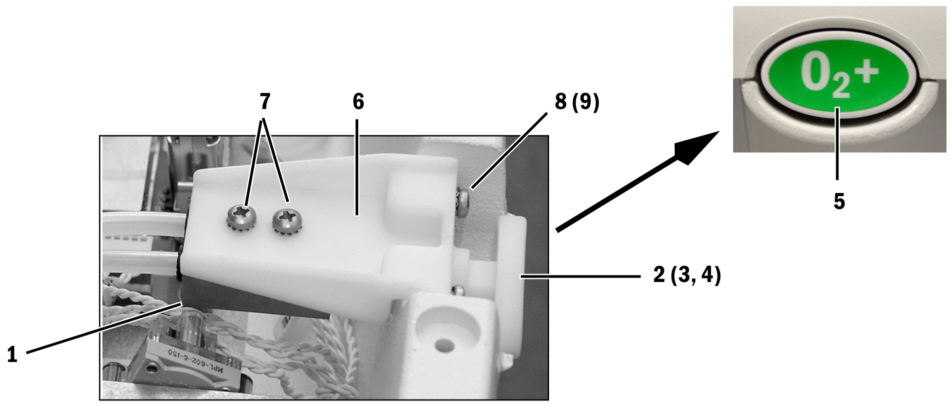
10.15 ABS to machine Interface Components (ACGO)



Item	Description	Stock Number
	ACGO Field Conversion Kit (parts to convert machine from SCGO to ACGO)	1011-8071-000
1	Port, ACGO body	1011-3361-000
2	Screw, M4x30	9211-0640-304
3	Lockwasher, M4	9213-0540-003
4	Cap, ACGO check valve	1009-3095-000
5	Screw, M4x8	9211-1040-069
6	Disk, ACGO check valve	1009-3062-000
7	Flapper, ACGO check valve	1009-3097-000
8*	O-ring	0210-0543-300
9	Fitting, barbed	1011-3830-000
10*	O-ring	0210-0691-300
11	Screw, M3x6	9211-1030-055
12	ACGO Selector Switch, complete (without guard - item 13)	1009-3099-000
12a	Flush pressure switch	1006-3972-000
12b	O-ring	1006-3213-000
12c	Screws	0144-2124-201
13	Guard	1011-3659-000
14	Tubing, silicone (72 mm, 62 mm)	1009-3164-000
15	Cable Tie	0203-5915-300

* Lubricate sparingly with Krytox.

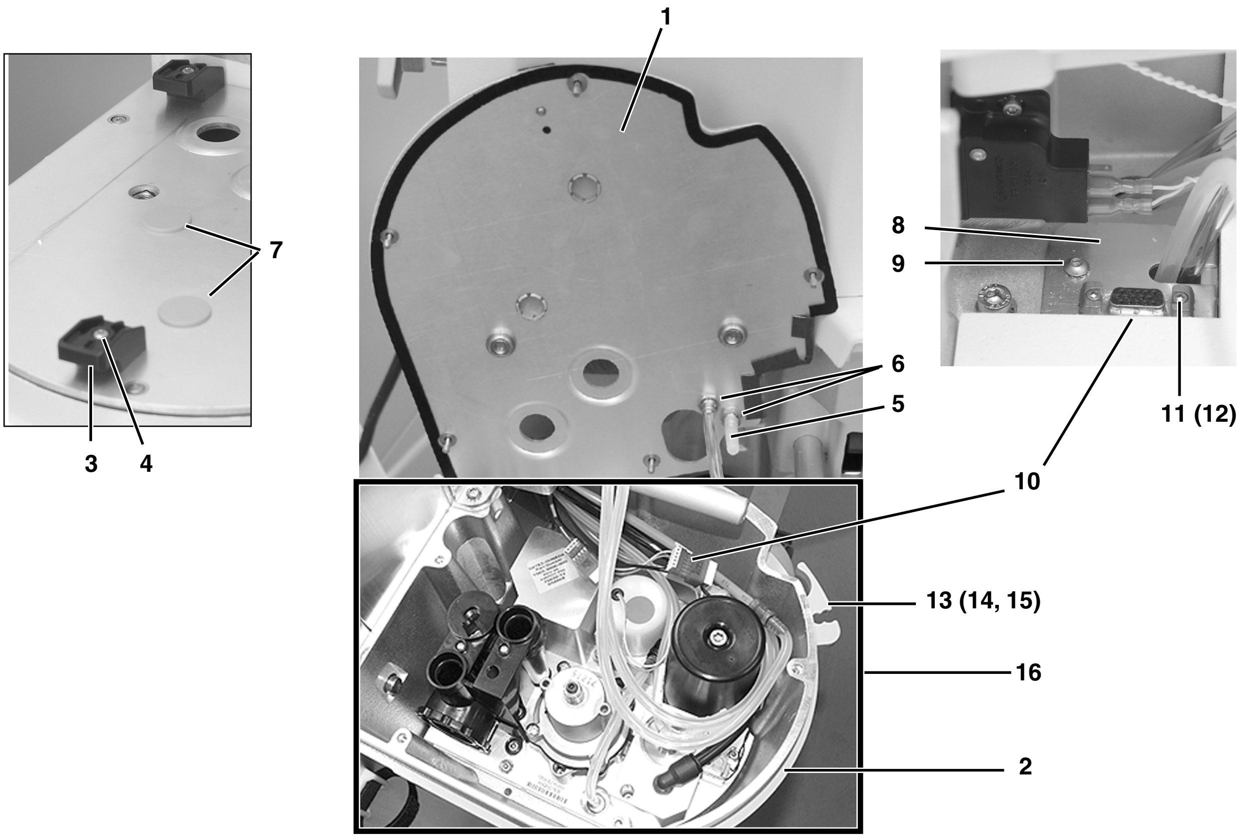
10.16 O_2 Flush Valve



Item	Description	Stock Number
1	Flush valve, without button	1006-8357-000-S
2	Flush Button with rod (O_2^+ black text)	1011-3354-000
3	Spring	1006-3186-000
4	E-clip	0203-5225-300
5	Label, O_2^+ green (for locations that require green)	1011-3988-000
6	Bracket	1011-3355-000
7	Screw, M4x8	1006-3178-000
8	Screw, M4x12	0140-6226-111
9	Lockwasher, M4	9213-0540-003

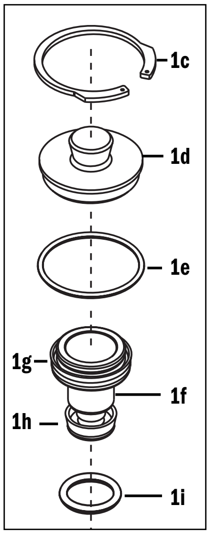
Note To reassemble the O_2 Flush Button, install the Flush Button onto the Pan Casting and align the Flush Button to the Pan Casting with a consistent gap around the lower edge, then tighten the screws. After the tabletop is installed, fully depress and release the O_2 Flush Button to ensure the O_2 Flush Button returns to its original position.

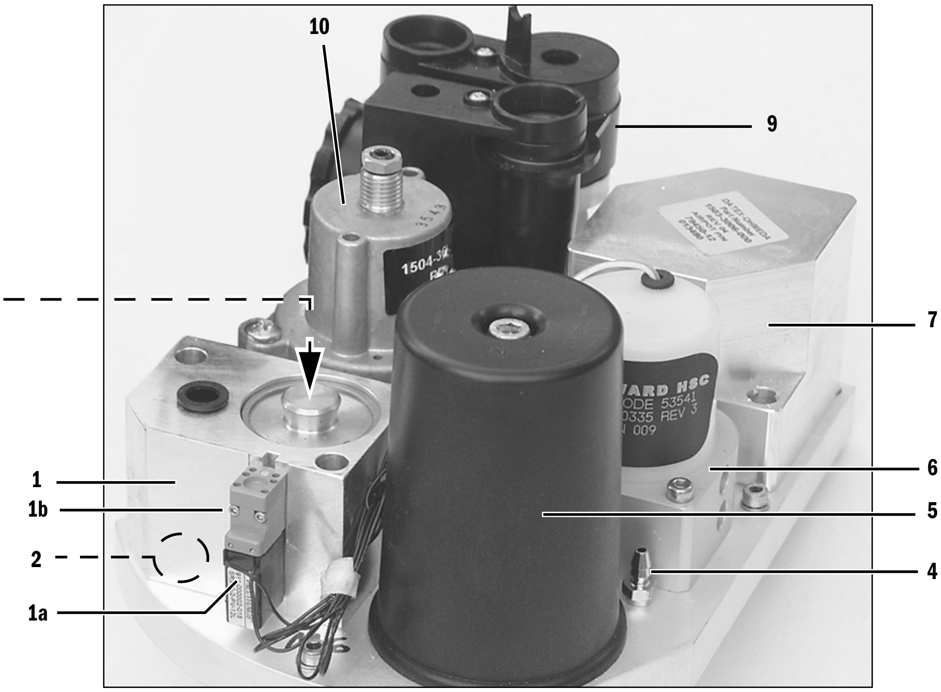
10.17 Vent Engine Housing

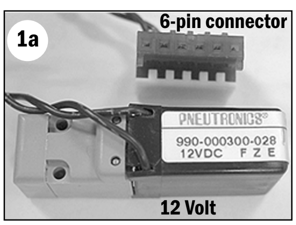


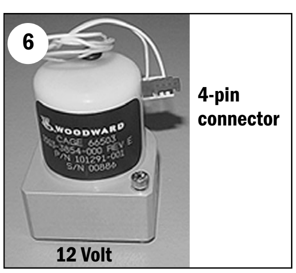
Item	Description	Stock Number	Qty
1	Vent Engine Cover Plate Assy	1407-7009-000	
2	CASTING VENT ENG HOUSING	M1226775	
3	TAB GUIDE BELLOWS BASE	1407-3313-000	(2)
4	SCR M3X16 POSI DR PAN HD A4 SST	1504-3003-000	(2)
5	Cap, Plug	1406-3524-000	
6	FITTING PNL MOUNT 3.18 HOSE BARB UNION	1504-3014-000	(2)
7	PLUG HOLE 15.9 DIA	M1137341	(2)
8	PLATE CONN VENT	1407-3321-000	
9	SCR M4X8 POZI-DR DIN84 PAN SERRATED	1006-3178-000	(3)
10	Harness, Vent Engine to Connector Plate	M1163431	
11	BLOCK LATCHING DSUB CONN	1504-3617-000	(2)
12	SCR 4-40 X 3/8 SKT BCG HD CAP	0144-2117-206	(2)
13	CLIP-SUCTION BAG HOSE, Teal Gray	M1213252	
14	SCR M5 X 16 PAN PH HD SST	9211-8350-163	(2)
15	Lockwasher	0144-1118-220	(2)
16	Vent Engine	Refer to Section 10.18	

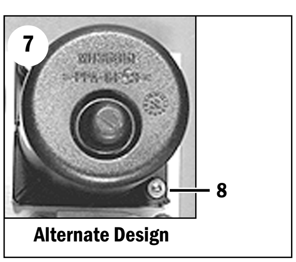
10.18 Vent Engine





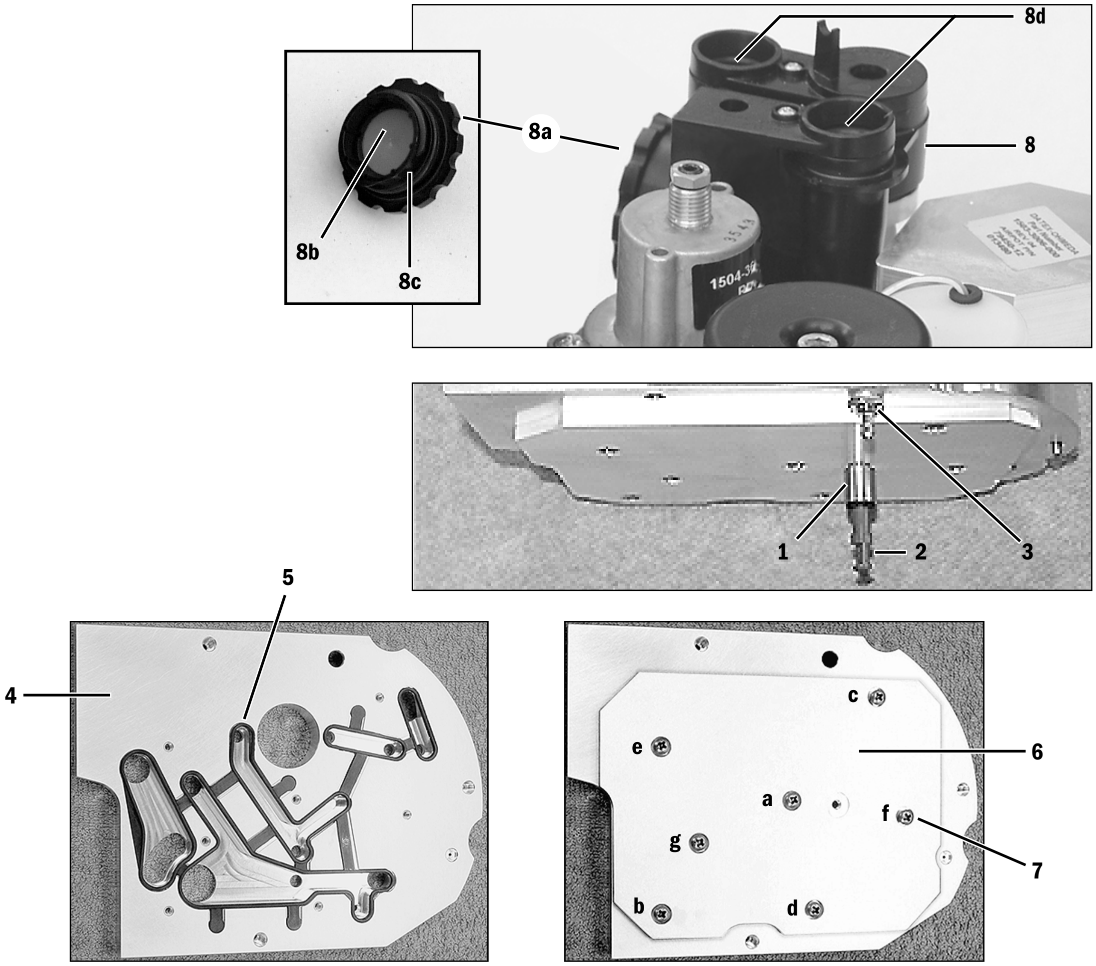






Item	Description	Stock Number
	Vent Engine Assembly, Service (Aisys CS2)	1009-8216-000
1	Gas Inlet Valve (GIV) components	Refer to Section 9.9.3
	GIV Service Kit (does not include Solenoid)	M1163730
1a	Solenoid, 3-way NO (12 Volt)	1503-3853-000
1b	Screw, M1.6x14	1006-4730-000
1c	Retaining ring, 34.9 mm	1500-3158-000
1d	Cap, inlet valve	1503-5006-000
1e	O-ring, upper Viton	9221-3032-116
1f	Shuttle, inlet valve	1503-5018-000
1g	U-cup, upper EDPM (fits on shuttle valve)	1503-3090-000
1h	U-cup, lower Viton (fits on shuttle valve)	1503-3089-000
1i	O-ring, lower Viton	1503-3108-000
2	Filter (under GIV), 2-micron (install coarse side DOWN)	1504-3708-000
4	Fitting, manifold pressure	1500-3116-000
5	Reservoir, pneumatic engine	1504-3704-000
	O-ring, base, 56.87 ID x 60.43 OD	1504-3614-000
	O-ring, screw head, 0.219 ID x 0.344 OD	0210-0686-300
	Screw, M6x90	1504-3004-000
6	Flow control valve (12 Volt)	1503-3854-000
	O-ring under flow control valve (2 each)	1503-3056-000
7	Drive gas check valve	1503-3006-000
	O-ring under drive gas check	1503-3213-000
8	Screw, M4x16	1503-3105-000
9	Interface Manifold, pneumatic engine	Refer to Section 10.18.1
10	Regulator, 172 kPa BCG	1504-3623-000

10.18.1 Vent Engine - additional components



Item	Description	Stock Number
1	Fitting, 6.35-mm (1/4-inch)	1504-3621-000
2	Plug, 6.35-mm (1/4-inch)	1503-3245-000
3	Fitting, barbed	1504-3014-000
4	Manifold	1503-3843-000
5*	Gasket, manifold	1503-3845-000
6	Plate, manifold	1503-3844-000
7**	Screw, M4x8 Pozidriv PAN	1006-3178-000
8	Interface Manifold, pneumatic engine	1504-8505-000
	(with free breathing valve and mechanical overpressure valve)	
	O-ring, 12.42 ID x 15.98 OD (2)	1006-3615-000
	8a - Seat, free breathing valve	1503-3204-000
	8b*** - Valve, flapper	0211-1454-100
	8c - O-ring	1503-3208-000
	8d**** - O-ring (2)	1504-3613-000

* Install gasket into manifold. Check to see that it is properly positioned.

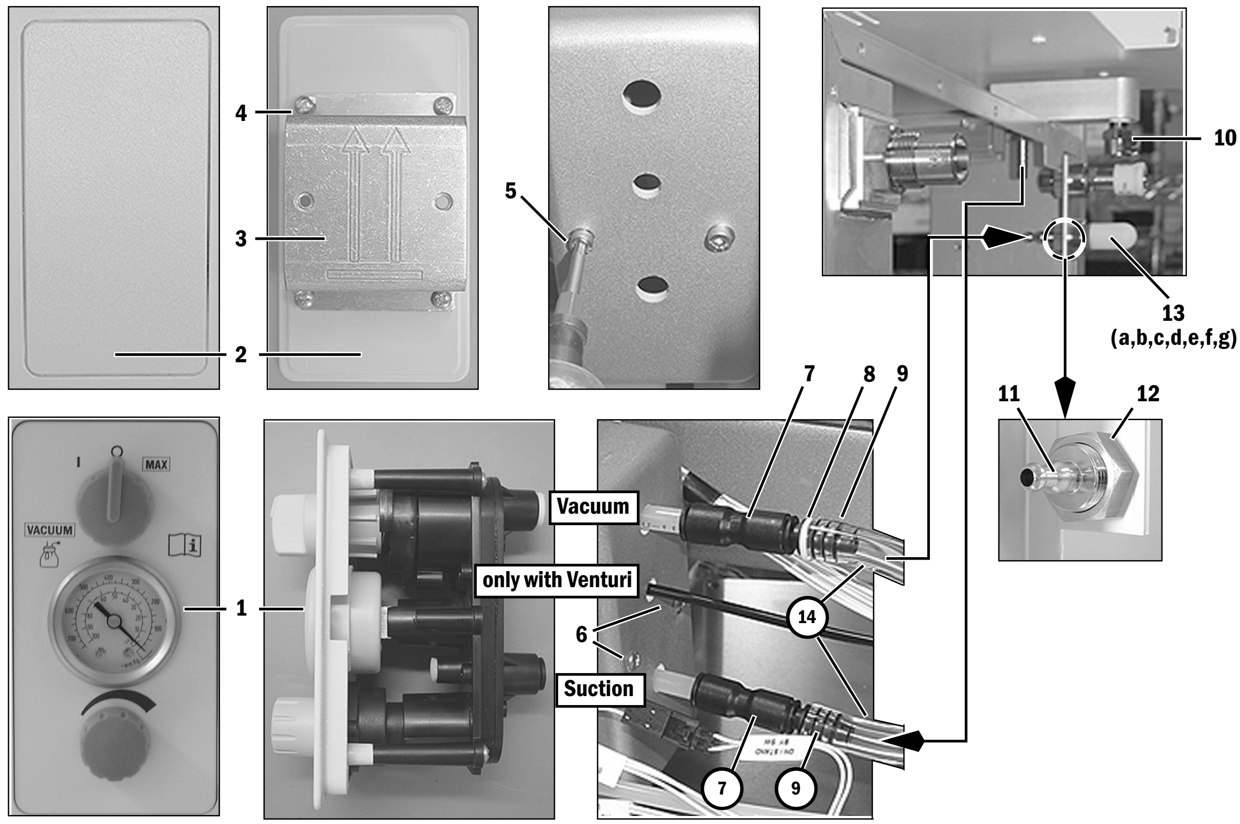
** Carefully install plate onto manifold making sure not to disturb the gasket. First, start all screws. Then, torque to 1.7 N-m (15 lb-in) using sequence shown.

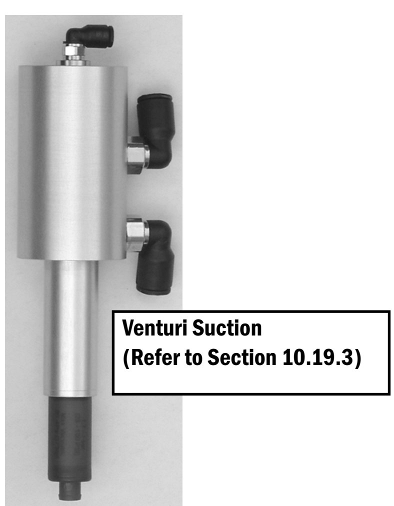
*** If necessary, clean with alcohol before installing new; trim off flush with outside surface of seat (refer to removed flapper).

**** Apply Krytox sparingly.

10.19 Integrated Suction Regulator

10.19.1 Components



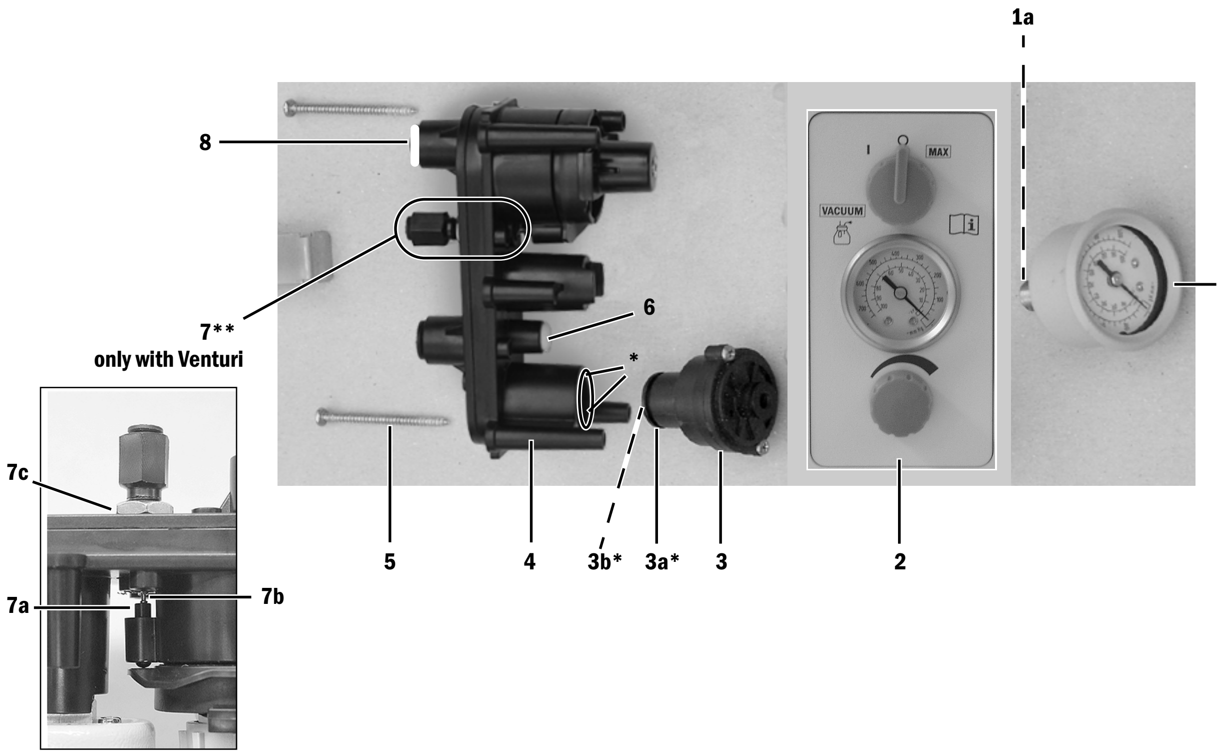


	Item	Description	Stock Number
	1	Suction Control Module	Refer to Section 10.19.2
	2	Cover, blank (if no Suction)	1011-3200-000
	3	Bracket, blank cover mounting	1011-3202-000
	4	Screw, M4x10 self-tapping	1009-5534-000
	5	Screw, M4x45 Hex	N122024
	6	Screw, #6 - 2 inch	1009-3340-000
		Washer, M4 flat	0144-1025-165
	7	Union, 8mm Legris	1006-3973-000
	8	Cap, white	1009-3385-000
	9	Fitting, barb to 8-mm Legris	1009-3137-000
	10*	Coupling, Colder insert metal	1009-3135-000
	11**	Adapter, 1/4 NPTF hose	1011-3603-000
	12	Nut, M20x1.5 Brass	1006-5065-000
	13a	Muffler, for Venturi Drive	1011-3511-000
	13b*	Connector, Barb	0221-0702-300
	13c*	Connector, NIST	1011-3524-000
	13d*	Connector, Air Liquide	1009-8292-000
	13e*	Connector, DISS	M1242889
	13f*	Connector, DISS Female (Yellow)	M1242890
	13g*	Connector, G1/4	M1242892
	14	Tubing	Refer to Section 10.33
Not Shown	15	Overflow Safety Trap	6700-0647-800

* Apply Teflon tape to threads (not 13a).

** Apply Loctite 242.

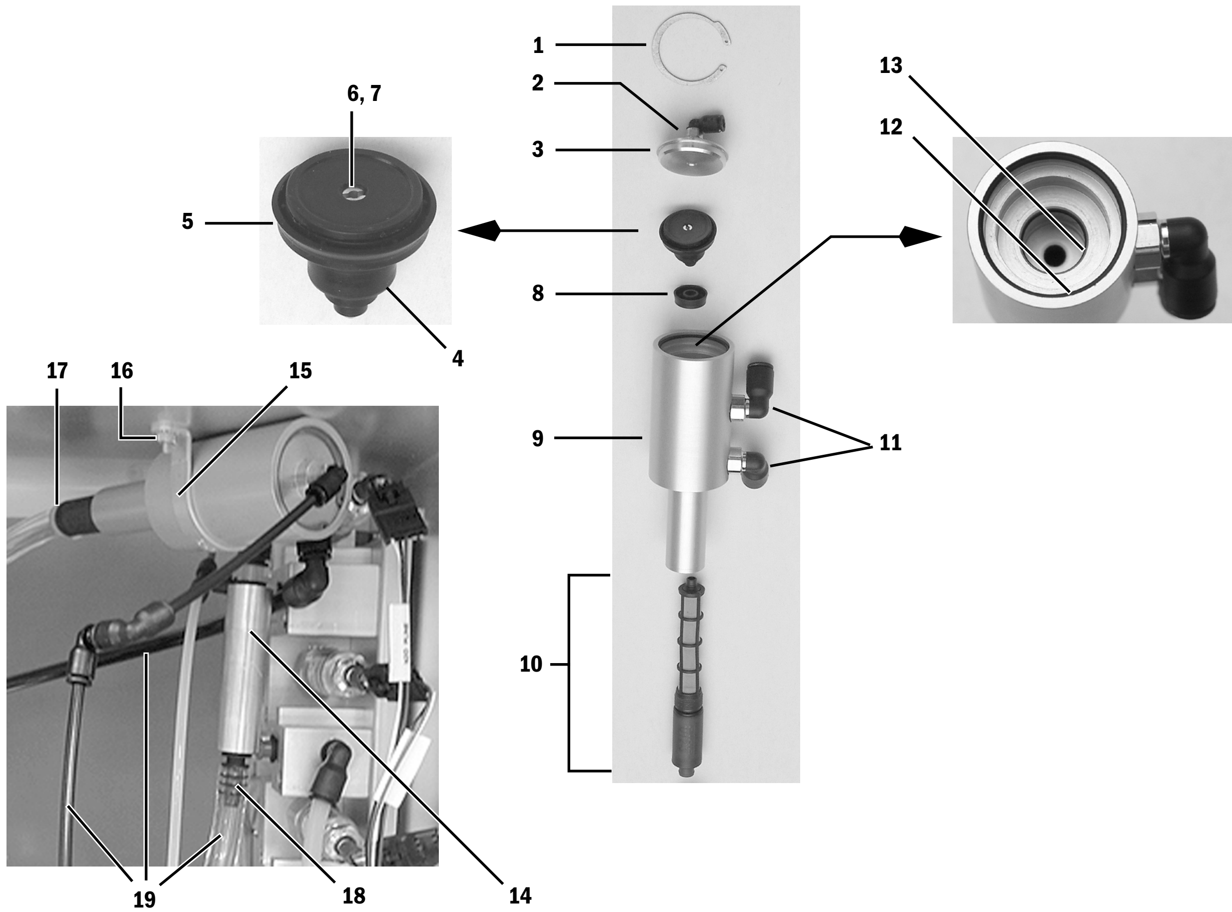
10.19.2 Suction Control Module



Item	Description	Stock Number
1	Gauge, 760 mmHg	1009-3227-000
1a	O-ring, Gauge (included with gauge assy, 2ea. required)	6700-0133-500
2	Control panel assembly, with suction regulator knob and mode control knob (does not include Gauge)	2068224-001
3	Regulator Module (plugs into manifold assembly)	6700-1225-800
3a	O-ring, Regulator Module, Large (included with regulator module)	6700-0136-500
3b	O-ring, Regulator Module, Stem (included with regulator module)	0210-0527-300
4	Manifold Assembly, without Gauge and Regulator Module	1009-3277-000
5	Screw, #6 - 2 inch	1009-3340-000
6	Filter	0206-5159-300
7	Pilot valve adapter assembly (includes plunger, jam nut, and valve assembly)	1009-3278-000
8	Cap, white	1009-3385-000

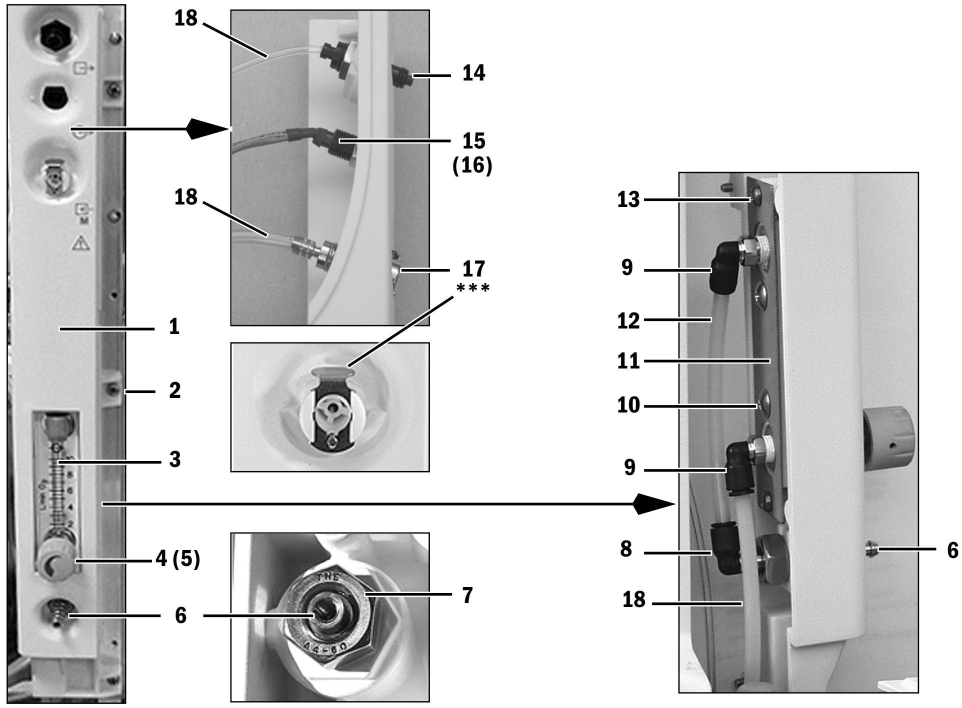
* Lubricate the regulator module o-rings and the mating bore of the manifold sparingly with Dow 111 lubricant.
** Drop the plunger (**7a**), round end first, into the manifold. Thread the pilot valve into the manifold body. Set the mode switch to raise the plunger. Adjust the pilot valve (**7b**) so that the plunger actuates the pilot valve approximately half of its travel. Tighten the jam nut (**7c**).

10.19.3 Venturi assembly

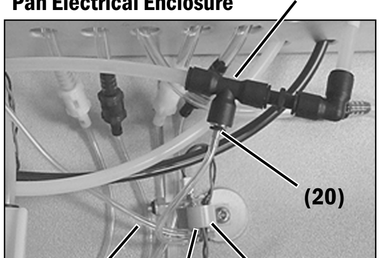


Item	Description	Stock Number
1	C-clip retainer, Truarc	1500-3158-000
2	Elbow fitting, 4-mm Legris	1006-3663-000
3	Cap	1011-5002-000
4	Poppet	1011-5001-000
5	Seal, u-cup large	1503-3090-000
6	Orifice	1011-3508-000
7	Screen, 150 mesh	1001-3808-000
8	Seal, u-cup small	1503-3089-000
9	Body	1011-5000-000
10	Venturi	1011-3509-000
11	Elbow fitting, 8-mm Legris	1011-3510-000
12	O-ring, large	9221-3032-116
13	O-ring, small	1503-3108-000
14	Check valve	1011-8002-000
15	Bracket, Venturi mounting	1011-3359-000
16	Nut, M4 Keps	0144-3717-314
17	Cable Tie	0203-5915-300
18	Fitting, barbed Legris	1009-3137-000
19	Tubing	Refer to Section 10.33

10.20 Aux O_2 Flowmeter, Et Control, and Sample Gas Return

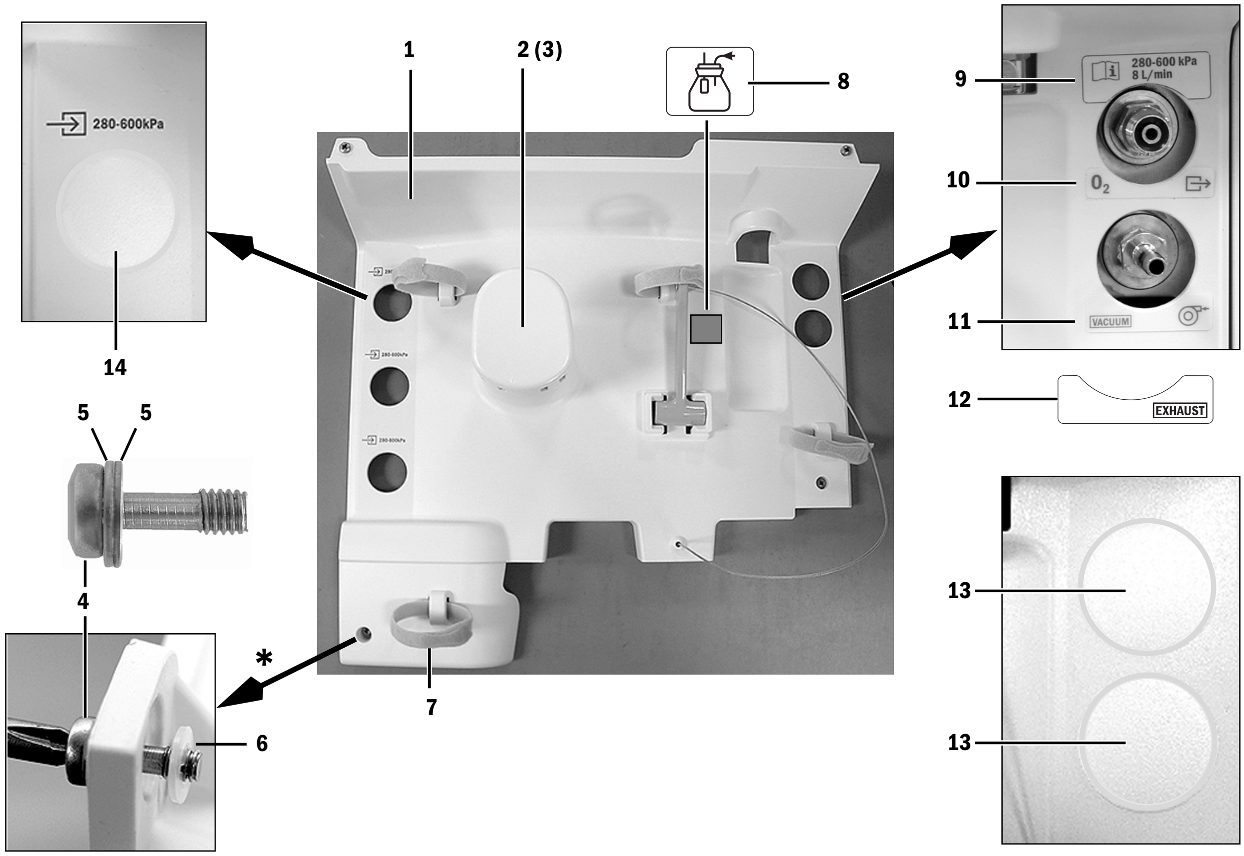


Pan Electrical Enclosure

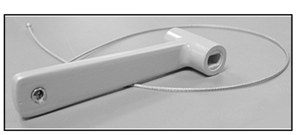


Item	Description	Stock Number
1	Cover, panel	1011-3230-000
2	Screw, M4X12 Pozidriv Pan HD	0140-6226-111
3	Flowmeter, 1-10 L/min, without fittings	1006-3841-000
4	Knob, Soft Teal	M1226468
5	Setscrew	9211-0830-053
6*	Nipple, Panel-Mount, Auxiliary O_2 Outlet	M1083541
7	Nut, M12x1.75, SST	0144-3132-140
8	Fitting, M5 BSPP x 6-mm Legris elbow	M1090972
9**	Fitting, 1/8 NPTM, 6-mm Legris elbow	1011-3824-000
10	Screw, 10-32 x 3/8	0140-6631-107
11	Plate, Flowmeter Mounting	1011-3947-000
12	Tubing, 6-mm Nylon (120 mm)	1001-3062-000
13	Screw, M4x8 Pozidriv DIN84	1006-3178-000
14	Coupling, body with nut	M1154463
15	Harness assembly; Et Control to CVIB	M1165991
16	Screw, M3x6 PT	628710
17***	Coupling, Colder	1009-3134-000
18	Tubing	Refer to Section 10.34
19	Tee, 1/4-inch x 1/8-inch (tube/tube/tube)	M1158691
20	Adapter, 1/8-inch tube to barb	M1158693
21	Valve assembly, fresh gas sample relief (Includes harness and tubing)	2068956-001
22	P-Clip	012-202
23	Screw, M4x8 DIN84	1006-3178-000
*	Apply Loctite 242.	
**	Apply Teflon tape.	
***	Note orientation of release; do not apply Loctite; tighten the nut until it is snug, so that the coupler cannot be rotated by hand — do not overtighten.	

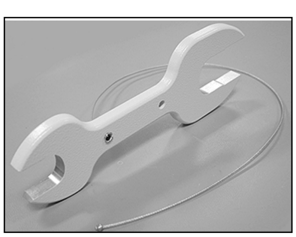
10.21 Rear panel components



15 (17, 18)



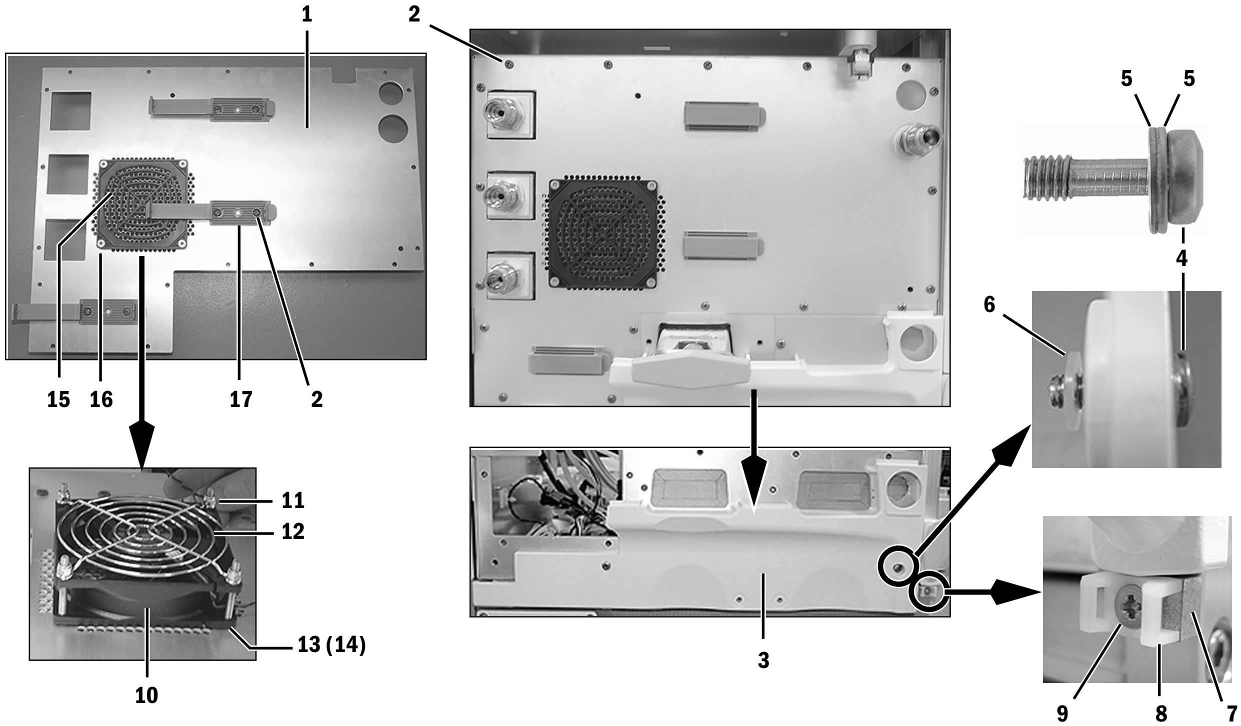
16 (17, 18)

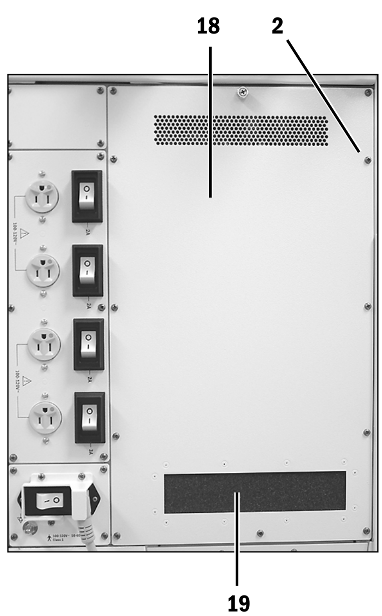


Item	Description	Stock Number
1	Cover, rear upper	1011-3227-000
2	Cap, hose reel	1009-3075-000
3	Screw, M5x20 BHSCS PT THD FORMING	1009-3384-000
4	Screw, M4x12 relieved	1504-3001-000
5	Washer, M4 flat	0144-1025-165
6	Washer, M4 retaining Nylon	1009-3178-000
7	Strap, hook/loop	1009-3233-000
8	Label set, Vacuum Input - Suction Bottle	1006-0275-000
9	Label, power outlet rating	2070918-001
10	Label, power outlet	1011-3563-000
11	Label, Vacuum (Pipeline Suction)	1011-3564-000
12	Label, Exhaust (Venturi Suction)	M1122792
13	Plug, 31.8 DIA hole	1011-3822-000
14	Plug, 38.1 DIA hole	1011-3971-000
15	Wrench, Pin Index cylinder (with cable)	0219-3415-800
16	Wrench, DIN cylinder (does not include cable)	1202-3651-000
17	Cable	1010-3049-000
18	Ferrule, cylinder wrench cable retainer	1001-3708-000

* Five locations

10.22 Panels, rear

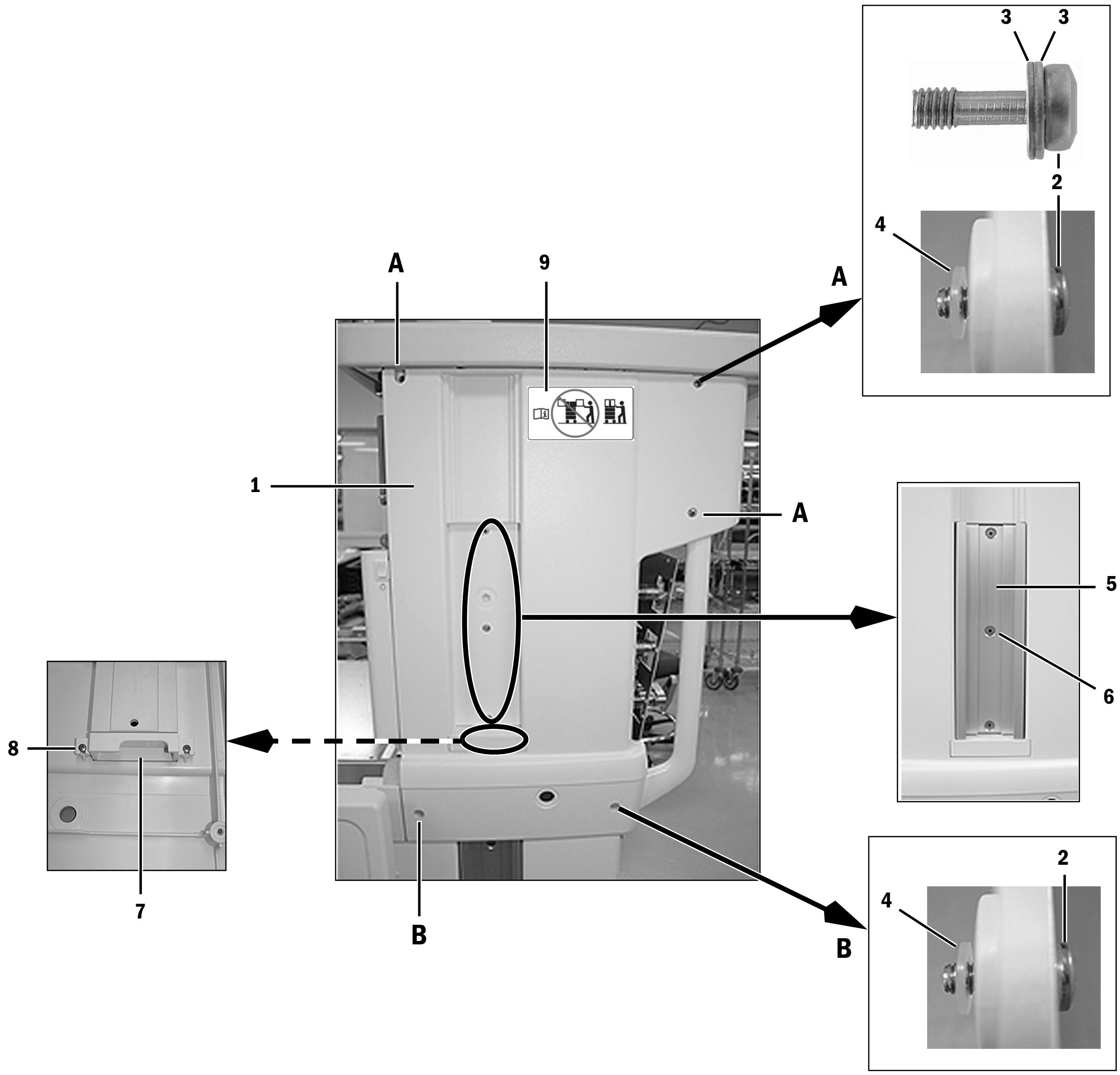




Item	Description	Stock Number
1	Panel, upper electrical rear	1011-3240-000
2	Screw, M4x8	1006-3178-000
3	Panel, cosmetic rear lower	1011-3655-000
4	Screw, M4x12 relieved	1504-3001-000
5	Washer, M4 flat	0144-1025-165
6	Washer, M4 retainer Nylon	1009-3178-000
7	Spacer, cable tie	1011-3657-000
8	Holder, cable tie	1011-3607-000
9	Screw, M4x16 FL HD	0140-6226-116
10*	Fan	1009-5697-000
11	Nut, M4 Keps	9212-0340-001
12	Guard, fan	0208-2737-300
13	O-ring, retaining	0210-0526-300
14	Washer, M4 flat	0144-1025-165
15	Filter with mount	0208-2734-300
16	Screw, M4x20	0144-2117-724
17	Clip, cable flat	1011-3653-000
18	Panel, lower electrical rear	1011-3208-000
19	Filter, foam	1011-3214-000

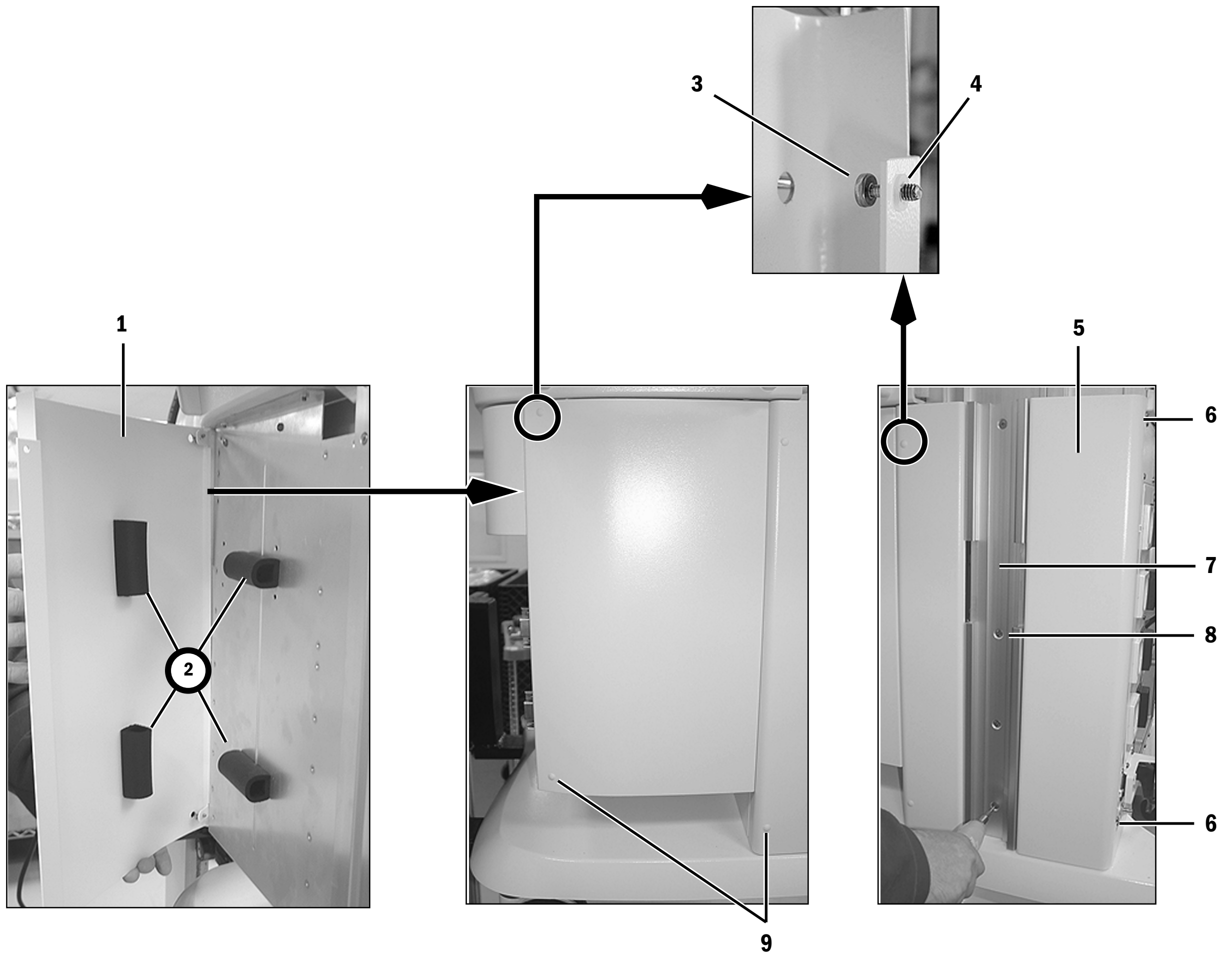
* Note: Air flow into electrical enclosure.

10.23 Panel, cosmetic upper right-side



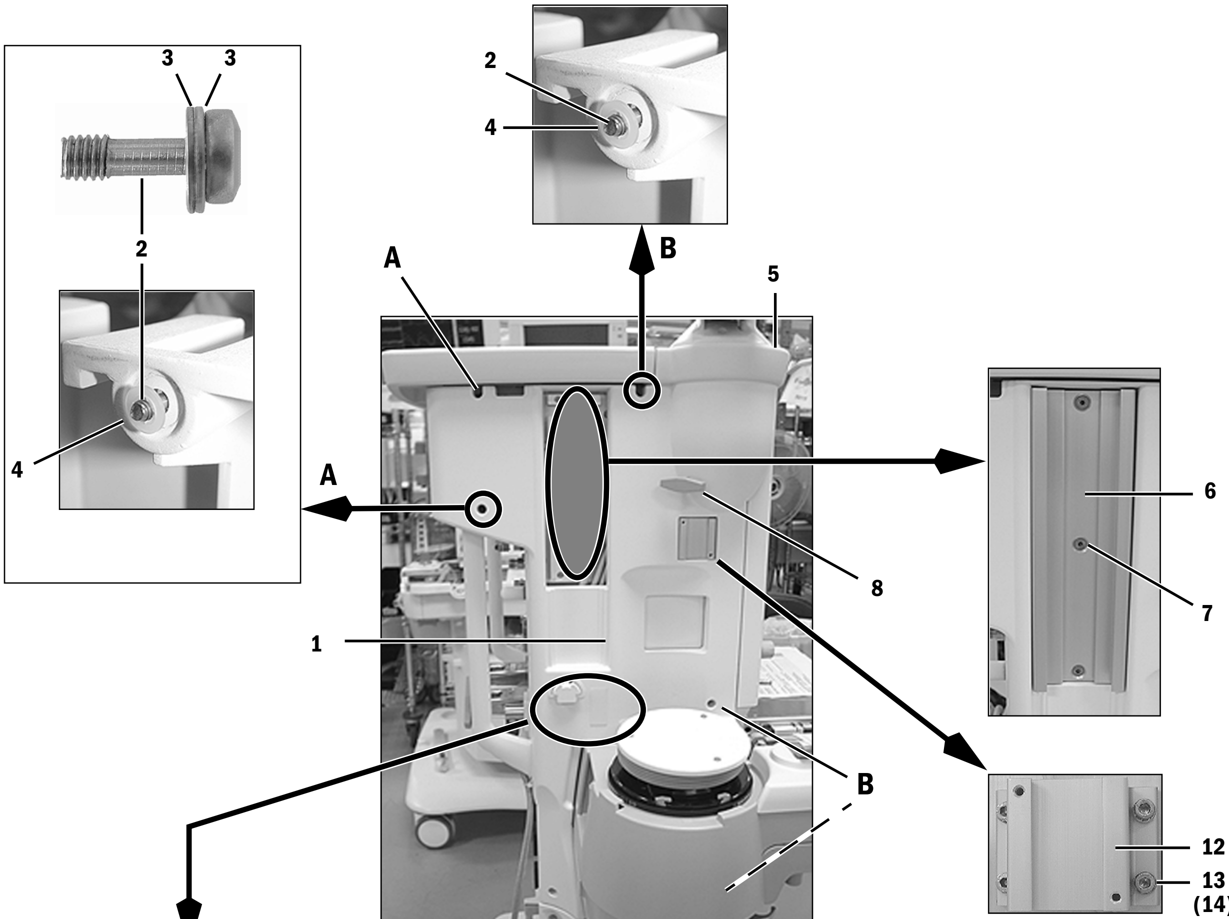
Item	Description	Stock Number
1	Panel, upper right cosmetic	1011-3222-000
2	Screw, M4x12 relieved	1504-3001-000
3	Washer, M4 flat	0144-1025-165
4	Washer, M4 retainer Nylon	1009-3178-000
5	Extrusion, dovetail/GCX upper	1011-3605-000
6	Screw, M5x16	0144-2117-727
7	Plug	1011-3619-000
8	Screw, M4x8	1006-3178-000
9	Label, transport	M1090653

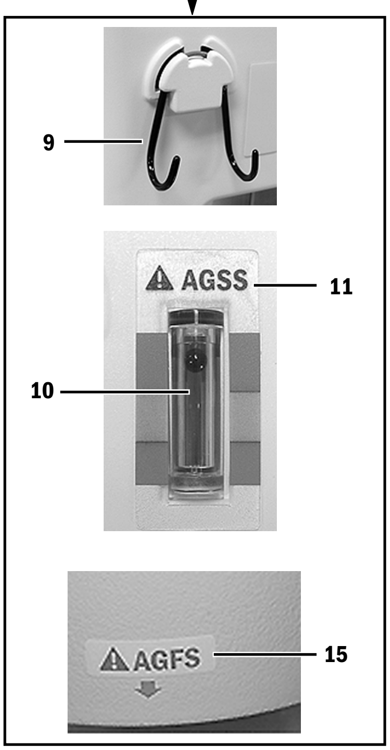
10.24 Panel, cosmetic lower right-side



Item	Description	Stock Number
1	Panel, lower drawer cosmetic	1011-3379-000
2	Seal	1006-4154-000
3	Screw, M4x12 relieved	1504-3001-000
4	Washer, M4 retainer Nylon	1009-3178-000
5	Panel, lower right-rear cosmetic (for pendant machines)	1011-3223-000 1011-3926-000
6	Screw, M4x8	1006-3178-000
7	Extrusion, dovetail/GCX lower	1011-3606-000
8	Screw, M5x16	0144-2117-727
9	Plug, 7.9 mm DIA hole	1011-3823-000

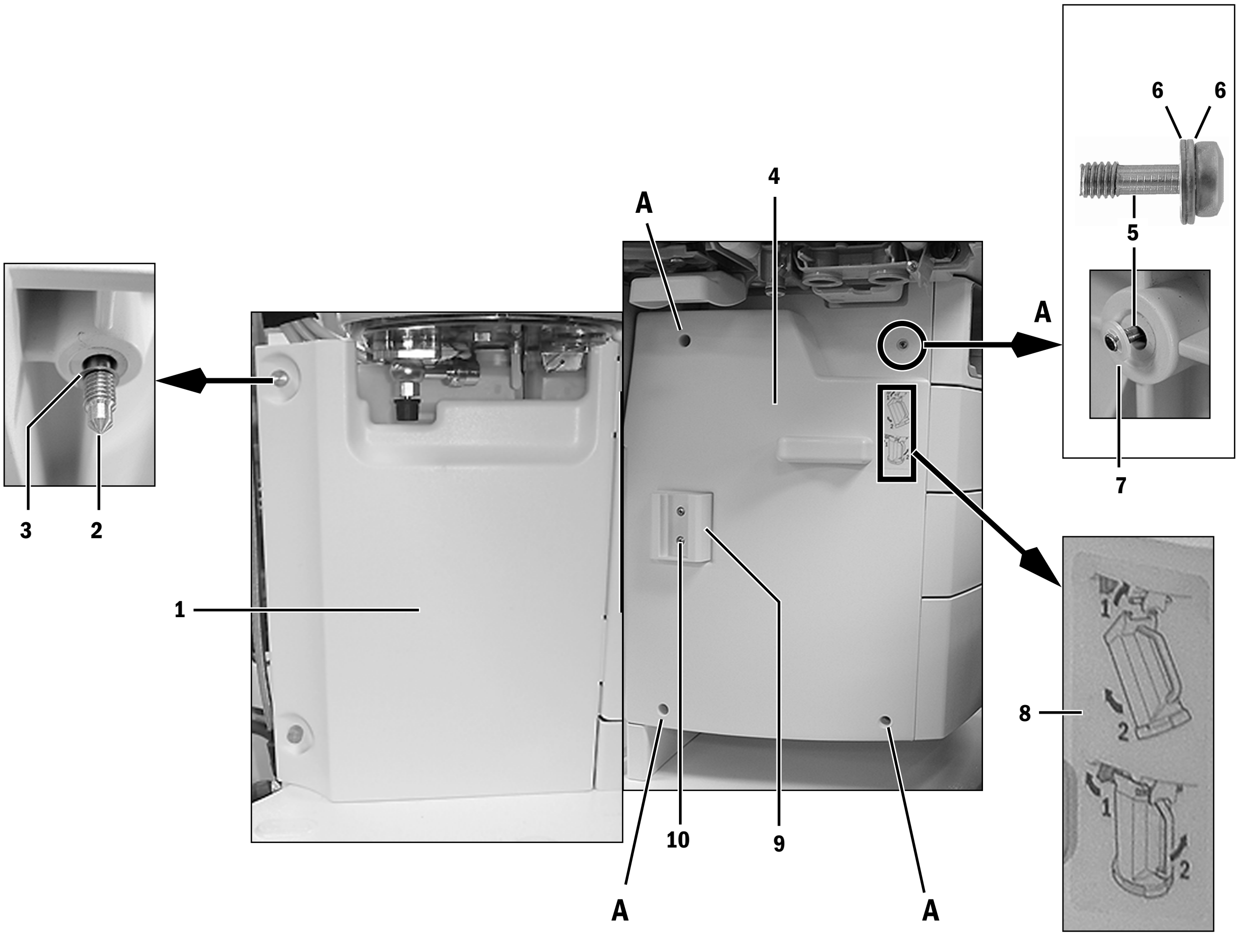
10.25 Panel, cosmetic upper left-side





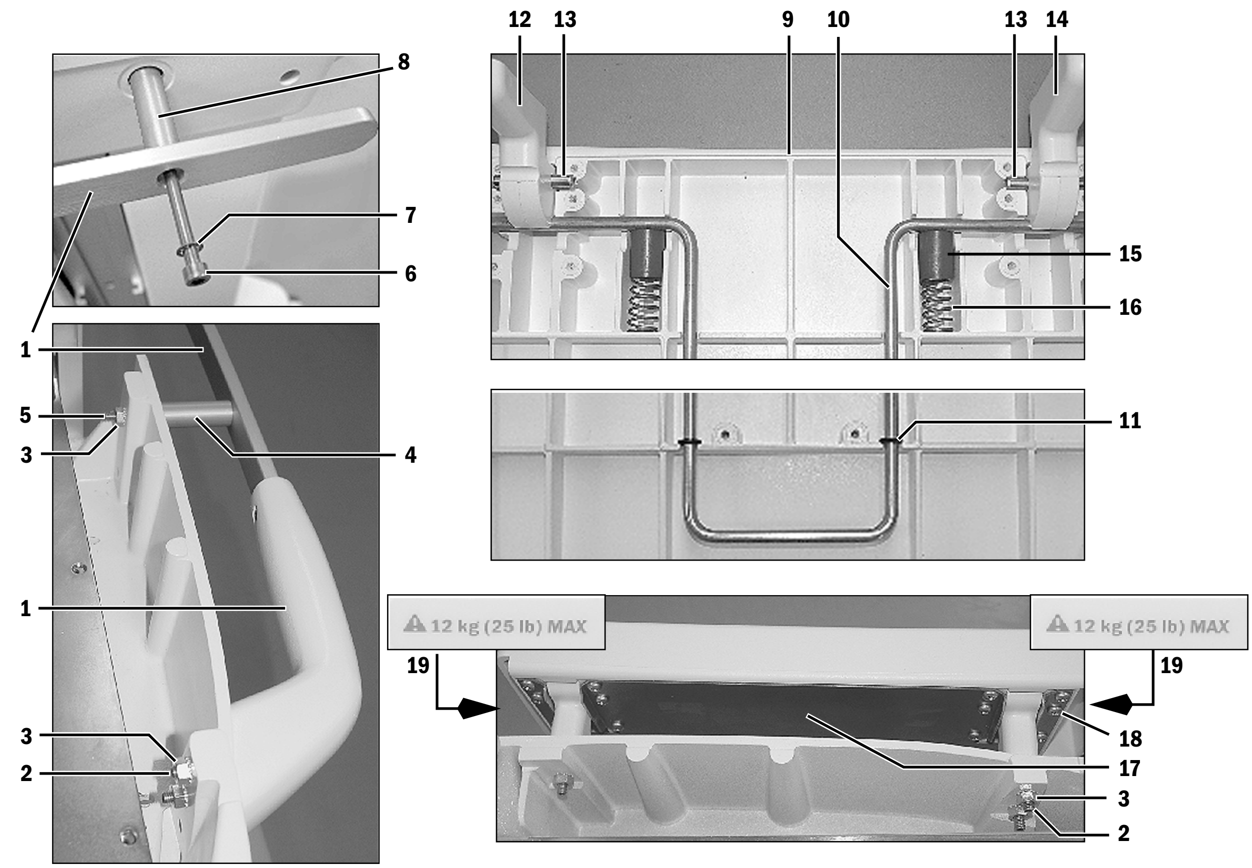
Item	Description	Stock Number
1	Panel, upper left cosmetic	1011-3224-000
	(for pendant machines)	1011-3927-000
2	Screw, M4x12 relieved	1504-3001-000
3	Washer, M4 flat	0144-1025-165
4	Washer, M4 retainer Nylon	1009-3178-000
5	Screw, M4x8	9211-0640-083
6	Extrusion, dovetail/GCX upper	1011-3605-000
7	Screw, M5x16	0144-2117-727
8	Handle, clamping display arm	2065581-001
9	Hook	1006-4192-000
10	Flowtube, AGSS	1406-3560-000
11	Label, flow indicator AGSS	1406-3527-000
	Label, flow indicator AGFS (for German variant)	1009-3301-000
	Label, blank (for machines without flow indicator)	1009-3241-000
12	Dovetail, CMA upper	1011-3307-000
13	Screw, M5x20 SKT HD CAP	0144-2131-919
14	Lockwasher, M5 internal	1011-3651-000
15	Label, AGFS (for German variant)	M1241823

10.26 Panel, cosmetic lower left-side



Item	Description	Stock Number
1	Panel, lower left AGSS cover	1011-3225-000
	(for pendant machines)	1011-3928-000
2	Screw, M6x43 thumb	1406-3304-000
3	Washer, split	1406-3319-000
4	Panel, cosmetic drawer left	1011-3277-000
5	Screw, M4x12 relieved	1504-3001-000
6	Washer, M4 flat	0144-1025-165
7	Washer, M4 retainer Nylon	1009-3178-000
8	Label, CO_2 canister	1011-3946-000
9	Bracket, suction reservoir	1009-3107-000
10	Screw, M4x16	9211-0440-163
11	Lockwasher, M4	9213-0540-003

10.27 Side handle and flip-up shelf.



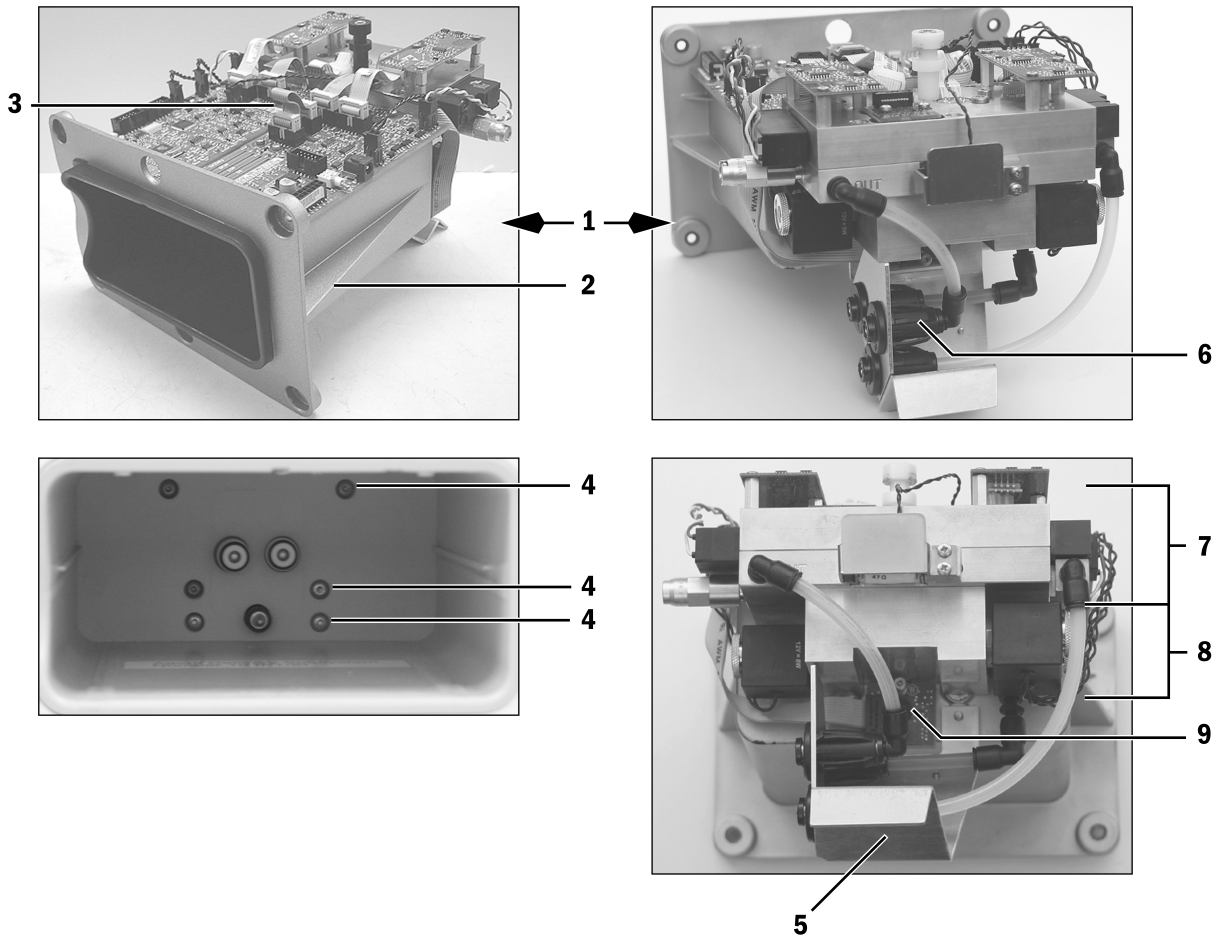
Item	Description	Stock Number	Qty
1	Side handle and rail assembly	M1135208	
2*	Screw, M6x40 CUP PT SET	1011-3204-000	(2)(3)
3	Nut, M6 Keps	0144-3717-330	(3)(3)
4	Standoff, 45.5	1011-3649-000	
5	Screw, M6x80 SKT HD CAP	0144-2131-913	
6	Screw, M6x90 SKT HD CAP	1504-3004-000	
7	Lockwasher, M6 internal	0144-1118-130	
8	Standoff, 80.9	1011-3648-000	
9**	Shelf, flip-up	1011-3377-000	
10	Rod, locking	1006-5040-000	
11***	O-ring, OD 10.47	1006-3613-000	(2)
12	Bracket, flip-up shelf RH (one mounting hole)	1011-3647-000	
13	Pin, hinge side shelf	1006-5041-000	(2)
14	Bracket, flip-up shelf LH (two mounting holes)	1011-3646-000	
15	Plug, cap	1006-3654-000	(2)
16	Spring	0203-3510-300	(2)
17	Plate	1006-3013-000	
18	Screw, M8x1	1006-3243-000	(14)
19	Label, 12 kg (25 lb) MAX	1006-4656-000	(2)

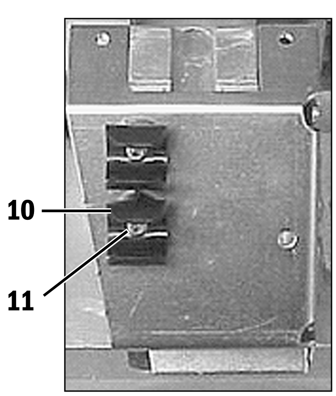
* Apply Loctite 242 to handle/shelf bracket end.

** Apply a weight label (**Item 19**) to each side of the shelf.

*** O-ring should contact rib when rod is in forward position.

10.28 Electronic Vaporizer



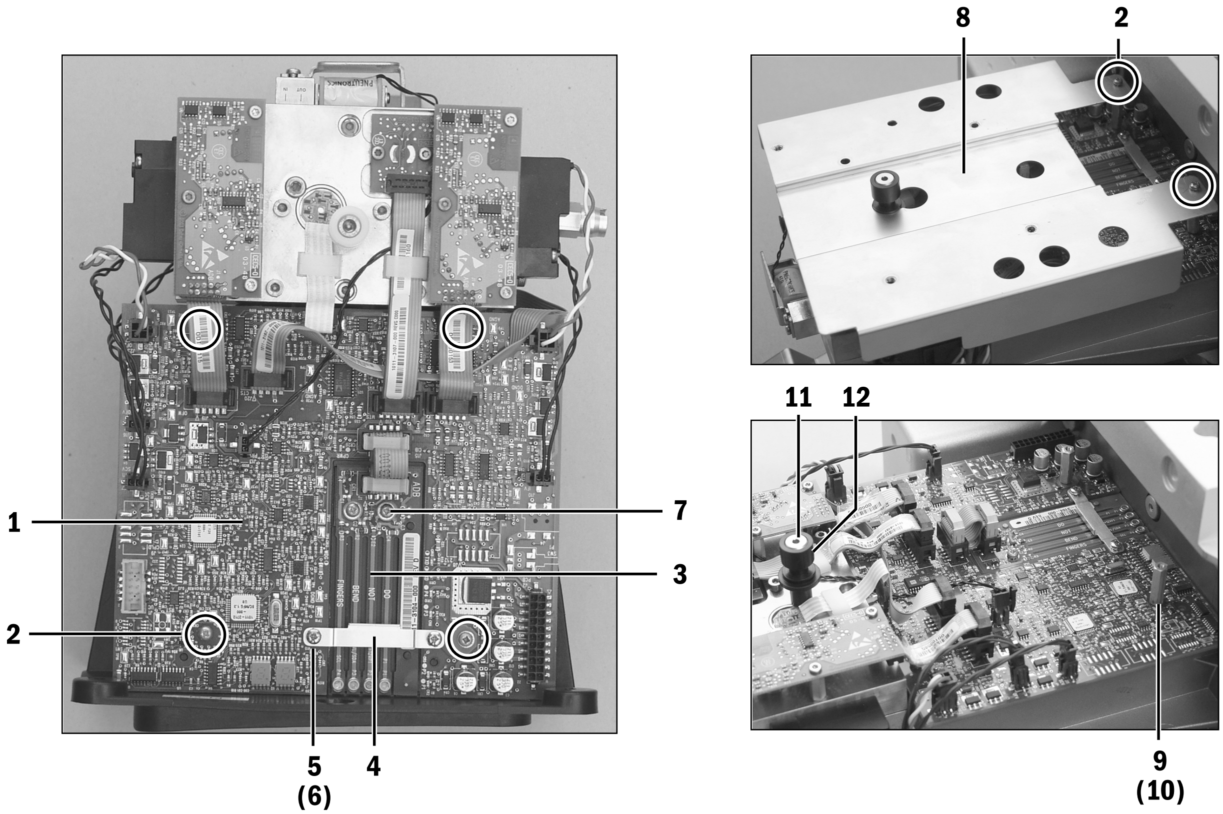


Item	Description	Stock Number	Qty
	Kinked Tubing Prevention Kit	M1166524	
1	Electronic Vaporizer Assembly	1011-7004-000-S	
2*	Cassette Bay, with Insulator installed	1011-3054-000-S	
3	Cable, Jumper	1011-3552-000	
4	Screw, M4x8 BT SKT HD SST Type 316 (6)	0140-6226-118	(6)
5**	Bracket, Support	1011-3137-000	
6	Union, Snap-in Bulkhead, 1/4-inch	M1130871	(3)
7	Flowmeter Subassembly	Refer to Section 10.28.3	
8	Valve Block Subassembly	Refer to Section 10.28.2	
9	Cassette Temperature Subassembly	1011-7002-000-S	
10	Clip, 8-mm Union Fitting	M1136830	
11	Screw, M3x8 Socket Head Cap	1006-3865-000	

* The original cassette bay included threaded inserts to mount the Cassette Interface Board using Sems screws. The current cassette bay uses studs to mount the Cassette Interface Board with nuts and washers instead (hardware included in kit). Refer to Section 10.28.1 for required hardware.

** The current bracket is backwards compatible with the original bracket.

10.28.1 Electronic Vaporizer Agent Delivery

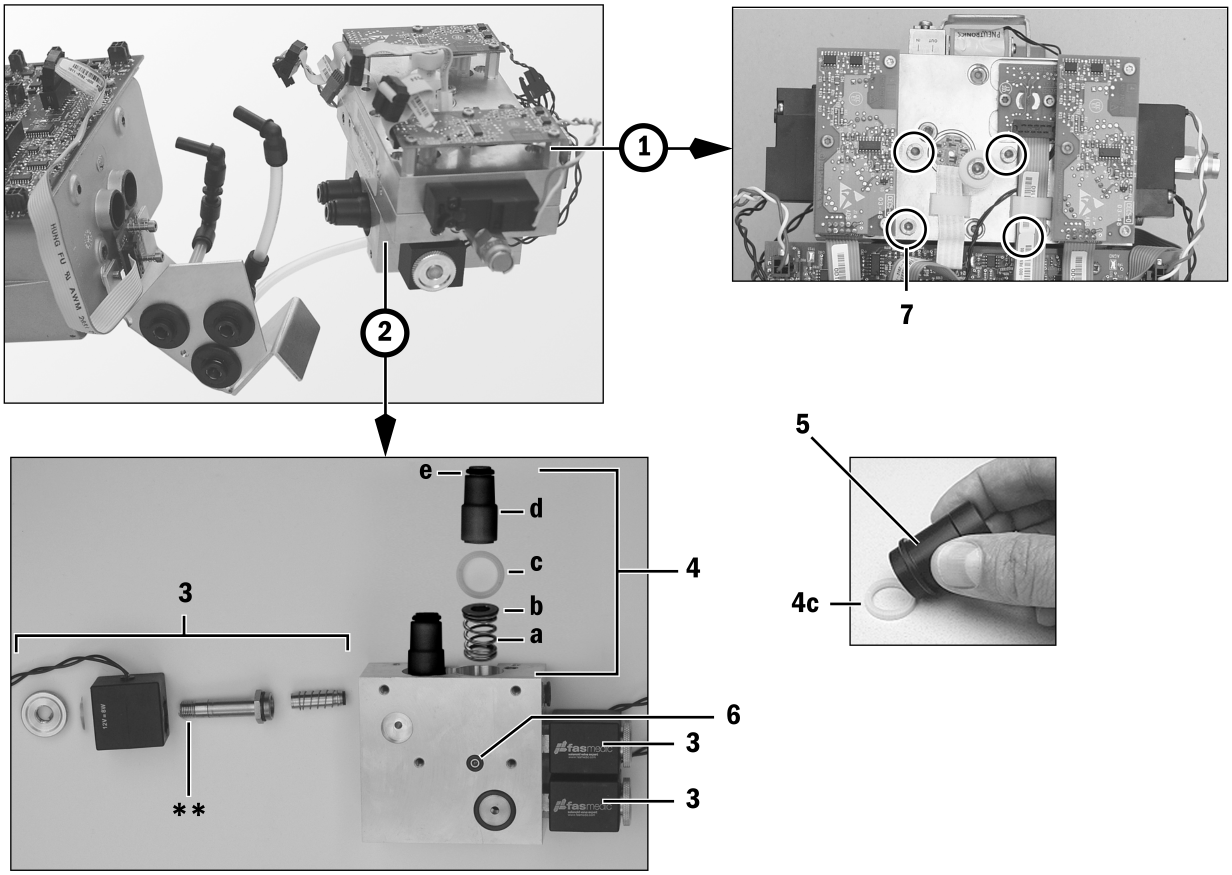


Item	Description	Stock Number	Qty
1	Agent Delivery Board	1011-3105-000-S	
2	Screw, Sems M3x6 Pozidriv Pan HD	0140-6219-128	(4)
3	Cassette Interface Board	1011-3104-000-S	
4	Bracket, Cassette Interface Board	1011-3571-000	
5	Screw M3x8 Pozidriv Pan HD	N111301	(2)
6	Lockwasher, M3 External	9213-0530-003	(2)
7a*	Screw, Sems M3x6 Pozidriv Pan HD	0140-6219-128	(2)
7b*	Stud, M3	M1111335	(2)
	Nut, M3	0144-3536-112	(2)
	Washer, M3	N115001	(2)
8	Cover Kit (includes Items 9 through 12)	M1126638	
9	Standoff, M3x28	M1123585	(2)
10	Lockwasher, M3 external	9213-0530-003	(2)
11**	Bolt, shoulder	M1123480	
12**	Hanging pin	M1126635	

* **Item 7a** used with original cassette bays. **Items 7b** used with current cassette bays.

** Use together if replacing in an original eVap without the cover.

10.28.2 Electronic Vaporizer - Valve Block

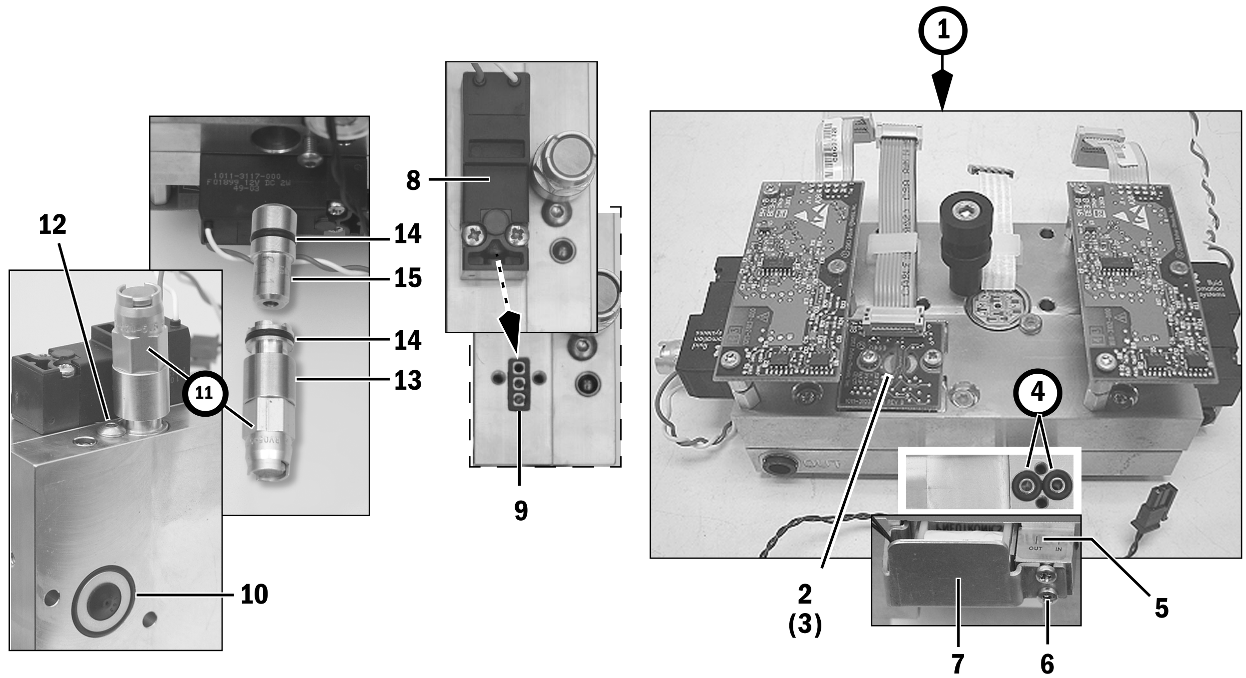


Item	Description	Stock Number	Qty
1	Flowmeter Subassembly	Refer to Section 10.28.3	
2*	Valve Block Subassembly	1011-7000-000-S	
3**	Valve, Solenoid 2-way BCG	1011-3115-000	(3)
4	Valve Connector Assembly	1011-7003-000-S	(2)
	4a - Spring	-----------------------	
	4b - Bushing, alignment	-----------------------	
	4c - Seal, Spring energized	-----------------------	
	4d - Connector Assembly	-----------------------	
	4e - O-ring ID7.00 BCG OD11.00 Viton Duro 75	1011-3125-000	
5	Insertion tool, spring energized seal	Refer to Section 10.1	
6	O-ring, ID3.68 OD7.24 BCG Viton Duro 75	1011-3139-000	
7	Screw, M4x45 Hex Cap Head	N122024	(4)

* The Valve Block Subassembly (**Item 2**) includes the Inflow Check Valve Assembly (**Item 10** on the following page).

** Apply a thin coat of silicone sealant (Refer to Section 10.1.6) to threads of mounting post after mounting the solenoid but prior to securing the thumb nut. Install the washer with the dome facing outward (toward nut) and the nut with raised surface against the washer.

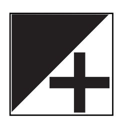
10.28.3 Electronic Vaporizer - Flowmeter Assembly



Item	Description	Stock Number	Qty
1*	Flowmeter Subassembly	1011-7001-000-S	
2	Manifold Temperature Sensor Board	1011-3107-000-S	
3	Screw, Sems M3x6 Pozidriv Pan HD	0140-6219-128	(2)
4	O-ring, ID3.68 OD7.24 BCG Viton Duro 75	1011-3139-000	(2)
5	Valve, Flow Control BCG	1011-3118-000	
6	Screw, M3x20 Pozidriv Pan HD	0140-6719-103	(2)
7	Bracket	1011-3989-000	
8	Valve, 3-Way Inflow/Outflow Zero	1011-3117-000	(2)
9	Gasket	1011-3136-000	(2)
10*	Inflow Check Valve Assembly	M1106739-S	
11	Valve, Relief 5.5 psi	1006-4128-000	
12	Screw, M4x8 BT SKT HD SST TYPE 316	0140-6226-118	
13	Plug, Backpressure Valve	1011-3142-000	
14	O-ring, Viton .364ID BCG .504OD X .070W	1605-3071-000	(2)
15	Valve, Backpressure	1011-3983-000	

* The Flowmeter Subassembly (**Item 1**) and the Valve Block Subassembly (**Item 2** on the previous page) include the Inflow Check Valve Assembly (**Item 10**).

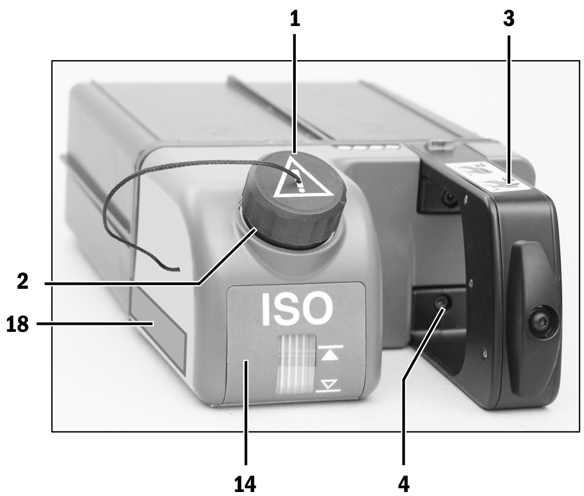
10.29 Aladin$_2$ Cassette Components

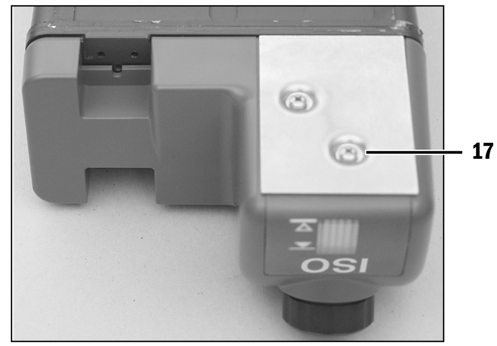
Item	Description		Stock Number	Qty
1	Filler cap (**includes O-ring and tether**)			
		for non-DES cassette	1100-3043-000	
		For Fixed Filler DES cassette	M1230022-S	
2	O-ring, filler cap			
		for non-DES cassette	1100-3135-000	
		For Fixed Filler DES cassette	M1230027-S	
3	Handle		1100-8001-000	
4	Screw, handle		1100-3134-000	(2)
5	Agent Cassette board		1011-3170-000	
6	Screw, M3x10 with Nylon, SKT HD CAP	non-DES	M1059773	(2)
7	Screw, M3x10 with Nylon, HEX HD CAP	DES	M1083995	(2)
8	Washer, insulating	DES	N115003	(2)
9	Relief Valve, DES cassette only	DES	1100-3077-000	
10	Sight glass, with two o-rings		1100-3083-000	
11	O-ring, sight glass		1100-3114-000	(2)
12	Screw, sight glass		1100-3134-000	(2)
13	Contact retainer		1100-3044-000	
14	Front labels, with Enhanced Temperature Sensing			
		(**See Note**) DES	1100-3052-000	
		ENF	M1127133	
		ISO	M1127135	
		SEV	M1127137	
	Front labels, without Enhanced Temperature Sensing			
		ENF	1100-3053-000	
		ISO	1100-3055-000	
		SEV	1100-3056-000	
15	Masks			
		(**See Note**) DES	1100-3058-000	
		ENF	1100-3059-000	
		ISO	1100-3061-000	
		SEV	1100-3062-000	
		Test	1011-3920-000	
16	Screw, M3x10 with Nylon, SKT HD CAP		M1059773	
17	Screw, bottom plate		6019-5404-301	(2)
18	Label, OEM			
		Baxter	1100-3140-000	
		Abbott SEVO	1100-3139-000	

Note:

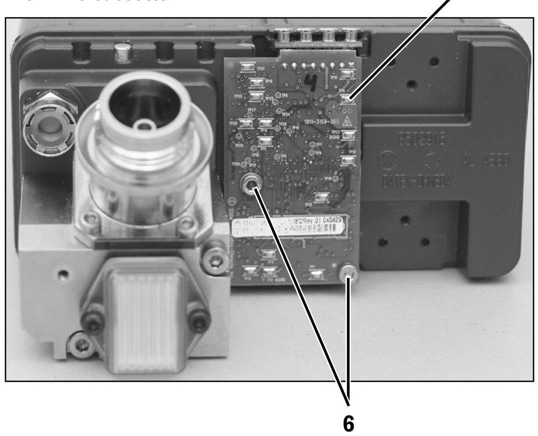
The Front Label and the Mask for a Saf-T-Fil DES cassette are available separately.

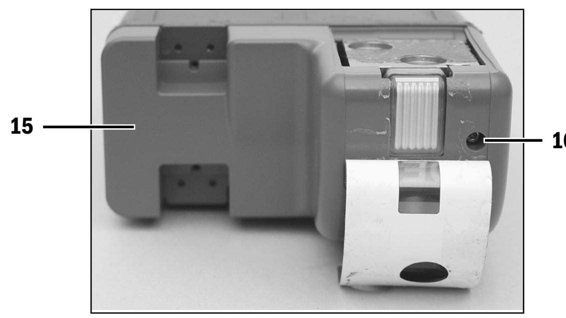
For the Fixed Filler DES cassette, the Front Label and Mask are available together in Kit M1232293.

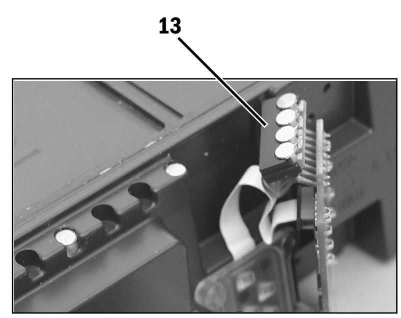




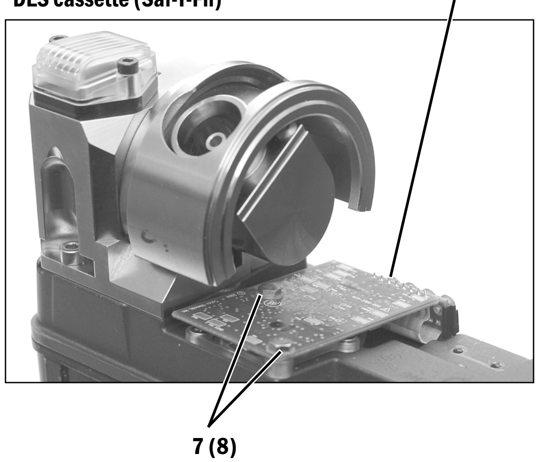
non-DES cassette

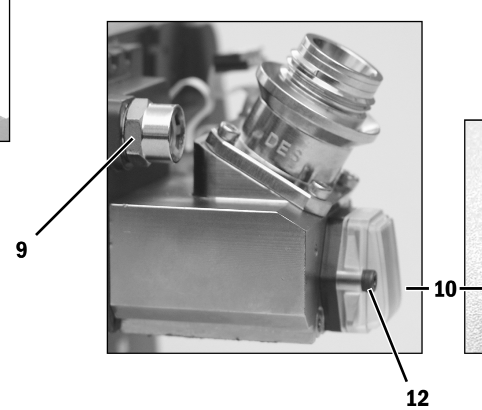


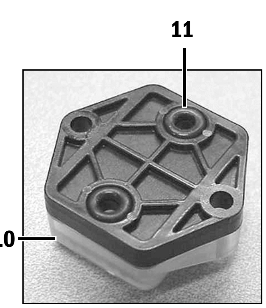




DES cassette (Saf-T-Fil)







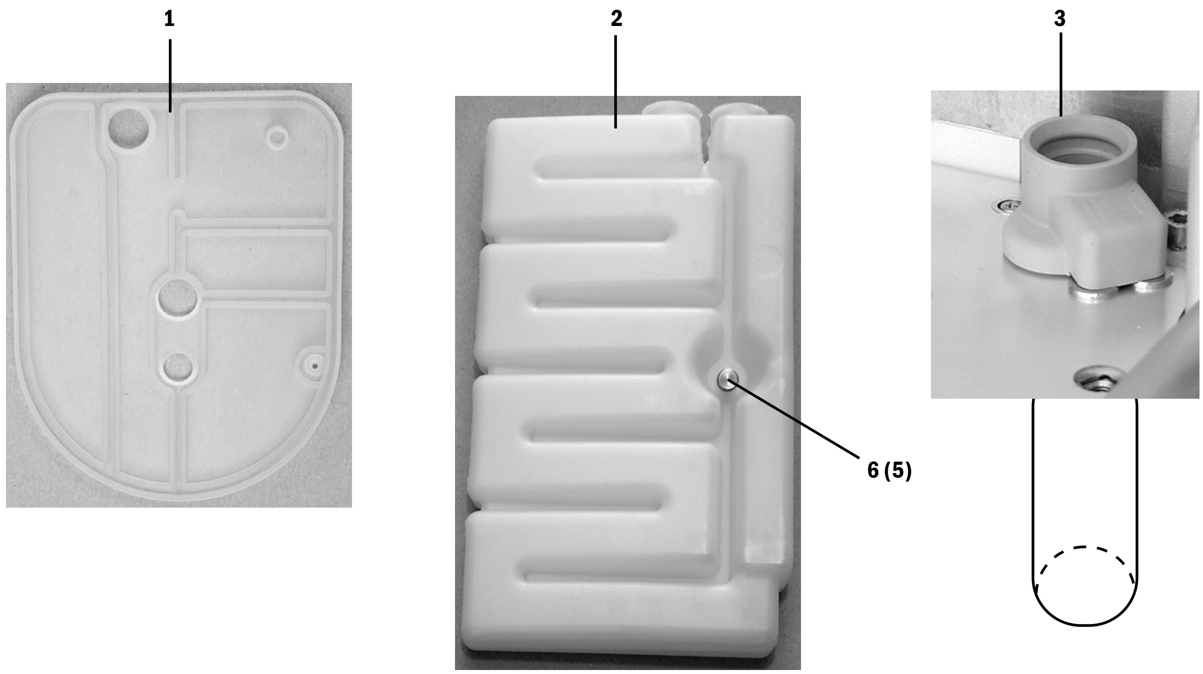
10.30 Anesthetic Gas Scavenging System — AGSS

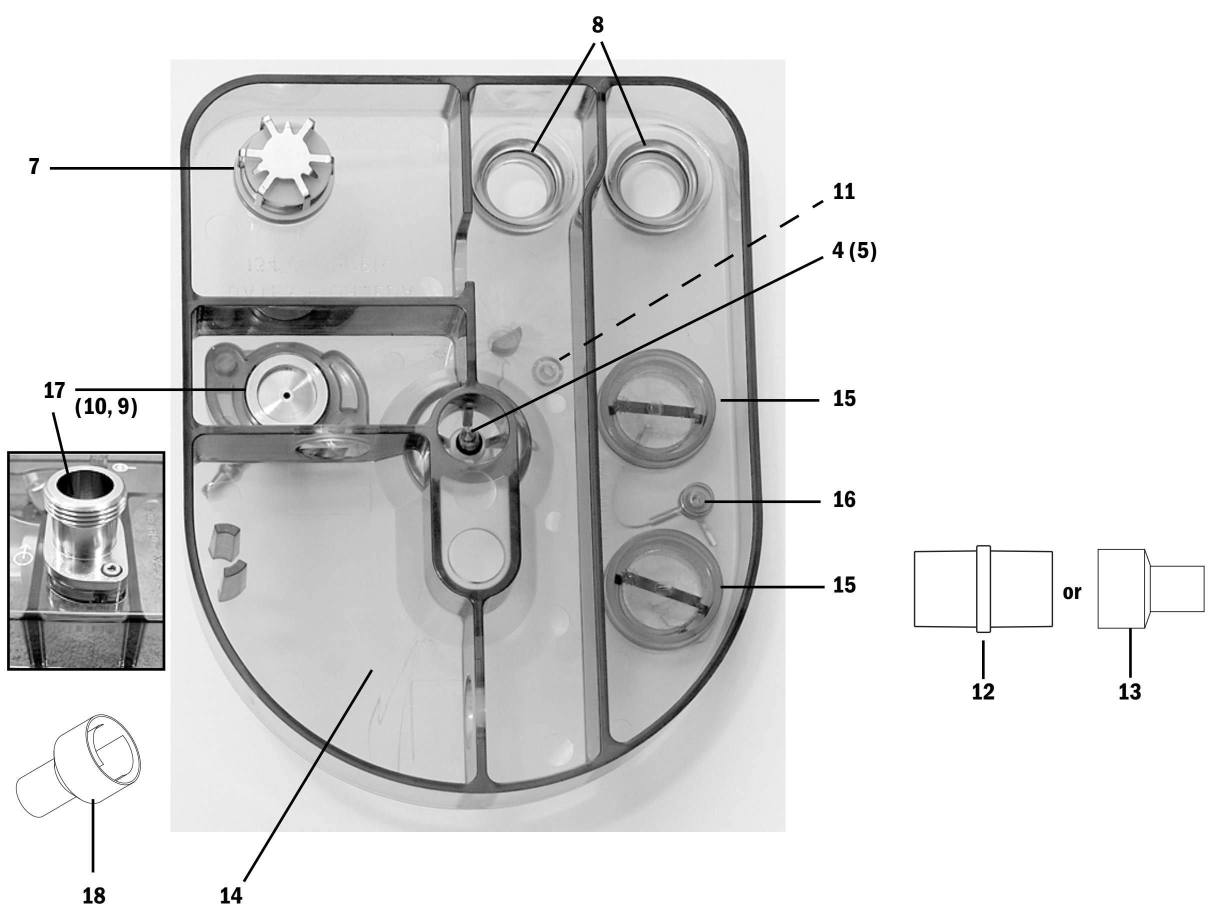
10.30.1 Passive AGSS

Items 1 through 13 are common within all AGSS systems.

Item	Description, Common Parts	Stock Number	Qty
1	Seal, Receiver Body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	Seal and scavenging down-tube	1407-3904-000	
4	Thumbscrew, M6x28.5	1406-3305-000	
5	O-ring, 4.42 ID, 9.65 OD	1407-3923-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	1406-8219-000	
7a	Seat, Valve, Negative Pressure	1406-3396-000	
7b	Retainer, disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 25.51 OD	1406-3558-000	
10	Screw, M4x8	9211-0640-083	(2)
11	Cap, 3.18 Barb, Silicone	1406-3524-000	
12	Adapter, auxiliary inlet, 30-mm male to 30-mm male	M1003134	
13	Adapter, auxiliary inlet, 30-mm male to 19-mm male	M1003947	
Passive AGSS Specific Parts			
14	Receiver, Passive/Adjustable	1407-3908-000	
15	Plug Assembly, tethered	1407-3909-000	(2)
16	Screw, shoulder M3	1407-3915-000	
17	Connector, 30-mm ISO, Male	1406-3555-000	
18	Adapter, scavenging, 30-mm female to 19-mm male	1500-3376-000	(5 pack)

* Lubricate sparingly with Krytox


1
2
3
6 (5)


8
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(10, 9)
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16
15
or
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13
18
14

10.30.2 Adjustable AGSS

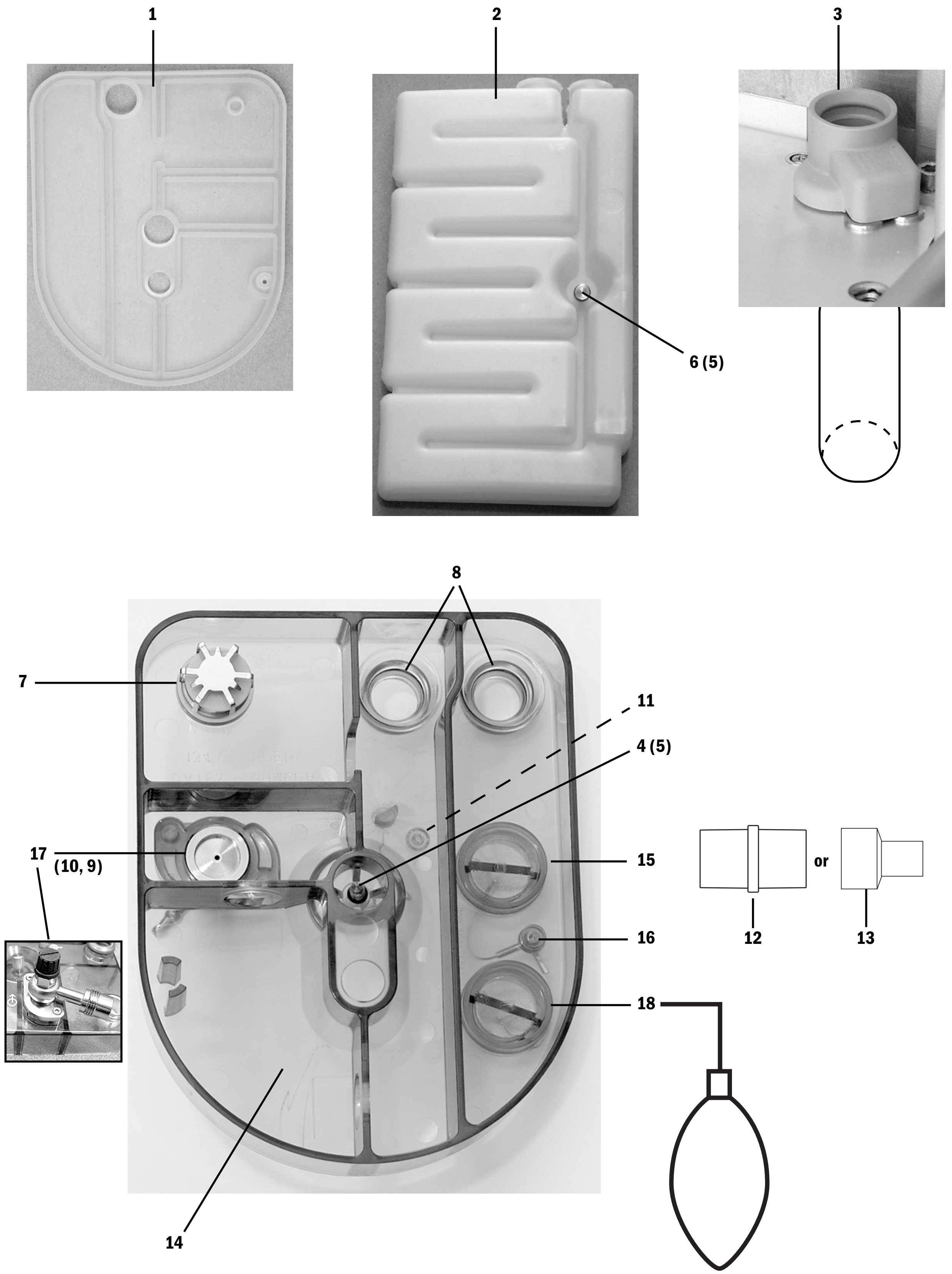
Items 1 through 13 are common within all AGSS systems.

Item	Description, Common Parts	Stock Number	Qty
1	Seal, Receiver Body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	Seal and scavenging down-tube	1407-3904-000	
4	Thumbscrew, M6x28.5	1406-3305-000	
5	O-ring, 4.42 ID, 9.65 OD	1407-3923-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	1406-8219-000	
7a	Seat, Valve, Negative Pressure	1406-3396-000	
7b	Retainer, disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 25.51 OD	1406-3558-000	
10	Screw, M4x8	9211-0640-083	(2)
11	Cap, 3.18 Barb, Silicone	1406-3524-000	
12	Adapter, auxiliary inlet, 30-mm male to 30-mm male	M1003134	
13	Adapter, auxiliary inlet, 30-mm male to 19-mm male	M1003947	

Adjustable AGSS Specific Parts

14	Receiver, Passive/Adjustable	1407-3908-000	
15	Plug Assembly, tethered	1407-3909-000	
16	Screw, shoulder M3	1407-3915-000	
17	Needle Valve Assembly (with DISS EVAC connector)	1407-3918-000	
18	Bag with 30 mm male connector	8004460	

* Lubricate sparingly with Krytox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or
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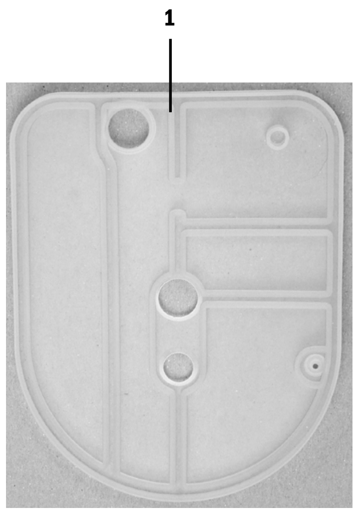
10.30.3 Active AGSS

Items 1 through 13 are common within all AGSS systems.

Item	Description, Common Parts	Stock Number	Qty
1	Seal, Receiver Body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	Seal and scavenging down-tube	1407-3904-000	
4	Thumbscrew, M6x28.5	1406-3305-000	
5	O-ring, 4.42 ID, 9.65 OD	1407-3923-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	1406-8219-000	
7a	Seat, Valve, Negative Pressure	1406-3396-000	
7b	Retainer, disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 25.51 OD	1406-3558-000	
10	Screw, M4x8	9211-0640-083	(2)
11	Cap, 3.18 Barb, Silicone	1406-3524-000	
12	Adapter, auxiliary inlet, 30-mm male to 30-mm male	M1003134	
13	Adapter, auxiliary inlet, 30-mm male to 19-mm male	M1003947	
Active AGSS Specific Parts			
14	Receiver, with air brake	1407-3900-000	
15	Seal, for filter and orifice	1407-3902-000	(2)
16	Filter	1406-3521-000	
Active High Flow Specific Parts			
17a	Connector, high flow M30 thread	1406-3557-000	
18	Orifice, high flow	1407-3920-000	
Active Low Flow with EVAC connector Specific Parts			
17b	Connector, low flow EVAC	1406-3597-000	
18	Orifice, low flow	1407-3919-000	
Active Low Flow with 25 mm connector Specific Parts			
17c	Connector, low flow 25 mm	1406-3573-000	
18	Orifice, low flow	1407-3919-000	
Active Low Flow with 12.7 mm hose barb connector Specific Parts			
17d	Connector, low flow 12.7 mm (1/2 inch)	1406-3574-000	
18	-none-		
Active Low Flow with 30 mm ISO male connector Specific Parts			
17e	Connector, 30 mm ISO, Male	1406-3555-000	
18	Orifice, low flow	1407-3919-000	

* Lubricate sparingly with Krytox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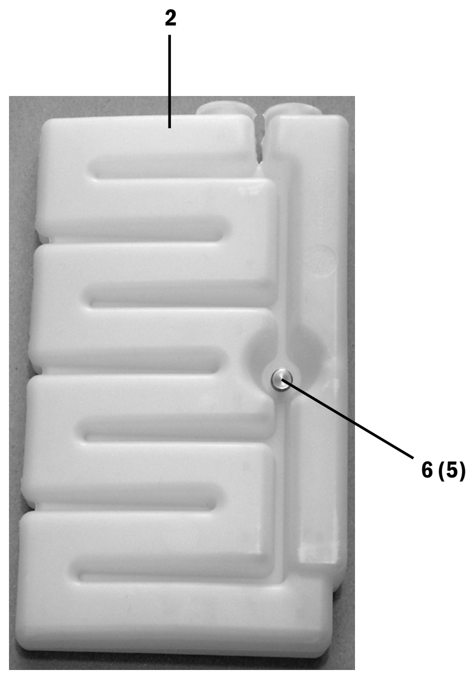
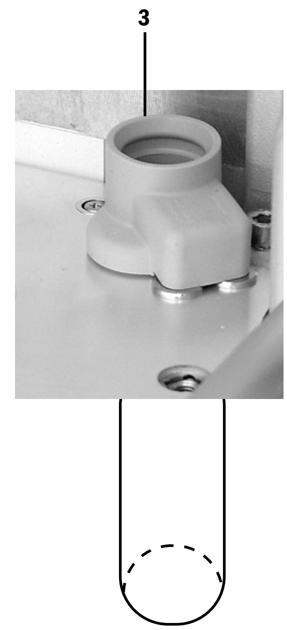

2
6 (5)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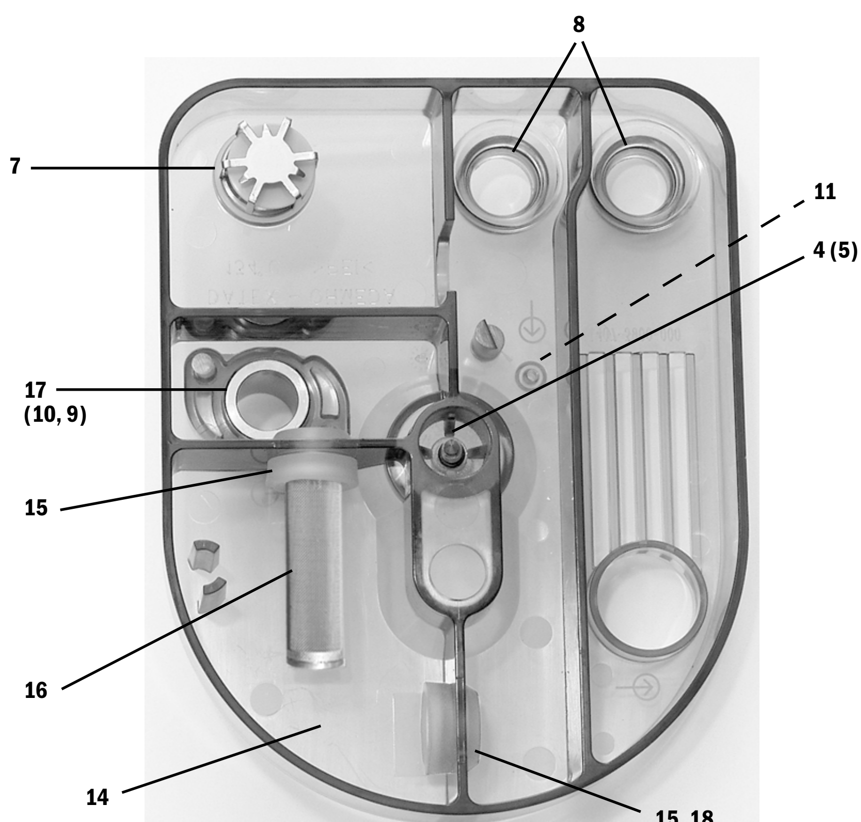
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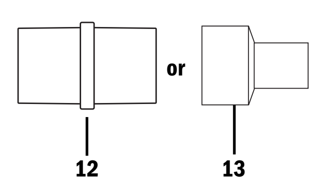
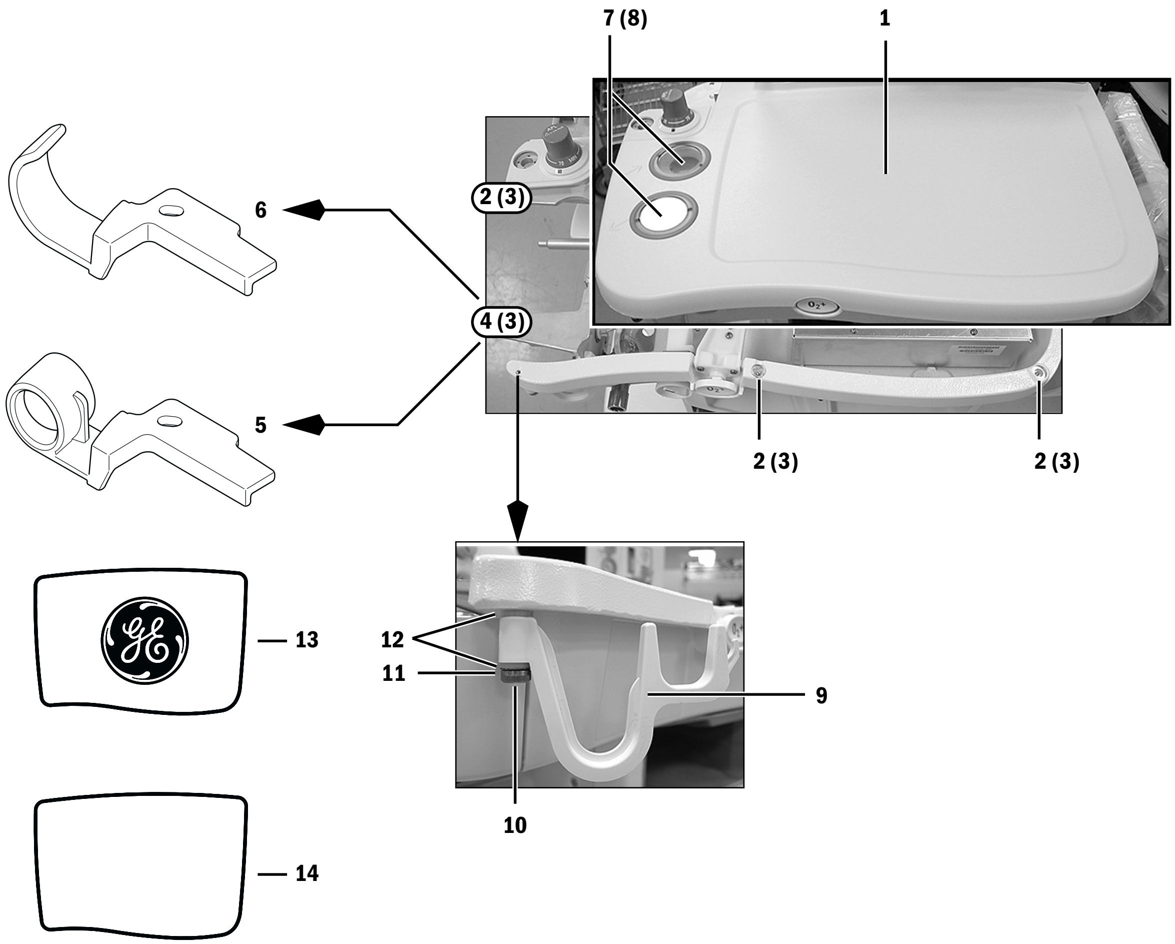

or
12
13

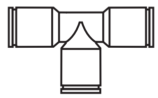
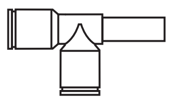
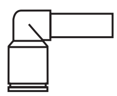
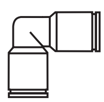
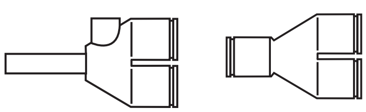
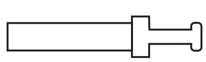
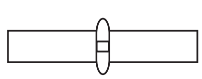

17a
17b
17c
17d
17e

10.31 Tabletop components



Item	Description	Stock Number
1	Tabletop, work surface	1011-3255-000
2	Screw, M4x12 relieved	1504-3001-000
3	Washer, M4 retainer Nylon	1009-3178-000
4a	Screw, relieved M4x16	1011-3980-000
4b	Washer, M5 flat	1006-1459-000
5	Clip (used with bag arm)	1009-3142-000
6	Clip (used with bag on tube)	1009-3139-000
7	Window, check-valve	1009-3088-000
8	Palnut	1009-3090-000
9	Hook, breathing circuit	1009-3086-000
10	Bolt, shoulder	1009-3172-000
11	Washer, wave	1009-3035-000
12	Washer, Nylon	1009-3150-000
13	Overlay, work surface, with GE logo	M1227207-S
14	Overlay, work surface, no logo	2063486-S

10.32 Legris quick-release fittings

	Item	Description	Stock Number
	1	**Tees — (tube/tube/tube)**	
		4 mm (N_2O)	1202-3653-000
		6 mm (O_2)	1006-3544-000
		8 mm (Air)	1006-3545-000
		8 mm/6 mm/8 mm (SCGO pilot)	1009-3297-000
		3/16 inch (CO_2 and Heliox)	0213-4727-300
	2	**Tees — (tube/tube/standpipe)**	
		6 mm (O_2)	1006-3862-000
		8 mm (Air - Drive gas)	1009-3370-000
		1/4 inch (mixed gas)	1006-4069-000
	3	**Elbow — (tube/standpipe)**	
		4 mm (N_2O)	1006-3533-000
		6 mm (O_2)	1006-3534-000
		8 mm (Air)	1006-3535-000
		1/4 inch (mixed gas)	1006-3737-000
	4	**Elbow — (tube/tube)**	
		1/4 inch (mixed gas)	1202-3804-000
		4 mm (N_2O)	1009-3040-000
		6 mm (O_2)	1009-3041-000
		8 mm (Air)	1009-3042-000
	5	**Y**	
		6 mm (O_2)	1009-3043-000
		8 mm (Air)	1009-3044-000
		8 mm Y with tailpiece	1009-3360-000
		1/4 inch (mixed gas)	1006-3065-000
	6	**Plug**	
		4 mm (N_2O)	1006-3530-000
		6 mm (O_2)	1006-3531-000
		8 mm (Air)	1006-3532-000
		3/16 inch (CO_2 and Heliox)	1006-3835-000
	7	**Union, male to male**	
		1/4 inch (mixed gas)	M1142987

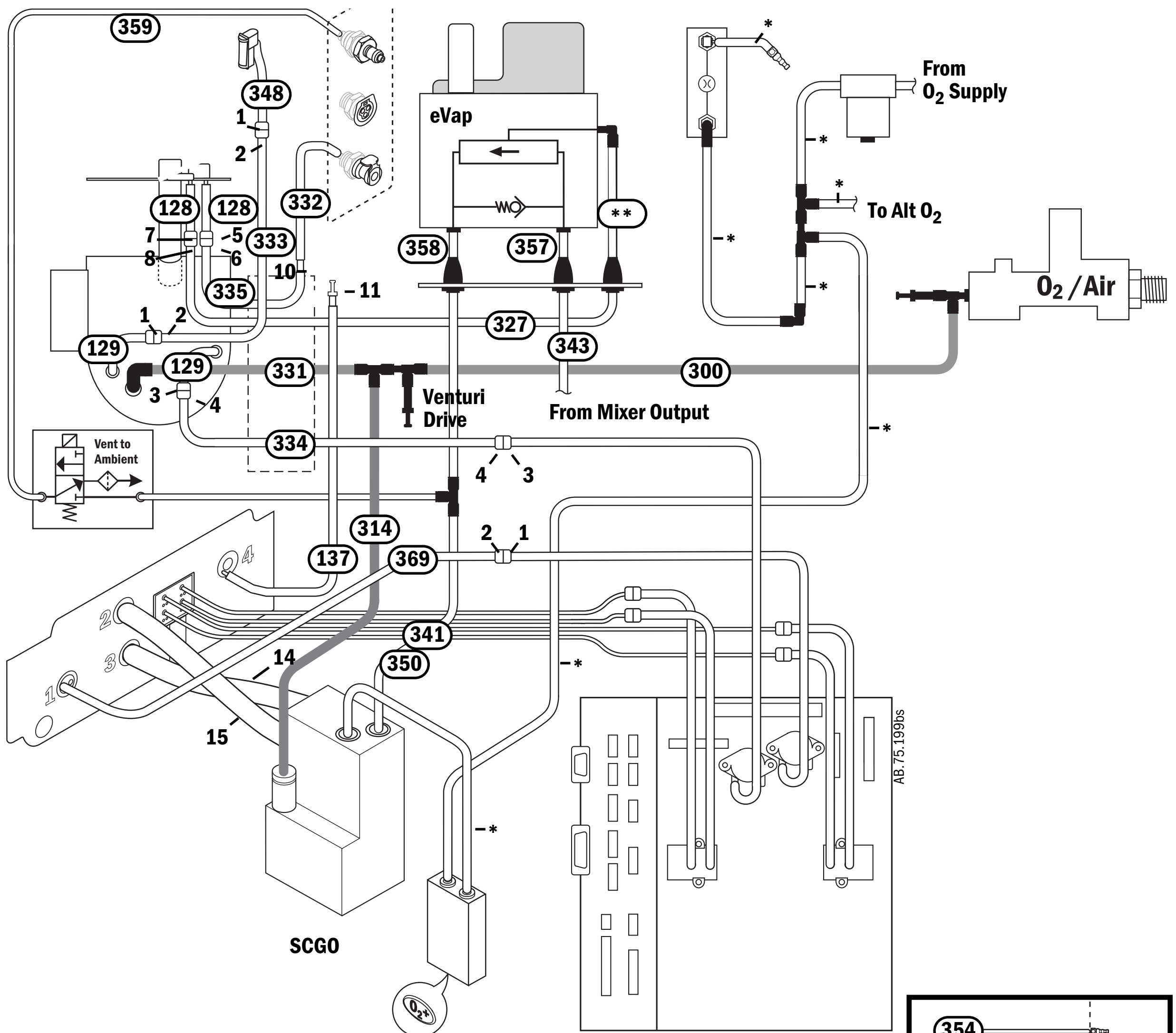
Note: Not every fitting is used in all machines.

10.33 Vent Drive and low-pressure tubing

Item	Description		Length — Size	Stock Number
1	Coupler, female - black			1503-3128-000
2	Coupler, male - black			1503-3237-000
3	Coupler, female - white			1503-3119-000
4	Coupler, male - white			1503-3236-000
5	Coupler, female - yellow			1503-3132-000
6	Coupler, male - yellow			1407-3330-000
7	Coupler, female - blue			1503-3130-000
8	Coupler, male - blue			1407-3331-000
9	Tee (male barb)			1009-3011-000
10	Fitting, coupler barb ends			1009-3077-000
11	Plug, 4-mm			1006-3530-000
12	Tubing (silicone)		72 mm - 3/8 inch	1009-3164-000
13	Tubing (silicone)		62 mm - 3/8 inch	1009-3164-000
14	Tubing (silicone)		75 mm - 3/8 inch	1009-3164-000
15	Tubing (silicone)		75 mm - 3/8 inch	1009-3164-000
	Tube Markings (factory build only)		**Length — Size**	
128	unmarked	(low-pressure)	300 mm - 1/4 inch	1605-1001-000
129	unmarked	(low-pressure)	151 mm - 1/4 inch	1605-1001-000
134	unmarked	(low-pressure)	25 mm - 1/4 inch	1605-1001-000
135	unmarked	(low-pressure)	50 mm - 1/4 inch	1605-1001-000
137	RGM to Circuit	(low-pressure)	300 mm - 1/4 inch	1605-1001-000
300	VENT DRIVE	(black)	360 mm - 8 mm	1009-3296-000
314	(with VIB) unmarked	(black)	550 mm - 6 mm	1009-3295-000
	(with cVIB) unmarked	(black)	590 mm - 6 mm	1009-3295-000
315	unmarked		60 mm - 8 mm	1001-3063-000
316	unmarked		300 mm - Tygon	6700-0005-300
321	unmarked	(black)	640 mm - 8 mm	1009-3296-000
322	unmarked	(black)	235 mm - 4 mm	1009-3363-000
323	unmarked	(black)	110 mm - 4 mm	1009-3363-000
327	VAP SCAV B/S SCAV	(blue)	940 mm - 1/4 inch	1011-3905-000
331	VENT DRIVE	(black)	430 mm - 8 mm	1009-3296-000
332	M GAS SCAV B/S SCAV	(low-pressure)	550 mm - 1/4 inch	1605-1001-000
333	B/S SCAV AGSS FLWMTR	(low-pressure)	500 mm - 1/4 inch	1605-1001-000
334	B/S PEEP PORT VIB	(low-pressure)	500 mm - 1/4 inch	1605-1001-000
335	M GAS SCAV B/S SCAV	(low-pressure)	200 mm - 1/4 inch	1605-1001-000
340	unmarked		40 mm - 8 mm	1001-3063-000
341	A/SCGO FG VAP OUT		600 mm - 1/4 inch	1001-3064-000
343	MIXER OUT VAP IN		660 mm - 1/4 inch	1001-3064-000
347	unmarked	(blue)	50 mm - 1/4 inch	1011-3905-000
348	unmarked	(low-pressure)	110 mm - 1/4 inch	1605-1001-000
350	unmarked		170 mm - 1/4 inch	1001-3064-000
354	unmarked		430 mm - Tygon	6700-0005-300
355	unmarked		225 mm - Tygon	6700-0005-300
356	unmarked		640 mm - Tygon	6700-0005-300
359	unmarked (polyurethane)	(clear)	890 mm	M1154119
369	PAW	(low-pressure)	160 mm - 1/4 inch	1605-1001-000

* Refer to Section 10.34

** Two segments (45.3 mm) joined by an elbow fitting.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348
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128
128
332
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5
333
8
6
10
335
11
1
2
129
129
3
4
331
Venturi Drive
334
4
3
eVap
**
358
357
327
343
From Mixer Output
300
From O_2 Supply
To Alt O_2
O_2 / Air
Vent to Ambient
314
2
1
137
369
341
14
350
15
SCGO
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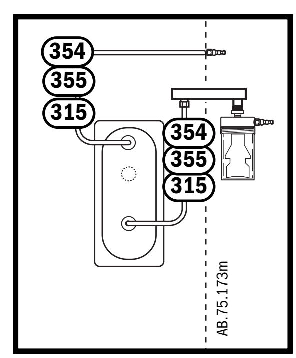
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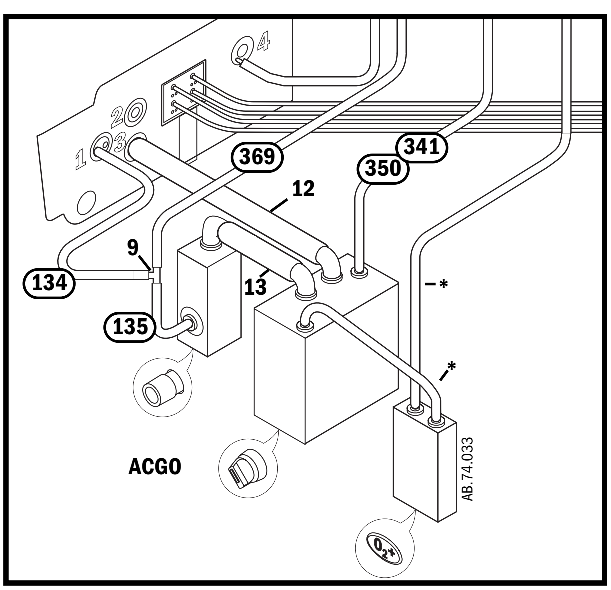
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341
350
12
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134
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135
ACGO
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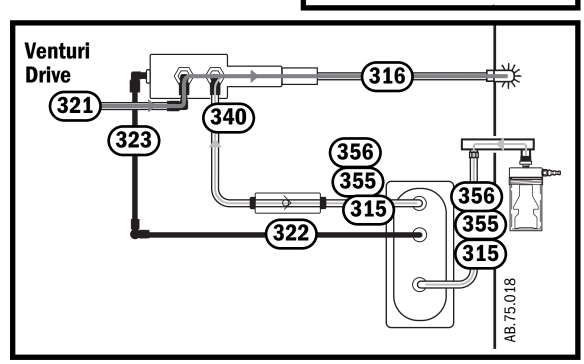
Venturi Drive
316
321
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323
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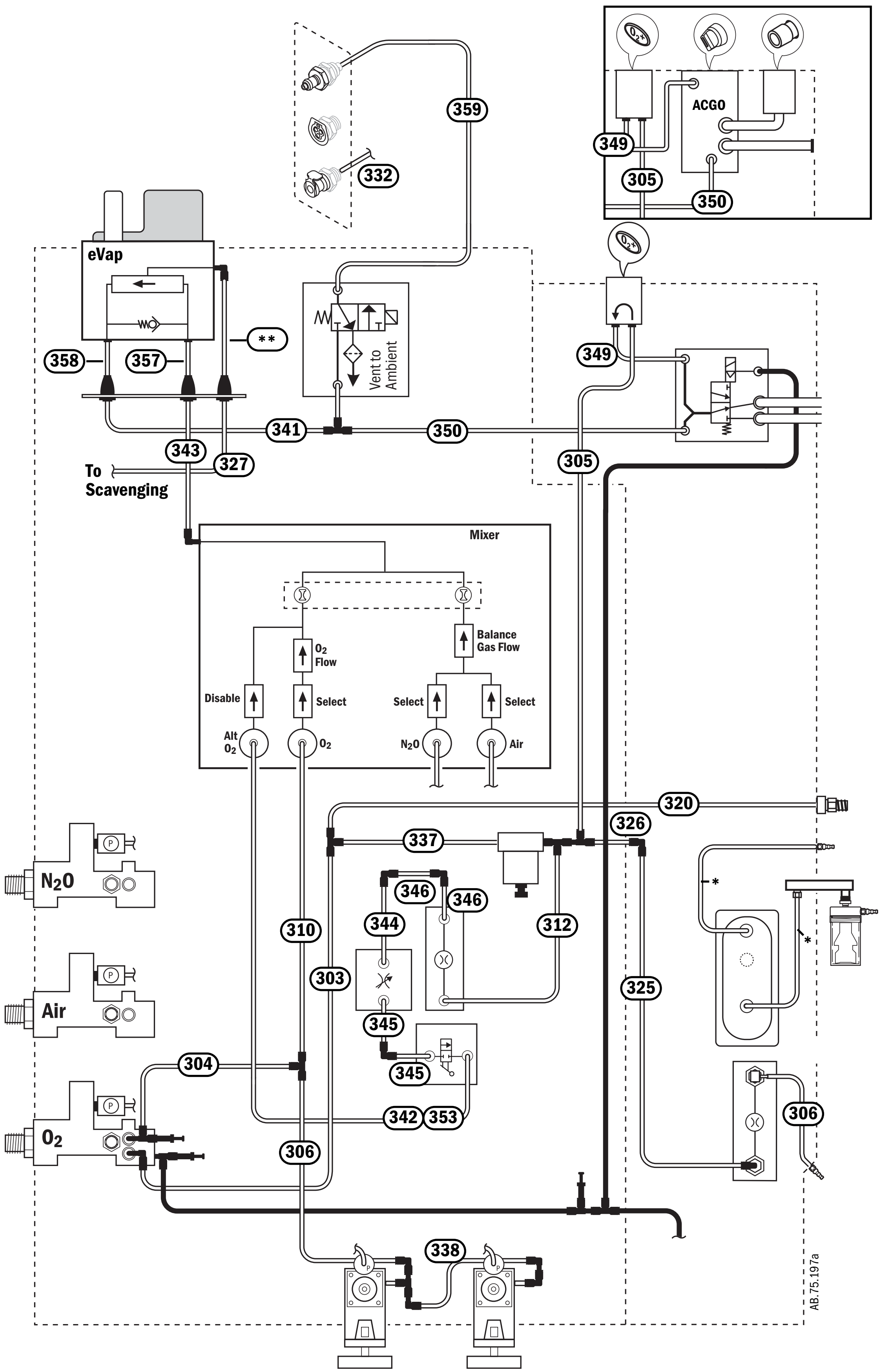
322
315
AB.75.018

10.34 Tubing for use with Legris fittings (O_2 supplies)

This tubing is a flexible, Nylon-type tubing for use with quick-release fittings.

Item	Description		Length — Size	Stock Number
	Tube Markings (factory build only)			
303	unmarked		200 mm - 6 mm	1001-3062-000
304	unmarked		150 mm - 6 mm	1001-3062-000
305	unmarked		445 mm - 6 mm	1001-3062-000
306	unmarked		120 mm - 6 mm	1001-3062-000
310	unmarked		310 mm - 6 mm	1001-3062-000
312	ALT O2 FLOWMETER ELBOW		380 mm - 6 mm	1001-3062-000
313	unmarked		140 mm - 6 mm	1001-3062-000
320	unmarked		420 mm - 6 mm	1001-3062-000
325	unmarked		130 mm - 6 mm	1001-3062-000
326	unmarker		210 mm - 6 mm	1001-3062-000
327	VAP SCAV B/S SCAV	(blue)	940 mm - 1/4 inch	1011-3905-000
332	M GAS SCAV B/S SCAV	(low-pressure)	550 mm - 1/4 inch	1605-1001-000
337	unmarked		45 mm - 6 mm	1001-3062-000
338	unmarked		130 mm - 6 mm	1001-3062-000
341	A/SCGO FG VAP OUT		600 mm - 1/4 inch	1001-3064-000
342	ALT O2 IN		425mm - 6 mm	1001-3062-000
343	MIXER OUT VAP IN		410 mm - 1/4 inch	1001-3064-000
344	unmarked		40 mm - 6 mm	1001-3062-000
345	unmarked		65 mm - 6 mm	1001-3062-000
346	unmarked		60 mm - 6 mm	1001-3062-000
**	unmarked	(blue)	45.3 mm - 1/4 inch	1011-3905-000
349	unmarked		130 mm - 1/4 inch	1001-3064-000
350	unmarked		170 mm - 1/4 inch	1001-3064-000
353	unmarked		75 mm - 6 mm	1001-3062-000
357	unmarked		167±2 mm - 1/4 inch	1001-3064-000
358	unmarked		96±2 mm - 1/4 inch	1001-3064-000
359	unmarked	(polyurethane)	890 mm	M1154119

* Refer to Section 10.33.
** Two segments (45.3 mm) joined by an elbow fitting.



eVap
**
358
357
359
332
Vent to Ambient
ACGO
349
305
350
341
343
327
To Scavenging
Mixer
Balance Gas Flow
O2 Flow
Disable
Select
Select
Select
Alt O2
O2
N2O
Air
320
326
337
346
346
344
312
310
303
325
345
345
304
342
353
306
306
338
N2O
Air
O2
AB.75.197a

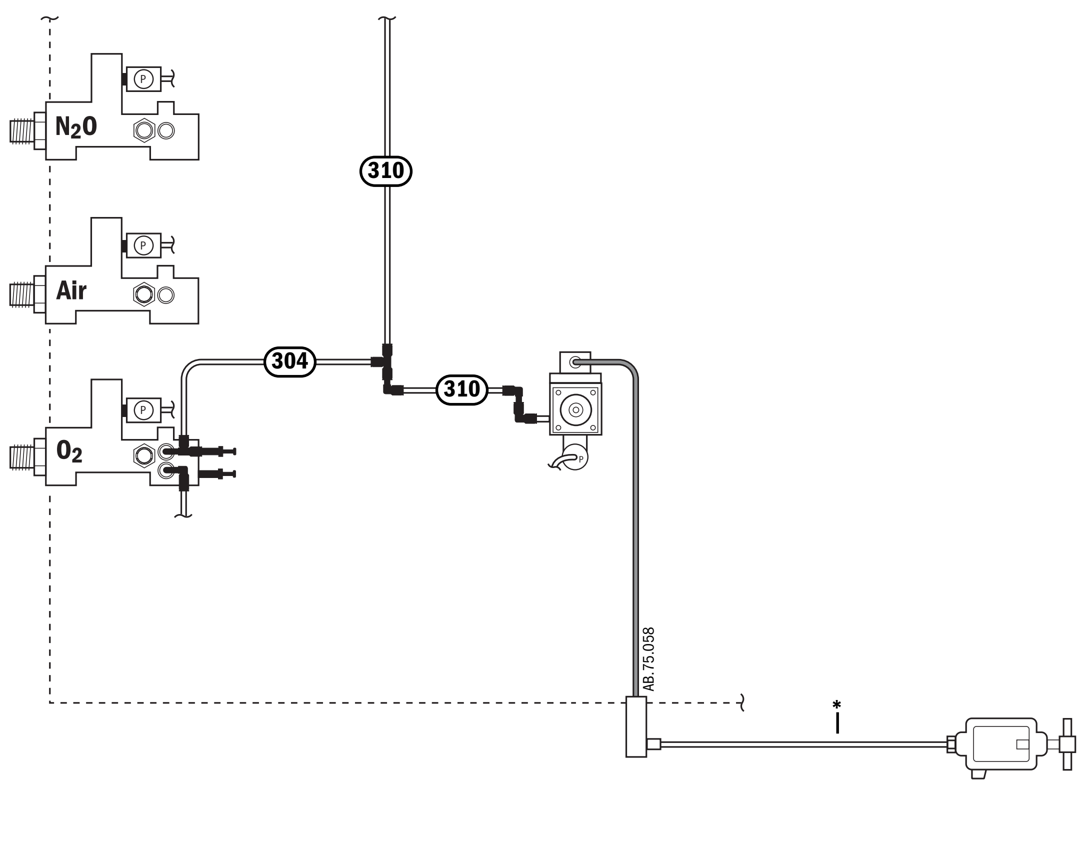
10.35 Tubing for use with Legris fittings (3rd cylinder)

This tubing is a flexible, Nylon-type tubing for use with quick-release fittings.

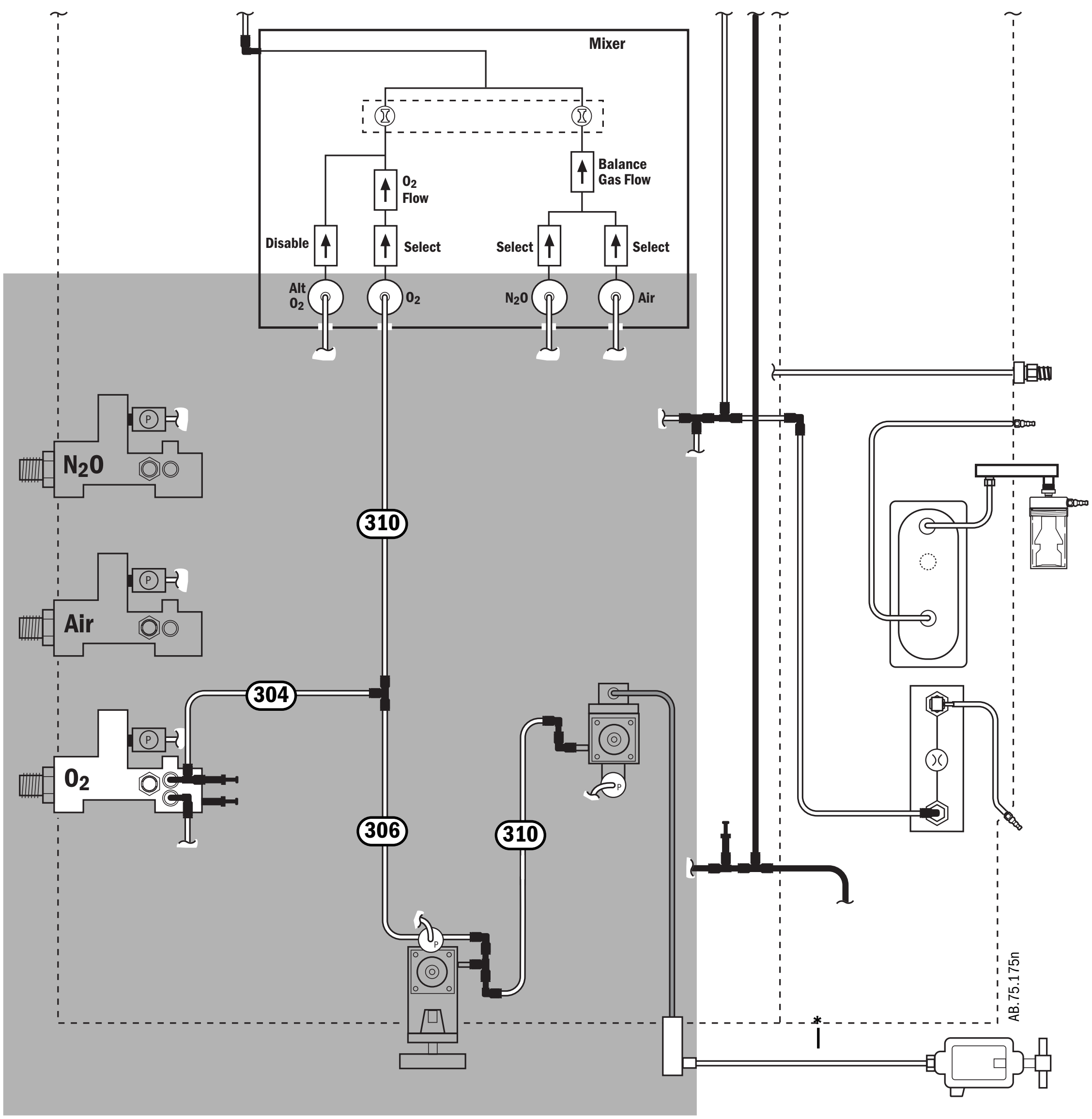
Item	Description	Length — Size	Stock Number
	Tube Markings (factory build only)		
304	unmarked	150 mm - 6 mm	1001-3062-000
306	unmarked	120 mm - 6 mm	1001-3062-000
310	unmarked	310 mm - 6 mm	1001-3062-000

* Refer to Section 10.13.1.

Single O_2 - Third Cylinder



2nd O_2 - Third Cylinder

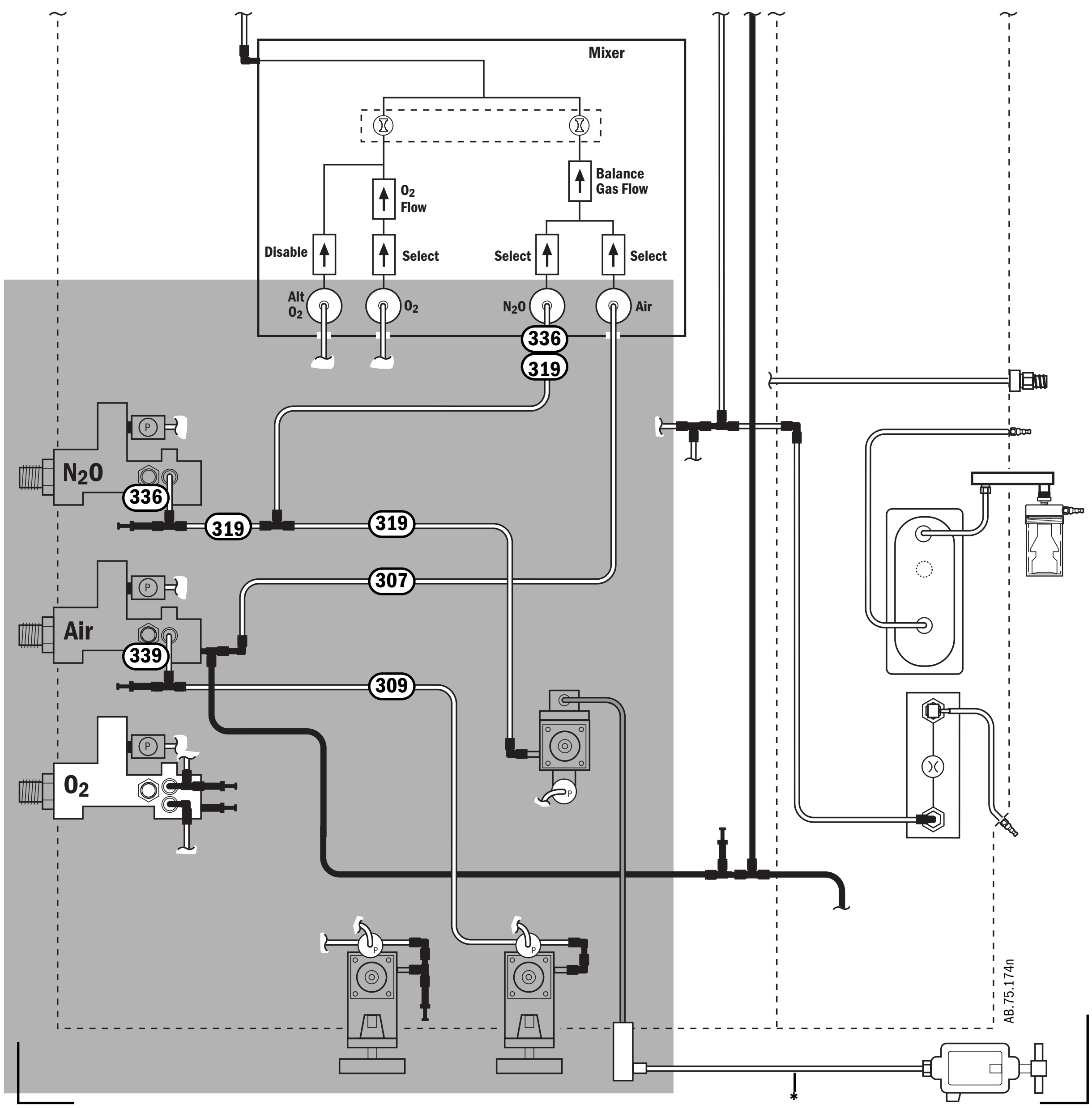


10.36 Tubing for use with Legris fittings (Air and N_2O supplies)

This tubing is a flexible, Nylon-type tubing for use with quick-release fittings.

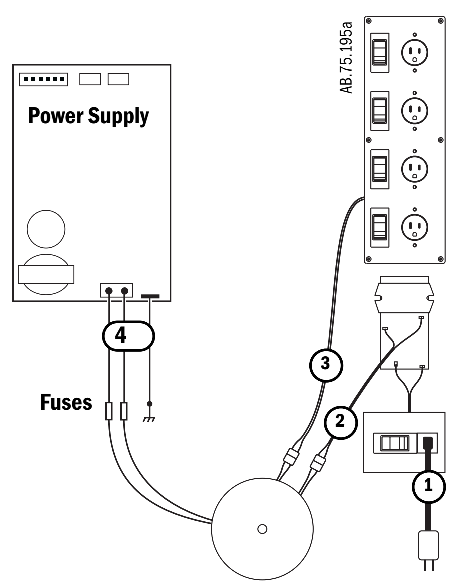
Item	Description	Length — Size	Stock Number
	Tube Markings (factory build only)		
307	unmarked	390 mm - 8 mm	1001-3063-000
309	unmarked	440 mm - 8 mm	1001-3063-000
319	unmarked	310 mm - 4 mm	1001-3060-000
336	unmarked	35±2 mm - 4 mm	1001-3060-000
339	unmarked	40 mm - 8 mm	1001-3063-000

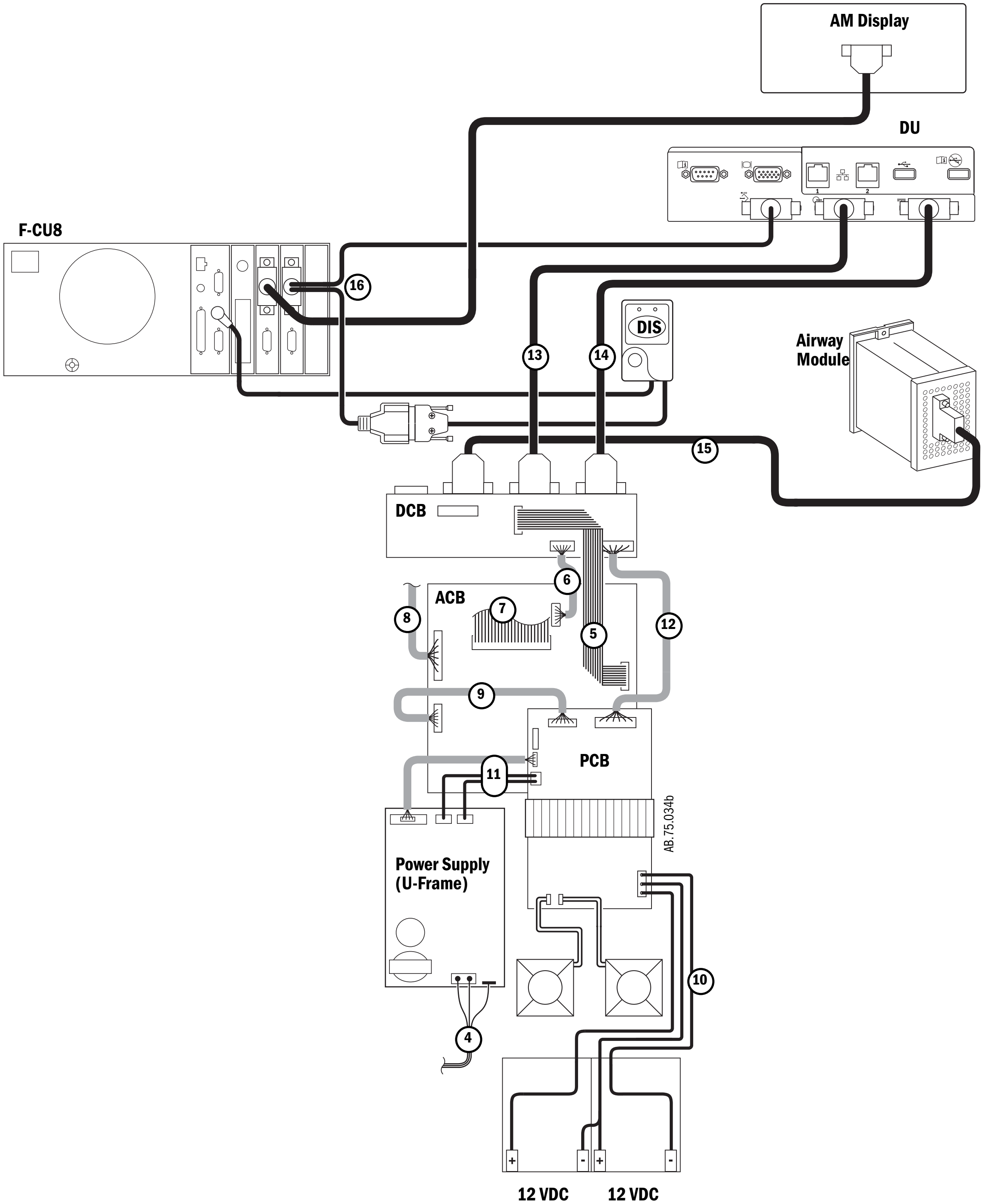
* Refer to Section 10.13.1.


Mixer
O2 Flow
Balance Gas Flow
Disable
Select
Select
Select
Alt O2
O2
N2O
Air
336
319
N2O
336
319
319
307
Air
339
309
O2
AB.75.174n
*

10.37 Cables and harnesses in lower electronic enclosure

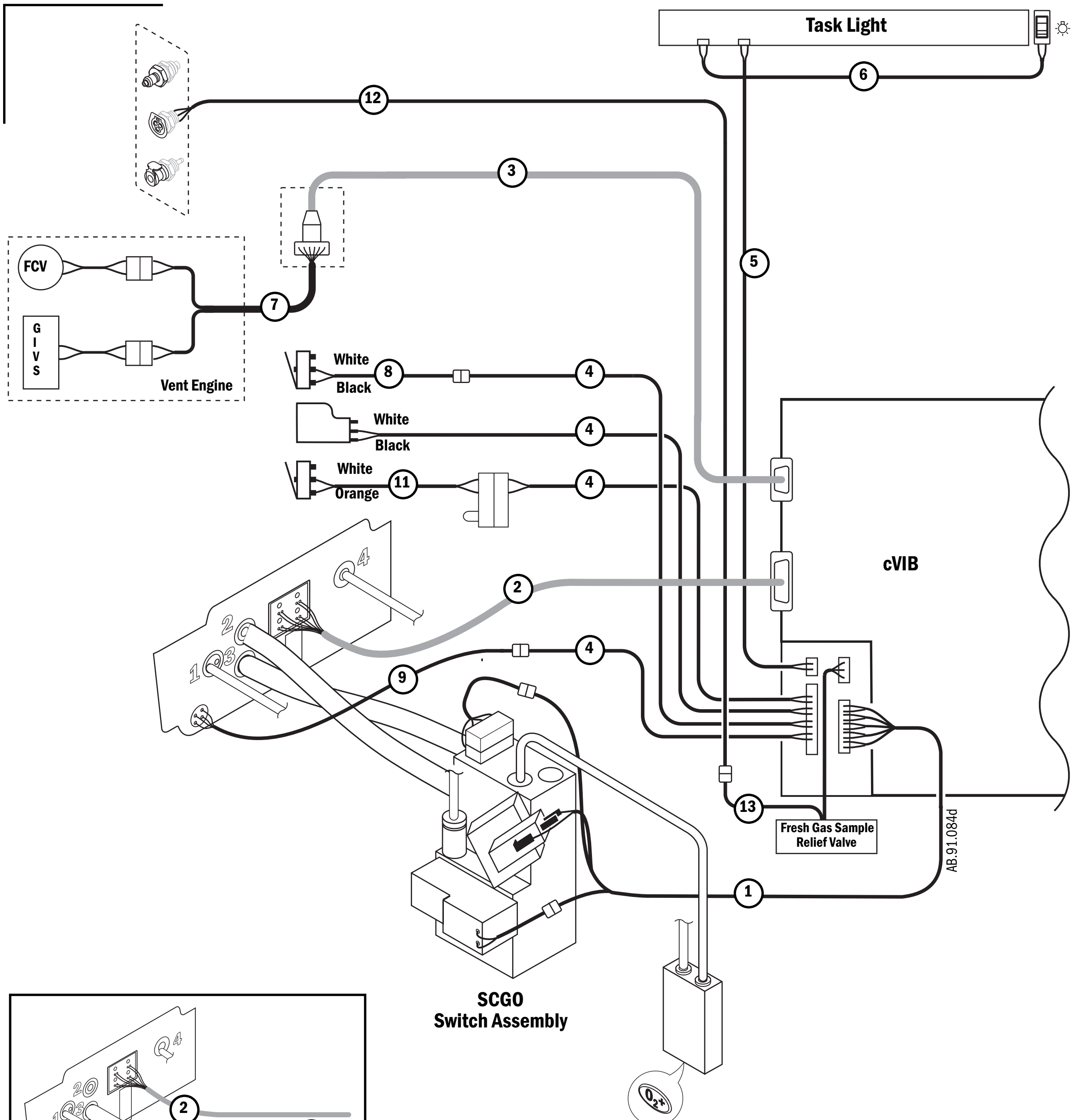
Item	Description	Stock Number
1	Power Cord	Refer to Section 10.7
2	Harness, 100/120 V to Toroid Harness, 220/240 V to Toroid	1011-3538-000 1011-3539-000
3	Harness, to 100/120 V outlets Harness, to 220/240 V outlets	1011-3526-000 1011-3527-000
4	Harness, Fuse block to Power Supply	1011-3581-000
5	Cable, ribbon J2-ACB to J9-DCB	1009-5561-000
6	Harness, J7-ACB to J6-DCB	1009-5556-000
7	Cable, ribbon J1-ACB to underside of Pan Connector Board	1011-3186-000
8	Harness, J3-ACB to underside of Pan Connector Board	1011-3199-000
9	Harness, J6-ACB to J4-PCB	1009-5551-000
10	Harness, battery (Refer to Section 10.9	M1198968-S
11	Harness, Power Supply to PCB	1011-3591-000
12	Harness, J3-PCB to J5-DCB	1009-5552-000
13	Cable, to Display Unit system signal interface (install with ferrite at DCB end)	1011-3548-000
14	Cable, to Display Unit system power interface	1011-3547-000
15	Cable, to Airway Module power supply	M1235139
16	Cable, On-Standby RS232	1009-5935-000

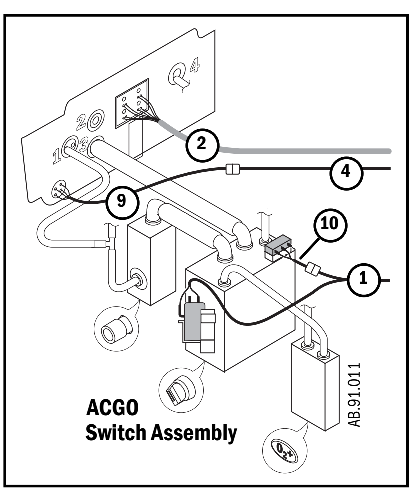



AM Display
DU
F-CU8
16
DIS
13
14
Airway
Module
15
DCB
6
ACB
7
8
5
12
9
PCB
11
AB.75.034b
Power Supply
(U-Frame)
10
4
12 VDC
12 VDC

10.38 Cables and harnesses in Pan

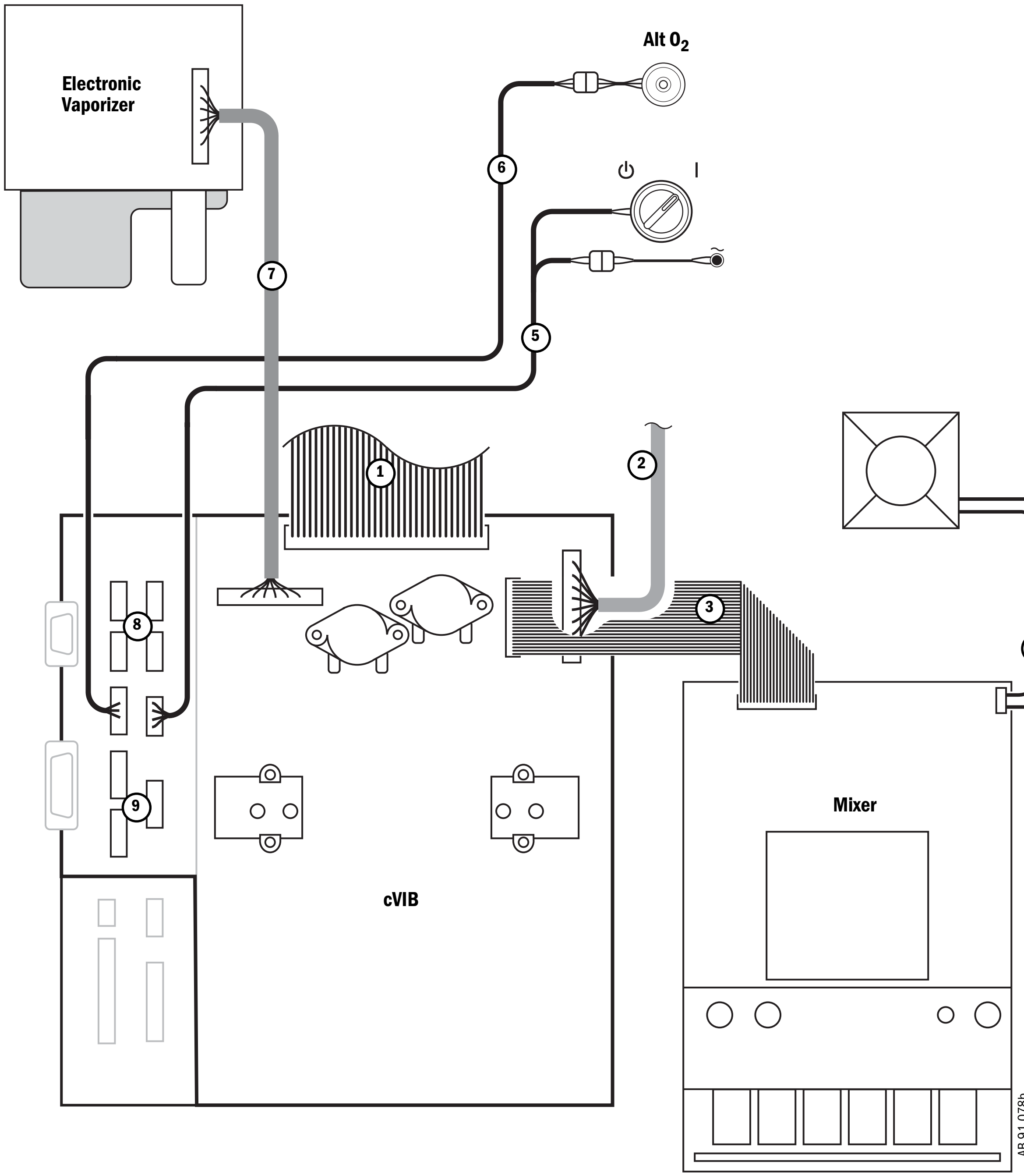
Item	Description	Stock Number
1	Harness, cVIB to SCGO/ACGO	1009-5528-000
2	Harness, cVIB to ABS flow sensors (includes tubing)	1009-8223-000
3	Cable, cVIB to Vent Engine harness connector	1009-5521-000
4	Harness, cVIB to O_2 Cell and ABS switches	1009-5531-000
5	Harness, cVIB to Task Light	1011-3400-000
6	Harness, Task Light switch (includes switch)	1011-3545-000
7	Harness, Vent Engine to Connector Plate	M1163431
8	Harness, Bag/Vent switch to cVIB harness	1009-5585-000
9	Harness, O_2 Cell to cVIB harness	1009-5586-000
10	Harness, ACGO switch to cVIB harness	1009-5872-000
11	Harness, Canister Release switch (CO_2 Bypass)	1407-3144-000
12	Harness, Et Control to cVIB	M1165991
13	Harness, Fresh Gas Sample Relief Valve	Refer to Section 10.20


Task Light
6
12
3
5
FCV
G I V S
7
Vent Engine
White
8
Black
4
White
Black
4
White
11
Orange
4
cVIB
2
4
9
13
Fresh Gas Sample Relief Valve
1
AB.91.084d
SCGO
Switch Assembly
O2+

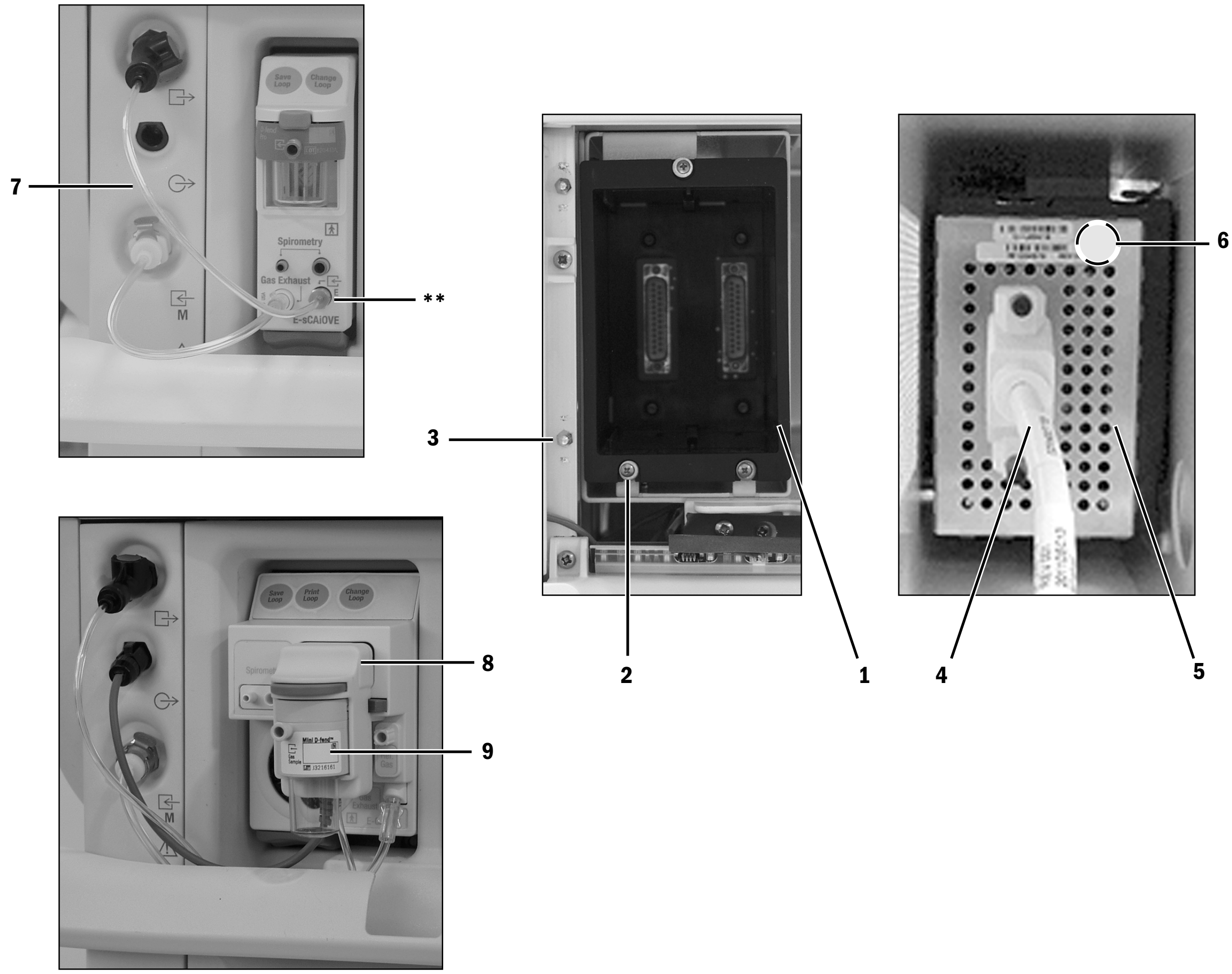

2
4
9
10
1
ACGO
Switch Assembly
O2+
AB.91.011

10.39 Cables and harnesses in Pan electrical enclosure

Item	Description	Stock Number
1	Cable, ribbon J1-ACB to cVIB	M1220571
2	Harness, J3-ACB to cVIB	M1220574
3	Cable, ribbon, cVIB to Mixer	M1220557
4	Harness, Pan Fan extension	1011-3561-000
5	Harness, cVIB to System switch	1009-5538-000
6	Harness, cVIB to Alt O_2	1009-5532-000
7	Harness, cVIB to EV	1011-3108-000
8	Cylinder Transducers	Refer to Section 10.13
9	Pipeline Transducers	Refer to Section 10.12


Electronic
Vaporizer
Alt O2
cVIB
Mixer
1
2
3
4
5
6
7
8
9
AB.91.078b

10.40 Airway module components

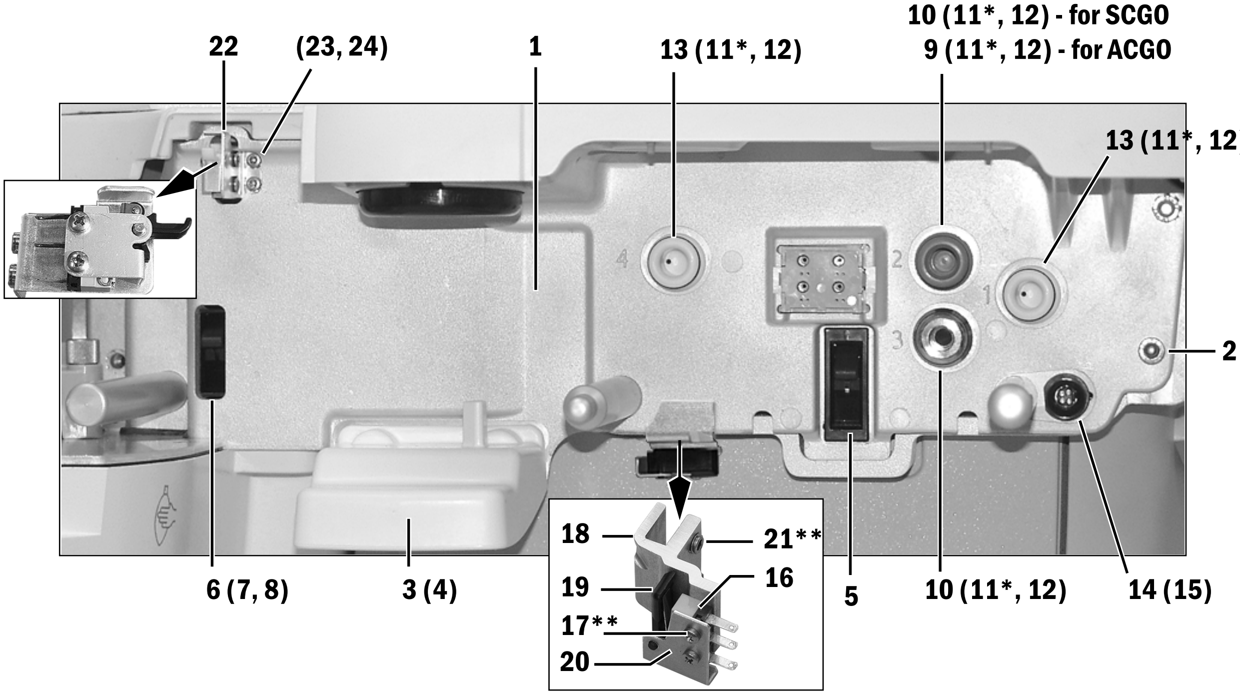


Item	Description	Stock Number
1	Bay, Airway module	M1222390
2	Screw, M3x8 Pan	9211-0430-083
3*	Fastener, stud ball	1202-3272-000
4	Cable, to Airway module power Supply	M1235139
5	Power Supply (for Item 2 - Double Bay; E-Gas/M-Gas/E-sGas	M1204970
	Pass-through board (for Item 1 - Single Bay; CARESCAPE E-sGas module)	M1224771
6	Screw, M4x10 SKT CAP Button Head	0144-2117-722
7	Tubing assembly (Fresh Gas Sample)	2063483-001
8	Fresh Gas Module (FGM)	M1153179
9	Mini D-fend Water Trap, package of 10	8002174

* Apply Loctite 242.

** Attach the tube connector to the Respiratory Module finger tight.
Use a 8-mm open-end wrench to snug the connection slightly.
Do not overtighten.

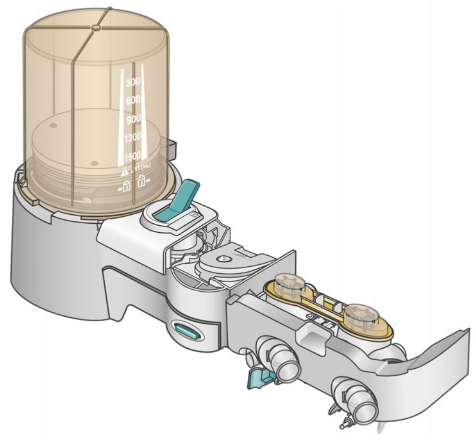
10.41 Breathing system interface



Item	Description	Stock Number	Qty
1	Assembly, main support casting	1407-7010-000	
2	Bolt, M6x16 flange	1009-3125-000	(5)
3	Handle, grip	1407-3317-000	
4	Screw, M6X16 Sems	0144-2436-109	(2)
5	Latch, push to close	1407-3309-000	
6	Latch, push to close w/microswitch	1407-3310-000	
7	Screw, SKT HD CAP M3x8 SST	1006-3865-000	(2)
8	Washer, lock external M3	9213-0530-003	(2)
9	Port, plug circuit (ACGO)	1407-3333-000	
10	Port, fresh gas (SCGO)	1407-3314-000	
11*	Seal, U-Cup 12.7 ID BCG 19.05 OD EPR	1407-3320-000	(4)
12	Ring, retaining 15.88 SHAFT DIA TYPE E SST	1406-3446-000	(4)
13	Port, sample gas	1407-3318-000	(2)
14	Connector, bulkhead O2 Cell, with harness	1009-5586-000	
15	Ring, retaining 9.53 SHAFT DIA TYPE E SST	1406-3277-000	
16	Switch, subminiature w/QDISC terminals	M1212924	
17**	Screw, M2.5 x10	1009-3153-000	(4)
18	Bracket, bypass switch	1407-3139-000	
19	Paddle, switch actuator	1407-3141-000	
20	Bracket, paddle hinge	1407-3140-000	
21**	Screw, M6x6 set cup	1007-3329-000	(2)
22	BTV switch assembly	M1204423	
23	Screw, SKT HD CAP M3x8 SST	1006-3865-000	(2)
24	Washer, lock external M3	9213-0530-003	(2)

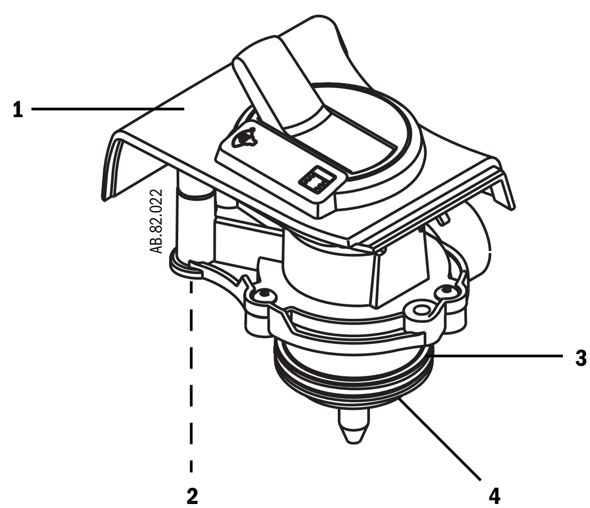
* Lubricate sparingly with Krytox.
** Apply Loctite 242.

10.42 Breathing System



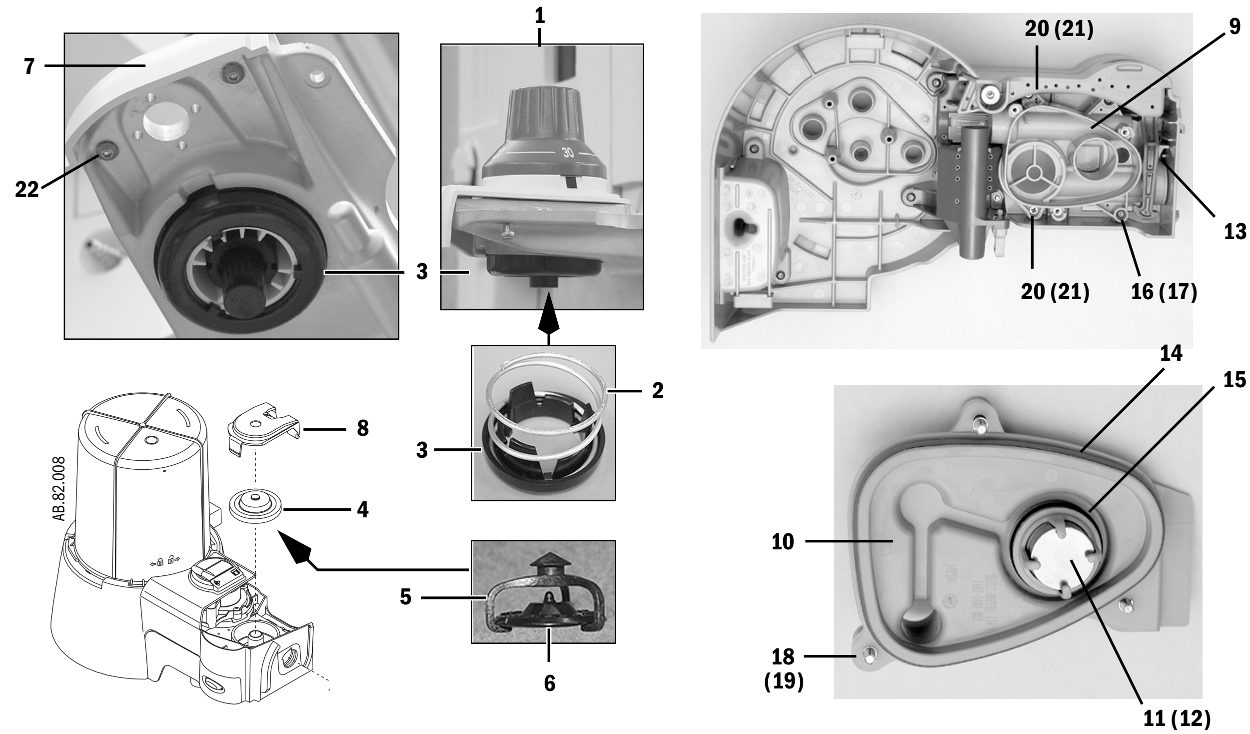
ABS Breathing System - complete (does not include flow sensors or O_2 cell)	Stock Number
All except Australia and New Zealand	2063823-001-S
Australia and New Zealand ONLY	2069565-001-S

10.42.1 Bag/Vent Switch



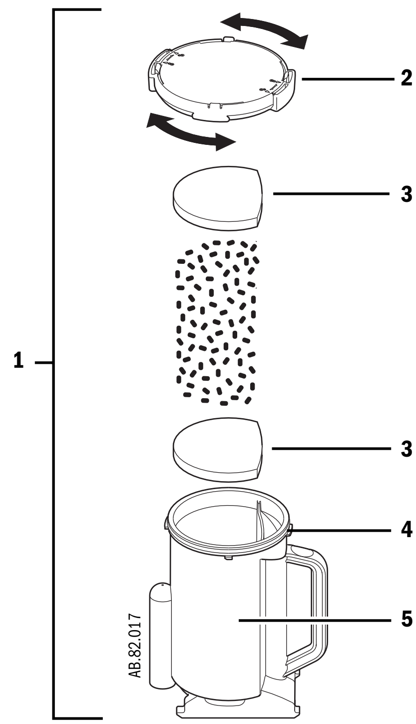
Item	Description	Stock Number	QTY
	Bag/Vent Switch Cartridge	1407-7003-000	
1	Cover, Bag/Vent Switch	1407-3500-000	
2	Screw, M4X8 Sems	0144-2436-108	(2)
3	O-ring , 44.02 ID 51.1 OD 3.53	1407-3507-000	
4	Seal, Bag/Vent Switch	1407-3506-000	

10.42.2 APL Valve



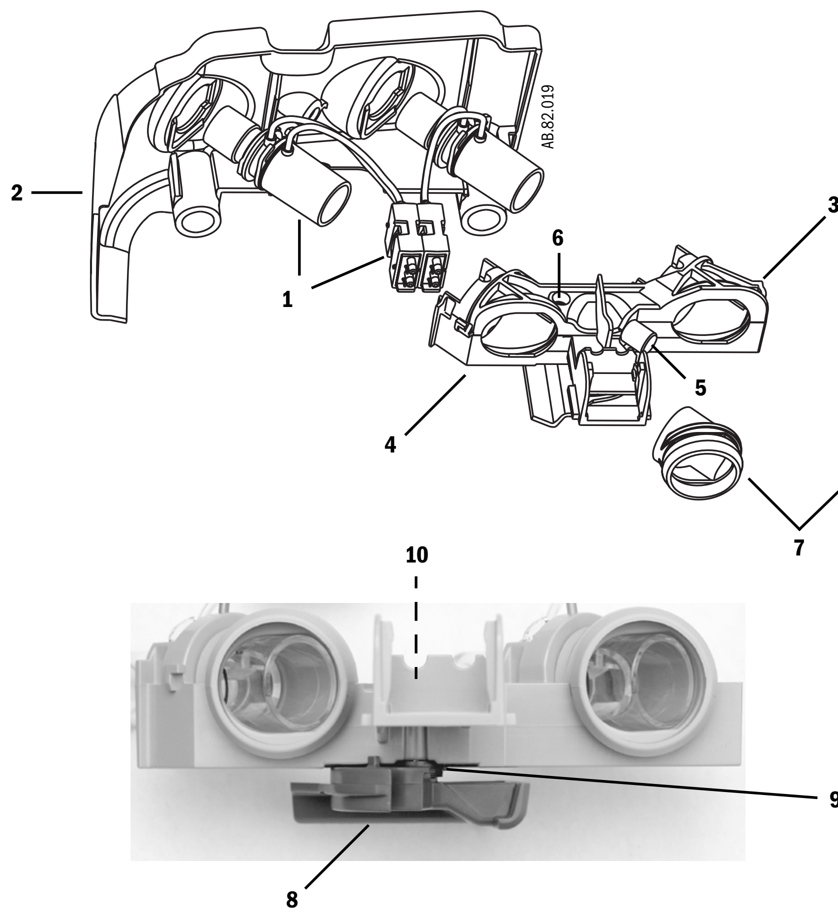
Item	Description	Stock Number	QTY
1	APL Valve Assembly Kit (includes Items 2 through 7 and Installation Instructions)	M1175511-S	
2	Spring, compression 53.14 OD 36.8 L	1406-3328-000	
3	Retainer, spring APL	1407-3404-000	
4	Diaphragm, APL	1406-3331-000	
5	Cage, APL	1406-3333-000	
6	Poppet, APL valve	1406-3332-000	
7	Cover, no longer available separately; now physically part of thr APL Valve Assembly	---------------------	
8	Ramp, APL	1407-3400-000	
9	Manifold, APL/BTV	1407-3401-000	
10	Cover, manifold APL/BTV (with 22-mm male bag port)	1407-3402-000	
	Cover, manifold APL/BTV (with Australian bag port - 22 mm female)	1407-3412-000	
11	Weight, negative relief	1407-3406-000	
12	Seal, ABS negative relief valve	1407-3407-000	
13	O-ring 22 ID 30 OD 4 W Silicone 40 DURO	1407-3104-000	
14	O-ring 88.49 ID 95.55 OD 3.53 W Silicone 50 DURO	1407-3403-000	
15	O-ring 1.049ID 1.255OD 0.103W EPDM NO 121	1407-3408-000	
16	Screw, M4x16 BT SKT HD SST TYPE 316	0140-6226-115	(2)
17	Lockwasher, M4 external	9213-0540-003	(2)
18	Thumbscrew, M4 shoulder 7.5x7	1407-3410-000	(3)
19	Ring, retaining 3.96 SFT DIA CRESCENT SST	1407-3411-000	(3)
20	Screw, M4x40 FL HD SST PH	0140-6226-122	(2)
21	O-ring 2.9 ID 6.46 OD 1.78 W EP 70 DURO	1407-3409-000	(2)
22	Screw, Sems M4x8	0144-2436-108	(3)

10.42.3 Absorber canister



Item	Description	Stock Number	Qty
1	Multi-Absorber canister, reusable (does not include absorbent)	1407-7004-000	
	With Chinese labeling for China market	M1084850	
2	Cover assembly, CO_2 canister	1009-8240-000	
3	Foam, CO_2 canister (pack of 40)	1407-3201-000	
4	O-ring	1407-3204-000	
5	Canister, CO_2	1407-3200-000	
---	Multi-Absorber canister, disposable (white to violet; pack of 6)	8003138	
---	Multi-Absorber canister, disposable (pink to white; pack of 6)	8003963	

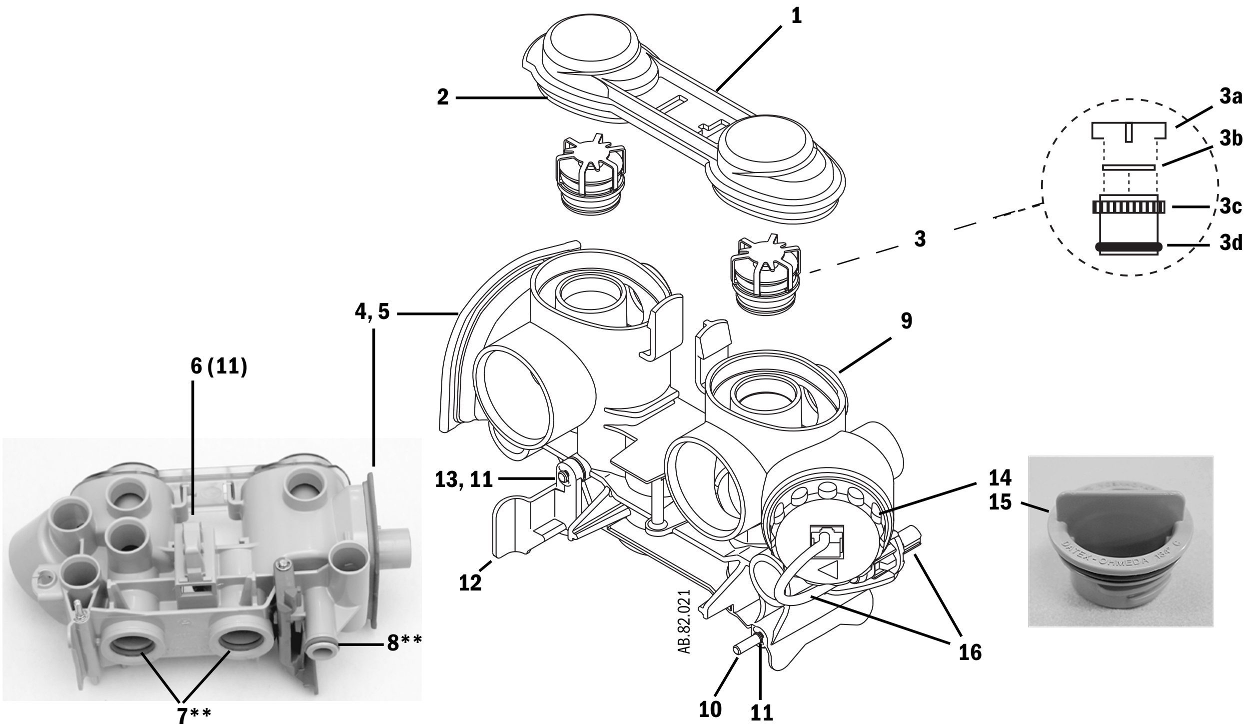
10.42.4 Flow Sensor Module



Item	Description	Stock Number	Qty
	Flow Sensor Module (*)	1407-7022-000	
1*	Flow Sensor (plastic - moisture resistant)	1503-3858-000	
	Flow Sensor (metal - autoclavable)	1503-3244-000	
2	Cover, Flow Sensor	1011-3283-000	
3	Holder, Flow Sensor, upper	1407-3002-000	
4	Holder, Flow Sensor, lower	1407-3003-000	
5	Thumbscrew, M6x43 SST	1406-3304-000	
6	Screw, M4x10 SKT HD SST	0144-2117-718	(2)
7	Cuff, Flow Sensor	1407-3004-000	(2)
8	Latch, Flow Sensor	1407-3001-000	
9	Spring, latch	1407-3005-000	
10	Ring, Truarc 0.188 shaft E-ring SST	0203-5225-300	

* The flow sensors are not included in the flow sensor module.

10.42.5 Breathing Circuit Module

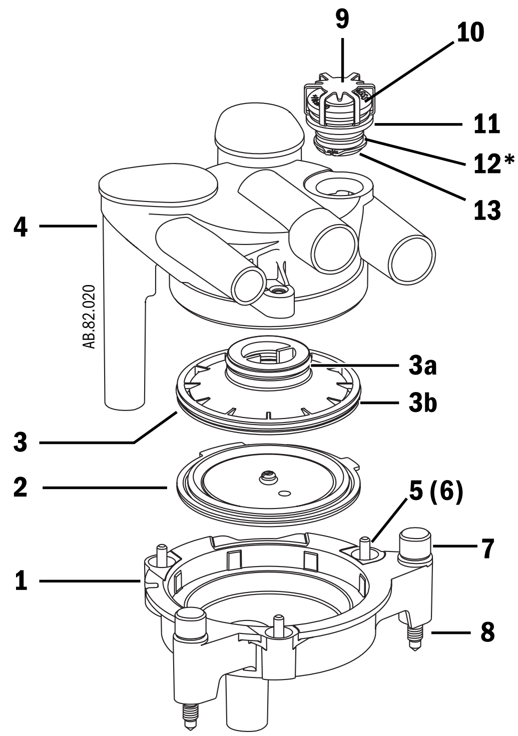


Item	Description	Stock Number	Qty
	Breathing Circuit Module *	1407-7002-000	
1	Lens, Circuit Check Valves	1407-3101-000	
2	O-ring, 44.02 ID 51.1 OD 3.53 W Silicone 70 DURO	1407-3507-000	(2)
3	Check Valve Assembly	1406-8219-000	(2)
3a	Retainer, Disk	1400-3017-000	(2)
3b	Disc, Check Valve	0210-5297-100	(2)
3c	Seat, unidirectional	1406-3396-000	(2)
3d	O-ring, 20.35 ID 23.90 OD 1.78W	1406-3397-000	(2)
4	Plate, circuit flange	1407-3110-000	
5	Screw, Sems M4x8 BT SKT HD W/EXT L/W SST 316	0144-2436-108	(6)
6	Hook, Latch	1407-3604-000	
7**	O-ring 22 ID 30 OD 4 W Silicone 40 DURO	1407-3104-000	(2)
8**	O-ring 12.37 ID 17.6 OD	1006-3968-000	
9	Manifold, Circuit	1407-3100-000	
10	Pin, Canister Pivot	1407-3109-000	
11	Ring, Truarc 0.188 SHAFT NO 5133-18H E-ring SST	0203-5225-300	(5)
12	Lever, Canister Latch	1407-3102-000	
13	Pin, Canister Lever	1407-3108-000	
14*	O_2 Cell (includes o-ring)	6050-0004-110	
	O-ring, cell	1406-3466-000	
15*	Plug with o-ring (for units without circuit O_2 sensing)	1503-3857-000-S	
	O-ring, plug	1406-3466-000	
16*	Cable, O_2 Cell	1009-5570-000	

* The O_2 cell (or plug) and the cell cable are not included in the breathing circuit module.

** Lubricate sparingly with Krytox.

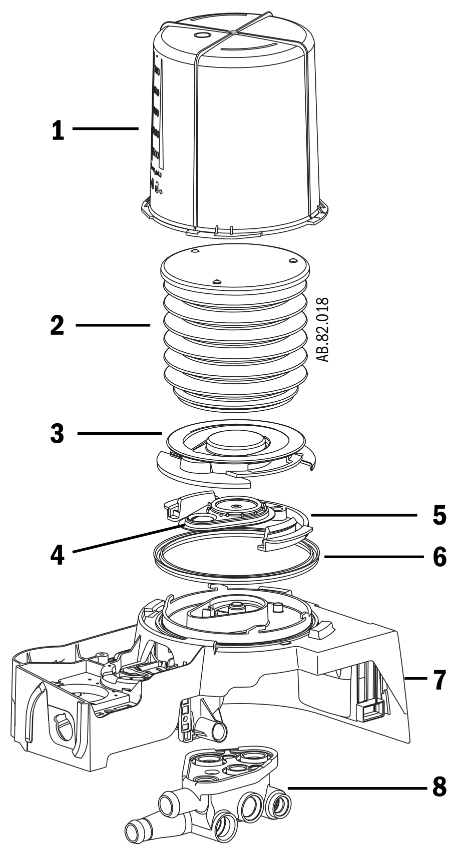
10.42.6 Exhalation valve



Item		Description	Stock Number	Qty
		Exhalation Valve assembly	1407-7005-000	
1		Base, exhalation valve	1407-3701-000	
2		Diaphragm assembly	1503-8121-000	
3		Seat, exhalation valve	1407-3704-000	
	3a	O-ring, 28.25 ID x 33.48 OD	1503-3058-000	
	3b	O-ring, 66.40 ID x 69.95 OD	1503-3059-000	
4		Cover, exhalation valve	1407-3700-000	
5		Screw, M4x16 PH PAN HD	9211-0440-163	(3)
6		O-ring, 2.9 ID 6.46 OD 1.78 W EP 70 DURO	1407-3409-000	(3)
7		Thumbscrew, M6x43 10mm head	1406-3306-000	(2)
8		O-ring, 4.47 ID x 8.03 OD 1.78 W EPR 70 DURO	1407-3703-000	(2)
9		Retainer, disk 26.97D 12.7H 0.76T SST flutter	1400-3017-000	
10		Weight, dead 10 cm H2O	1406-3572-000	
11		Seat	1406-3571-000	
12*		O-ring, OD19.16 ID15.6 EPDM DURO 70 -016	1006-3616-000	
13		Ring, retaining 19.05 SHAFT DIA	1406-3577-000	

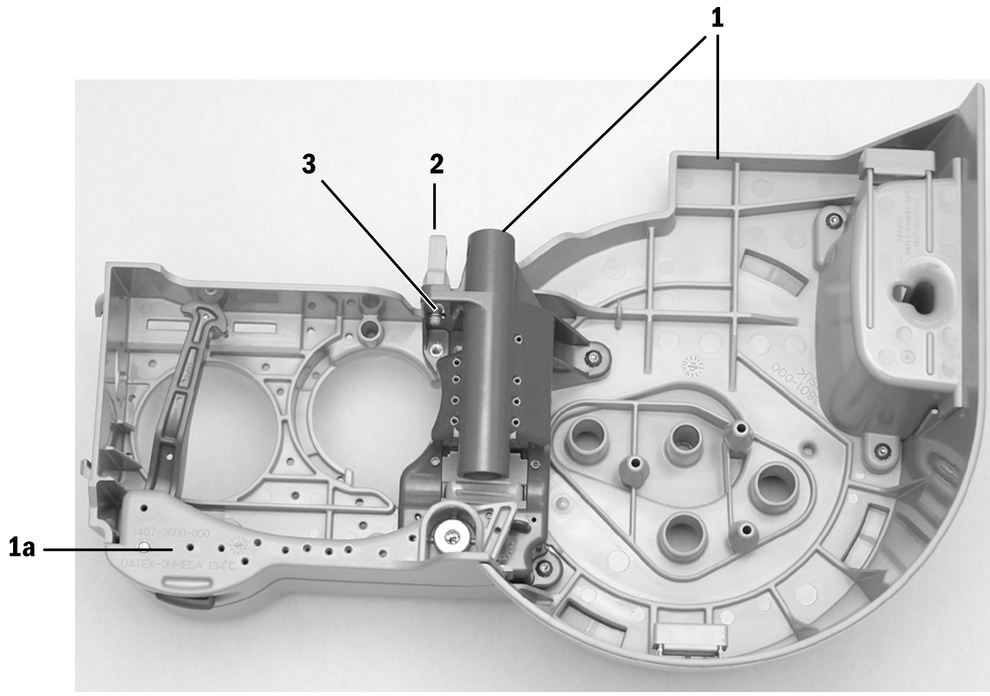
* Lubricate sparingly with Krytox.

10.42.7 Bellows



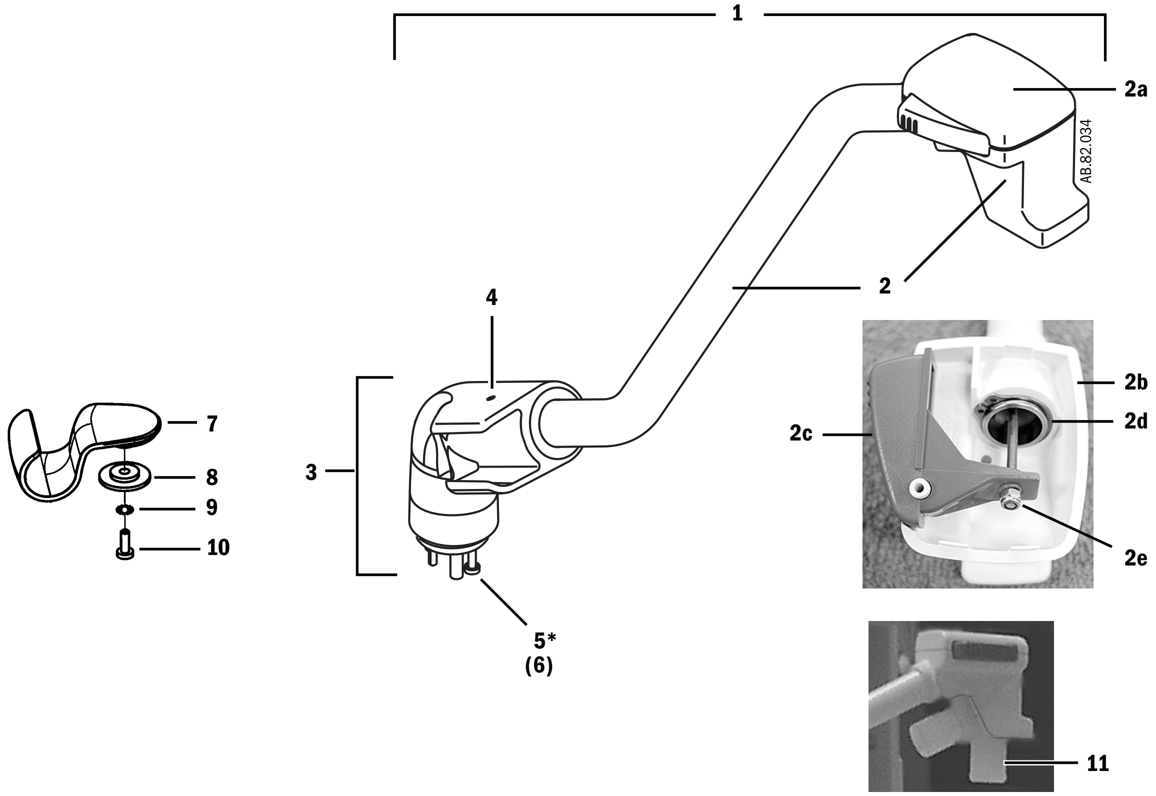
Item	Description	Stock Number
1	Bellows housing, Clear	M1239264
2	Bellows	1500-3378-000
3	Rim	1500-3351-000
4	Pressure relief valve assembly	1500-3377-000
5	Latch, base	1500-3352-000
6	Seal, base	1500-3359-000
7	Base, bellows	Refer to Section 10.42.8
8	Manifold, bellows base	1407-3702-000

10.42.8 Bellow base



Item		Description	Stock Number
1		Bellows base assembly	M1213265
	1a	Latch assembly (Teal Gray)	M1237943
2		Hook, latch	1407-3604-000
3		E-ring	0203-5225-300

10.42.9 Bag Arms

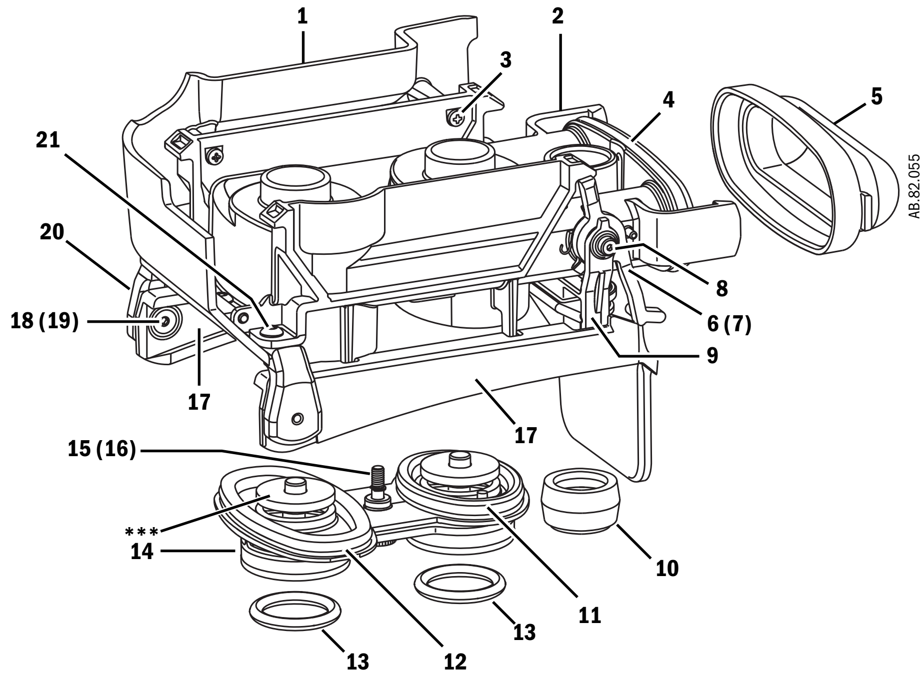


Item	Description	Stock Number	Qty
1**	Bag Arm Assembly (complete Kit)	1009-8284-000	
2	Bag Arm Upper Assembly	1407-7011-000	
2a	Cover, bag port housing Screw, M3x20 Lockwasher, M3 internal	1407-3807-000 0140-6719-103 9213-0430-003	
2b	Housing, bag port	1407-3806-000	
2c	Lever, lock release	1407-3808-000	
2d	Ring, retaining	1406-3577-000	
2e	Nut, M3 Nyloc	0144-3536-112	
3	Bag Arm Lower Assembly	1407-7012-000	
4	Pin, dowel 3.18 DIA 31.8 L SST	1407-3804-000	
5*	Screw, M3x20 SKT HD CAP	0144-2124-201	(2)
6	Washer, M3 flat	0144-1003-132	(2)
Items if no Bag Arm (Bag on Tube)			
**	Bag on tube Kit (includes Items 7 through 10)	1009-8285-000	
7	Clip, patient tubing	1407-3810-000	
8	Washer, shoulder	1407-3814-000	
9	Lockwasher, M4 external	9213-0540-003	
10	Screw, M4x16	9211-0440-163	
Accessory items			
11	Bag arm connector, reusable (All except China) Bag arm connector, reusable (China)	8004459 M1082613	

* Apply Loctite 242.

** These kits also include the related Clip and hardware detailed in the “Tabletop components” section.

10.42.10 EZchange Canister system (CO_2 Bypass)



Item	Description	Stock Number	Qty
	EZchange Manifold Upgrade Kit (includes EZchange manifold and switch kit with guide ring)	M1053007	
	EZchange Manifold with Condenser Upgrade Kit (includes EZchange manifold, condenser, condenser guard, and switch kit with guide ring)	M1053008	
	EZchange Module and Condenser	1407-7027-000	
	EZchange Canister module (includes **Items 1 through 21**)	1407-7021-000	
	Valve Assembly, EZchange (includes **Items 11 through 16**)	1407-7023-000	
1	Cover, Bypass Manifold	1407-3123-000	
2	Manifold, Bypass	1407-3113-000	
3	Screw, M3x8 PT PAN PH SST	0142-4254-106	(2)
4*	O-ring, 59.92 ID 66.98 OD 3.53 W Silicone 50 DURO	1407-3142-000	
5	Cap, Manifold	1407-3130-000	
6	Lever, Switch Actuator	1407-3116-000	
7	Spring, Torsion Switch Actuator Lever	1407-3117-000	
8	Screw, M3x0.5 Shoulder 4 DIA X 4 L SST	1407-3915-000	(2)
9	Lever, Canister Latch	1407-3115-000	
10	Seal, Drain	1407-3121-000	
11*	O-ring, 37.69 ID 44.75 OD 3.53 W Silicone 50 DURO	1407-3129-000	
12*	O-ring, 50.39 ID 57.45 OD 3.53 W Silicone 50 DURO	1407-3143-000	
13*	O-ring, OD30 ID 22 4W SIL 40 DURO	1407-3104-000	(2)
14***	Valve, Housing Assembly Bypass	1407-3126-000	
15	Screw, Thumb M4 Shoulder 7.5 X 7	1407-3410-000	
16	Ring, Retaining 3.96 Shaft DIA SST	1407-3411-000	
17	Cradle Canister	1407-3118-000	
18**	Screw, M4x10 CSK SKT HD SST TYPE 316	0140-6226-119	(2)
19	Spacer, Shoulder 6.8 DIA x4.1 L	1407-3120-000	(2)
20	Support, Cradle Pivot	1407-3119-000	
21**	Screw, M4x8 Sems BT SKT HD SST 316	0144-2436-108	(3)

* Lubricate sparingly with Krytox.

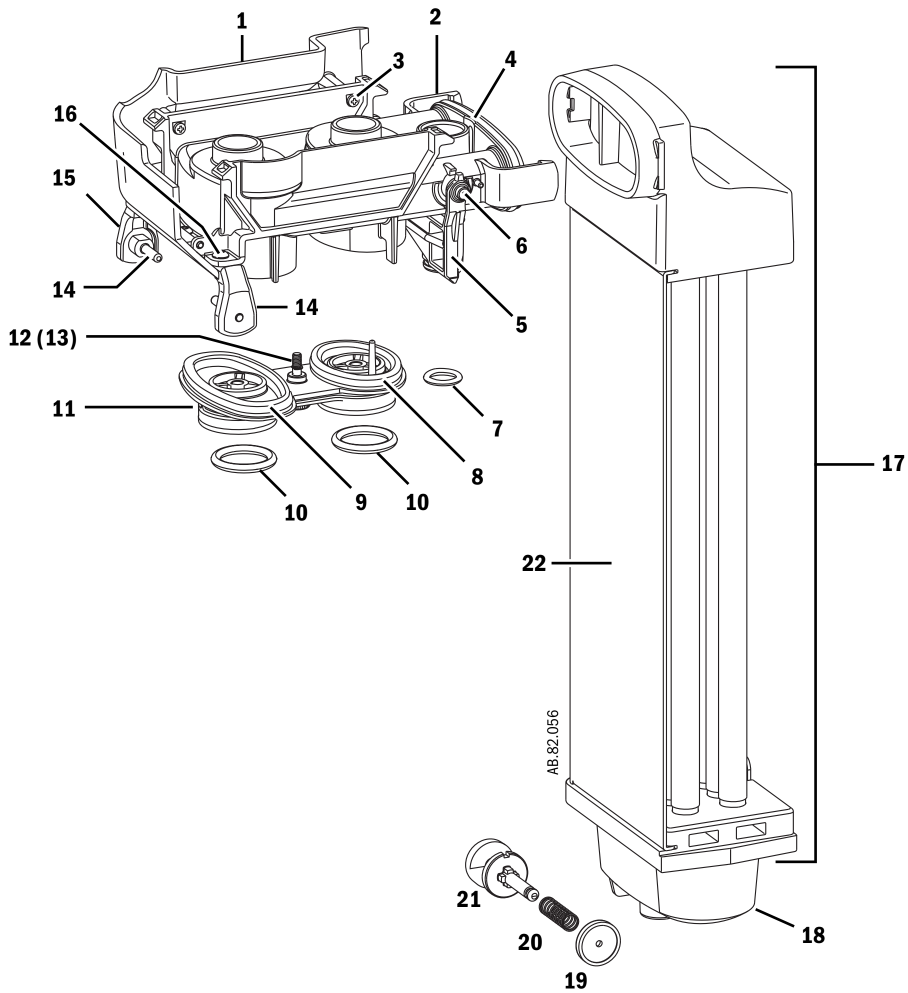
** Apply Loctite 242.

*** Rubber valve seats can not be removed from assembly (**Item 14**).

10.42.11 Condenser

Item	Description	Stock Number	Qty
	Condenser assembly (includes all Items)	1407-7026-000	
	Condenser module (Items 1 through 16)	1407-7025-000	
	Condenser (Items 17 through 22)	1407-7024-000	
1	Cover, Bypass Manifold	1407-3123-000	
2	Manifold, Condenser	1407-3114-000	
3	Screw, PT PAN PH M3X8 SST	0142-4254-106	(2)
4*	O-ring, 63.09 ID 70.15 OD	1407-3142-000	
5	Lever, Canister Latch	1407-3115-000	
6	Screw, M3x0.5 Shoulder 4 DIA X 4 L SST	1407-3915-000	(2)
7	O-ring, 12.37 ID 17.6 OD	1006-3968-000	
8*	O-ring, 37.69 ID 44.75 OD	1407-3129-000	
9*	O-ring, 50.39 ID 57.45 OD	1407-3143-000	
10*	O-ring, 22 ID 30 OD	1407-3104-000	(2)
11	Cap, Valve Housing	1407-3125-000	
12	Screw, Thumb M4 Shoulder 7.5 X 7	1407-3410-000	
13	Ring, Retaining 3.96 Shaft DIA SST	1407-3411-000	
14**	Pin, Condenser Manifold	1407-3131-000	(2)
15	Support, Cradle Pivot	1407-3119-000	
16	Screw, M4x8 Sems BT SKT HD	0144-2436-108	(3)
17	Tube Assembly	1407-3133-000-S	
18	Reservoir, Condenser	1407-3137-000	
19	Seal, Condenser Reservoir	1407-3136-000	
20	Spring, Compression Drain Button	1407-3135-000	
21	Button, Drain	1407-3134-000	
22	Cover, Condenser	1407-3138-000	
23	Guard	1407-3145-000	

* Lubricate sparingly with Krytox.
** Apply Loctite 242.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AB.82.056
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AB.75.p80
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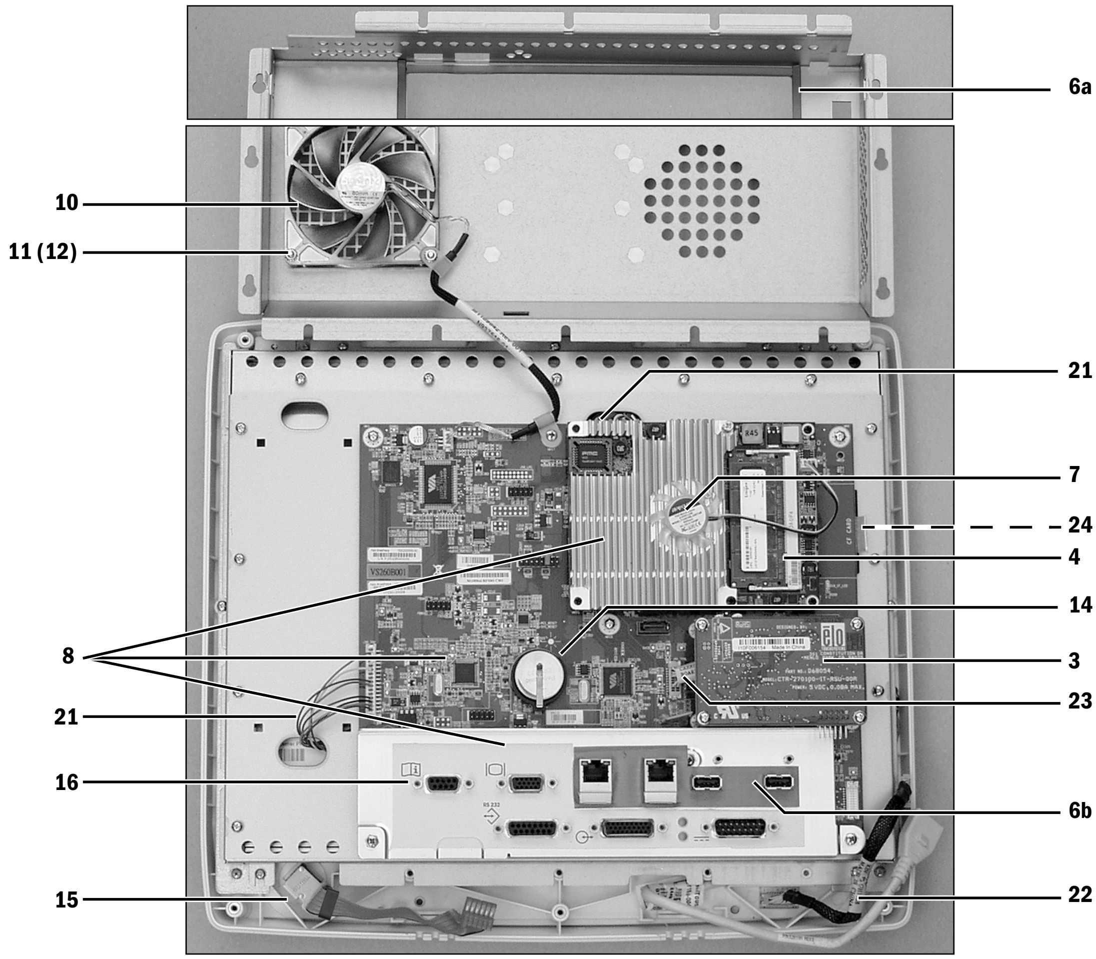
10.43 Display Unit

Item	Description	Stock Number
	Display Unit, **complete** with 15-inch LCD and Touch Screen	2067727-001-S
1*	KIT, LCD Touch Bezel Assembly (Includes harness **Item 21**)	M1220153
2	Keypad Assembly	M1219029
3	KIT, Touch Controller Board	M1220150
4	Memory Module, DDR2 SODIMM	M1232960
5	Fan Filter, Multipack (10)	M1220155
6	KIT, Gasket EMC, Connector Panel	M1220156
7	KIT, Fan, Com Express	M1220157
8	KIT, Carrier Board and Com Express Board assembly (Includes battery **Item 14**, Memory Module **Item 27**, and EMC gasket **Item 6b**; does not include CF Card **Item 28**.)	2067705-001
9	Rear Housing Assy (Includes captive screws **Item 24**.	M1233656
10	Fan, Case (includes mounting hardware)	M1220149
11	Screw, M3X12 PAN POZI-DR SST	M1229946
12	Nut, M3 Keps	0144-3717-302
13	Screw, M3x5 PAN PH SST	M1227729
14	Battery, 3V, 1000mAh Lithium Coin Type	1009-5800-000
15	Encoder, Rotary with Push-Button Switch	2067672-001
16	Standoff, 4-40 UNC 5mm	M1229948
17	Knob, Encoder	M1081590-S
18	Gasket, EMC LCD, Horizontal (2 required)	M1203117
19	Cover	M1203125
20	Speakers, 4-ohm with Cable	M1203144
21	Harness, Carrier Board to LCD LVDS	M1236421
22	Harness, Carrier Board to Keypad	M1203148
23	Harness, Carrier Board to Touch Controller Board	M1203151
24	CF Card (formattted for DU)	M1238655
25	Screw, Captive M3x14 PAN PH SST	M1219217
26	Gasket, EMC LCD Vertical (2 required)	M1227733

* Keypad assembly from existing bezel assembly can not be reused, order Keypad Assembly (**Item 2**) separately.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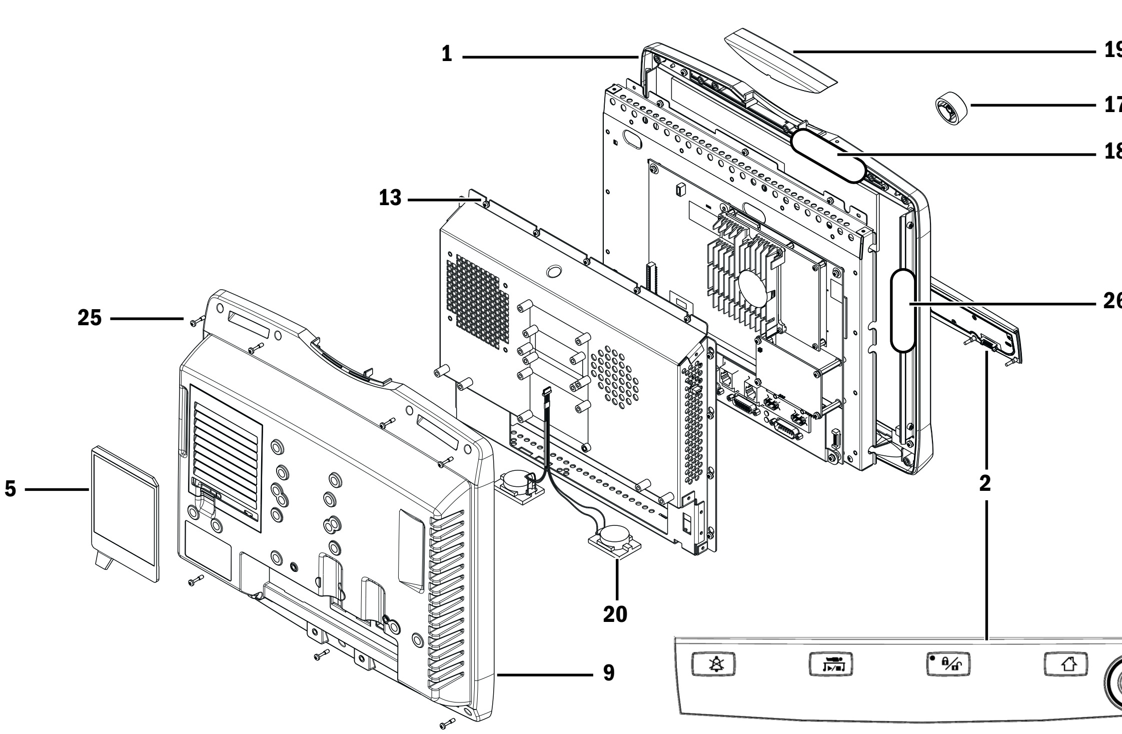
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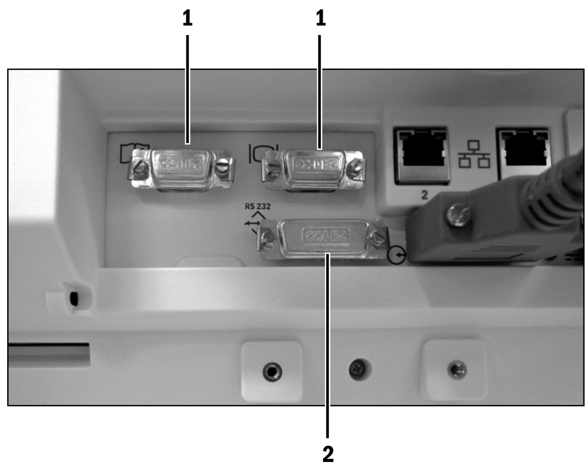
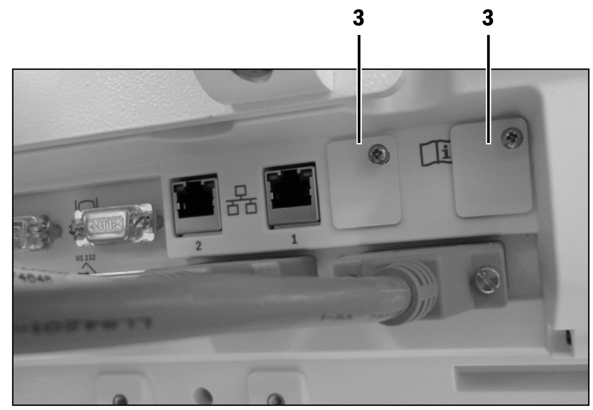
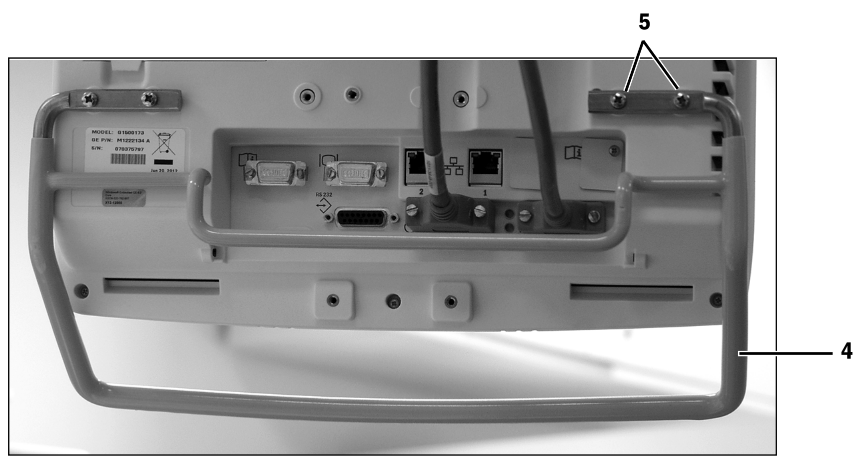
10.44 Display Unit - external components

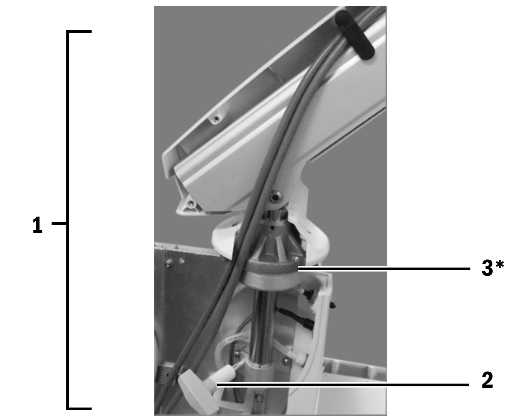


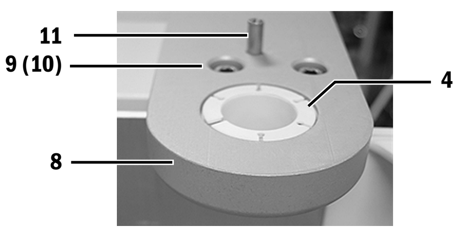


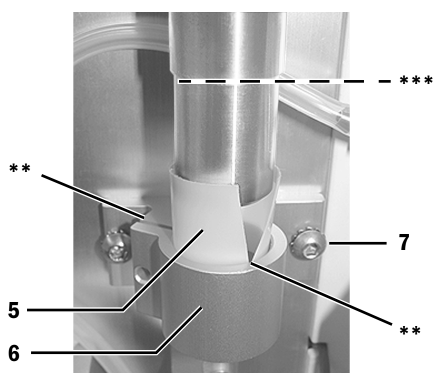


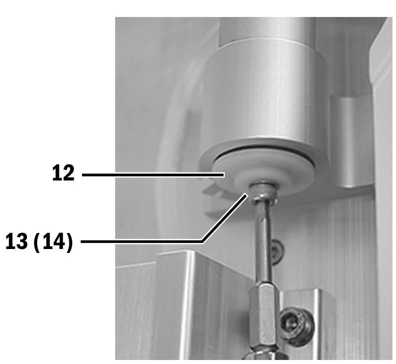
Item	Description	Stock Number
1	Cap, DSUB 9 - VGA	M1141813
2	Cap, DSUB 15 - Serial Port	M1141814
3	Cover, USB connector	M1229955
4	Handle	M1236670
5	Screw, M4x16 Pan HD	9211-0440-163

10.45 Display arm







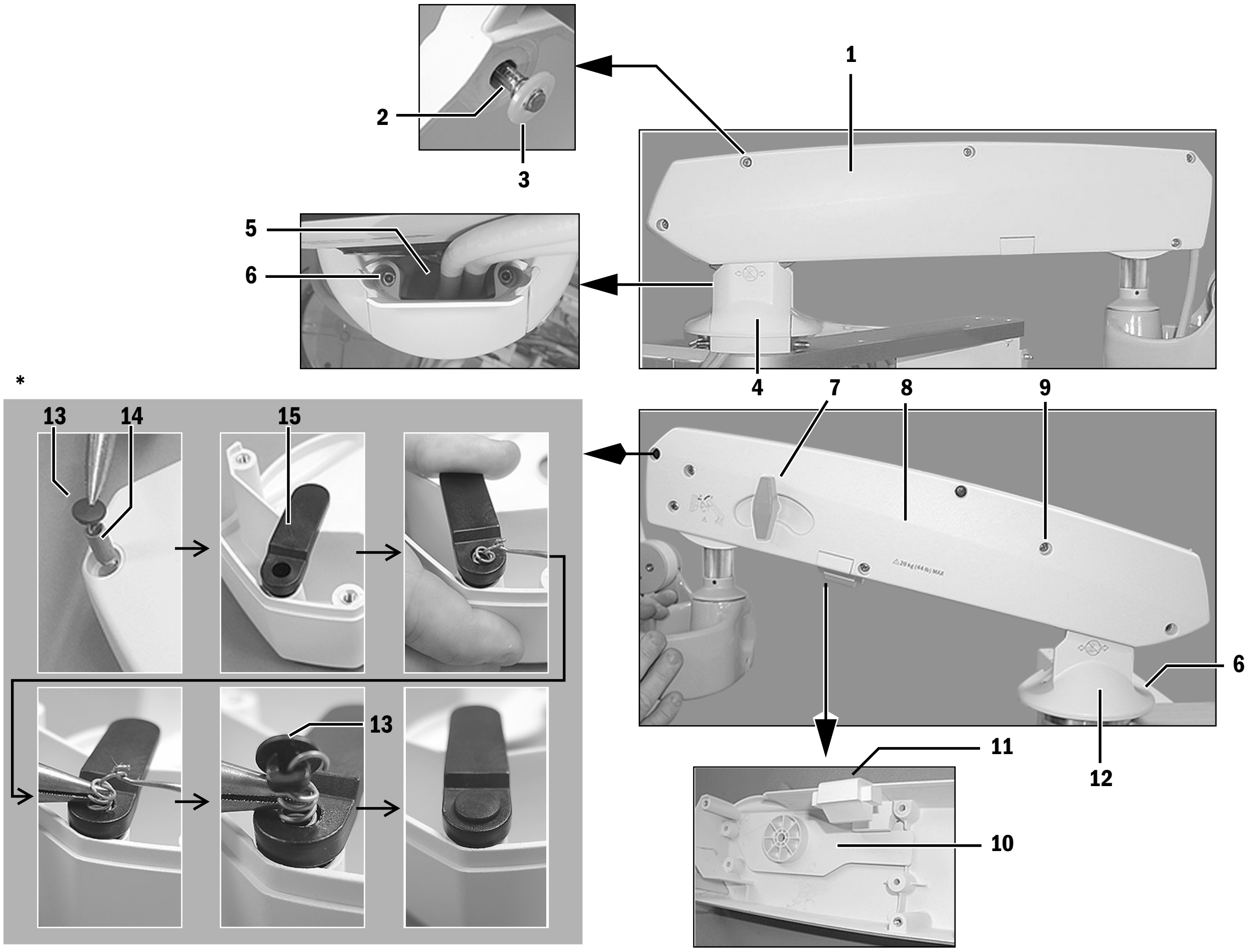


Item	Description	Stock Number	Qty
1	Display arm assembly (does not include shroud)	M1240734	
2	Handle, clamping display arm	2065581-001	
3*	Washer, friction shoulder	1011-3390-000	
4	Bearing, Nyliner with key	1006-3228-000	
5**	Spacer, split plastic	1011-3393-000	
6	Support, shaft bottom	1011-3388-000	
7	Screw, M6x16 Sems	0144-2436-109	2
8	Support, shaft top	1011-3389-000	
9	Screw, M6x16 SKT HD CAP	1011-3894-000	4
10	Lockwasher, M6 internal	0144-1118-130	4
11	Roll pin, 0.25 OD	0201-0757-300	
12	Washer, shoulder	1407-3814-000	
13	Screw, M4x12 SKT HD CAP	1102-3006-000	
14	Lockwasher, M4 internal	0144-1118-128	

* Lubricate both sides of friction washer (**Item 3**) and completely around the first 3 cm of shaft next to washer.
** Ensure end-gap of spacer is opposite slot in lower support.
*** Push spacer (**Item 5**) into lower support using shoulder on shaft.

Note:
When replacing the display arm, loosen the mounting screws (**Item 7**) for the bottom shaft support (**Item 6**) to ease alignment. Retighten the screws before replacing the shoulder washer (**Item 12**).

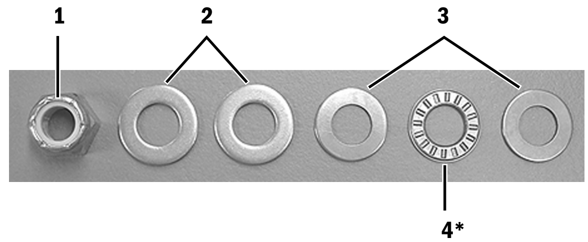
10.45.1 Display arm shroud and covers

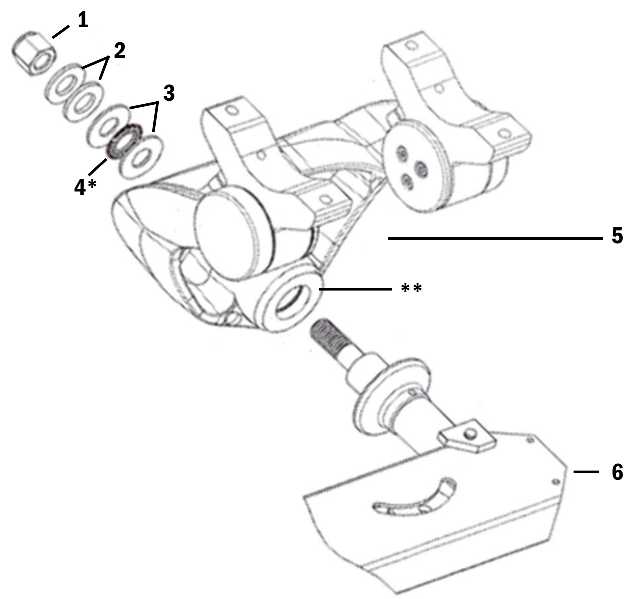


Item	Description	Stock Number	Qty
1	Cover, display arm	1011-3629-000	
2	Screw, M4x12 captive	1504-3001-000	5
3	Washer, M4 retaining Nylon	1009-3178-000	5
4	Cover, base	1011-3631-000	
5	Strain relief, sponge	1011-3642-000	
6	Screw, M4x20 SKT HD CAP	0144-2124-218	4
7	Handle, display arm clamping (Teal)	2065580-001	
8	Shroud, display arm	M1240732	
9	Screw, M4x12 Pan HD	0140-6226-111	5
10	Cover, sliding locking handle	M1240728	
11	Bumper, display arm	M1240726	
12	Cover, base display arm rear	M1240730	
13	Button, retaining spring	1602-3010-000	4
14	Spring, 6.1 OD	1602-3022-000	2
15	Swivel, display arm shroud	1602-3011-000	2

* Attach a button at one end of the spring; from the other side, hook the spring and extend it through the swivel; hold the spring with needle nose pliers and attach the second button to the spring to hold the swivel in place.

10.46 Wrist casting assembly mounting

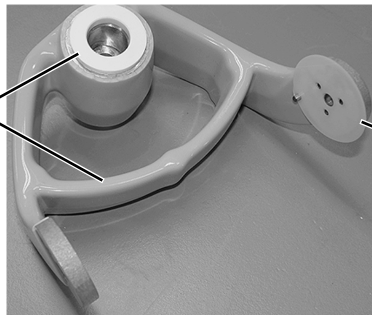


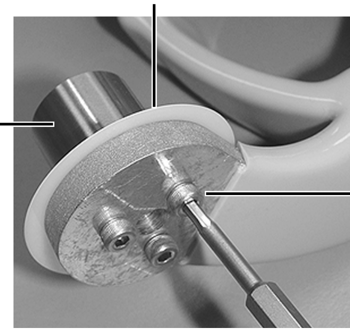


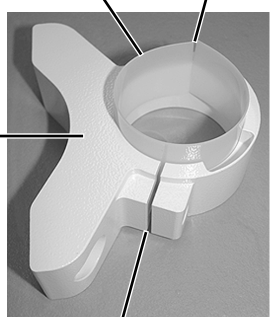
Item	Description	Stock Number	Qty
1	Nut, 1/2-13 Hex Nyloc	1006-4595-000	
2	Washer, 13.5 ID 25.4 OD	1006-3828-000	2
3	Washer, bearing 0.5 inch ID	1006-4593-000	2
4*	Bearing, thrust 0.5 inch ID	1006-4594-000	
5	Wrist casting assembly	Refer to 10.46.1	
6	Display arm assembly	Refer to 10.45	

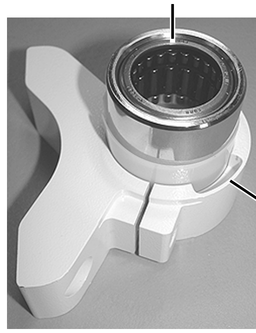
* Lubricate both sides sparingly with Krytox.
** Lubricate surface of friction washer sparingly with Krytox

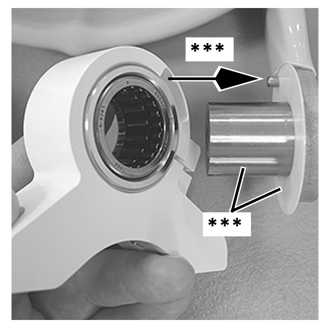
10.46.1 Wrist casting assembly







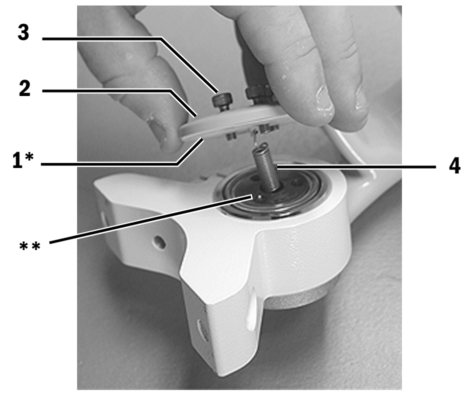


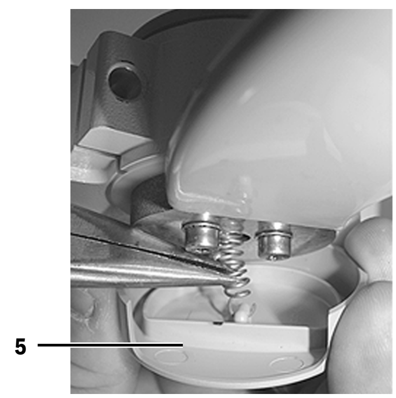


Item	Description	Stock Number	Qty
	Double stop-pin Wrist Casting Upgrade Kit (Includes **Item 1** and two of **Item 6**)	M1169243	
1	Wrist casting (double stop-pin) with friction washer	M1056169	
2	Washer, thrust - plastic	1602-3017-000	2
3	Axle bearing	1602-3021-000	2
4	Screw, M4x16 SKT HD CAP	1011-3893-000	6
5	Lockwasher, M4 internal	0144-1118-128	6
6	Housing, bearing (revised to include a pin relief on both sides)	1011-3391-000	2
7*	Spacer, slip - plastic	1602-3015-000	2
8**	Bearing assembly	M1055689	2

* Ensure end-gap of spacer is opposite slot in housing.
** Insert the bearing assembly into the bearing housing with writing on side of bearing facing up (same side as relief on bearing housing.
*** Lubricate axle bearing and thrust washer sparingly with Krytox. On right-side axle bearing, align relieved area on bearing housing with pin on wrist casting. On left-side axle bearing, the relieved area faces away from the wrist casting.

10.46.2 Wrist casting bearing caps



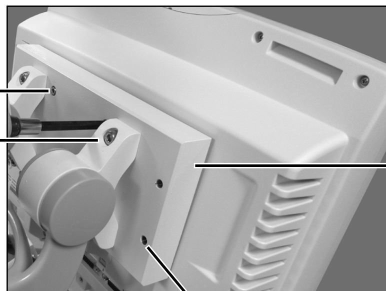


Item	Description	Stock Number	Qty
1*	Washer, thrust - plastic	1602-3017-000	2
2	Cap, arm bearing inner	1011-3392-000	2
3	Screw, M4x12 SKT HD CAP	1102-3006-000	6
4	Spring, extension 6.1 OD	1602-3022-000	2
5	Cap, arm bearing outer	1011-3600-000	2

* Lubricate the bearing facing thrust washer sparingly with Krytox.
** Apply Loctite 242 (into screw holes).

10.47 Display mounting solutions

10.47.1 Default mounting (DU only — no monitors)

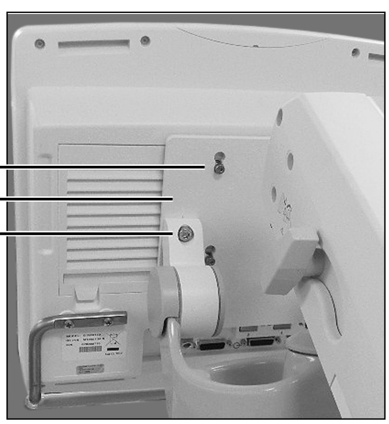


Item	Description	Stock Number
1	Counterweight	1011-3295-000
2*	Screw, M6x20 SKT HD CAP	0144-2131-921
3	Screw, M4x30 CAP HD	9211-0640-304
4	Lockwasher, M4 internal	0144-1118-128

* Apply Loctite 242.

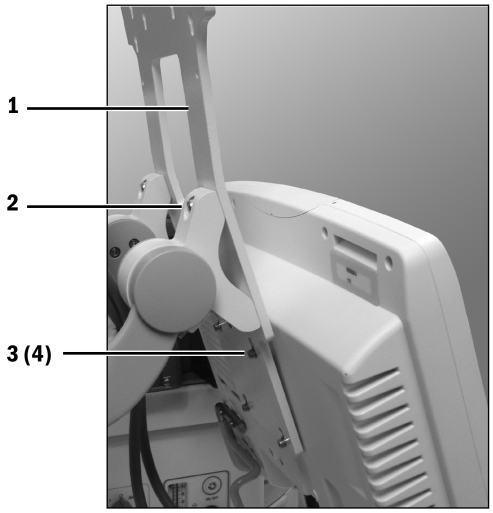
** Orient unused holes toward breathing system side.

10.47.2 DU with 15-, 17, or 19-inch monitor (horizontal) option 2065377-001-S



Item	Description	Stock Number
1	Bracket, horizontal 15/17/19-inch	M1237029
2*	Screw, M6x16 SKT HD CAP	1011-3894-000
3	Screw, M4x12 SKT HD CAP	1102-3006-000
4	Lockwasher, M4 internal	0144-1118-128
* Apply Loctite 242.		
Not shown: (hardware to mount monitor display)		
	Screw, M4x16 PAN HD(4)	9211-0440-163
	Lockwasher, M4 internal (4)	0144-1118-128
Validated monitor displays:		
	CARESCAPE B850 15-inch and 19-inch	
	Solar 15-inch, 18-inch, and 19-inch	

10.47.3 DU with 15-, 17-, or 19-inch monitor (vertical) option 2065378-001-S



Item	Description	Stock Number
1	Bracket, vertical 15/17/19-inch	M1237032
2*	Screw, M6x16 SKT HD CAP	1011-3894-000
3	Screw, M4x12 SKT HD CAP	1102-3006-000
4	Lockwasher, M4 internal	0144-1118-128

* Apply Loctite 242.

Not shown: (hardware to mount monitor display)

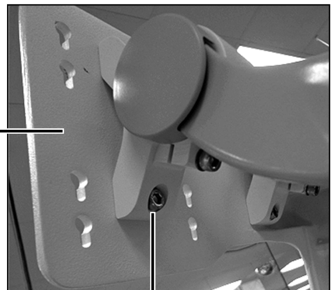
	Screw, M4x16 PAN HD(4)	9211-0440-163
	Lockwasher, M4 internal (4)	0144-1118-128

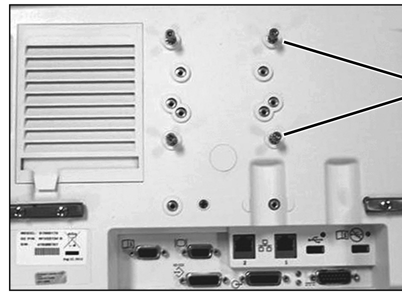
Validated monitor displays:

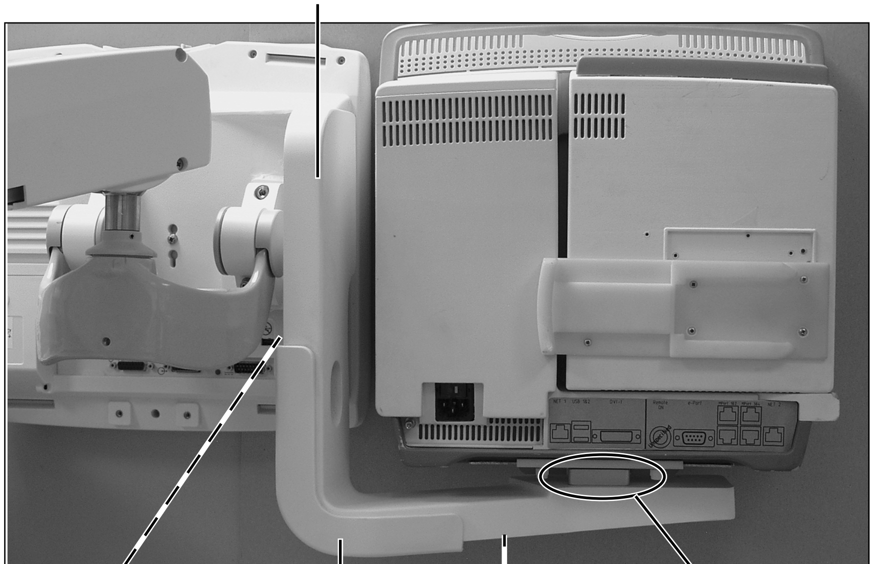
CARESCAPE B850 15-inch and 19-inch

Solar 15-inch, 18-inch, and 19-inch

10.47.4 Horizontal display mount B650/B450/MX800



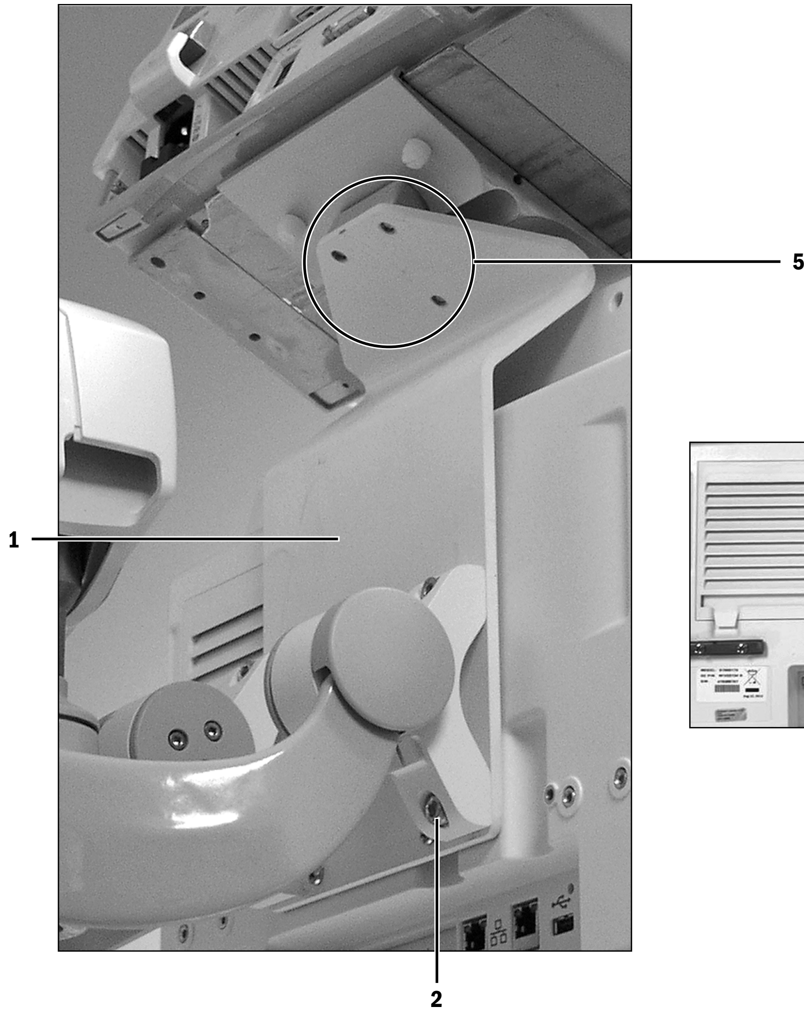


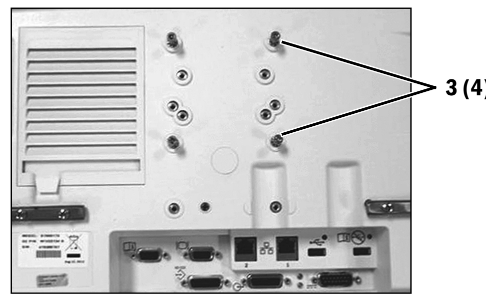


Item	Description	Stock Number
	Patient Monitor Mount Kit - Horizontal B650/B450	2065379-001-S
1	Bracket, horizontal B650/MX800 display mounting	Available in Kit only
2*	Screw, M6x16 SKT HD CAP	1011-3894-000
3	Screw, M4X16 SKT HD CAP	1011-3893-000
4	Lockwasher, M4 internal	0144-1118-128
5	Bumper	2067074-001
6	Cover, B650 bracket - side	2063313-001
7	Screw, M3x8 PAN HD	9211-0430-083
8	Cover, B650 bracket - bottom	2063312-001
9	Screw, M3x10 FL PH HD	0140-6226-100
10	Plate, B650 mounting adapter	2065925-001

* Apply Loctite 242.

10.47.5 Vertical display mount B650/B450/MX800

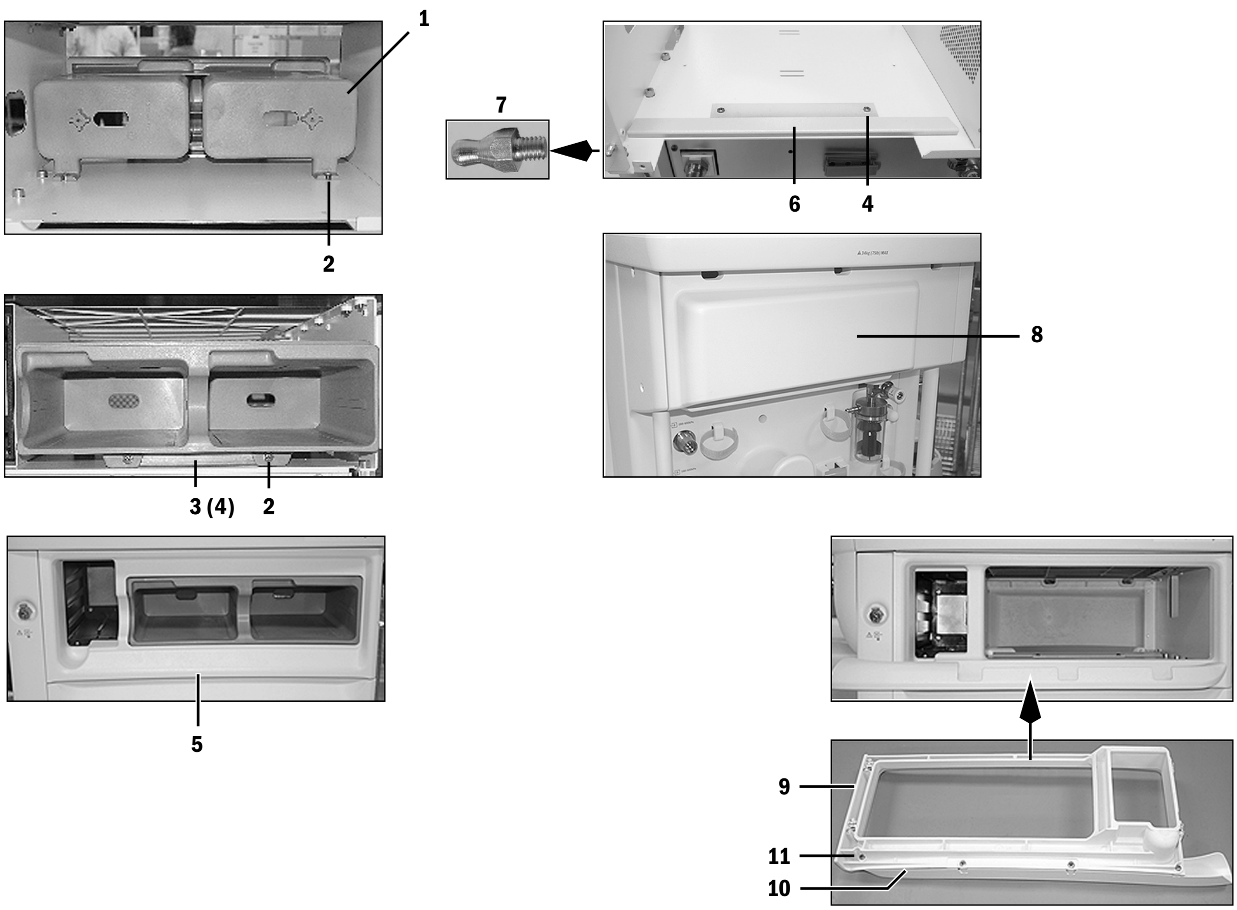




Item	Description	Stock Number
	B650 Patient Monitor Mounting Kit (Vertical)	2065380-001-S
1	Bracket, vertical B650	Available in Kit only
2*	Screw, M6x16 SKT HD CAP	1011-3894-000
3	Screw, M4X12 SKT HD CAP	1102-3006-000
4	Lockwasher, M4 internal	0144-1118-128
5	Hardware to mount monitor bracket is provide it kit.	

* Apply Loctite 242.

10.48 Components - upper bay



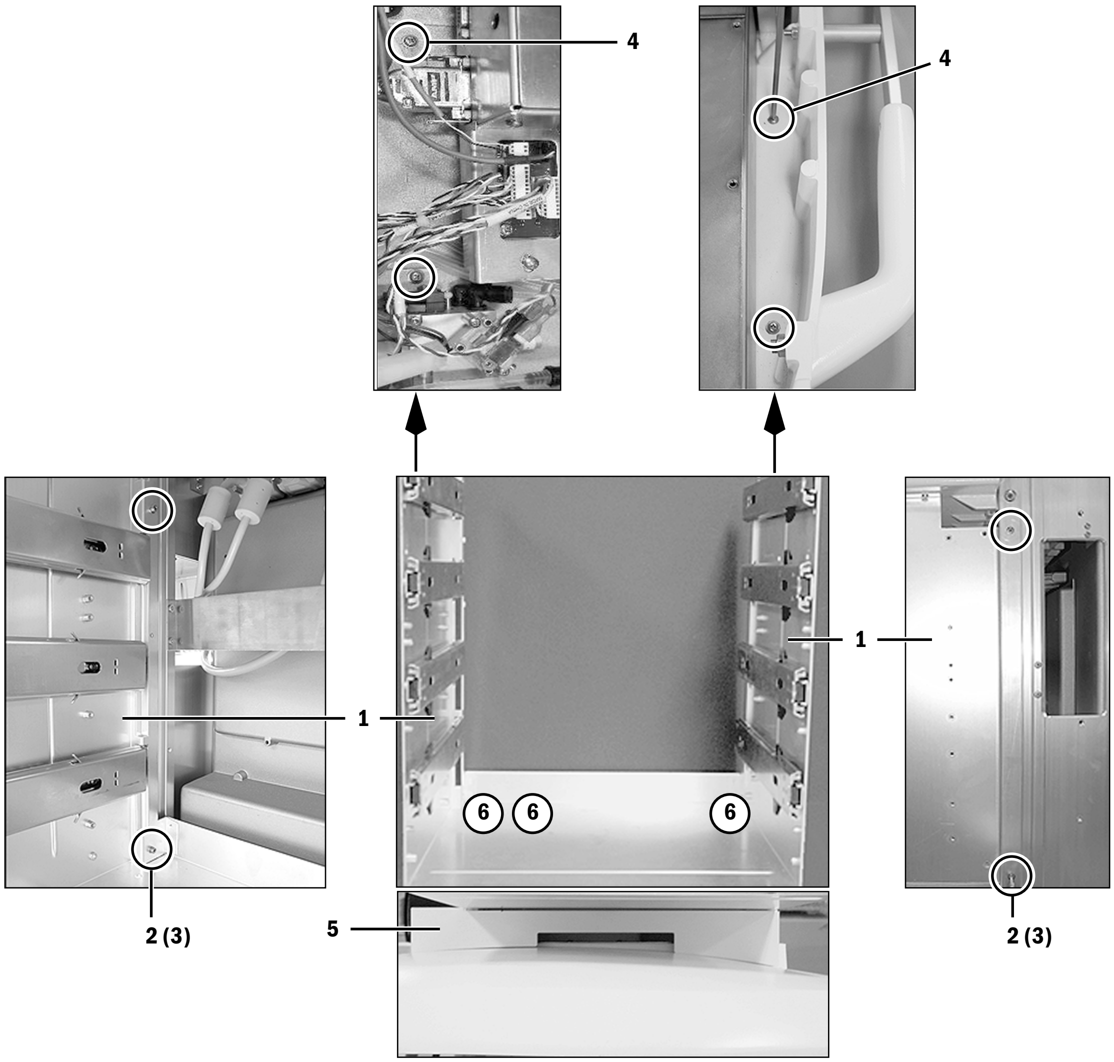
Item	Description		Stock Number
1	Bay, upper cassette storage		1011-3628-000
2	Screw, M4x6 PAN		1009-3283-000
3	Bracket		1011-3635-000
4	Screw, M4x8 DIN84		1006-3178-000
5	Bezel, cassette storage	Wide	M1230420
		Narrow	M1230419
6	Ramp, module rack		1011-3334-000
7*	Ballstud		1202-3272-000
8	Panel, cosmetic upper rear		1011-3228-000
9	Bezel, upper module rack (for cable raceway)	Wide	M1225142
		Narrow	M1225141
10	Raceway, upper cable manage		1011-3383-000
11	Screw, M4x20 PAN HD		0140-6226-121

* Apply Loctite 242.

10.49 Drawer packs

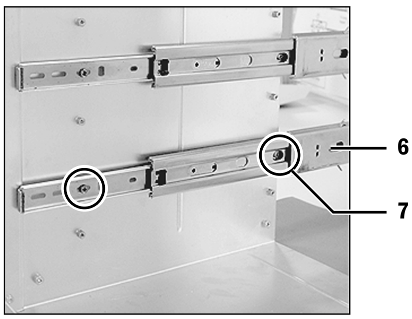
Item	Description	Stock Number
1	Drawer. 105 with lock	Refer to Section 10.49.2
2	Drawer, 105 without lock	Refer to Section 10.49.2
3	Drawer, 150	Refer to Section 10.49.2
4	Bay, lower cassette storage	Refer to Section 10.49.3
5	Shelf, clipboard	Refer to Section 10.49.4

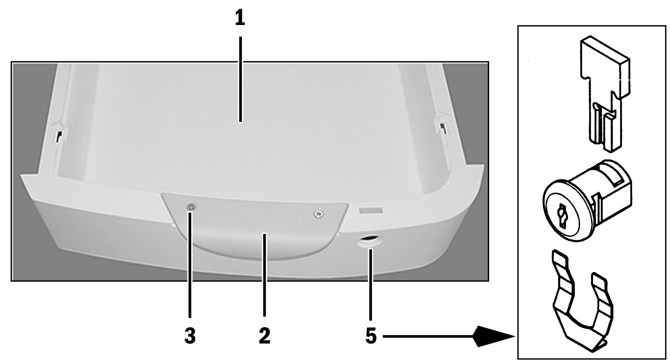
10.49.1 Drawer pack hardware

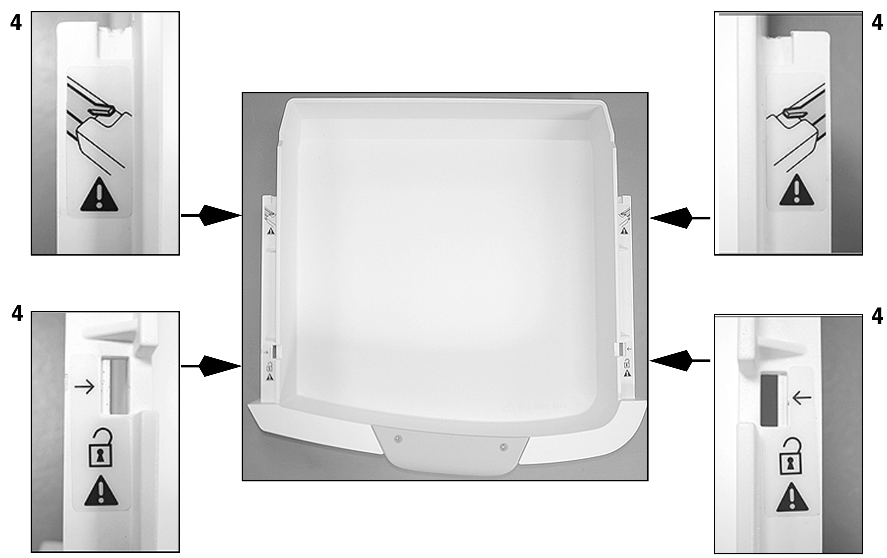


Item	Description	Stock Number	Qty
1	Cabinet, drawer pack	1011-3274-000	
2	Screw, M4x16 SKT HD CAP	1011-3893-000	(3)
3	Lockwasher, M4 internal	0144-1118-128	(3)
4	Screw, M4x12 PAN HD	1009-3341-000	(4)
5	Panel, cosmetic bottom	1011-3367-000	
6	Screw, M4x8 FLAT HD	0140-6226-107	(3)

10.49.2 Drawers

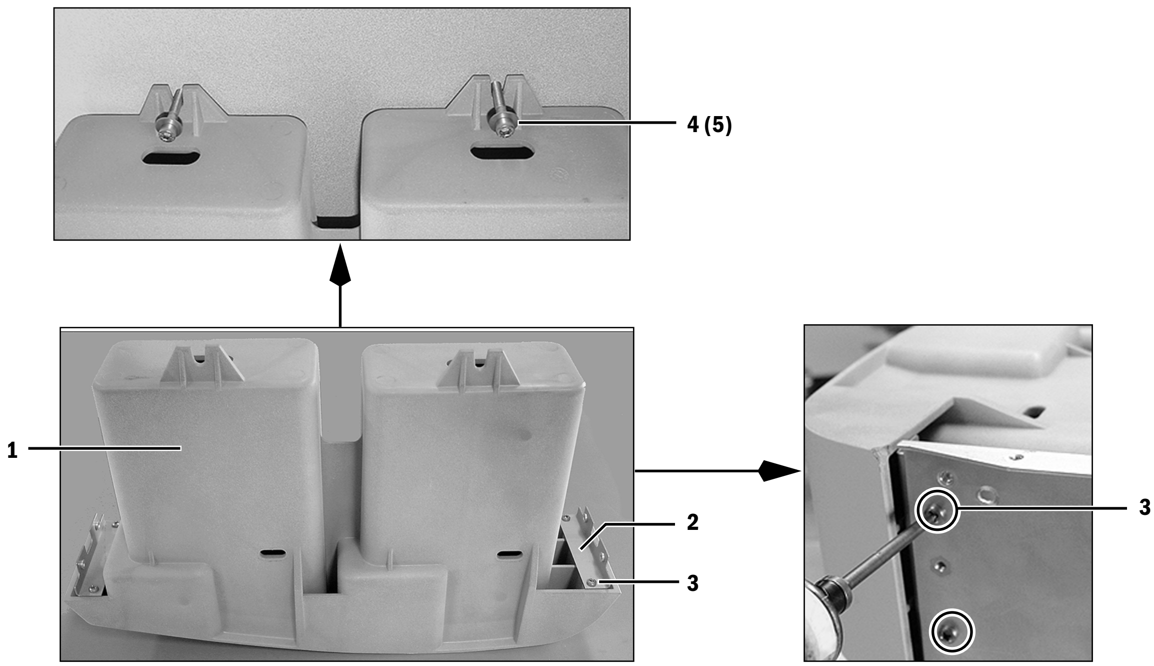






Item	Description	Stock Number
1	Drawer, 105 locking (lock not included) Drawer, 105 non-locking Drawer, 150	1011-3620-000 1011-3273-000 1011-3281-000
2	Handle, drawer	M1227208
3	Screw, M4x8 FLAT HD	0140-6226-107
4	Label Set, drawer	1006-4524-000
5	Lock, assembly	1006-3184-000
6	Slide, drawer	1006-4549-000
7	Screw, M4x8 DIN84	1006-3178-000

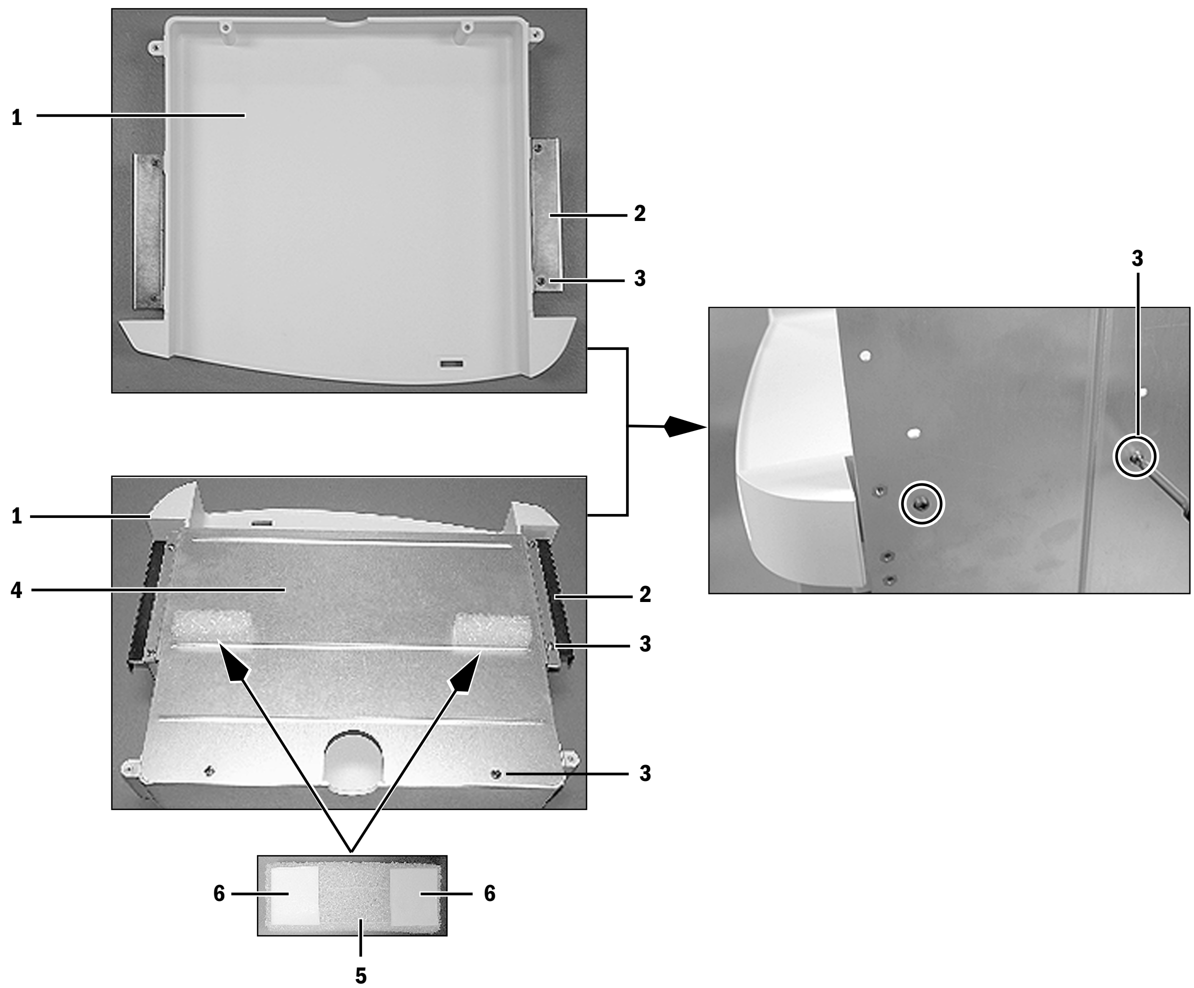
10.49.3 Storage bay - lower



Item	Description	Stock Number
1	Bay, lower cassette storage	1011-3617-000
2	Bracket, cassette storage	1011-3637-000
3	Screw, M4x8 DIN84	1006-3178-000
4*	Screw, M6x35 SKT HD CAP	0144-2131-912
5	Washer, flat 0.25 inch	0144-1014-168

* Apply Loctite 242.

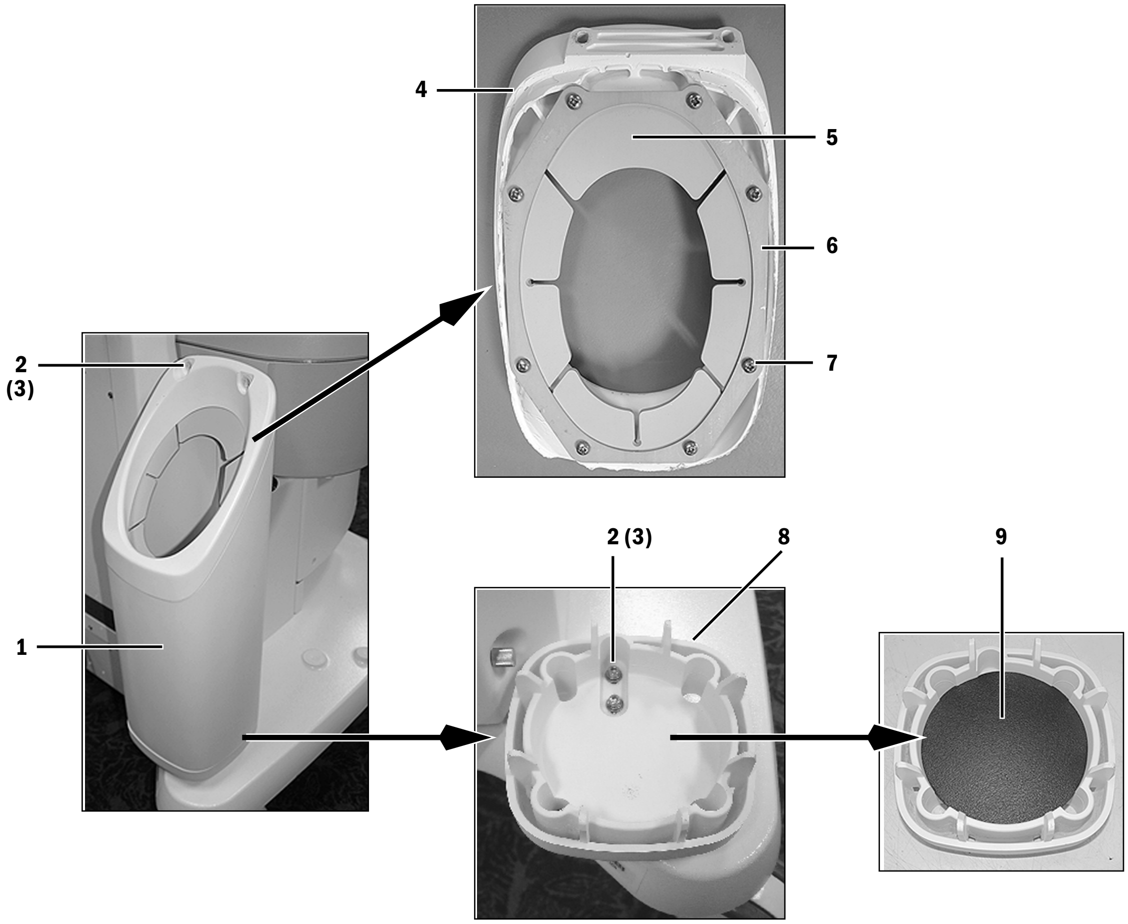
10.49.4 Clipboard



Item	Description	Stock Number
1*	Shelf, clipboard storage	1011-3636-000
2	Bracket, rack and clipboard	1011-3635-000
3	Screw, M4x8 DIN84	1006-3178-000
4	Cover, clipboard storage	1011-3248-000
5	Seal, PE Foam	1011-3820-000
6	Tape, Acrylic Foam	1009-3272-000

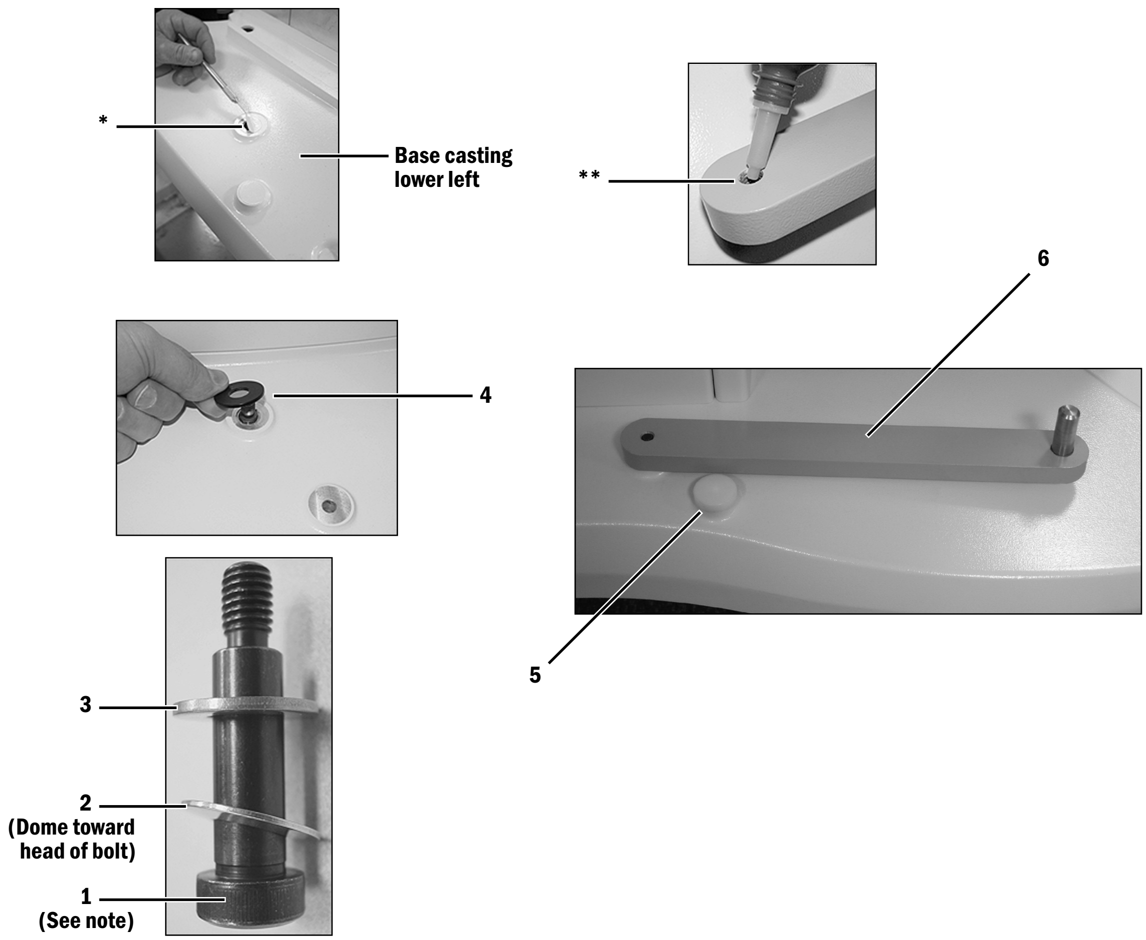
* Below a cassette bay, use clipboard shelf with a cover (**Item 4**).
Below a module rack, use clipboard shelf without a cover.

10.50 Outboard cylinder mount



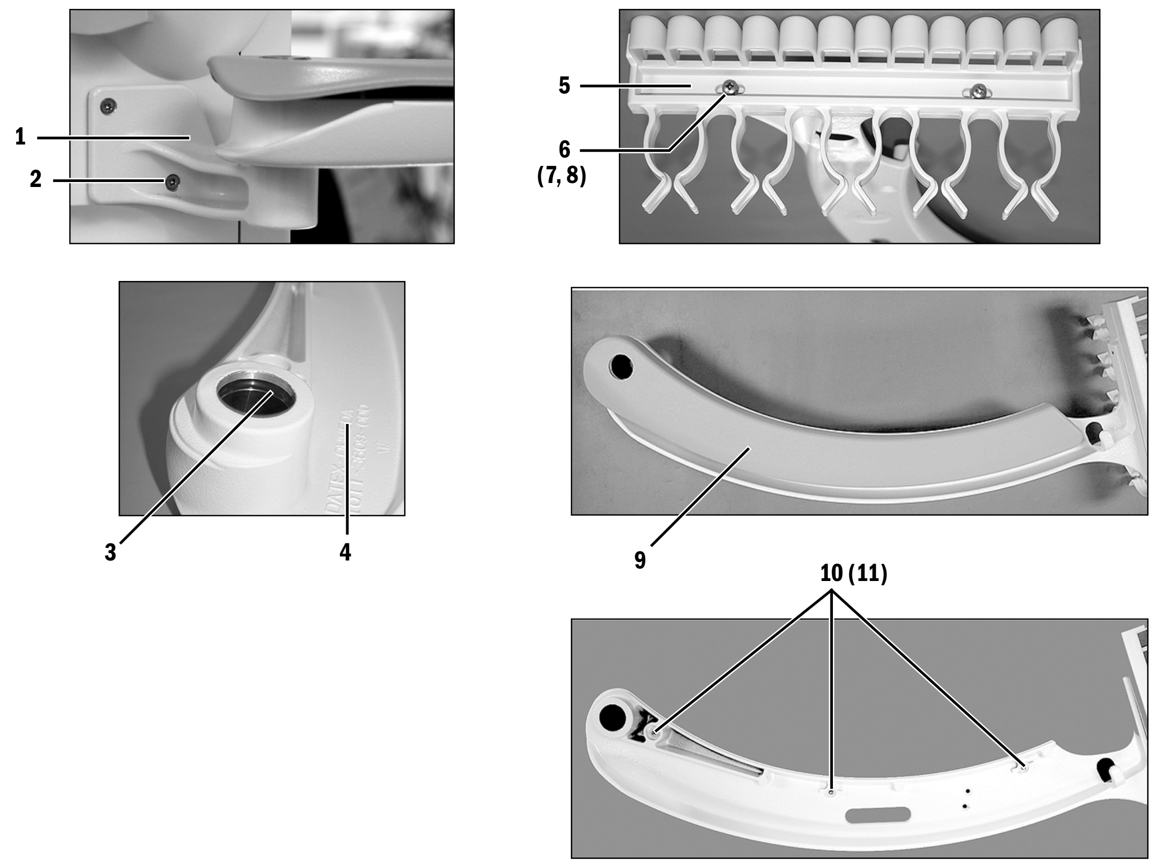
Item	Description	Stock Number
	Outboard cylinder mount kit for Aisys (includes items 1 through 9)	1011-8090-000
1	Shroud, Auxiliary Cylinder	1011-3908-000
2	Screw, M5X25 Pan Head Pozidriv	0144-2531-916
3	Lockwasher, M5 External	0144-1118-220
4	Cap	1011-3906-000
5	Bumper	1011-3909-000
6	Retainer	1011-3924-000
7	Screw, M4x8 Sems Pozidriv	0140-6226-113
8	Base, Auxiliary Cylinder	1011-3907-000
9	Pad, Auxiliary Cylinder	1011-3911-000

10.51 Suction bottle mounting arm kit



Item	Description	Stock Number
	Suction bottle mounting arm kit	1009-8164-000
1	Bolt, Shoulder 3/8-16	1006-3832-000
2	Washer, Belleville	1006-3830-000
3	Washer, Flat	1006-3828-000
4	Washer, Delrin	1006-3829-000
5	Stop, Pin base	1009-3106-000
6	Arm assembly (not available separately)	--------------------
*	If required, remove masking labels.	
**	Apply Loctite 242.	
Note	Tighten shoulder bolt until light resistance is felt when moving arm.	

10.52 Cable management arm



Item	Description	Stock Number
	Cable management arm with post kit	1011-8337-000
1	Post, support cable manage arm	1011-3850-000
2	Screw, M4x16 FL HD	0140-6226-116
3	O-ring	0210-0611-300
4	Arm	1011-3609-000
5	Retainer, multiple cable	1009-3252-000
6	Screw, M4x12 Pozidriv Pan	0140-6226-111
7	Lockwasher, M4 external	9213-0540-003
8	Washer, M4 flat	0144-1025-165
9	Cover, management arm	1011-3610-000
10	Screw, M4x12 relieved body	1504-3001-000
11	Washer, retainer Nylon	1009-3178-000

11 Schematics and Diagrams

In this section

Schematics are subject to change without notice.

Circuit boards are available only as complete assemblies.

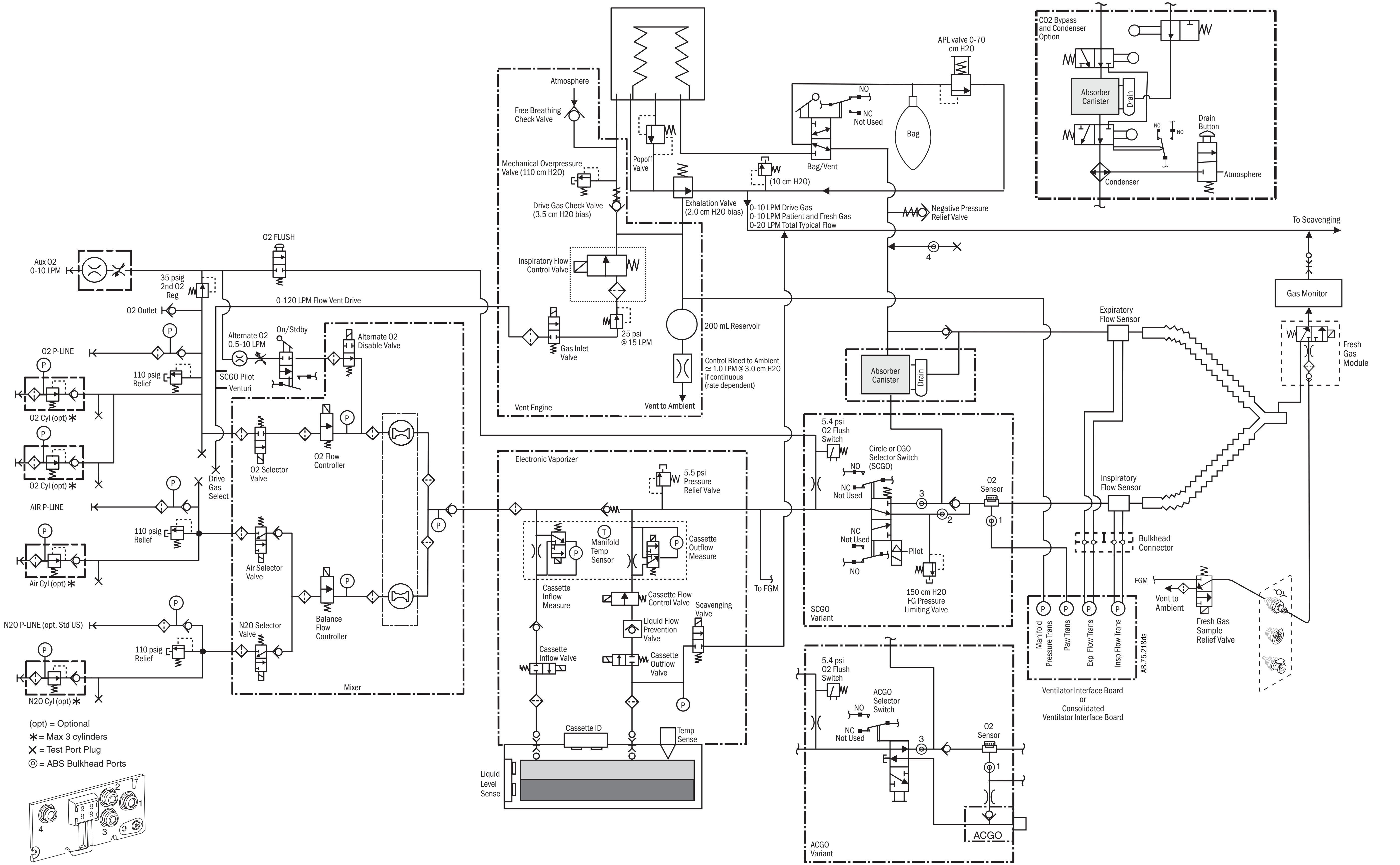
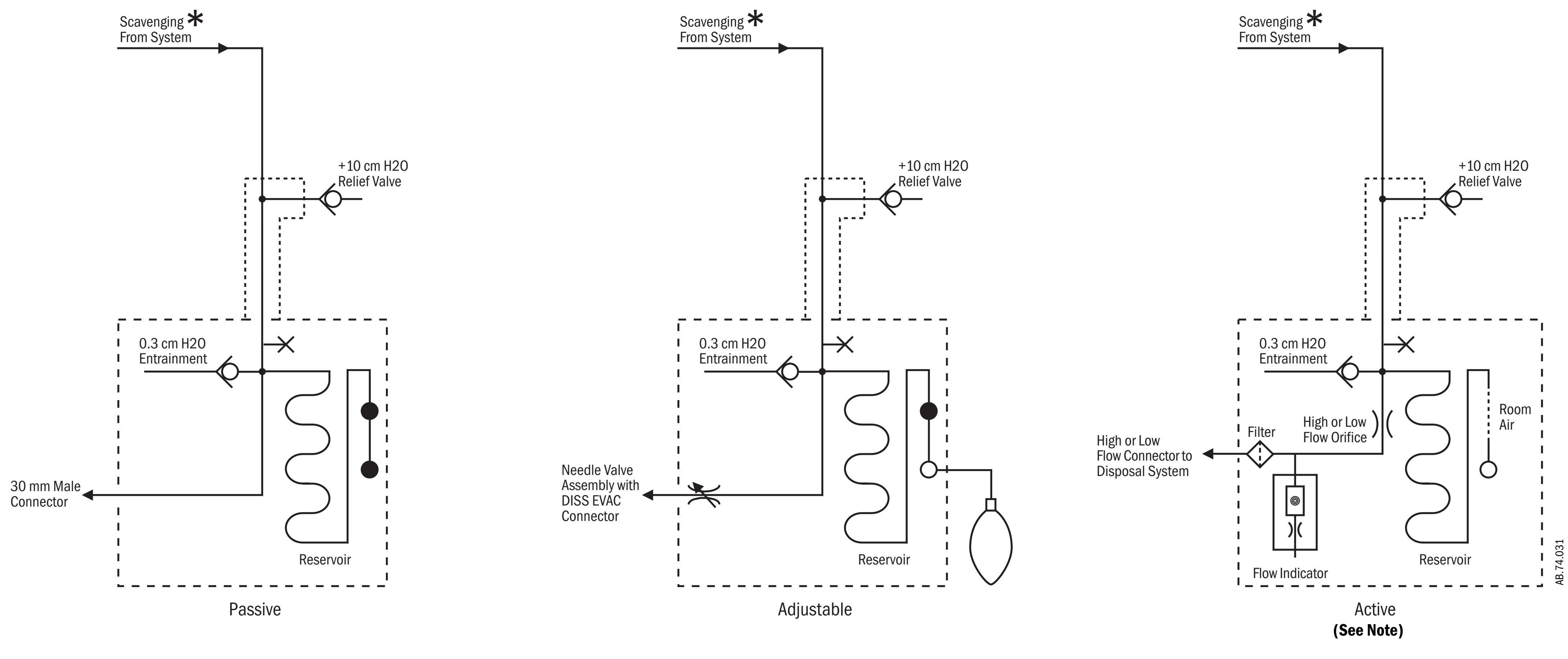


Figure 11-1 • System circuit diagram



Key to Symbols

- ✕ = Plugged port (1/8 inch) for sample gas return.
- ● = Plugged port (30 mm) for auxiliary breathing system scavenging.
- ○ = Open port (30 mm) for auxiliary breathing system scavenging.
- * = Zero to 10 l/min drive gas; zero to 10 l/min patient and fresh gas; zero to 20 l/min total typical flow.

Note: Active AGSS systems with a 12.7 mm connector do not include the Flow Orifice and the Flow Indicator.

Figure 11-2 ▪ Gas scavenging circuits

Key to Numbered Components

1. Pipeline inlet
2. Pipeline pressure transducer
3. High-pressure relief valve (758 kPa / 110 psi)*
4. Supply connections for the ventilator and pilot pressure for SCGO
   a. O_2 drive gas
   b. Air drive gas
5. Venturi suction supply connection
   a. O_2 drive gas
   b. Air drive gas
6. Cylinder inlet
7. Cylinder pressure transducer
8. Primary regulator (cylinder pressure)
9. Test port (primary regulator)
10. System switch
11. Selector valve
    a = O_2; b = Air; c = N_2O
12. Flow controller
    a = O_2; b = balance gas
13. Alternate O_2 disable valve
14. Hot-wire anemometer
    a = O_2 flow sensor channel; b = balance gas flow sensor channel
15. Mixed gas
16. Backpressure valve
17. Low-pressure relief valve (38 kPa / 5.5 psi)*
18. O_2 flush and auxiliary flowmeter regulator (241 kPa / 35 psi)*
19. O_2 Flush valve
20. Pressure switch (used with the ventilator)
21. Breathing system pressure relief valve (SCGO only — 150 cmH_2O)*
22. To Port 3 of ABS interface (circle)
23. For SCGO, to Port 2 of ABS interface (non-circle Inspiratory port)
    For ACGO, to external 22-mm ACGO connector
24. Auxiliary O_2 flowmeter

* Approximate values

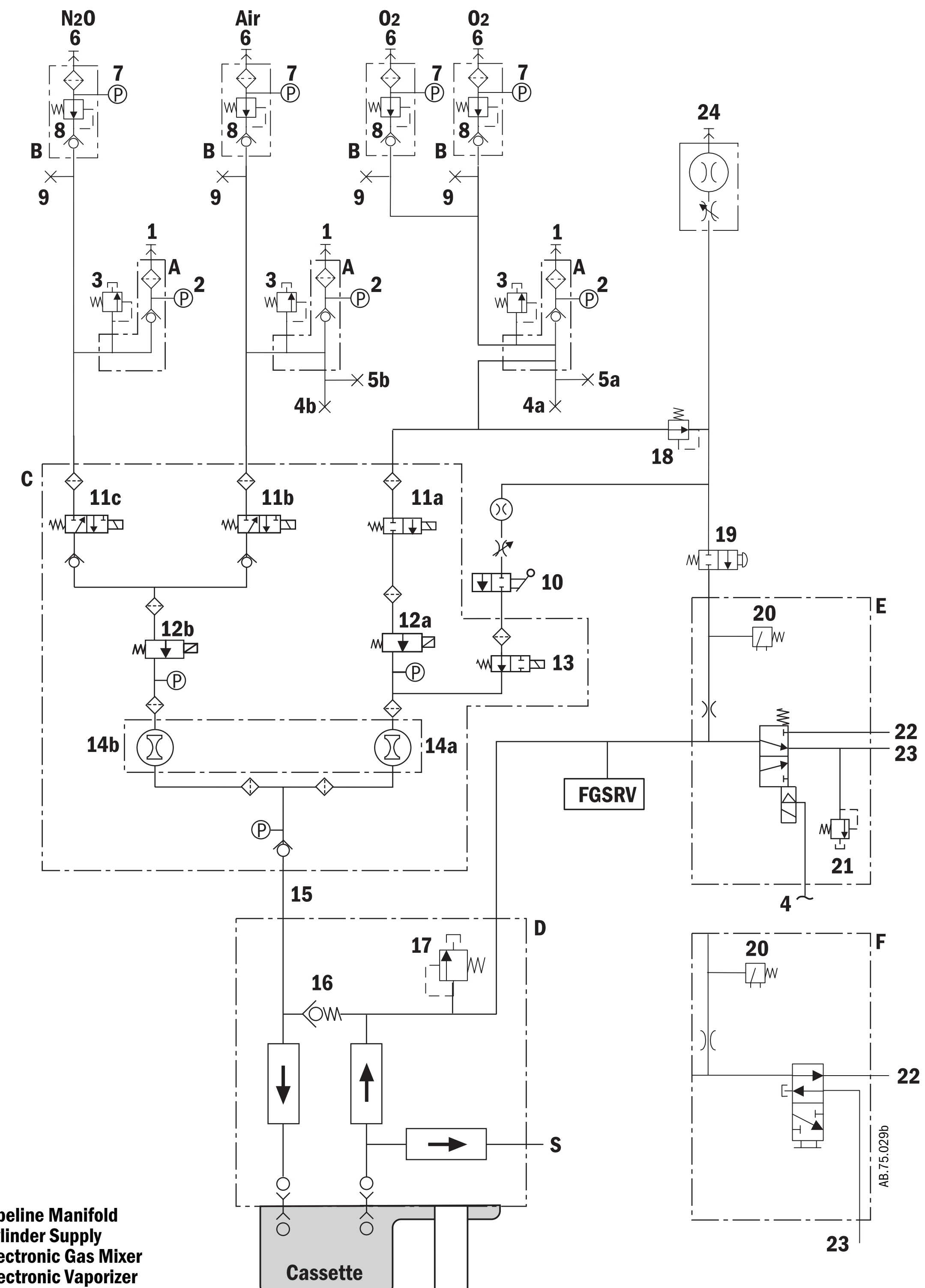
Key to Symbols

Pneumatic Connection

Filter

Direction of Flow

Check Valve



A - Pipeline Manifold
B - Cylinder Supply
C - Electronic Gas Mixer
D - Electronic Vaporizer
E - SCGO Assembly
F - ACGO Assembly
P - Pressure Transducer
S - To Scavenging
FGSRV - Fresh Gas Sample Relief Valve (Refer to Section 2.10.4)

26. Inflow flowmeter
27. Outflow flowmeter
28. Inflow check valve
29. Inflow valve
30. Outflow valve
31. Scavenge valve
32. Liquid prevention valve
33. Proportional valve

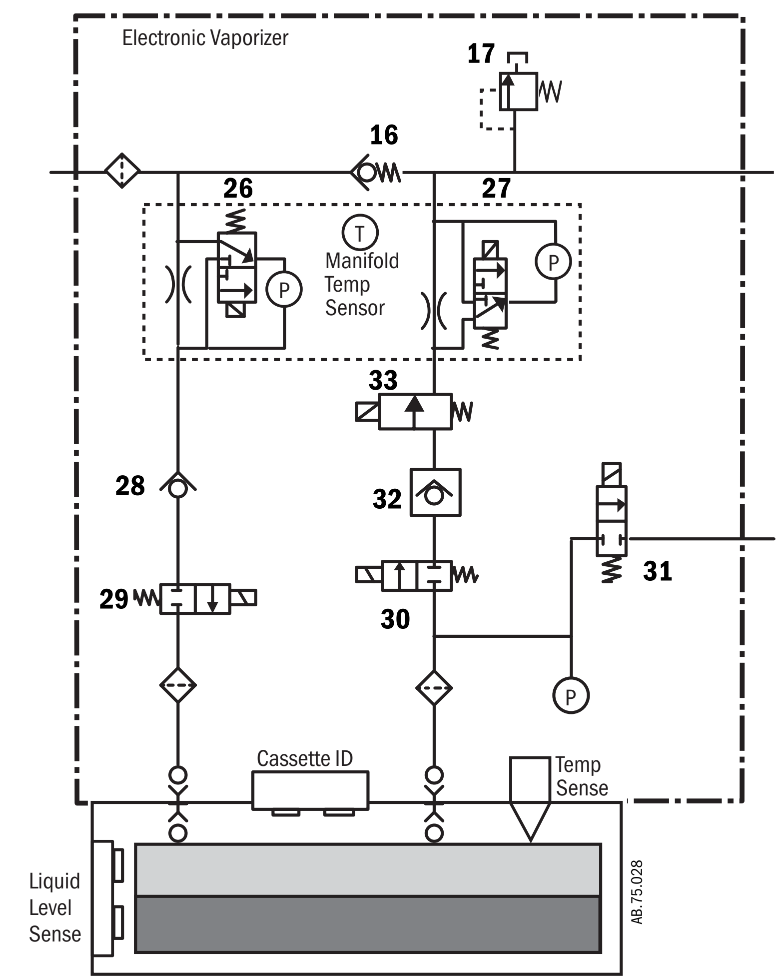
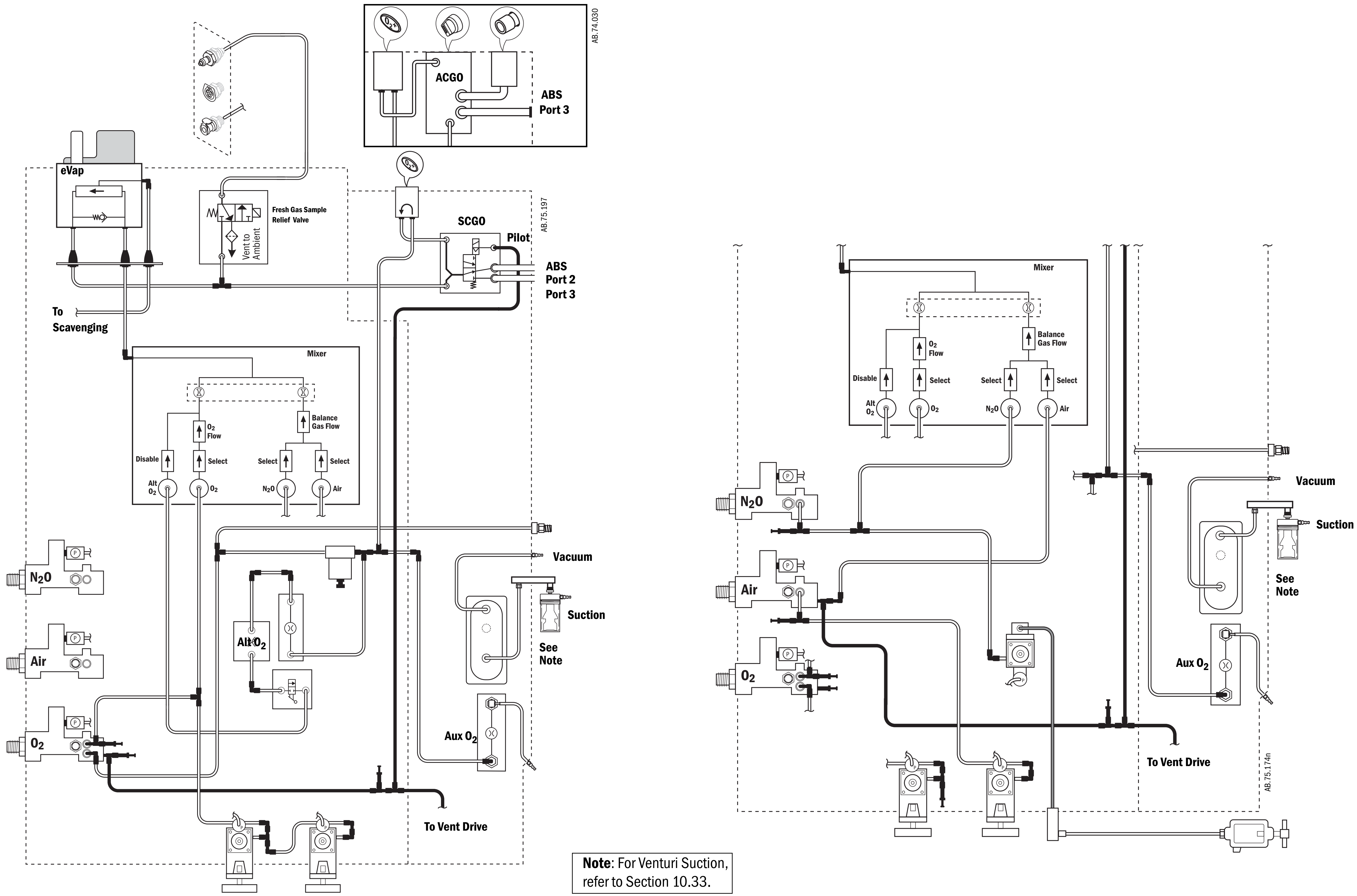


Figure 11-3 • Pneumatic circuit diagram



Note: For Venturi Suction, refer to Section 10.33.

Figure 11-4 ▪ Tubing (1 of 2)

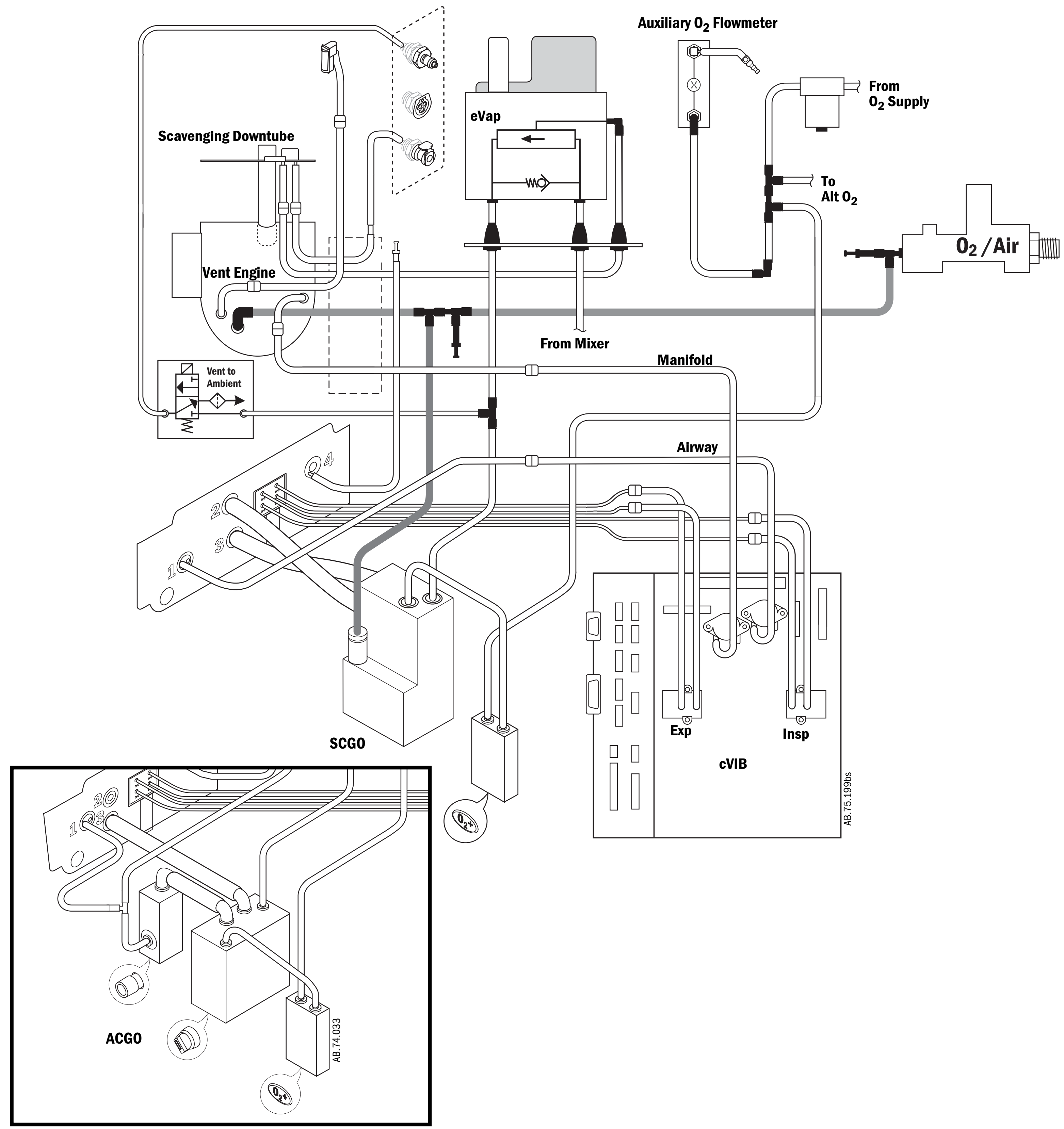
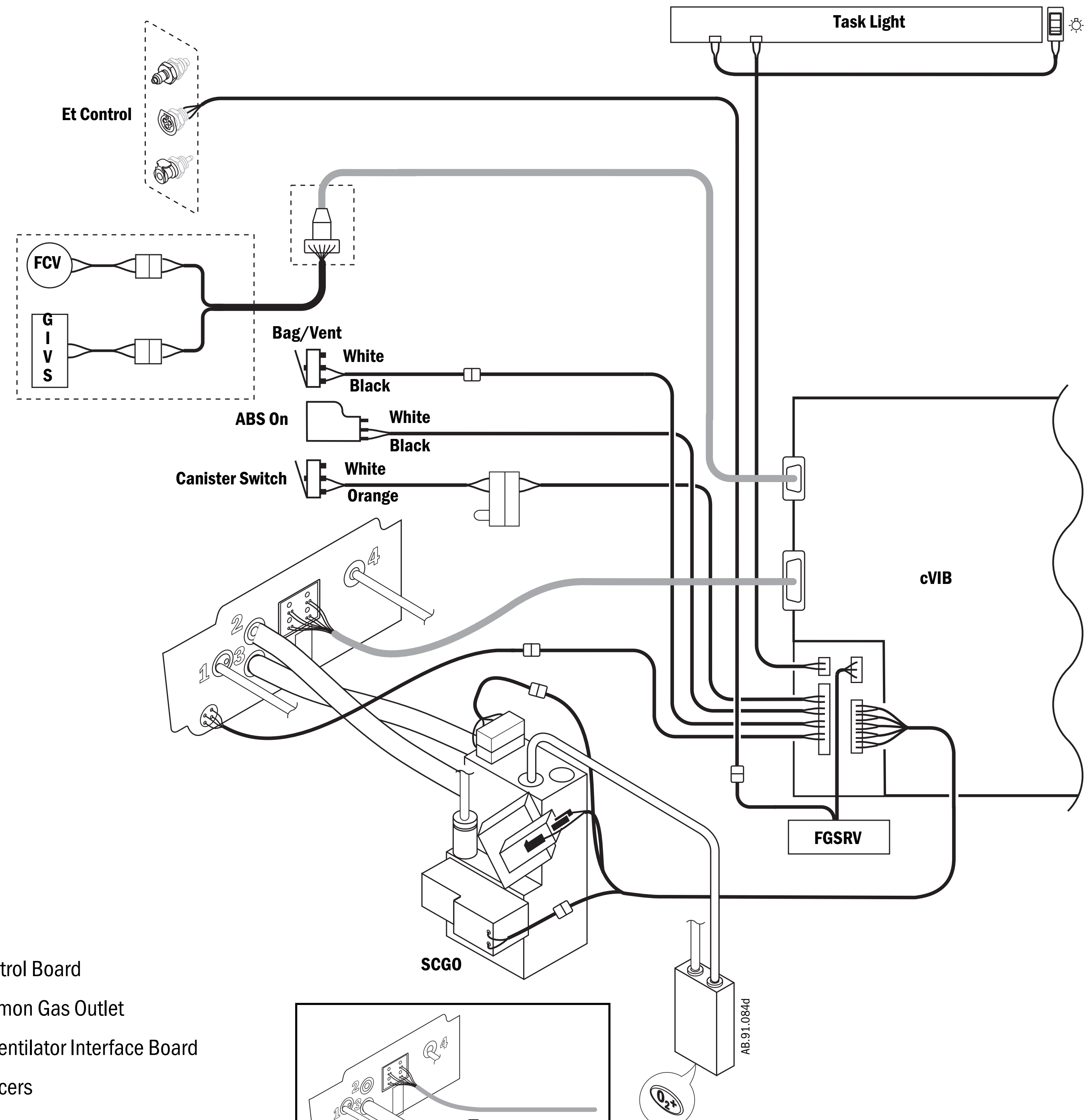
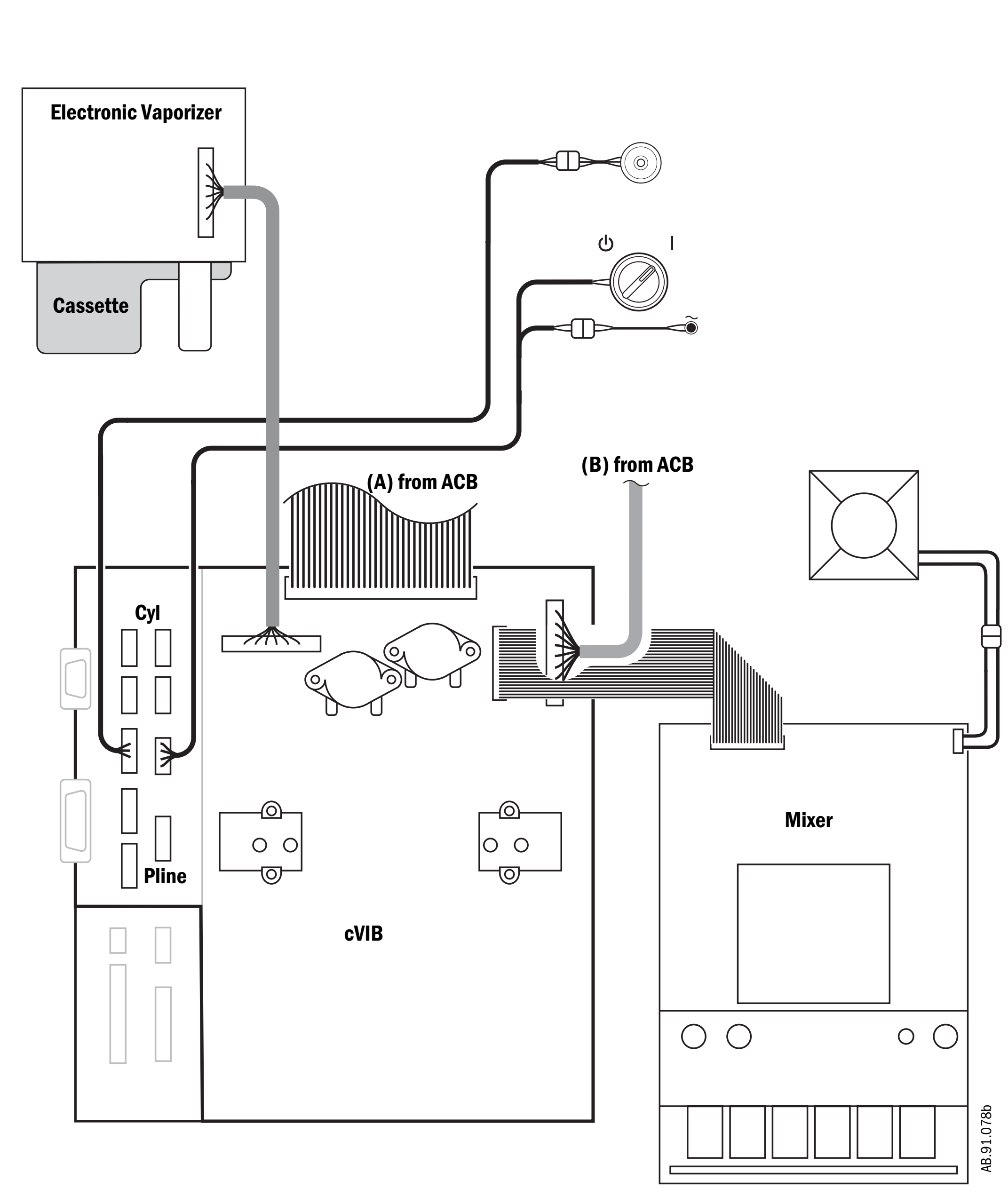


Figure 11-5 • Tubing (2 of 2)





Key to Symbols

ACB = Anesthesia Control Board

ACGO = Auxiliary Common Gas Outlet

cVIB = Consolidated Ventilator Interface Board

Cyl = Cylinder Transducers

FCV = Flow Control Valve

FGSRV = Fresh Gas Sample Relief Valve

GIVS = Gas Inlet Valve Solenoid

PCB = Power Controller Board

Pline = Pipeline Transducers

SCGO = Switched Common Gas Outlet

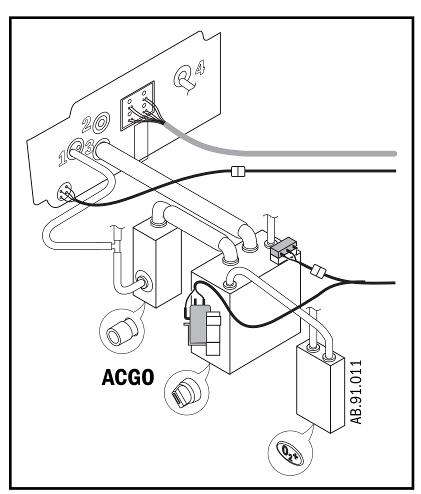
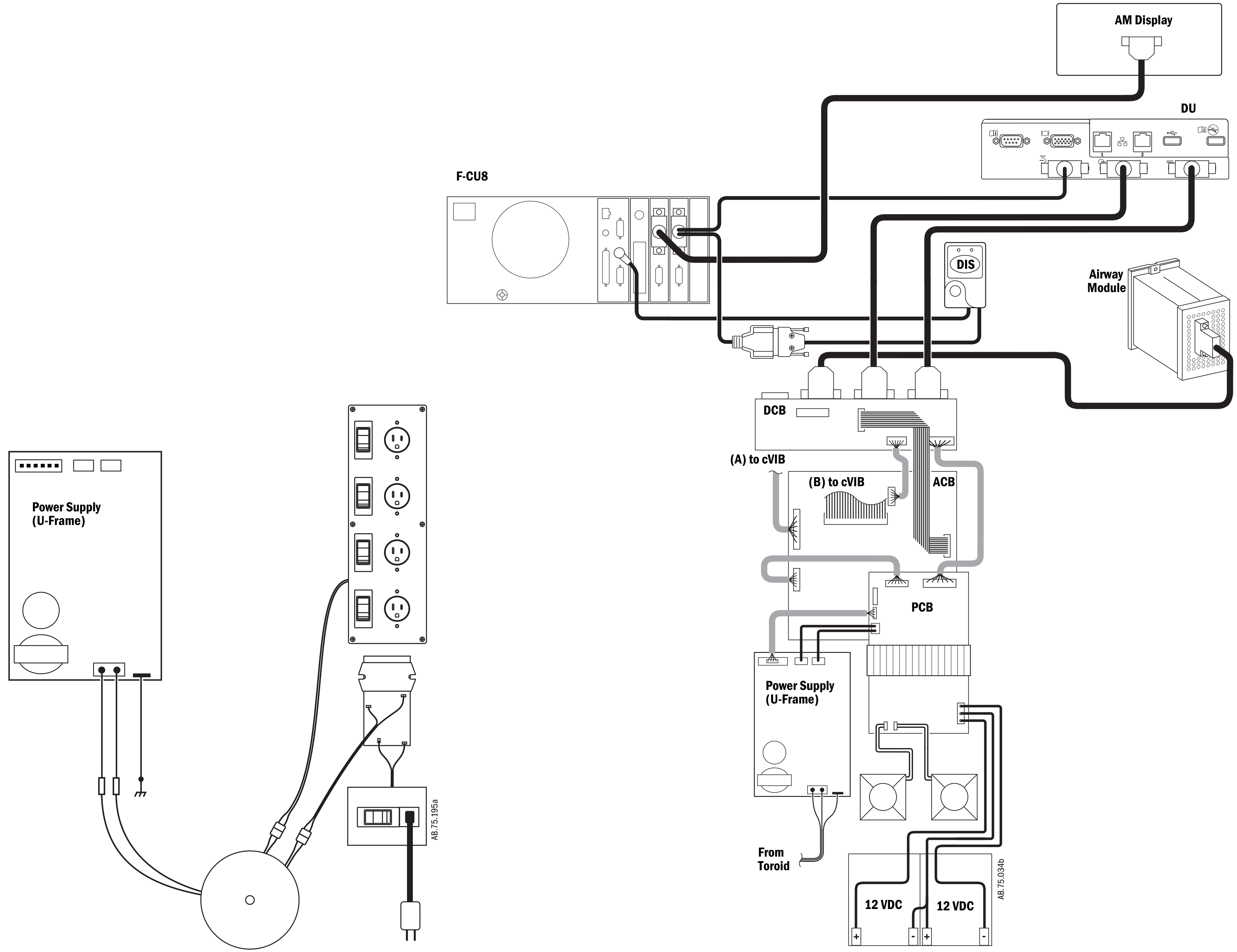


Figure 11-6 • Wiring



Key to Symbols

ACB = Anesthesia Control Board

AM = Anesthesia Monitorx

cVIB = Consolidated Ventilator Interface Board

DCB = Display Connector Board

DIS = Device Interface Solution

DU = Display Unit

F-CU8 = Central Unit, 8 module frame

PCB = Power Controller Board

Figure 11-7 • Electrical cabling block diagram

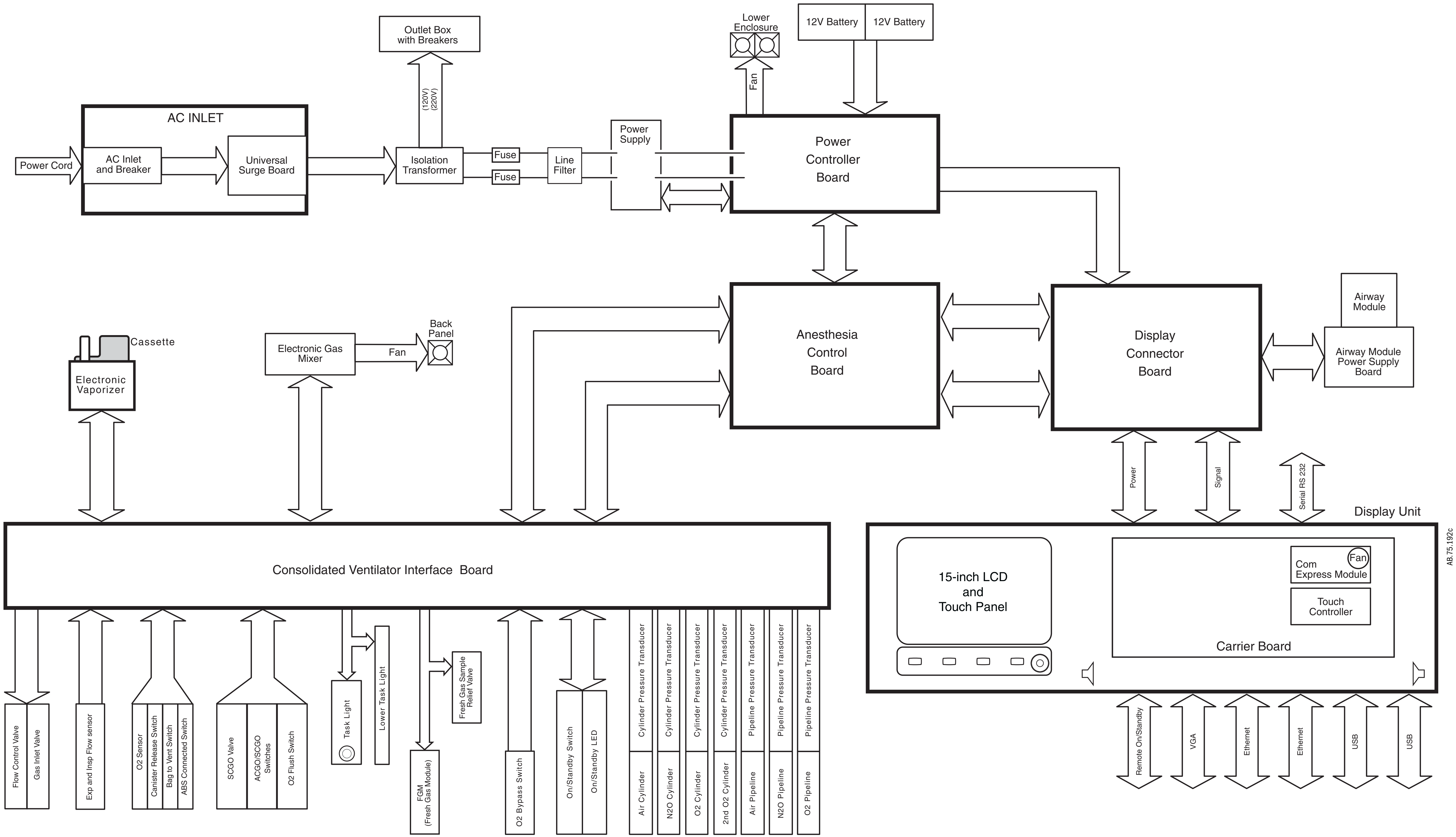


Figure 11-8 • Cabling block diagram

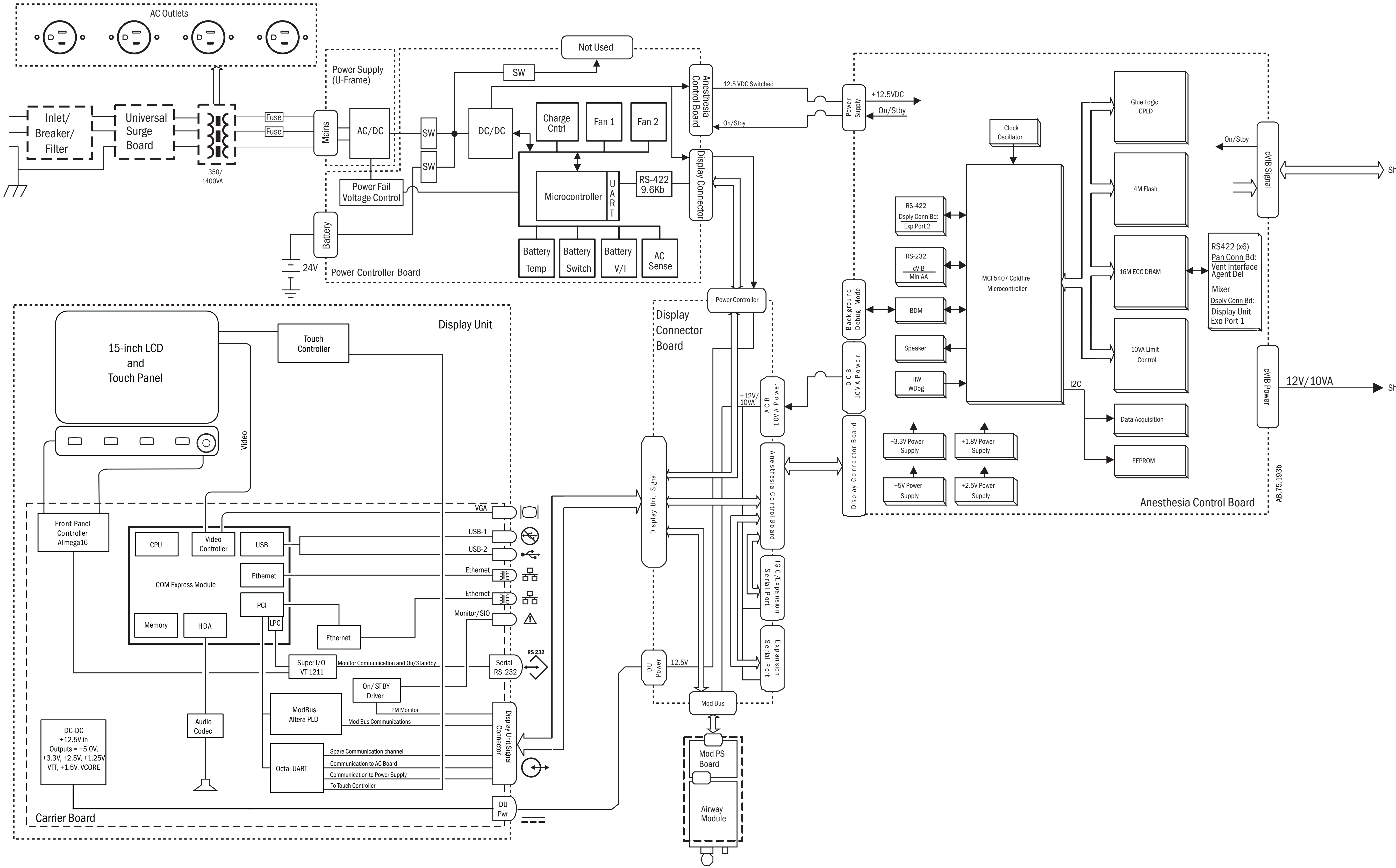


Figure 11-9 • System block diagram (sheet 1 of 3)

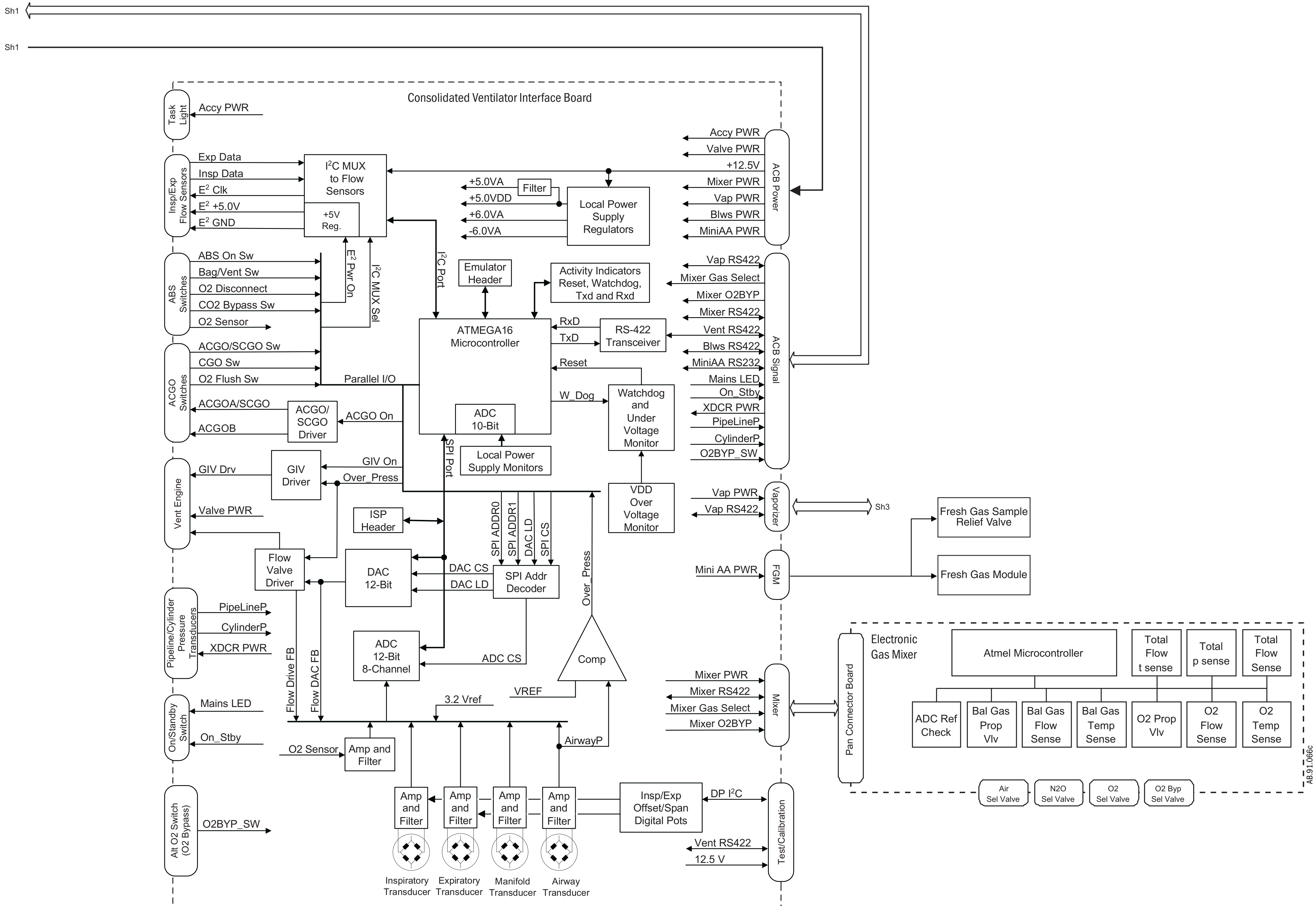


Figure 11-10 • System block diagram (sheet 2 of 3)

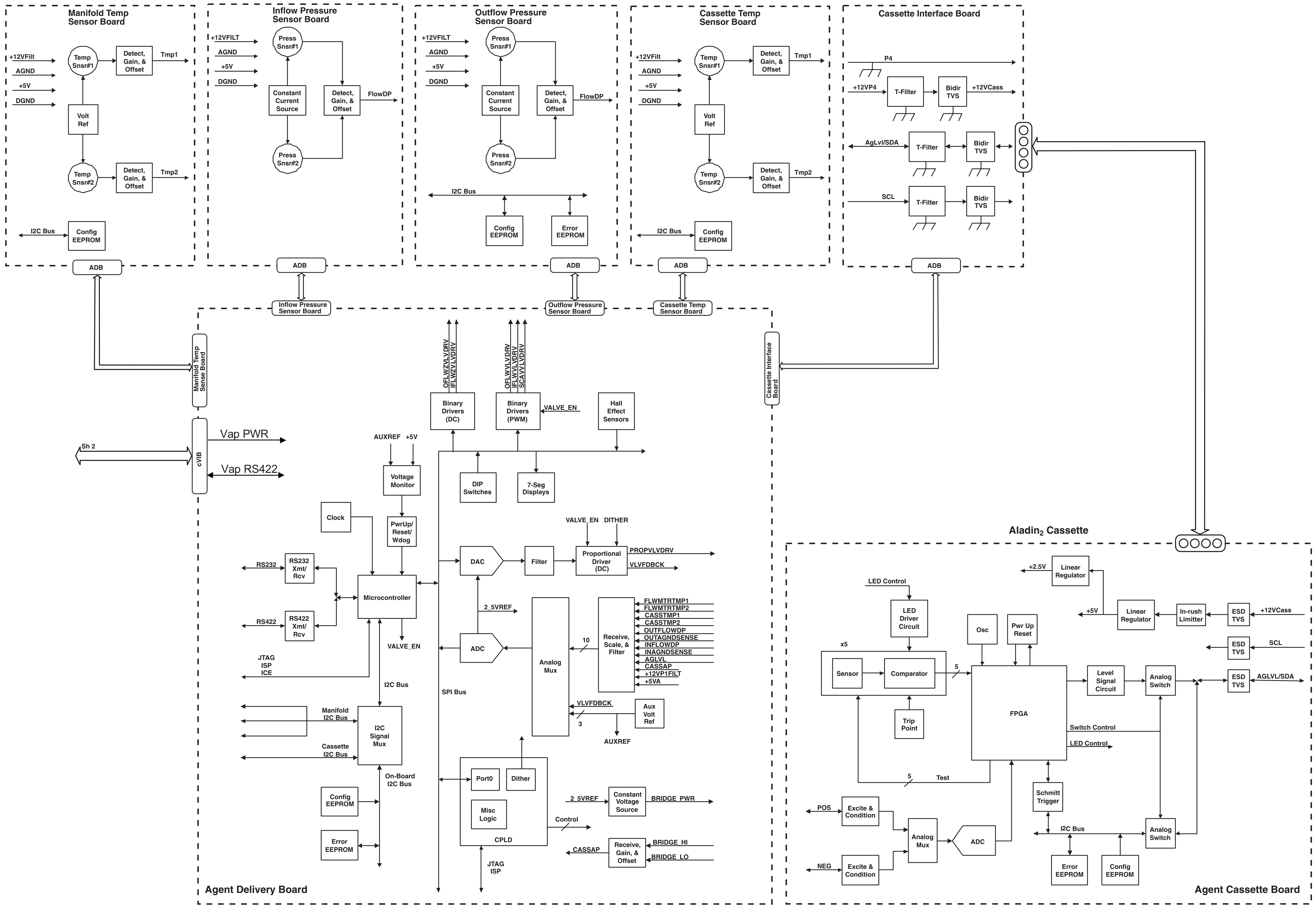


Figure 11-11 ▪ System block diagram - eVAP (sheet 3 of 3)

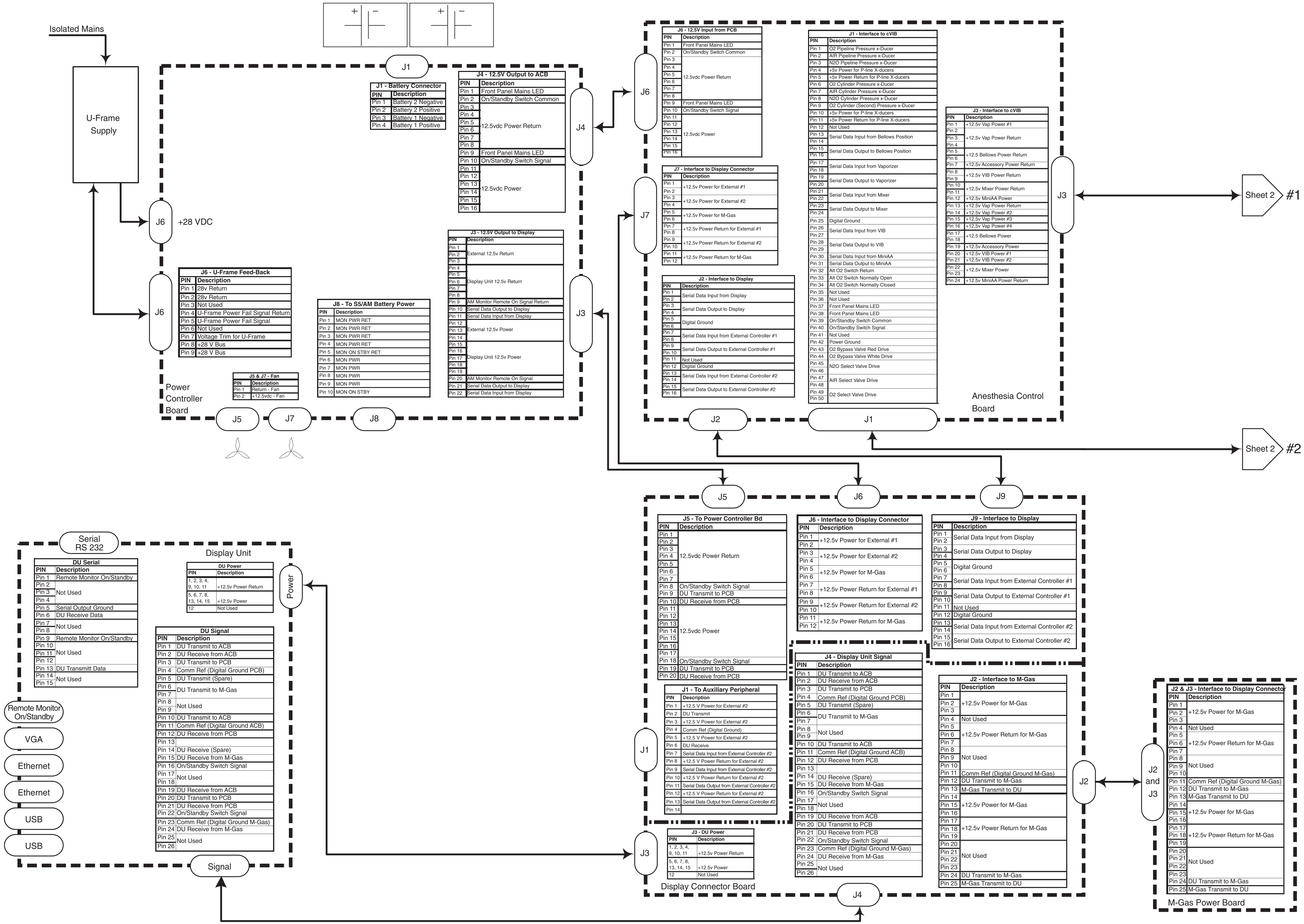


Figure 11-12 • Signal diagram (sheet 1 of 2)

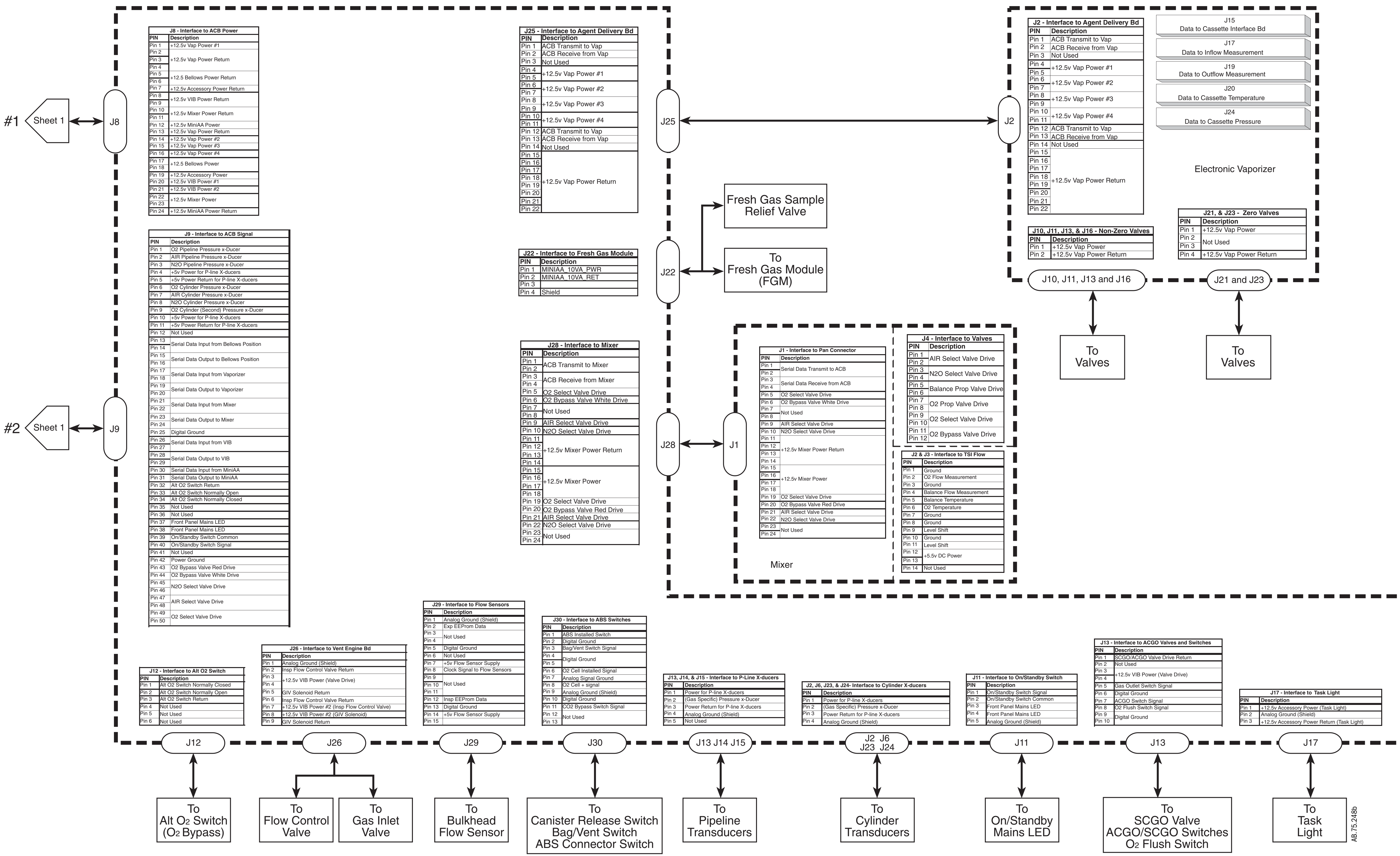


Figure 11-13 • Signal diagram (sheet 2 of 2)

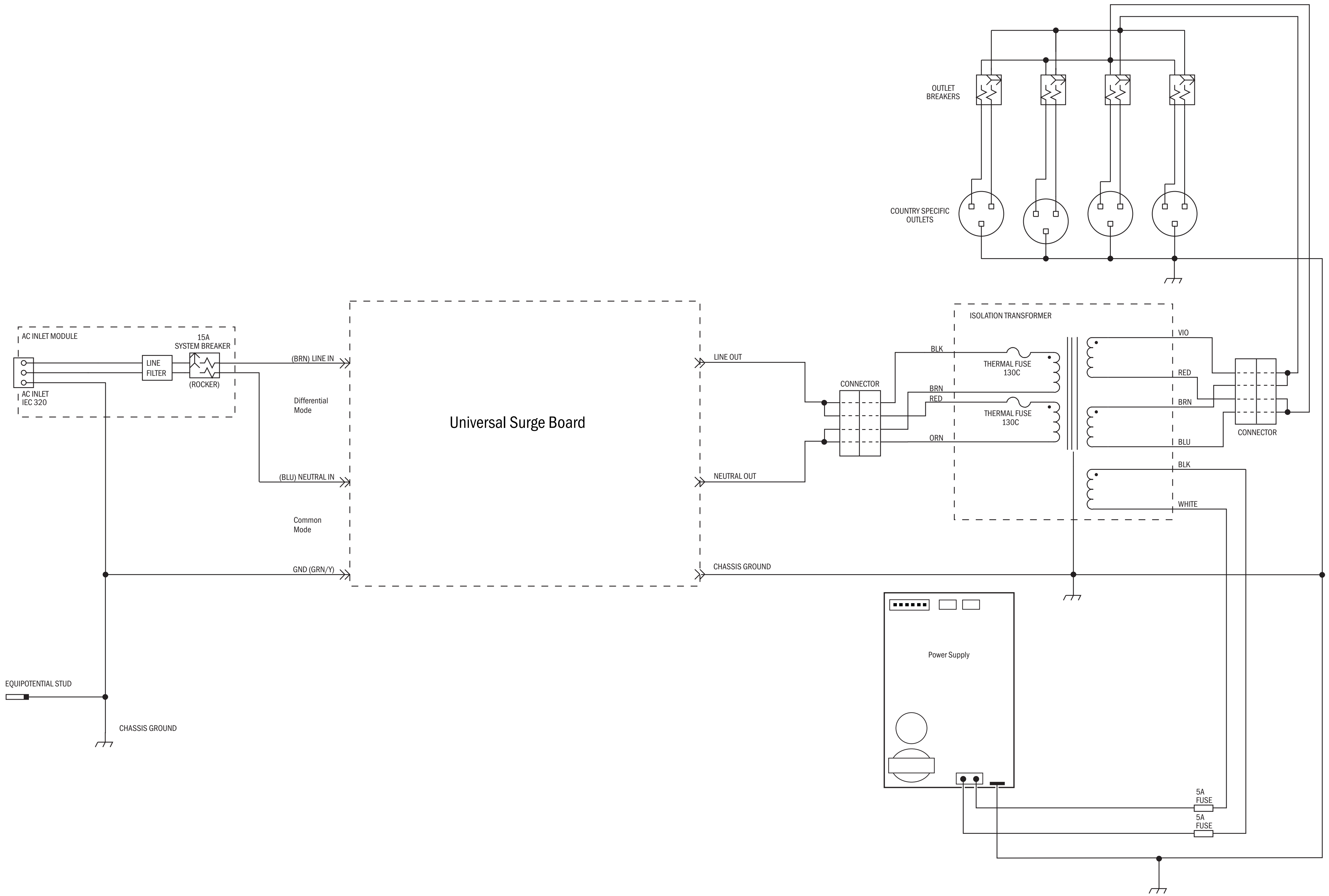


Figure 11-14 ▪ Schematic, AC Inlet module; 100–120 V (with isolated outlets)

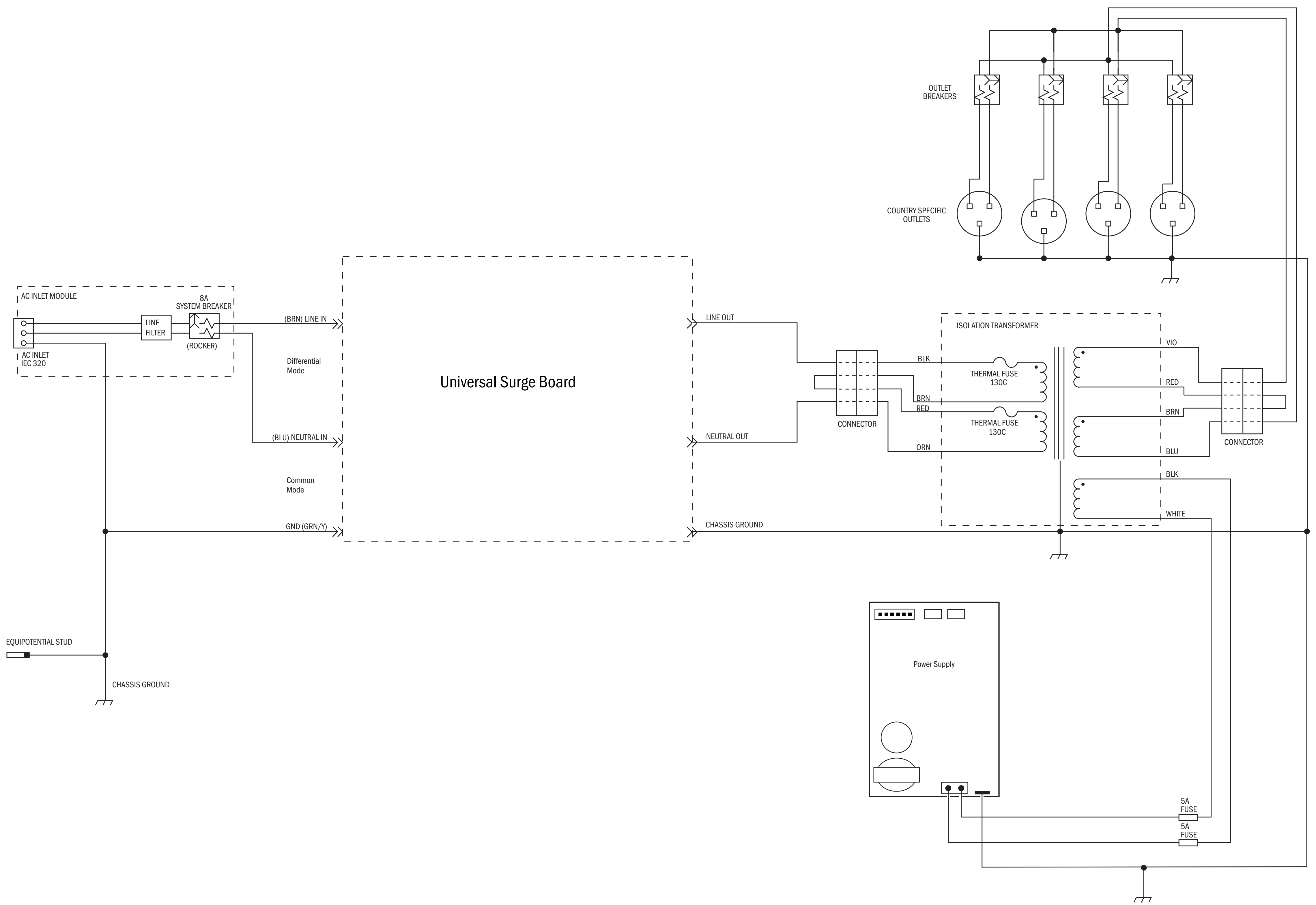


Figure 11-15 ▪ Schematic, AC Inlet module; 220–240 V (with isolated outlets)

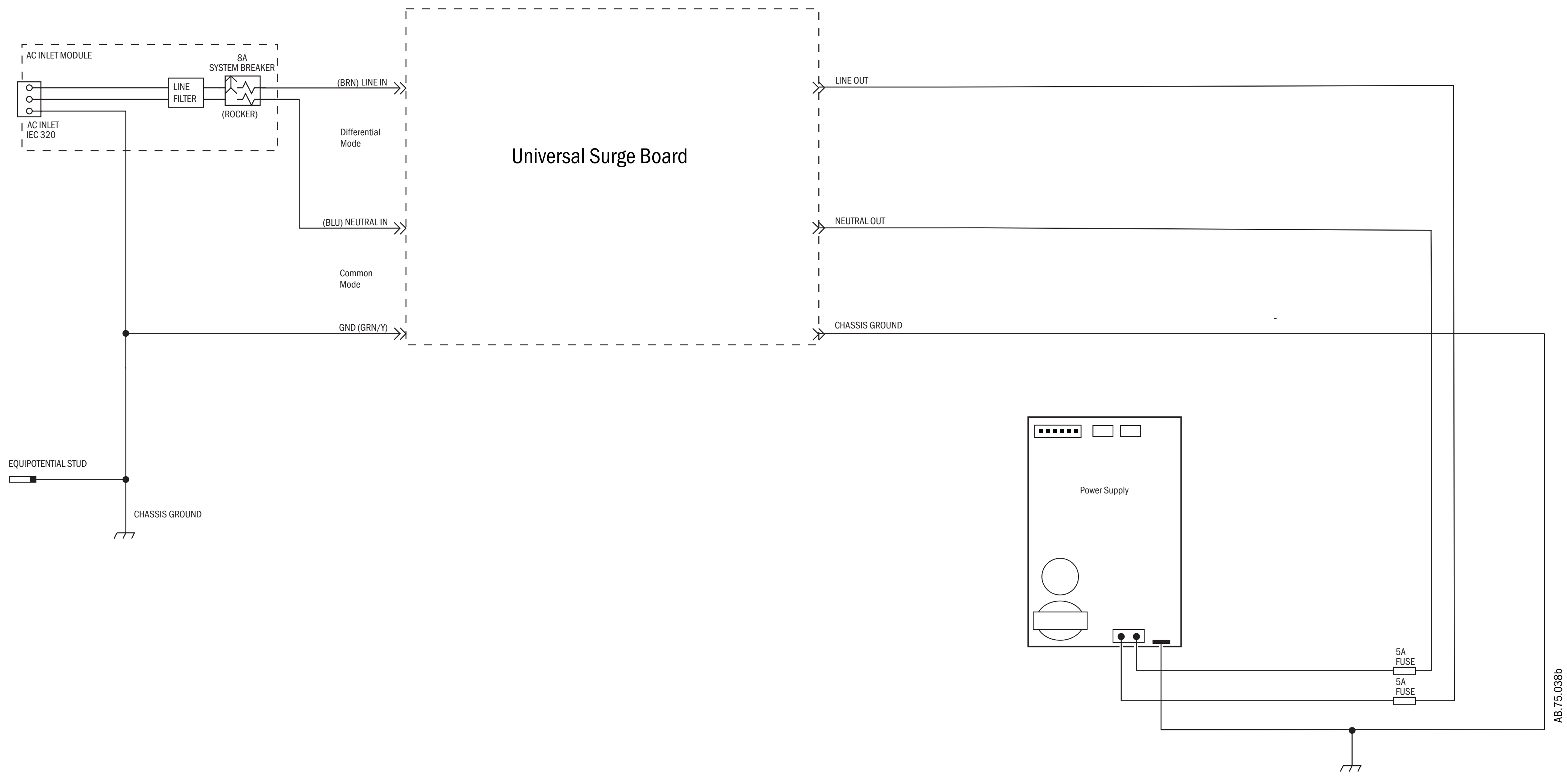


Figure 11-16 ▪ Schematic, AC Inlet module; 120V/220–240 V (no outlets)

Notes

12 Service Application

In this section

12.1 Aisys CS2 Service Application (PC based)

This section documents the Aisys CS2 Service Application that runs on a Windows based computer and communicates with the display unit. It is compatible with all Aisys CS2 systems.

To enable communication with the Service Application, the Aisys CS2 system must be in the “Installation and Service” mode (or in a failed state provided the display unit is able to communicate).

The application can be used to diagnose electronically detectable failures in an Aisys CS2 system.

Note This program is for machine diagnosis. It cannot be used for machine checkout or acceptance tests.

12.1.1 PC Requirements

Minimum requirements to run the application include:

- Personal computer using a Pentium 600 or higher microprocessor
- Windows XP/Windows 7
- 1024 by 768 resolution (or higher) video adapter
- Minimum of 128 MB of RAM, 256 MB recommended
- About 150 MB free hard disk space
- Microsoft-compatible mouse or equivalent device
- Serial Port or USB port with an RS-232 adapter

Port Setup

The Service Application communicates with the system through the serial port on the display unit (refer to section 2.5.1).

By default, the communication is channeled through the COM1 port on the PC.

Note: Ensure that no other application is using this port while the Service Application is running.

If other ports are available, you can select an available port in “Preferences” on the File menu (Section 12.5.1).

Note: Use the Device Manager in your PC to determine which Com port your PC has assigned to Communicate with the PC Service Application.

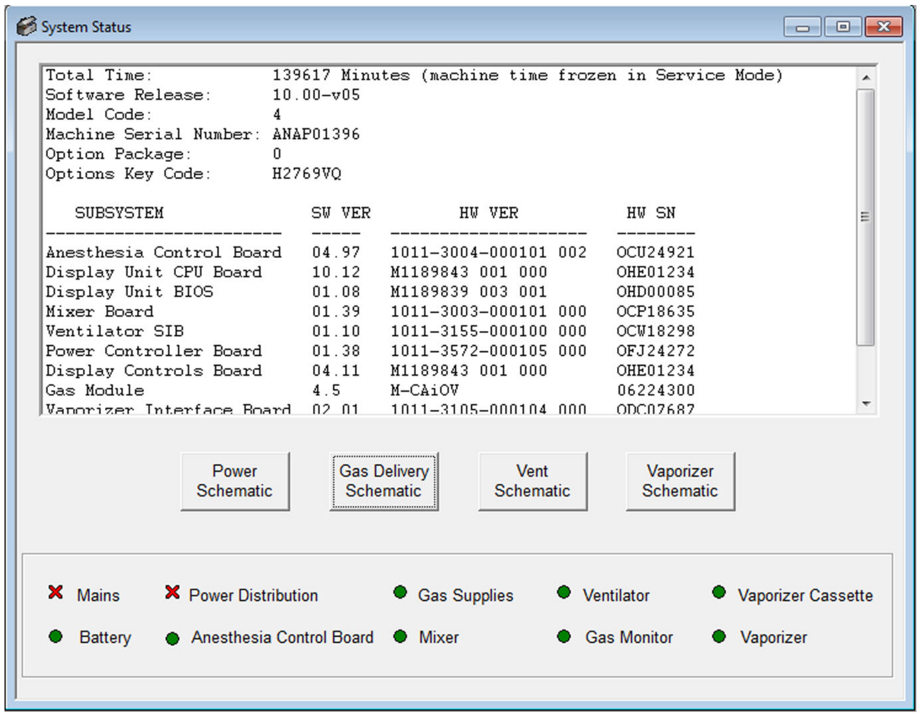
Startup Screen

Launching the Service Application opens the System Status screen. The startup screen establishes proper communications with the system.

12.2 Startup screen — System Status

If proper communication is established, the System Status screen displays the software and hardware revisions of various subsystems in the tested machine.

If there is a communication problem with the system, an error message is displayed and the connection is not completed.



A series of indicator lights at the bottom of the screen give an overall assessment of the system.

- a green bullet indicates that
  no faults, Alarms, or Errors were detected in that subsystem.
- a red X indicates that
  a fault, Alarm, or Error is present in that subsystem.
- Clicking on any red X opens the appropriate diagnostics screen.

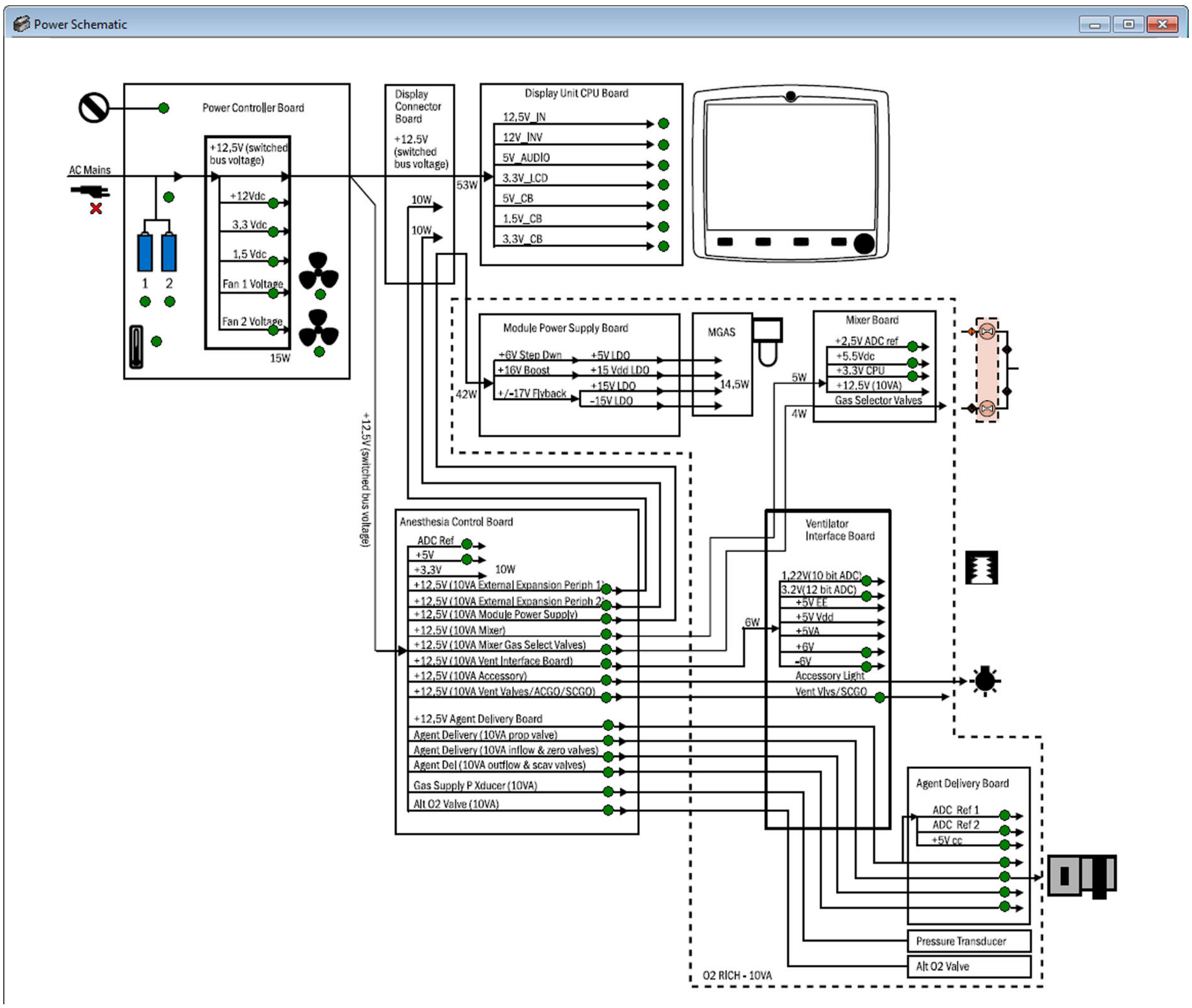
Schematics

The System Status screen includes three Softkeys that provide direct access to the schematical representation of a subsystem as shown in the following sections.

- The Power Schematic indicates the condition of power supplies throughout the system (*Section 12.3.1*).
- The Gas Delivery Schematic (*Section 12.3.2*)
  and the Vent Schematic (*Section 12.3.3*)
  include control devices that allow direct manipulation of components in the subsystem and displays the resulting output values for select downstream components.

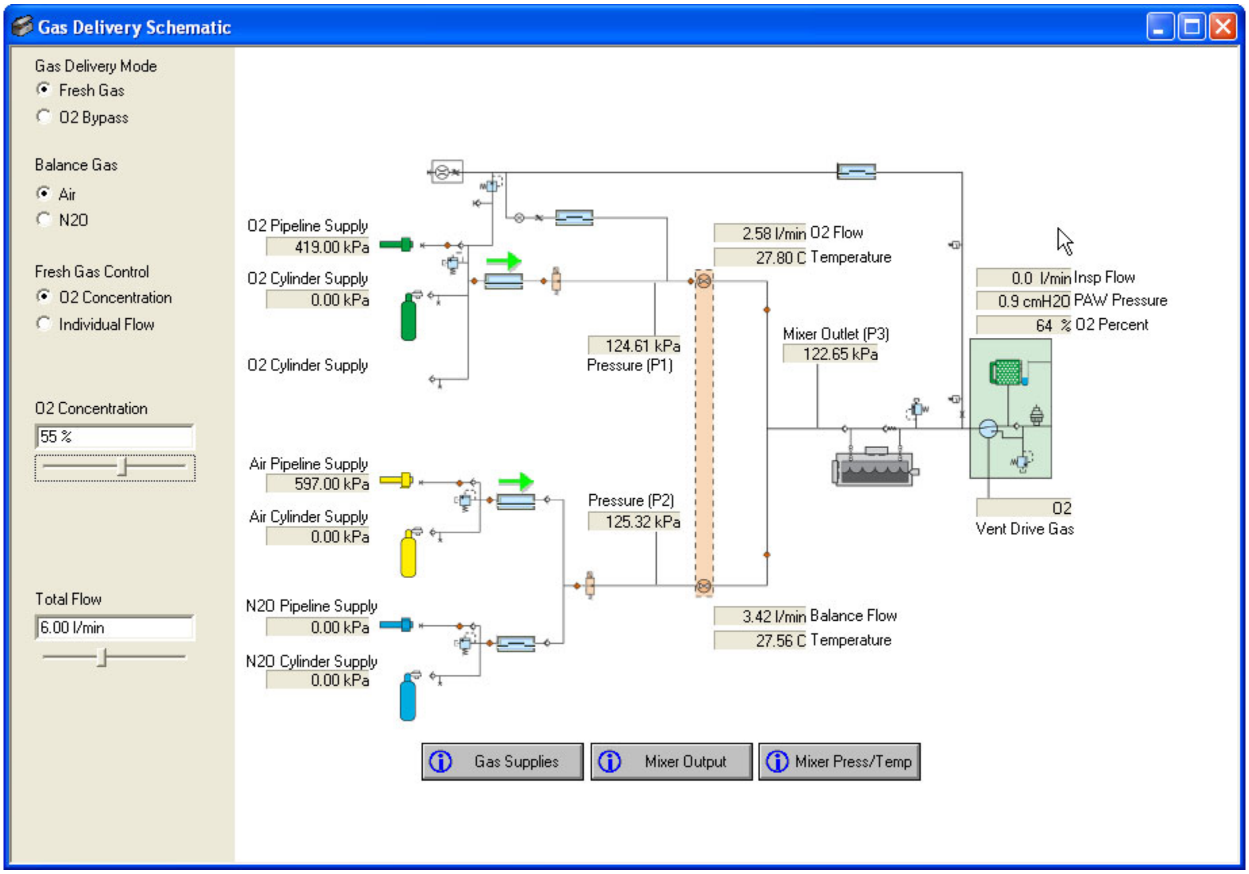
12.3 System Schematics

12.3.1 Power Schematic



Clicking on any red X opens the appropriate diagnostics screen.

12.3.2 Gas Delivery Schematic



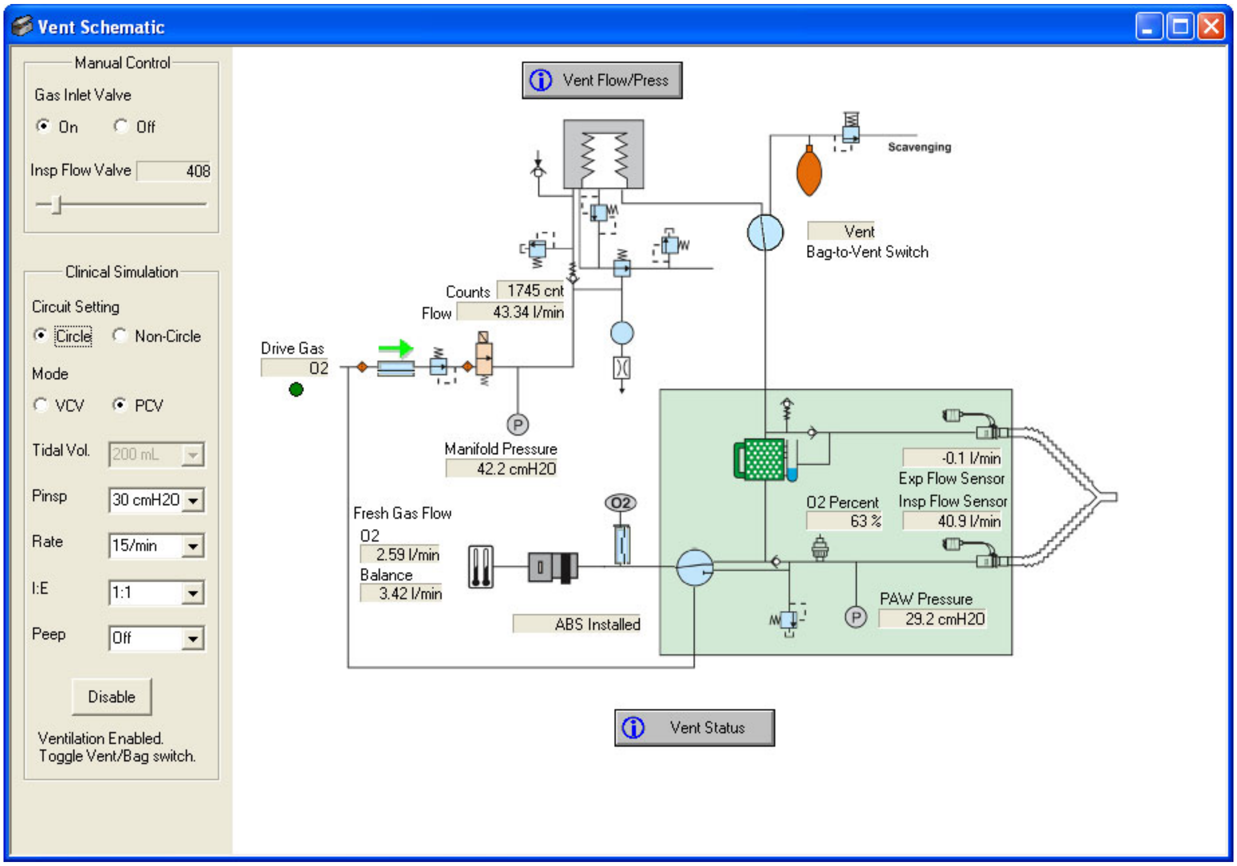
The Softkeys at the bottom of the Gas Delivery schematic bring up related diagnostic screens that are also accessible from the Gas Delivery Subsystem menu.

- ***Gas Supplies —*** (Section 12.8.1)
- ***Mixer Output —*** (Section 12.8.2)
- ***Mixer Press/Temp —*** (Section 12.8.5)

Notes

Settings	Remarks/Values
Flow/Concentration	Move slider to increase/decrease value. Use the up/down arrow keys on the PC to fine tune setting.
O2 Concentration (if O2 Concentration selected)	0%, 21%, 25% to 100%. 21% minimum for Air Balance Gas 0% minimum for N2O Balance Gas
Total Flow (if O2 Concentration selected)	Off, 0.10 l/min to 0.50 l/min (in 10 ml/min increments) 0.50 l/min to 15.0 l/min (in 0.25 l/min increments)
* O2 Flow (if Individual Flow selected)	0.00 l/min to 15.00 l/min
* Balance Gas Flow (if Individual Flow selected)	Air = 0.00 l/min to 15.00 l/min N2O = 0.00 l/min to 12.00 l/min
* Total Fresh Gas Flow limited to 15.00 l/min	

12.3.3 Vent Schematic



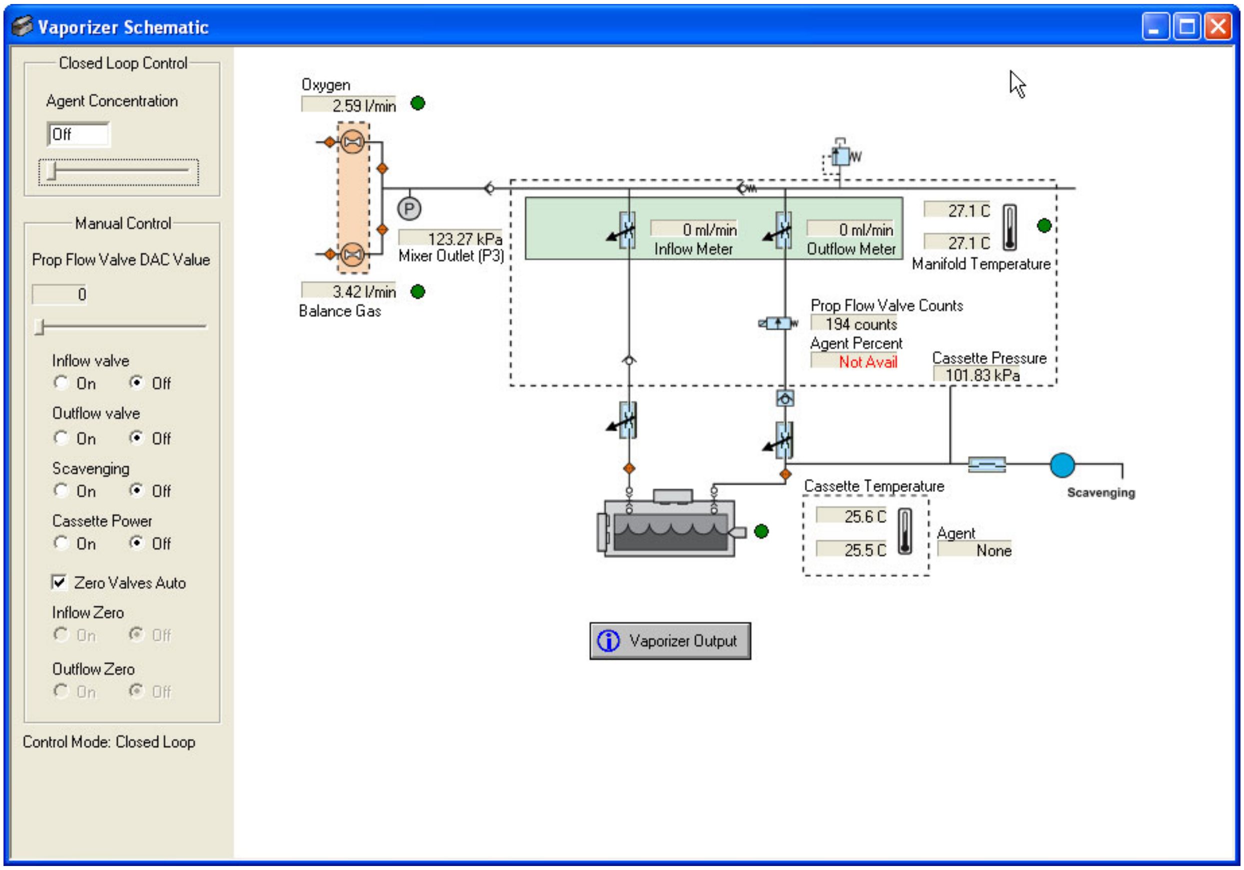
The Softkeys at the top and bottom of the Vent schematic bring up related diagnostic screens that are also accessible from the Vent Subsystem menu.

- ***Vent Flow/Press* —** (Section 12.9.2)
- ***Vent Status* —** (Section 12.9.1)

Notes

Settings	**Values**	**Units**
Tidal Vol	200, 225, 250, 500, 700 (not settable if PCV selected)	mL
Pinsp	10, 15, 30 (not settable if VCV selected)	cmH20
Rate	10, 13, 15, 20, 30, 35	breaths/min
I:E	2:1, 1:1, 1:2, 1:3	
PEEP	Off, 5, 10	cmH20

12.3.4 Vaporizer Schematic



The Softkey at the bottom of the Vaporizer schematic brings up a related diagnostic screen that is also accessible from the Vaporizer Subsystem menu.

- ***Vaporizer Output* —** (Section 12.10.1)

Notes

Settings	**Remarks**
Manual Control	Set “Agent Concentration” to “Off” to enable Manual Control
Agent Concentration or Prop Flow Valve DAC Value	Move slider to increase/decrease value. Use arrow keys to fine tune setting.
Zero Valves Auto	Select “Zero Valves Auto” for best accuracy flow measurements.
Inflow Zero Outflow Zero	Not settable if “Zero Valves Auto” is checked.
	Outflow Meter reading are compensated by ambient pressure stored at machine start-up.

12.4 Menu Items

In addition to the schematic representations, the Service Application provides access to diagnostic screens through the following menu item structure.

File (*Section 12.5*)
- Preferences (*Section 12.5.1*)
- Exit

Tools (*Section 12.6*)
- Communication Status (*Section 12.6.1*)
- System Calibrations (*Section 12.6.2*)
- Transfer Logs (*Section 12.6.3*)

Power Diagnostics (*Section 12.7*)
- Power Schematic (*Section 12.3*)
- Power Board (*Section 12.7.1*)
- Anesthesia Control Board Power (*Section 12.7.2*)
- Mixer Board Power (*Section 12.7.3*)
- Vent Interface Board Power (*Section 12.7.4*)
- Display Unit Power (*Section 12.7.5*)

Gas Delivery Subsystem (*Section 12.8*)
- Gas Delivery Schematic (*Section 12.3.2*)
- Gas Supply Status (*Section 12.8.1*)
- Mixer Output (*Section 12.8.2*)
- Mixer Pressure and Temperature (*Section 12.8.3*)
- Gas Delivery Status (*Section 12.8.4*)
- Mixer Post/Checkout Test Results (*Section 12.8.5*)
- Perform Mixer Tests (*Section 12.8.6*)

Vent Subsystem (*Section 12.9*)
- Vent Schematic (*Section 12.3.3*)
- Vent Status (*Section 12.9.1*)
- Vent Flow and Pressure (*Section 12.9.2*)

Vaporizer Subsystem (*Section 12.10*)
- Vaporizer Schematic (*Section 12.3.4*)
- Vaporizer Output (*Section 12.10.1*)
- Perform Vaporizer Test (*Section 12.10.2*)

Gas Monitor (*Section 12.11*)
- Gas Monitor Service (*Section 12.11.1*)

Window (*Section 12.12*)
- standard “Window” manipulation items
- (list of all open windows)

Help (*Section 12.13*)
- About

12.5 File menu

The File menu includes the following menu items:

- Preferences (*Section 12.5.1*)
- Exit (quits the application)

12.5.1 File — Preferences

Selections on this screen affect the format of applicable values displayed on several of the diagnostic screens.

Unit Selection	
Label	**Value**
Gas Supply Pressure Units	kPa psi bar
Airway Pressure Units	cmH2O kPa hPa mmHg mbar
Temperature Units	Celsius Fahrenheit
Gas Color Code	ANSI ISO

Serial Port Selection

If the COM1 port is in use by another application, use the ***COM Port*** drop-down list on the **Serial Port Selection** screen to select an alternate COM port to use with the Service Application.

Port Selection	
COM Port:	COM1 -------- COM6*

* The available COM Ports are specific to the PC being used.

12.6 Tools menu

The Tools menu includes the following menu items:

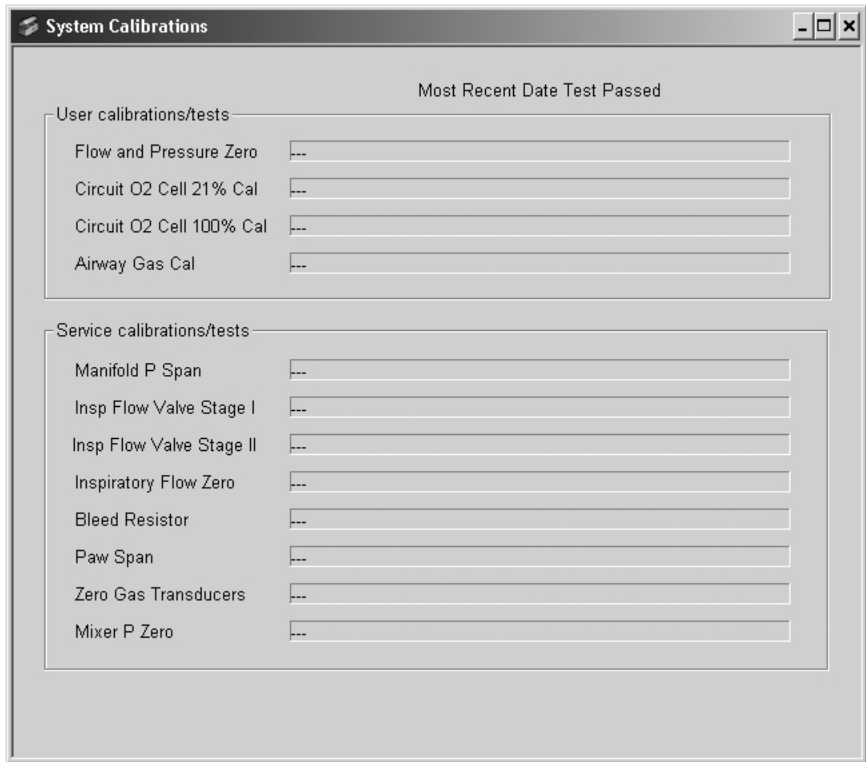
- Communication Status (*Section 12.6.1*)
- System Calibration (*Section 12.6.2*)
- Transfer Logs (*Section 12.6.3*)

12.6.1 Tools — Communication Status

Communications Status	
Label	**Value**
Anesthesia Control Board	OK, Fail, ---
Mixer Board	OK, Fail, ---
Ventilator Interface Board	OK, Fail, ---
Power Controller Board	OK, Fail, ---
Controls (Front Panel) Board	OK, Fail, ---
Gas Module	OK, Fail, not detected, ---
Agent Delivery Board	OK, Fail, ---
Link Status	Good Link, No Link

12.6.2 Tools — System Calibrations

The System Calibrations screen displays the most recent date that the system passed a User or Service calibration or test.

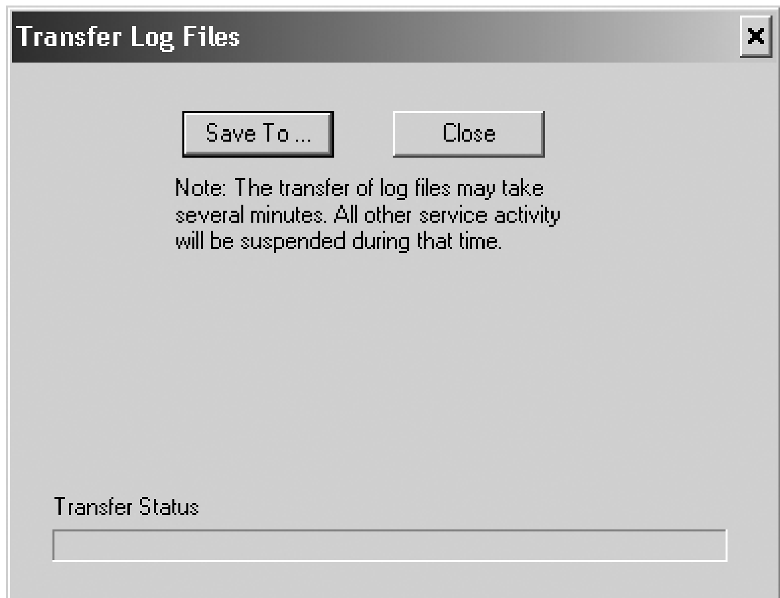


Note These dates may not be displayed correctly after completing a software download. The actual calibrations are not affected. These dates will update as new calibrations are completed.

12.6.3 Tools — Transfer Logs

The Transfer Logs menu gives access to all logs stored in the Display Unit.

The logs are transferred as text files. The file names consist of log type and a unique number (time stamp) identifier.



12.7 Power Diagnostics menu

The Power Diagnostics menu includes the following menu items:

- Power Schematic (*Section 12.3*)
- Power Board (*Section 12.7.1*)
- Anesthesia Control Board Power (*Section 12.7.2*)
- Mixer Board Power (*Section 12.7.3*)
- Vent Interface Board Power (*Section 12.7.4*)
- Display Unit Power (*Section 12.7.5*)

12.7.1 Power Diagnostics — Power Board

Power Controller Board			
Label	**Value Format**	**Units**	**Range**
12Vdc Supply	XX.XX	Vdc	11.70 to 12.30
3.3Vdc Supply	X.XXX	Vdc	3.201 to 3.399
1.5 Vdc Supply	X.XXX	Vdc	1.450 to 1.550
Battery Connected	Yes, No		
Calc Battery Time	XX	Min	00 to 30
Battery 1 Volts	10.00 to16.50 (black) <10.00; >16.50 (red)	Vdc	10.00 to 16.50
Battery 2 Volts	10.00 to16.50 (black) <10.00; >16.50 (red)	Vdc	10.00 to 16.50
Battery Current	X.XXX	A	- 11.000 to 4.000
Battery Status	Bulk Chg Over Chg Float Chg Trickle Chg On Trickle Chg Off Discharge		
<*> Date battery Tested	--/---/----		
Last Full Discharge	XX	Min	
Board Temperature	≤75C OK (black) >75C Fail (red)	C F	max 75 max 167
Fan Speed	Slow, Fast		
Fan 1 Voltage	XX.XX	Vdc	Fast 11.52 - 12.48 Slow10.08 - 10.92
Fan 1 Status	OK, Fail		
Fan 2 Voltage	XX.XX	Vdc	Fast 11.52 - 12.48 Slow10.08 - 10.92

<*> Date battery Tested = date of Last Full Discharge (refer to section 6.11).

12.7.2 Power Diagnostics — Anesthesia Control Board Power

Anesthesia Control Board Power

Label	Value	Units	Normal range
12 Vdc Supply	XX.XX	Vdc	11.92 to 13.00
ADC Ref	X.XXX	Vdc	4.018 to 4.176

Label	Value	Label	Value
Gas Select 10VA Volts	OK, Fail	Periph1 10VA Volts	OK, Fail
Gas Select 10VA Amps	OK, Fail	Periph1 10VA Amps	OK, Fail
Press Transducer 10VA Amps	OK, Fail		
		Periph2 10VA Volts	OK, Fail
Vent Interface Board 10VA Volts	OK, Fail	Periph2 10VA Amps	OK, Fail
Vent Interface Board 10VA Amps	OK, Fail		
Vent Valves 10VA Volts	OK, Fail	Agent Delivery 10VA Volts	OK, Fail
Vent Valves 10VA Amps	OK, Fail	Agent Delivery 10VA Amps	OK, Fail
Acces 1 10VA Volts	OK, Fail	Agent Deliv Prop Valve 10VA Volts	OK, Fail
Acces 1 10VA Amps	OK, Fail	Agent Deliv Prop Valve 10VA Amps	OK, Fail
Gas Unit 10VA Volts	OK, Fail	Agent Deliv Inflow and Zero 10VA Volts	OK, Fail
Gas Unit 10VA Amps	OK, Fail	Agent Deliv Inflow and Zero 10VA Amps	OK, Fail
Mixer 10VA Volts	OK, Fail	Agent Deliv Outflow and Scav 10VA Volts	OK, Fail
Mixer 10VA Amps	OK, Fail	Agent Deliv Outflow and Scav 10VA Amps	OK, Fail
Alt O2 10VA Volts	OK, Fail		
Alt O2 10VA Amps	OK, Fail		

12.7.3 Power Diagnostics — Mixer Board Power

Mixer Board Power			
Label	**Value Format**	**Units**	**Range**
Mixer 10VA Volts	OK, Fail		
12.5 V	XX.X	Vdc	11.8 to 13.0
5.5V	X.XX	Vdc	5.39 to 5.61
3.3V CPU	X.XX	Vdc	3.22 to 3.38
2.5V ADC Ref	X.XX	Vdc	2.47 to 2.53

12.7.4 Power Diagnostics — Vent Interface Board Power

Vent Interface Board Power			
Label	**Value Format**	**Units**	**Range**
Vent Board 10VA Volts	OK, Fail		
Vent Valves 10VA Volts	OK, Fail		
Vent Board 12.5V	XX.XX	Vdc	11.30 to 13.13
Vent Valves 12.5V	XX.XX	Vdc	11.30 to 13.13
3.2 Vdc (12bit Vref)	X.XXX XXXX	Vdc Counts	3.179 to 3.221
1.22 Vdc (10bit Vref)	X.XXX XXXX	Vdc Counts	1.074 to 1.367
+6.0Vdc	X.XX	Vdc	5.51 to 6.50
-6.0Vdc	-X.XX	Vdc	-6.72 to -5.28

12.7.5 Power Diagnostics — Display Unit Power

Display Unit Power			
Label	**Value Format**	**Units**	**Range**
12.5V_IN	XX.XX	Vdc	11.48 to 13.39
12.0V_INV	XX.XX	Vdc	10.45 to 13.65
5.0V_AUDIO	X.XX	Vdc	4.51 to 5.51
3.3V_LCD	X.XX	Vdc	2.98 to 3.63
5V_CB	X.XX	Vdc	4.51 to 5.51
1.5V_CB	X.XX	Vdc	1.35 to 1.65
3.3V_CB	XX.XX	Vdc	2.98 to 3.63

12.7.6 Power Diagnostics — Vaporizer Power

Vaporizer Power			
Label	**Value Format**	**Units**	**Range**
ADB +12.0V	X.XX	Vdc	11.1 - 12.9
ADC Ref 1	X.XX	Vdc	3.99 - 4.20
ADC Ref 2	X.XX	Vdc	3.99 - 4.20
ADB +5V Vcc	X.XX	Vdc	4.625 - 5.375
Agent Delivery 10VA Volts	OK, Fail		
Agent Deliv Prop Valve 10VA Volts	OK, Fail		
Agent Deliv Inflow and Zero 10VA Volts	OK, Fail		
Agent Deliv Outflow and Scav 10VA Volts	OK, Fail		

12.8 Gas Delivery Subsystem menu

The Gas Delivery Subsystem menu includes the following menu items:

- Gas Delivery Schematic (*Section 12.3.2*)
- Gas Supply Status (*Section 12.8.1*)
- Mixer Output (*Section 12.8.2*)
- Mixer Pressure and Temperature (*Section 12.8.3*)
- Gas Delivery Status (*Section 12.8.4*)
- Mixer Post/Checkout Test Results (*Section 12.8.5*)
- Perform Mixer Tests (*Section 12.8.6*)

12.8.1 Gas Delivery Subsystem — Gas Supply Status

Gas Supply Status				
Label	**Value Format**	**Range (kPa)**	**Range (psi)**	**Range (bar)**
O2 Cylinder 1	XXXXX.XX	0.00 to 27580.00	0.00 to 4000.14	0.00 to 275.80
O2 Cylinder 2	XXXXX.XX	0.00 to 27580.00	0.00 to 4000.14	0.00 to 275.80
Air Cylinder	XXXXX.XX	0.00 to 27580.00	0.00 to 4000.14	0.00 to 275.80
N2O Cylinder	XXXX.XX	0.00 to 9805.00	0.00 to 1422.10	0.00 to 98.05
O2 Pipeline	XXX.XX	0.00 to 798.00	0.00 to 115.74	0.00 to 7.98
Air Pipeline	XXX.XX	0.00 to 798.00	0.00 to 115.74	0.00 to 7.98
N2O Pipeline	XXX.XX	0.00 to 798.00	0.00 to 115.74	0.00 to 7.98
O2 Select Valve	Open, Closed (Open = connected to Mixer)			
Air Select Valve	Open, Closed (Open = connected to Mixer)			
N2O Select Valve	Open, Closed (Open = connected to Mixer)			
Alt O2 Valve	Open, Closed (Open = O2 bypass)			
Alt O2 Button	Not Pressed, Pressed			
O2 Flush	Not Pressed, Pressed			
Gas Outlet Config.	Circle, SCGO, ACGO			

12.8.2 Gas Delivery Subsystem — Mixer Output

Mixer Output			
Label	**Value**	**Units**	**Range**
O2 Flow	XX.XX	l/min	0.00, 0.10 to 15.75
O2 Flow Verify	XX.XX	l/min	2.00 - 18.00
O2 Flow Signal	X.XXXX	Vdc	0.0986 to 4.0100
O2 Prop Valve Drive	XXX	mA	0, 29 to 138
Balance Gas ID	None, Air, N2O		
Balance Flow	XX.X	l/min	0.1 - 15.75 for Air 0.1 - 12 for N2O
Balance Flow Verify	XX.X	l/min	2 - 18 for Air 2 - 14.4 for N2O
Balance Flow Signal	X.XXX	Vdc	0.050 to 4.045
Balance Prop Valve Drive	XXX	mA	0, 29 to 138
O2 Select Valve	Open, Closed		
Air Select Valve	Open, Closed		
N2O Select Valve	Open, Closed		
ADC Ref Voltage	X.XX	Vdc	2.47 to 2.53

12.8.3 Gas Delivery Subsystem — Mixer Pressure and Temperature

Mixer Pressure and Temperature					
Label	**Value**	**Units**	**Range (kpa/C)**	**Range (psi/F)**	**Range (bar/C)**
O2 Pressure	XXX.XX		62.05 to 220.63	9.00 to 32.00	0.62 to 2.21
O2 Pressure Cal	X.XX	Vdc	0.55 to 2.90	0.55 to 2.90	0.55 to 2.90
Balance Pressure	XXX.XX		62.05 to 220.63	9.00 to 32.00	0.62 to 2.21
Balance Pres Cal	X.XX	Vdc	0.55 to 2.90	0.55 to 2.90	0.55 to 2.90
Mixer Output Pres	XXX.XX		62.05 to 199.95	9.00 to 29.00	0.62 to 2.00
Mixer Output Pres Cal	X.XX	Vdc	0.55 to 2.90	0.55 to 2.90	0.55 to 2.90
O2 Temp	XXX.XX		5.00 to 50.00	41.00 to 122.00	5.00 to 50.00
O2 Temp Volts	X.XX	Vdc	0.25 to 3.00	0.25 to 3.00	0.25 to 3.00
Balance Temp	XXX.XX		5.0 to 50.00	41.0 to 122.0	5.0 to 50.00
Balance Temp Volts	X.XX	Vdc	0.25 to 3.00	0.25 to 3.00	0.25 to 3.00

12.8.4 Gas Delivery Subsystem — Gas Delivery Status

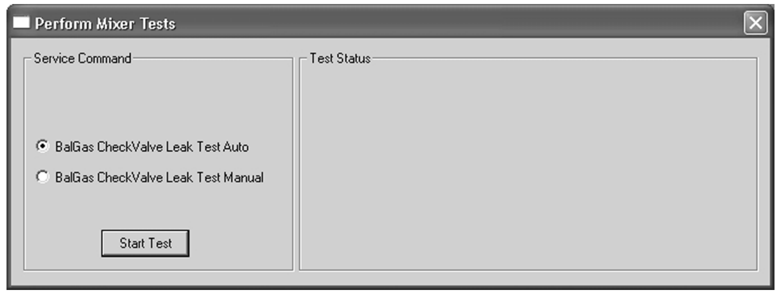
Gas Delivery Status			
Label	**Value**	**Units**	**Range**
O2 Flow	XX.XX	l/min	0.00, 0.10 to 15.75
Air Flow	XX.XX	l/min	0.00, 0.10 to 15.75
N2O Flow	XX.XX	l/min	0.00, 0.10 to 12.60

12.8.5 Gas Delivery Subsystem — Mixer Post/Checkout Test Results

Mixer Post/Checkout Test Results	
Label	**Test Results**
Alt O2 Valve Leak	Leak Pass Fail. O2 Bypass valve leaks
O2 Valve Leak	Leak Pass not performed (if O2 Valve Leak fails) Not done. No supply pressure Not done. Selector valve incorrect state Fail. Selector valve leaks Fail. Proportional valve leaks
Balance Gas Valve Leak	Pass Not done. No supply pressure Not done. Selector valve incorrect state Fail. Selector valve leaks Fail. Proportional valve leaks
O2 Flow Test	Pass Not done. No supply pressure Not done. Selector valve incorrect state Fail, 3 LPM test failed Fail, 10 LPM test failed
Balance Flow Test	Pass Not done. No supply pressure Not done. Selector valve incorrect state Fail, 3 LPM test failed Fail, 10 LPM test failed

12.8.6 Gas Delivery Subsystem — Perform Mixer Tests

Selecting ***Perform Mixer Tests*** brings up the following screen. This screen includes and automatic and a manual leak test of the Mixer's balance gas inlet check valves.



Automatic

The ***BalGas Check Valve Leak Test Auto*** does not require disassembly of the system. It is a sensitive test that will Pass check valve that have leak rates within specifications; however, it may Fail some Mixers with marginal but acceptable leak rates.

- Mixers that Pass the auto leak test do not require further testing and can be left in service.
- Mixers that Fail the auto leak test should be further tested using the manual leak test.

Manual

The ***BalGas Check Valve Leak Test Manual*** requires disassembly of the system.

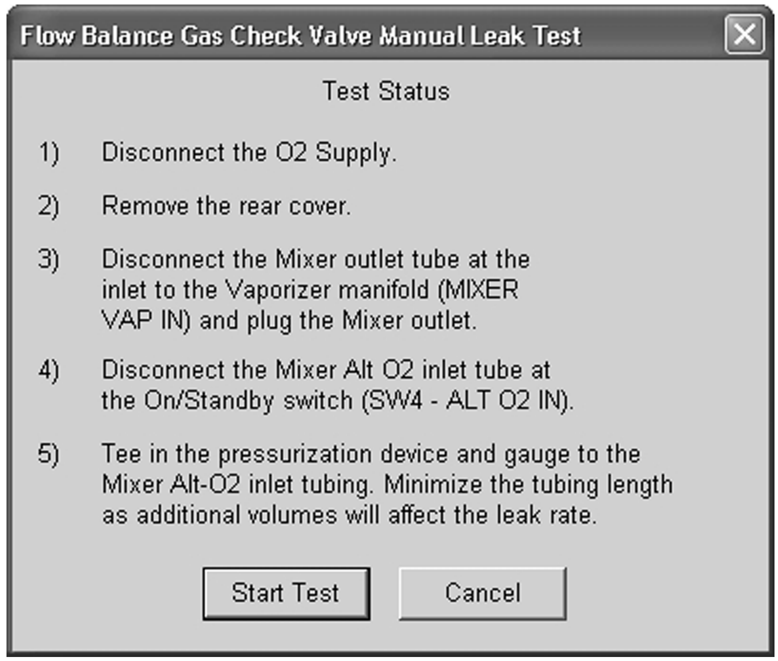
- Mixers that Pass the manual leak test have acceptable leak rates and can be left in service.
- Mixers that Fail the manual leak test should be replaced.

Automatic leak test

1. Connect an O_2 supply.
2. Select ***Start Test*** to perform the ***BalGas Check Valve Leak Test Auto***.
    - If Pass, balance gas check valve leak rate is acceptable.
    - If Fail, verify leak rate using the manual leak test.

Manual leak test

Selecting ***BalGas Check Valve Leak Test Manual*** brings up the manual leak test setup instructions.



Select ***Start Test*** to perform the manual leak test as follows.

1. Slowly pressurize the Mixer to 400 mmHg (over a 5-second period), as read on the test device.
2. The pressure shown on the test gauge should not decrease to zero in less than 10 seconds.
3. Select 'End Test' when done.

After completing the test:

1. Remove all test fixtures.
2. Re-assemble Mixer pneumatics and remove plugs from Mixer assembly.
3. Re-attach Oxygen supply and activate 'Confirm'.

12.9 Vent Subsystem menu

The Vent Subsystem menu includes the following menu items:

- Vent Schematic (*Section 12.3.3*)
- Vent Status (*Section 12.9.1*)
- Vent Flow and Pressure (*Section 12.9.2*)

12.9.1 Vent Subsystem — Vent Status

Vent Status	
Label	**Value**
Vent Drive Gas	Air or O_2
ABS Installed	Installed or Not Installed
Flush Valve	Not Pressed or Pressed
<*> CO_2 Bypass	Closed or Open
O_2 Cell Status	Connected or None
Bag/Vent Switch	Bag or Vent
Circuit Feedback	Circle, Non-circle, or fault
Over Pressure Circuit	OK or High-Pressure
ACGO/SCGO Config	ACGO or SCGO
Gas Inlet Valve Feedback	Open or Closed

<*> This refers to the Canister Release switch. The value defaults to Closed if the switch kit is not installed (refer to section 10.41).

12.9.2 Vent Subsystem — Vent Flow and Pressure

Vent Flow and Pressure

	Menu Item	Value	Units	Range	Counts (0-4095)
	Inspiratory Flow	XXX.X	l/min	-120.0 to 120.0	XXXX
	Expiratory Flow	XXX.X	l/min	-120.0 to 120.0	XXXX
<*>	Airway Pressure	XX X	cmH_2O	-20.0 to 120.0	XXXX
<*>	Manifold Pressure	XXX	cmH_2O	-20.0 to 120.0	XXXX
	O2 Cell	XXX	%	5 to 110	XXXX
	ADC Ref Voltage	X.XXX	Vdc	3.179 to 3.221	
	Flow Valve Setting	XXX.X	l/min	0.00 to 140.00	XXXX
	Flow Valve Feedback	xxxx	mV	0 to 4095	XXXX
	Flow Valve Current	xxxx	mA	0.0 to 102.4	XXXX

	Units	Range
<*>	kPA	-2.0 to 11.8
	hPA	-19.6 to 117.7
	mmHg	-14.7 to 88.3
	mBar	-19.6 to 117.7

12.10 Vaporizer Subsystem menu

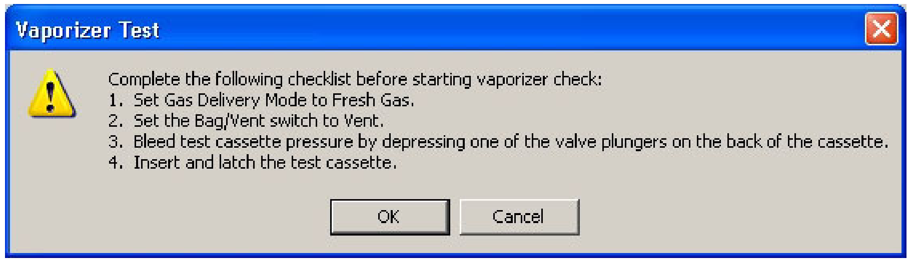
The Vaporizer menu includes the following menu items:

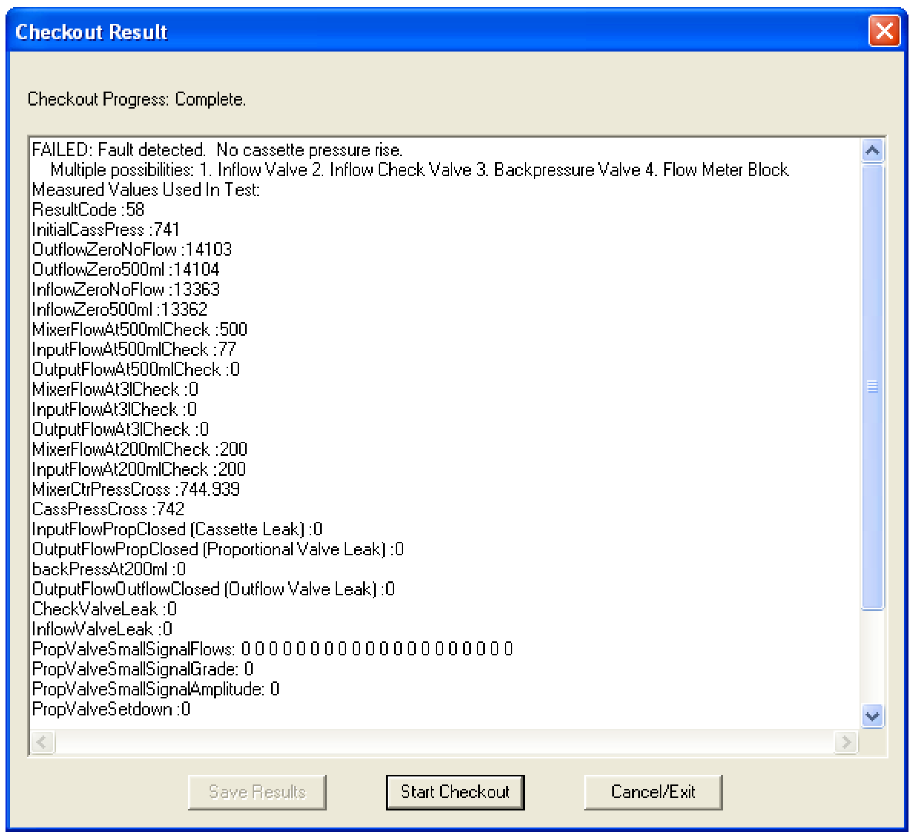
- Vaporizer Schematic (*Section 12.3.4*)
- Vaporizer Output (*Section 12.10.1*)
- Perform Vaporizer Test (*Section 12.10.2*)

12.10.1 Vaporizer Subsystem — Vaporizer Output

Vaporizer Output			
Label	**Value**	**Units**	**Range**
Cassette Temp 1	XX.X	C F	5.0 to 55.0 41.0to 131.0
Cassette Temp 2	XX.X	C F	5.0 to 55.0 41.0to 131.0
Manifold Temp 1	XX.X	C F	5.0 to 55.0 41.0to 131.0
Manifold Temp 2	XX.X	C F	5.0 to 55.0 41.0to 131.0
Input Flow	XX.X	ml/min	-200 to 6500
Output Flow	XX.X	ml/min	-200 to 6500
Valve Drive Sense	XX.X	mA	N/A
Cassette Pressure	XX	kPa psi bar	77.89 to 192.51 11.30 to 27.92 0.78 to 1.93
Agent ID	None, ENF, DES, HAL, ISO, SEV, TEST, INVALID		
Agent %	XXX		ENF, ISO, HAL • 0.0%, 0.2% to 5% SEV • 0.0%, 0.2% to 8% DES • 0.0%, 1% to 18%
Agent Level	Full, 1/2 Full, 1/4 Full, Empty, Overfilled, Not Available		

12.10.2 Vaporizer Subsystem — Perform Vaporizer Test





12.11 Gas Monitor menu

The Gas Monitor menu includes the following menu items:

- Gas Monitor Service (*Section 12.11.1*)

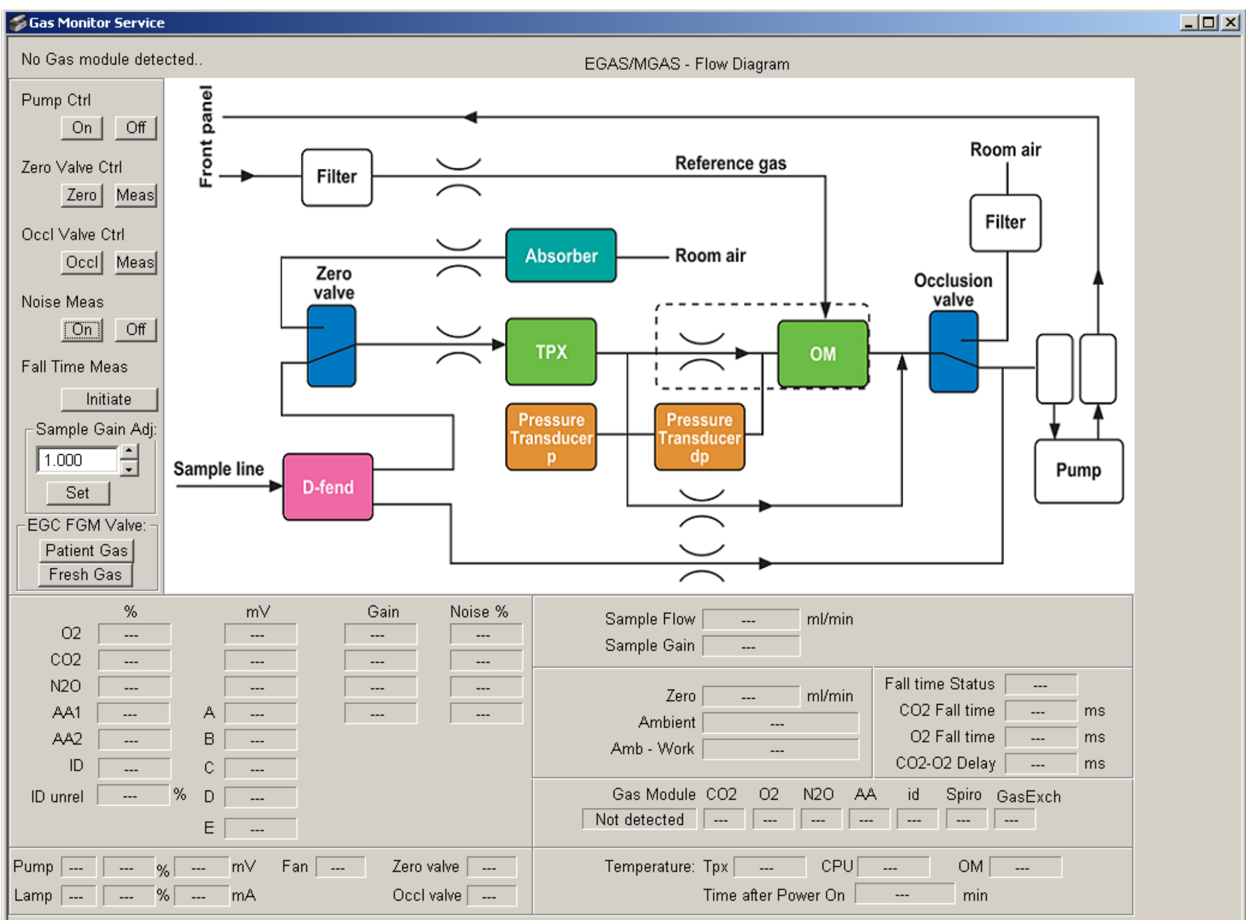
12.11.1 Gas Monitor Service

The Aisys CS2 PC Service Application is compatible with M-Gas, E-Gas, and CARESCAPE E-sGas Airway Modules (refer to *Section 1.4*).

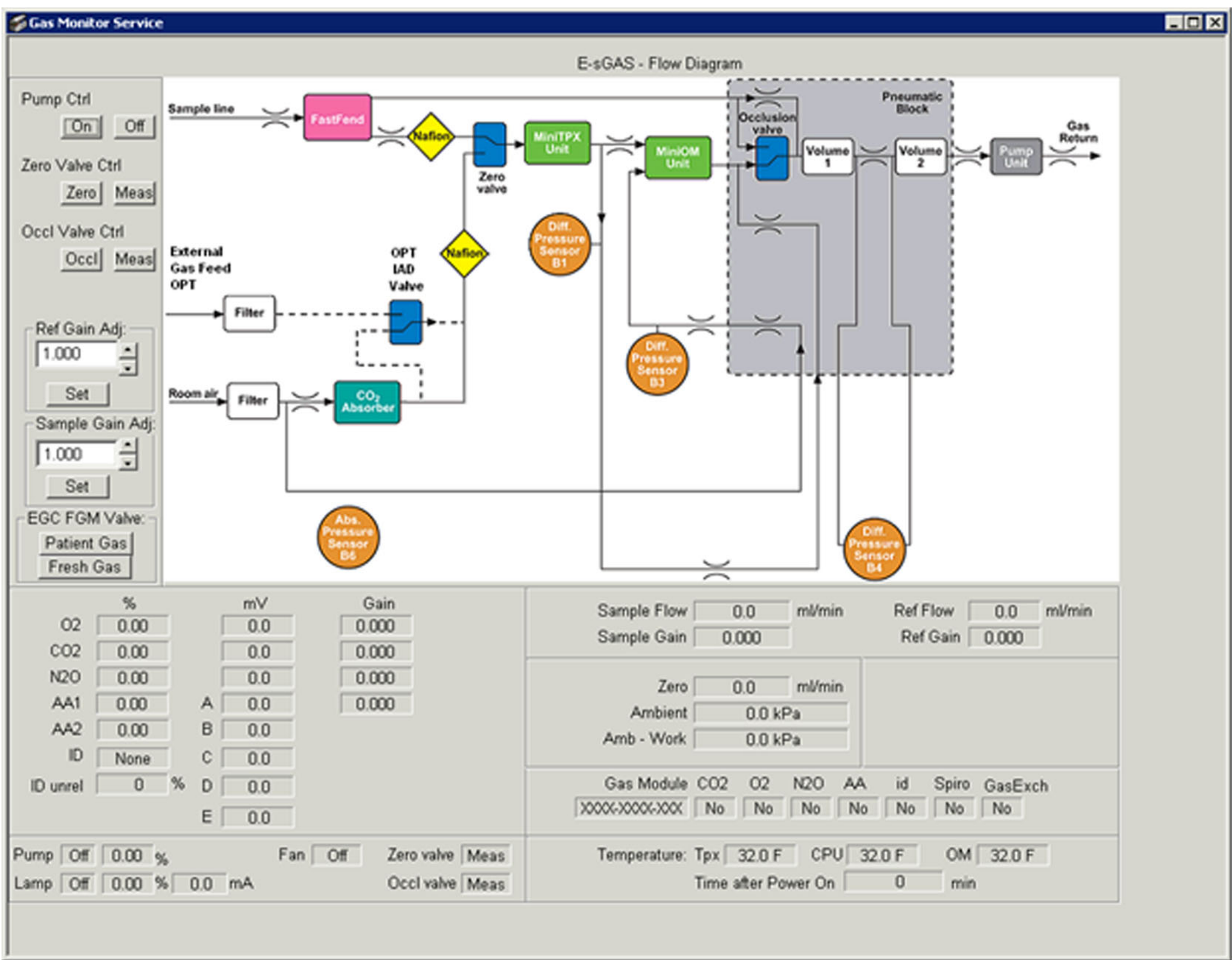
For Airway Module troubleshooting and repair instructions, refer to the latest version of the applicable Technical Reference Manual.

Selecting ***Gas Monitor Service*** on the Gas Monitor menu, brings up the respective Airway Module Flow Diagram.

Flow Diagram for EGAS/MGAS



Flow Diagram for E-sGAS



12.12 Window menu

The Window menu includes the following menu items:

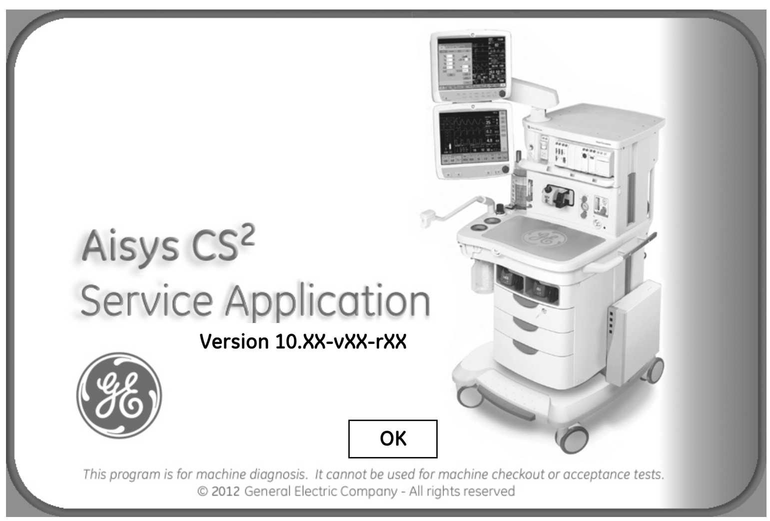
- Cascade
- Tile Horizontal
- Tile Vertical
- Close
- Close All
- (list of all open windows)

12.13 Help menu

The Help menu includes the following menu items:

About...

About



13 Maintenance Procedures

In this section This section covers the 12-month maintenance procedures required to make sure that the Aisys CS2 anesthesia machine operates to specifications.

⚠ WARNINGS Do not perform testing or maintenance on the Aisys CS2 anesthesia machine while it is being used on a patient. Possible injury can result.

Items can be contaminated due to infectious patients. Wear sterile rubber gloves. Contamination can spread to you and others.

Obey infection control and safety procedures. Used equipment may contain blood and body fluids.

13.1 Aisys CS2 Planned Maintenance Checklist

Serial Number:			Date: (YY/MM/DD) / /
Hospital:			Performed by:
☐ 12 months	☐ 24 month	☐ 48 month	☐ ______________

13.1.1 Parts Replacement

All parts should be replaced before performing the checks, tests, and calibrations.

Every twenty-four (24) months

Replace the following parts every 24 months.

Refer to *TRM - Section 6.10*; perform the following:

☐ Replace the free breathing flapper valve (Stock Number 0211-1454-100).

☐ Replace the free breathing valve o-ring (Stock Number 1503-3208-000).

Every forty-eight (48) months

In addition to the 24-month requirements, replace the following parts every 48 months.

Refer to *TRM - Section 9.13.3*; perform the following:

☐ Replace the Display Unit battery (Stock Number 1009-5800-000).

Refer to *TRM - Section 9.14.4*; perform the following:

☐ Replace the system batteries* (Stock Number 1009-5682-000).

***Note**: Refer to the "*Battery capacity test*" in *TRM - Section 6.11*.

13.1.2 Respiratory Gas Modules

The Aisys CS2 anesthesia machine may be configured for use with a GEHC Respiratory Gas Module. When the GEHC Respiratory Gas Module is configured with the Aisys CS2 anesthesia system, reference the appropriate GEHC Respiratory Gas Module Technical Reference Manual for relevant information regarding Theory of Operation, Installation procedures, Maintenance and Checkout, Calibration and Adjustments, Troubleshooting, Disassembly and Reassembly, and Service Parts.

13.1.3 Test procedure outline

Perform the following steps every 12 months.
For details, refer to the following section.

- ☐ Visual Inspection Procedures
  - Machine Frame and External Connections
- ☐ Verify annunciators
- ☐ Pipeline and cylinder tests
  - Cross-Connect and High Pressure Leak test
  - O2 supply alarm test
- ☐ AGSS Inspection and Testing
  - Passive Internal Gas Scavenging, if equipped
  - Adjustable Active Gas Scavenging (AGSS), if equipped
  - Active Gas Scavenging (AGSS), if equipped
- ☐ Scavenger Positive Relief Functional Check
- ☐ ABS Inspection
  - Flow Sensor Module
  - Breathing Circuit Module and O2 Sensor
  - Absorbent Canister
  - Bellows Assembly Inspection
  - Bellows Assembly Tests
  - Exhalation Valve Inspection
  - EZ Change and Condenser Inspection (if equipped)
  - ABS Assembly
- ☐ Ventilator
  - Free breathing valve maintenance (Every 24 Months)
- ☐ Ventilator Tests
  - View and/or download error logs
  - Perform the User Calibrations
    - Flow and pressure calibration
    - Circuit O2 cell calibration
  - MOPV pressure relief valve test
  - Pressure Limit Circuit test
  - Manifold P Span
  - Inspiratory Flow Valve Cal
  - Bleed Resistor Cal
  - Paw Span
  - Zero Gas Xducer
  - Zero the Mixer
- ☐ Display Diagnostics
  - Test LEDs
  - Test Speaker
  - Test Battery
  - Test Hard Keys
  - Test LCD
  - Calibrate Touch

- ☐ Vaporizer Tests
  - eVap Test with a Test Cassette inserted
  - eVap Therapy Cassette Leak Test
- ☐ Mixer tests
  - Mixer outlet check valve leak test
  - Mixer flow verification
- ☐ Alternate O2 flowmeter tests
  - Functional Test
  - Flow Accuracy test
- ☐ Auxiliary O2 flowmeter tests
  - Functional Test
  - Flow Accuracy test
- ☐ Integrated Suction Regulator tests (if equipped)
  - Gauge Accuracy
  - Flow Test
  - Regulation Test
  - Vacuum Bleed Test
  - Vacuum Leak Test
- ☐ Flush Flow test
- ☐ Calibrating the Airway Module
- ☐ System checkout
  - Full Test
  - Low P Leak (machines with SCGO)
  - Low P Leak (machines with ACGO)
- ☐ Alarm tests
- ☐ Power failure test
- ☐ Electrical Safety Checks
  - Preparation
  - Ground Resistance Check
  - Chassis Leakage Current
  - Additional Electrical Test Steps
- ☐ Final Machine Checks

13.2 Aisys CS2 Planned Maintenance Checkout Procedure

This procedure provides a sequential PM workflow.

Note These procedures are not intended for individual tests or calibrations outside of the sequential procedure. To perform an individual test or calibration, refer to the individual procedures in this manual or the User's Reference Manual.

Scope This procedure is for all Aisys CS2 factory trained personnel globally.

General Information The following planned maintenance procedures are to be performed every 12 months, except where specifically stated differently.

Note If any of the tests fail in this procedure, refer to the appropriate sections to perform calibrations or repairs.

There are many types of flow and pressure test devices available that can be used to complete the test procedures. Unless otherwise specified, the flow and pressure test devices should have an accuracy of ± 2.5% of reading or better.

13.2.1 Visual Inspection Procedures

Machine Frame and External Connections

1. Check the fan filter at the back of the Display and the filters on the upper and lower rear access panels. Replace as necessary.
2. Check the condition and tightness of all display, cabinet, frame, drawer, arm, and shelf parts.
3. Check the casters for proper operation and mounting. DO NOT LUBRICATE THE CASTERS. Check the brakes for proper operation.
4. Verify that all labels are in place and are clearly legible.
5. Check any external tubing, including rubber goods, hoses and pipeline hoses, and ensure there is no visible deterioration and that they are securely attached.
6. Check all external electrical cabling. Ensure all are correctly connected and are not deteriorated.
7. Verify proper adjustment of the display arm for movement and maneuverability (Section 9.27).
   - Counterbalance of the display arm
   - Side to side movement of displays
   - Tilt position of the displays

13.2.2 Verify annunciators

The Aisys CS2 system includes several annunciators (speakers) that produce audible tones in response to system alarms and other hardware or software fault conditions. Verify the integrity of the annunciators at system startup.

1. Set the System switch to On.
   - Verify that an audible "beep" is heard immediately after the System switch is turned to On (Power Controller Board).
2. After several seconds into power-up:
   - Verify that a second audible "beep" is heard (Anesthesia Control Board).
3. Before the power-up is completed:
   - Verify that a third and fourth audible "beep" is heard from the Display Unit.

13.2.3 Pipeline and cylinder tests

Cross-Connect and High Pressure Leak test

Ensure the Gas Supply window is visible on the screen.

1. Connect the pipeline supplies one at a time and ensure that the corresponding display indicates pipeline pressure.
2. Disconnect all pipeline supplies.
3. Open each cylinder valve one at a time and ensure that the corresponding display indicates appropriate cylinder pressure.
   - Make sure that each cylinder has sufficient pressure. If not, close the applicable cylinder valve and install a full cylinder.
4. Test the cylinder supplies for a high pressure leak:
   a. Turn the auxiliary O_2 flow control fully clockwise (no flow).
   b. If equipped, turn off venturi derived suction.
   c. Open each cylinder.
   d. Note the cylinder pressure.
   e. Close each cylinder valve.
   f. Record the cylinder pressure after one minute. If the pressure decreases more than indicated below, there is a leak.

      690 kPa (100 psig) for all gases.
   g. If a cylinder supply fails this test, install a new cylinder gasket and repeat the high pressure leak test.
5. Close all cylinder valves.

WARNING Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

6. Select ***Start Case*** and ***Start Case Now***.

O2 supply alarm test

1. Establish O_2, Air, and (if equipped) N_2O gas supplies.
2. Set O_2 to 25% and (if equipped) N_2O as balance gas. For machines without N_2O, set Air as balance gas.
3. Set total flow to 3 l/min.
4. Stop the O_2 supply. (Disconnect the pipeline supply or close the cylinder valve.)
5. Make sure that:
   a. The low "O_2 supply pressure low" alarm occurs.
   b. The N_2O (if equipped) and O_2 flows stop.
   c. "Air only" selection prompt appears.
6. Reconnect the O_2 supply.
7. Push the Start/End key and select ***End Case Now***.

13.2.4 AGSS Inspection and Testing

Passive Internal Gas Scavenging, if equipped

1. Remove the side cover at the breathing system side of the machine. There are two thumbscrews that secure the cover. These thumb screws are located at the rear of the machine.
   - Note: If present, remove outboard cylinder mount.
2. Remove the scavenging reservoir assembly. Empty the reservoir if water is present.
3. Remove the scavenger receiver.
4. Inspect the receiver. Replace any damaged, distorted, missing or worn parts. Clean if contaminated.
5. Check and/or replace as necessary:
   - Scavenging hose.
   - All unused evacuation ports must be capped.
6. Inspect the negative pressure relief valve. Ensure it is clean and the retainer is securely attached.
7. Invert the scavenging assembly to ensure the disk moves freely without sticking.
8. Perform the Scavenger Positive Relief Functional Check before reassembly (Section 13.2.5 - following).

Adjustable Active Gas Scavenging (AGSS), if equipped

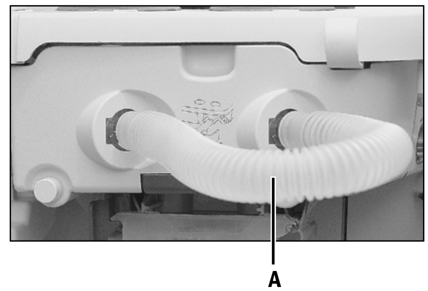
1. Remove the side cover at the breathing system side of the machine. There are two thumbscrews that secure the cover. These thumb screws are located at the rear of the machine.
2. Remove the scavenging reservoir assembly. Empty the reservoir if water is present.
3. Remove the scavenger receiver.
4. Inspect the receiver. Replace any damaged, distorted, missing or worn parts. Clean if contaminated.
5. Check and/or replace as necessary:
   - 1/4 inch vacuum hose from the wall outlet.
   - All unused evacuation ports must be capped.
   - Evacuation hoses.
   - Three-liter evacuation bag.
6. Inspect the needle valve orifice for blockage. Clean or replace as necessary.
7. Inspect the negative pressure relief valve. Ensure it is clean and the retainer is securely attached.
8. Invert the scavenging assembly to ensure the disk moves freely without sticking.
9. Perform the Scavenger Positive Relief Functional Check before reassembly (Section 13.2.5 - following).

Active Gas Scavenging (AGSS), if equipped

1. Remove the side cover at the breathing system side of the machine. There are two thumb screws that secure the cover. These thumb screws are located at the rear of the machine.
2. Remove the scavenging reservoir assembly. Empty the reservoir if water is present.
3. Remove the scavenger receiver.
4. Inspect the receiver. Replace any damaged, distorted, missing or worn parts. Clean if contaminated.
5. Inspect the internal filter for blockage. Clean or replace as necessary.
6. Inspect the negative pressure relief valve. Ensure it is clean and the retainer is securely attached.
7. Inspect the low flow orifice and seal. Clean or replace if necessary.
8. Perform the Scavenger Positive Relief Functional Check before reassembly (Section 13.2.5 - following).

13.2.5 Scavenger Positive Relief Functional Check

1. Connect tubing (**A**) from the inspiratory to expiratory ports.
2. Occlude the bag port (**B**).
3. Occlude the downtube (**C**) located under vent engine housing as seen in the following picture.



4. Set APL at min and Bag/Vent switch to bag position.
5. Push the Start/End Case key on display key pad and select "Start Case". Adjust the O_2 flow to 6 l/min.
6. After one minute, observe the Mean Pressure on the screen.
   - The pressure should rise to approximately 10 cmH_2O (some noise chattering should be heard).
   - The pressure should not indicate a pressure rise of more than 10 cmH_2O.
   - If the pressure rise is greater than 10 cmH_2O, replace the dead weight and seat on the Exhalation Valve (refer to Section 10.42.6).
     - Repeat this test procedure.
7. Remove the occlusions from the downtube (**C**) and bag port (**B**).
8. Remove the short tube (**A**) from the inspiratory and expiratory ports.
9. Push the Start/End Case on display key pad and select "End Case".
10. Reinstall scavenger receiver, reservoir and side cover.
11. Connect the AGSS to the hospital evacuation system.
12. For Active systems, attach hose to vacuum source and verify scavenger flowmeter is indicating proper flow. The ball should be in the normal (green) zone.

13.2.6 ABS Inspection

Flow Sensor Module

1. Remove the flow sensor module.
2. Inspect the housing, tubing and connectors of both flow sensors. Ensure the tubing is not kinked.
3. Inspect the flow sensor connector on the bulkhead. Ensure the electrical and pneumatic connection points are clean with no residue and secure.
4. Replace any components that look damaged or worn.
5. Set aside for later installation.

Breathing Circuit Module and O2 Sensor

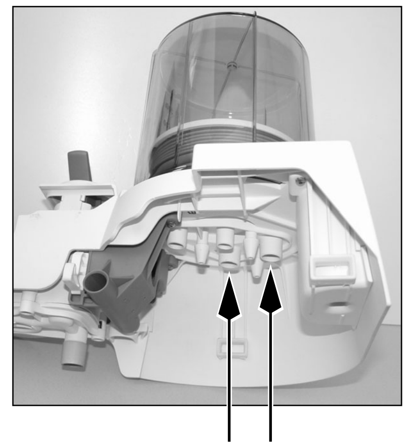
1. Remove the O_2 sensor (if installed).
2. Inspect the sensor and o-ring.
   - Replace if physically damaged.
   - Reinstall the O_2 Sensor.
3. Inspect the sensor cable. Replace if physically damaged or worn.
4. Remove the ABS from system.
5. Separate the breathing circuit module from the bellows assembly by turning the breathing circuit module 1/4 turn CCW and pulling it away from the bellows housing.
6. Inspect the seals, check-valve disks and check-valve seats. Replace as necessary.

Absorbent Canister

1. Release the canister lock ensuring that the release latch operates properly and smoothly.
2. Remove the absorber assembly and inspect. If a reusable canister is present, clean any absorbent dust from the lid and lid o-ring, lightly lubricate the lid o-ring with Krytox, replace any parts that look damaged, distorted or worn.
3. Inspect the o-rings that make a seal with the top canister ports (located on the Breathing Circuit Module). Ensure the o-rings are properly in place. Replace any parts that look damaged, distorted or worn. Clean any that are contaminated.
4. Lock the canister in place. Ensure the canister locks into position.

Bellows Assembly Inspection

1. Disassemble the bellows assembly.
2. Inspect all removed components. Check that the bellows housing is not cracked, chipped or damaged. Also check the condition of the housing lettering. Replace any components that appear damaged, distorted or worn.
3. Reassemble the bellows assembly. Ensure all components are secure.
4. Perform the Bellows Assembly Test:



   - Hold the bellows assembly vertical and use the appropriate test plugs to seal the ports shown.
   - Invert the bellows assembly. The bellows must not fall within one minute.

     If it does:
     - The ports are not tightly sealed.
     - The bellows is incorrectly installed.
     - The seal inside the bellows is not correctly installed (with its groove pointed up).
     - Parts are damaged.

   - Remove the plugs from the ports. Permit the bellows to fully extend. Use the appropriate test plug to seal the port shown.
   - Hold the bellows assembly upright. The bellows must not fall past the guide line within one minute.

     If it does:
     - The port is not tightly sealed.
     - The bellows or the pressure-relief valve is not correctly installed.
     - Parts are damaged.
5. Inspect the APL valve diaphragm, disk and cage. Replace any that look damaged, distorted or worn. Clean the seat and disk.
6. Remove the 3 thumbscrews holding the bag port cover in place.
7. Inspect all gaskets, o-rings, manifolds, and the relief valve. Replace as necessary.
8. Cycle the Bag/Vent switch several times. Ensure it snaps firmly from one position to the other. Replace any parts that look damaged, distorted or worn.
9. Install the bag port cover.

Exhalation Valve Inspection

1. Remove and disassemble the exhalation valve.
   - Clean disk, relief valve weight and seat, if necessary.
2. Inspect the diaphragm, replace as necessary.
3. Assemble the exhalation valve, and reinstall it if not performing the 24-month PM.

EZchange and Condenser Inspection (if equipped)

1. Remove the EZchange module or Condenser module and Condenser (if installed).
2. Separate the Condenser from the EZchange Module / Condenser Module.
3. Inspect Condenser Reservoir and drain seal. Clean drain seal if necessary.
4. Remove the Bypass Valve Housing and inspect the valve seals. Reinstall the Bypass Valve Housing and Condenser Module.
5. Replace any components that look damaged or worn.

ABS Assembly

1. Assemble the entire ABS, but do not attach it to the machine at this time.

Note: Leave the Circuit module detached from the Bellows module. The Circuit module will be required for the Pressure Limit test.

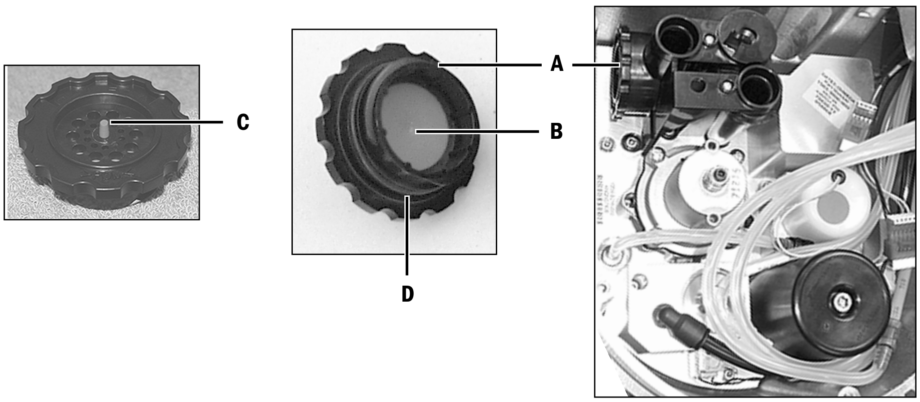
2. Set aside for later installation.

13.2.7 Ventilator

Note: Go to Ventilator Tests (following) if not performing the 24-month PM.

Free breathing valve maintenance (Every 24 Months)

1. Verify the machine is off, gas cylinders are off and the pipelines are disconnected. (Not necessary if you can access the valve without engine removal.)
2. Remove the top cover of the vent engine compartment.



Note You may have to remove the Vent Engine to be able to remove the valve seat.

3. Unscrew the valve seat (**A**) from the side of the interface manifold.
4. Inspect the flapper (**B**) and valve seat for nicks, debris and cleanliness.
5. To replace the flapper valve, remove the old flapper valve from the valve seat (**A**).
6. If necessary, clean the new flapper valve with alcohol.
7. Pull the tail (**C**) of the new free breathing valve flapper through the center of the valve seat until it locks in place.
8. Trim the tail with 2 to 3 mm outside surface of the valve seat (refer to the removed flapper).
9. Replace the o-ring (**D**). Lubricate with a thin film of Krytox.
10. Hand screw the assembly into the interface manifold.
11. Reinstall the tubing and electrical connections.
12. Reconnect the pipeline supplies (if previously removed).
13. Reinstall the breathing system.
14. Perform the Ventilator Tests (following).

13.2.8 Ventilator Tests

Ventilator Test Set-up

1. Connect AC power to the machine.
2. Turn the System Master Switch to the ON position and enter the Service Mode.
   - To enter Service Mode, ***Start Case*** and select ***System Setup*** in the right-hand button bar.
   - Select ***Super User Password*** (16-4-34).
   - Select ***Installation and Service*** (26-23-8).
3. On the Service menu, select ***Service Logs***.
   - View or ***Copy Logs***.
   - Take appropriate actions on log entries.

Perform the User Calibrations

On the Service menu, select ***Calibrations***.

On the Calibrations menu, select ***User Calibrations***.

Select ***Flow and Pressure*** and follow the instructions on the screen.

1. Remove flow sensor module to start.
2. Reinstall flow sensor module when results appear.
3. Make sure the module latches securely.

Select ***Circuit O2 cell 21%*** and follow the instructions on the screen.

1. Remove the flow sensor module and the O_2 cell.
2. Hold the O2 cell in room air.
3. Select Start. Test may take up to 3 minutes.
4. Install the Circuit O2 cell and flow sensor module.
5. Make sure the module latches securely.

Select ***Circuit O2 cell 100%*** and follow the instructions on the screen.

- Ensure there is no patient tubing connected to the system.
- (ACGO option only.) Set the ACGO switch to Circle.

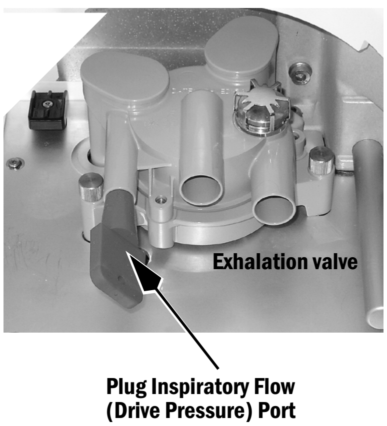
1. Make sure the O2 cell is installed correctly.
2. Set the Bag/Vent switch to Vent.
3. Select Start.

MOPV pressure relief valve test

⚠ **WARNING** Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

Test setup



1. Remove the breathing system.
2. Plug the inspiratory flow (drive pressure) port of the exhalation valve with a stopper.

Note: To test the pressure relief valve, you must establish a flow from the Vent Engine of 30 l/min through the Inspiratory Flow Control valve. Use the PC Service App to establish the flow.

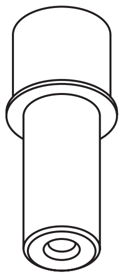
Test procedure

1. On the Main Menu of the Service Application, select Vent Schematic from the Vent Subsystem tab.
2. Set Gas Inlet Valve radio button to ON.
3. Adjust the Insp Flow Valve slider until the displayed Flow Valve flow is 30 l/min.
4. Carefully listen for the MOPV relief weight to be relieving and "popping off" from its seat (a purring sound). This indicates the valve is functioning correctly.
5. Remove the stopper from the inspiratory flow port.

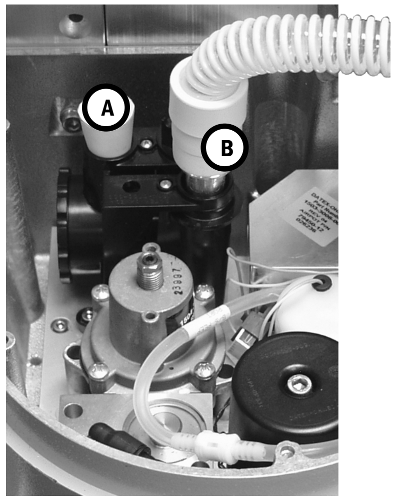
Pressure Limit Circuit test

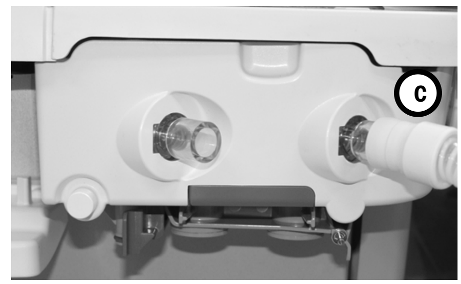
The ABS breathing system and Exhalation Valve should not be installed on the machine.

Calibration setup

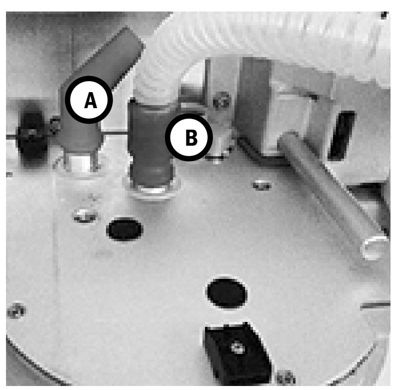


Calibrated Flow Orifice
1504-3016-000





Alternative setup



1. Remove the exhalation valve.
2. Separate the Circuit Module from the ABS Bellows Module.
3. Install the Circuit Module only.
4. Plug the Drive Port (**A**) on the Vent Engine interface valve.
5. Attach a patient circuit tube to the Calibrated Flow Orifice test tool.
6. Insert the Calibrated Flow Orifice into the Manifold (pilot) Port (**B**).
7. Connect the open end of the patient circuit tube to the inspiratory flow patient connection (**C**). Be sure the module is seated fully.

Test Procedure

1. On the Main Menu of the Service Application, select Vent Schematic from the Vent Subsystem tab.
2. Set Gas Inlet Valve radio button to ON.
3. Adjust the Insp Flow Valve slider until the "Airway Pressure" reading reaches approximately 109 cmH_2O.
4. Continue to increase the flow and observe the airway pressure until gas flow stops.
5. Select the "Vent Status" page and verify that:
   - "Over Pressure Circuit" reads OK.
   - "Gas Inlet Valve Feedback" reads Closed.

Note: If you cannot build pressure, make sure the module is fully seated.

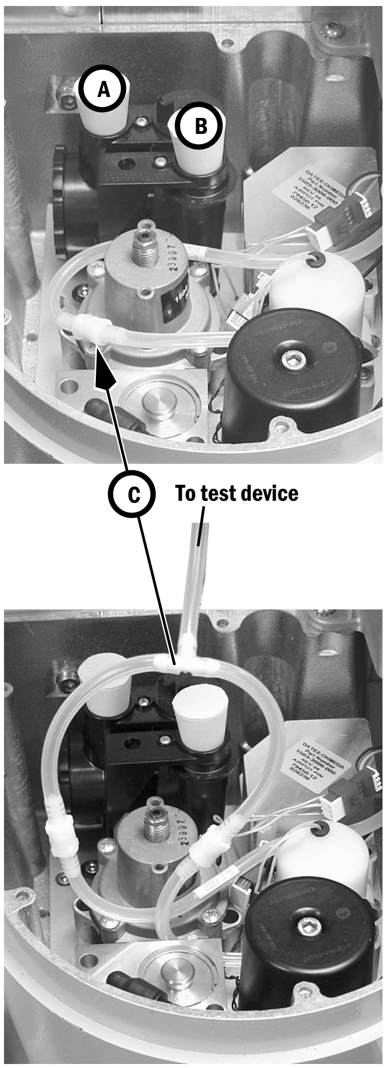
6. Remove the plug and flow orifice previously installed.

Manifold P Span

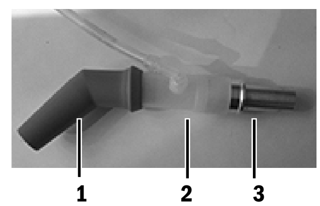
1. Disconnect the PC Service Application from machine or reset all the settings to default.

Calibration setup

2. Plug the Drive Port (**A**) and the Manifold Port (**B**) on the Vent Engine interface valve.
3. Connect the manifold pressure tee adapter (**C**) (refer to TRM Section 10.1.2 for configuration) to the Manifold Pressure Transducer tubing (white inline connectors).
4. Connect a test device capable of measuring 0 to 150 cmH_2O to the open port of the tee adapter. Set measuring device to read cmH_2O.



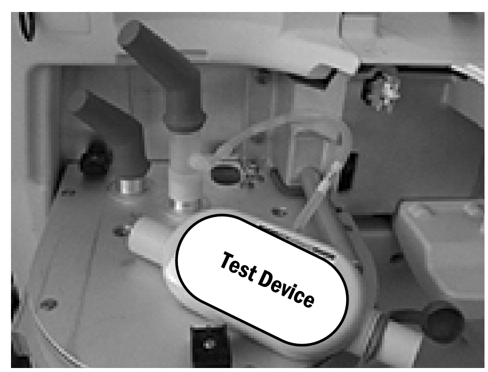
Alternative setup



(1) 1407-8503-000
Plug, BTV 18mm

(2) 1504-3011-000
Airway Pressure Tee

(3) 1504-3016-000
PEEP/Insp Cal Orifice

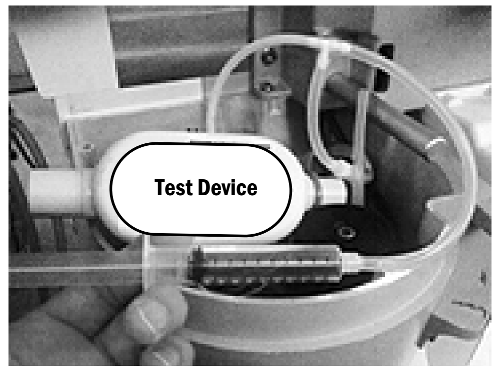


Calibration procedure:

1. In the Calibration menu on the display screen, select "Manifold P Span".
2. Select "Start Manifold P Span".
3. Adjust the Insp Flow Valve (DAC) setting until the manometer reading equals 75 cmH_2O ± 0.5:
   - Start at approximately 750 counts (press the ComWheel to activate).
   - Continue to increment the count until the manometer reading equals 75 cmH_2O ± 0.5.
4. Select "Save Calibration". Verify "Pass" is displayed.
5. Select Previous Menu.
6. Disconnect the manometer from the tee adapter.
7. Remove the tee adapter and reconnect the Manifold Pressure Transducer tubing.

Alternative Calibration Method

1. Tee in a test device capable of measuring 0 to 150 cmH_2O and a syringe to the Manifold Pressure Transducer tubing (white inline connectors).

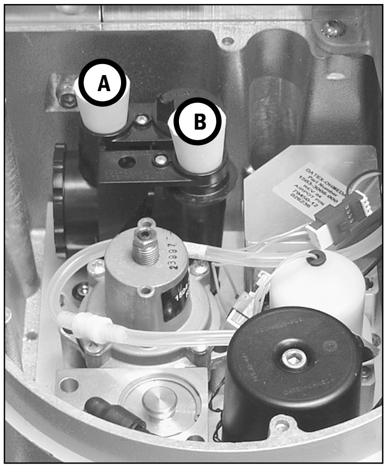


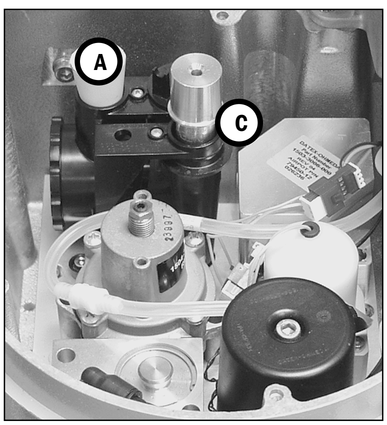
2. Slowly pressurize the Manifold Pressure Transducer until the test device reads
75 cmH_2O ± 0.5.
3. When the pressure on the test stabilizes at 75 cmH_2O, select "Save Calibration". Verify "Pass" is displayed.
4. Select Previous Menu.
5. Disconnect the manometer from the tee adapter.
6. Remove the tee adapter and reconnect the Manifold Pressure Transducer tubing.

Inspiratory Flow Valve Cal

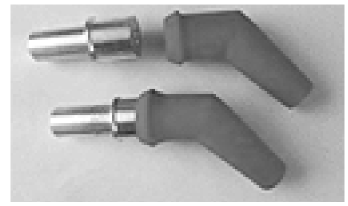
Leave the Drive Port (**A**) and the Manifold Port (**B**) on the interface valve plugged.

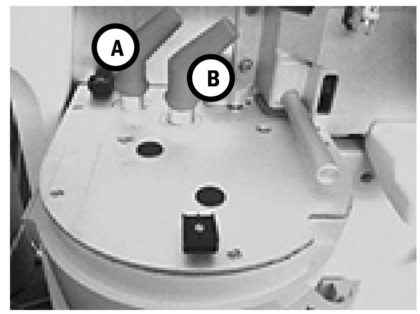
Calibration setup

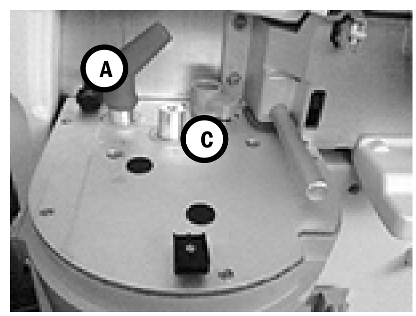




Alternative setup







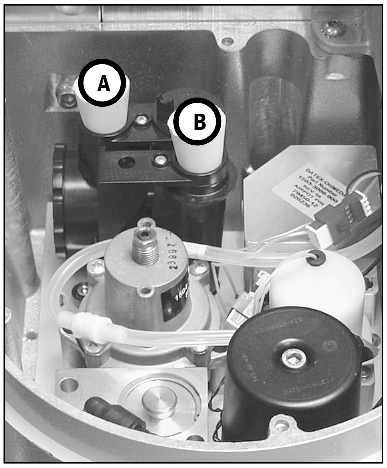
Calibration procedure:

1. On the Calibration menu, select ***Insp Flow Valve***.
2. Select ***Stage 1 calibration***.
   Note that "Status..." is displayed.
3. When Stage 1 passes, remove the plug (or Stopper) from the Manifold port (**B**) and insert the calibrated orifice (**C**).
4. Select ***Continue***.
5. Select ***Start Stage 2***.
   (May take two minutes before you see any effects of the test on the screen.)
6. When Stage 2 is passes, select ***Back***.

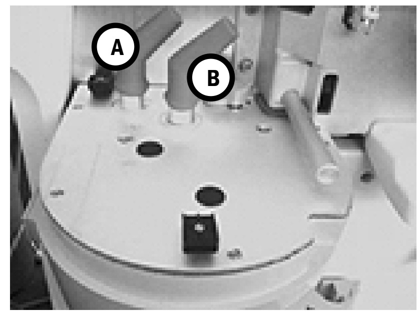
Bleed Resistor Cal

Plug the Drive Port (**A**) and the Manifold Port (**B**) on the interface valve plugged.

Calibration setup



Alternative setup

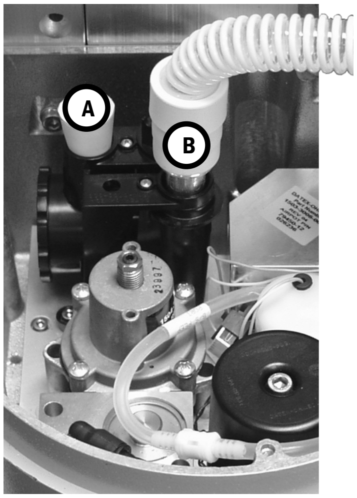


Calibration procedure

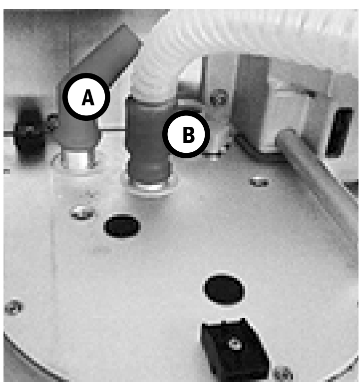
1. On the Calibration menu, select ***Bleed Resistor***.
2. Select "Start".
3. When the test is completed, select ***Continue***.

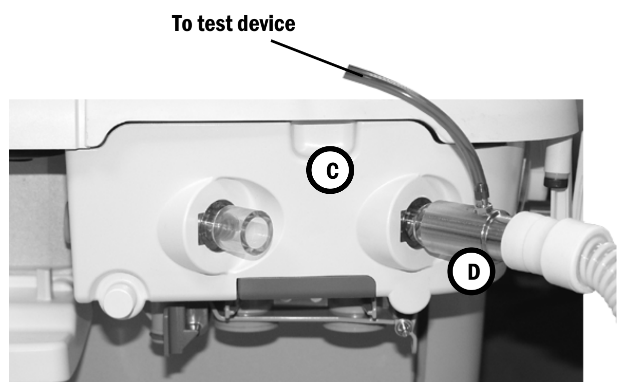
Paw Span

Calibration setup



Alternative setup





1. Leave the Drive port (**A**) port plugged.
2. Remove the plug from the Manifold port.
3. Attach a patient circuit tube to the Calibrated Flow Orifice.
4. Insert the Calibrated Flow Orifice into the Manifold port (**B**).
5. Install only the Circuit module (**C**) on to the machine. Be sure module seats properly.

Note: If the EZchange is not installed make sure the canister is in place.

6. Connect a pressure sensing tee (**D**) to the inspiratory flow patient connection.
7. Connect the open end of the patient circuit tube to the flow port of the pressure sensing tee.
8. Connect a test device capable of measuring 0 to 100 cmH_2O to the pressure sensing port of the tee connector.

Calibration procedure

1. On the Calibration menu, select ***Paw Span***.
2. Select ***Start Paw Span***.
3. Adjust the Insp Flow Valve (DAC) setting until the manometer reading equals 75 ± 0.5 cmH_2O:
   - Start at approximately 700 counts (press the ComWheel to activate).
   - Continue to increment the count until the manometer reading equals 75 ± 0.5 cmH_2O.
4. Select ***Save Calibration*** (verify "Pass" is displayed).
5. Select ***Back***.

Zero Gas Transducers

On the Calibration menu, select ***Zero Gas Transducers***.

Follow the instructions that appear on the screen:

1. Remove all cylinders.
2. Disconnect all pipeline supplies.
3. Select ***Start Transducer Zero***.

Zero the Mixer

Instructions for the Mixer P Zero will appear when the focus is on the individual menu. Follow on-screen instructions to complete each test.

Reconnect gas supply lines after completing the test.

Note: If repeated zero attempts fail, refer to Section 4.8.7.

13.2.9 Display Diagnostics

Instructions for each test/calibration will appear when the focus is on the individual menu. Follow on-screen instructions to complete each test.

- Test LEDs
- Test Speaker
- Test Battery
- Test Hard Keys
- Test LCD
- Calibrate Touch

13.2.10 Vaporizer Tests

Perform the following diagnostics using the PC Service Application.

eVap Test with a Test Cassette inserted

- Follow instruction on screen.

eVap Therapy Cassette Leak Test

1. Connect and establish communication with the PC Service Application.
2. On the **Gas Delivery Schematic**, set the following:
   - Mixer O2 Flow to ***2.0*** l/min.
3. On Vaporizer Schematic, set the following:
   - Inflow valve to ***On***
   - Outflow valve to ***Off***
   - Scavenging to ***Off***
   - Prop Flow Valve DAC Value to ***0***
   - Cassette Power to ***Off***
   - Zero Valves Auto box checked (☑)
4. After the readings stabilize, record the **eVap Inflow** flow value. It should be zero or near zero.
   - Note: Stable readings are defined as either a) not changing or b) shifting up and down through some minimum to maximum range. If shifting up and down, record the maximum inflow value displayed once the displayed flow range is neither increasing nor decreasing significantly. Disregard values during and immediately after flow meter zeroing.
5. Insert cassette under test.
6. Allow the **eVap Inflow** flow reading to stabilize and record flow.
   - Pass/Fail Criteria: Stable flow readings above 10 ml/min indicate a potential leak in the cassette or eVap Connection Valves.
7. Repeat steps 5 through 6 for each non-DES therapy cassette on the machine four to five times with varying insertion forces (gentle, normal, and aggressive).
8. If therapy cassette leak rate is greater than 10 ml/min, insert test cassette and confirm eVap leakage with test cassette is less than 10 ml/min.
   - Replace therapy cassette if therapy leak rate is greater than 10 ml/min and test cassette leak rate is less than 10 ml/min in same eVap unit.
9. Replace any cassette that exhibits leak rates above 10 ml/min.
10. If multiple (therapy and test) cassettes tested on one machine exhibit leaks, replace the Valve Connector Assembly or o-ring on the Valve Connector Assembly in the eVap subassembly.

13.2.11 Mixer tests

Mixer outlet check valve leak test

To test the mixer outlet check valve, you must apply back pressure to the check valve through the mixer outlet tubing and time the leak down rate of the pressure.

1. Tee in a test device capable of reading 200 mmHg and a syringe to the mixer outlet tube.
2. Slowly pressurize the mixer outlet check valve to approximately 200 mmHg.
3. The pressure shown on the test gauge should not decrease by more than 10 mmHg in 30 seconds.

Mixer flow verification

To perform the flow verification test, you must attach a flow measuring test device to the mixer outlet tubing and access the Gas Diagnostics function of the Service Diagnostics application (PC Service App).

1. Connect a test device capable of reading 15 l/min to the mixer outlet tubing.
2. If the system includes an N_2O supply, when flowing N_2O connect a tube from the flow device to a scavenger source. (For most digital test devices, the low flow module or low flow port should be used.)

Note Some flowmeter test devices are not backpressure compensated. Connecting the output of the flowmeter test device to the input of the vaporizer manifold can cause readings outside limits.

3. On the Main Menu of the Service Application, select Gas Delivery Schematic from the Gas Delivery Subsystem tab select the following and verify the readings on the test flowmeter.

	Verify Flowmeter Reading	
Set Flow	**Lower Limit (sl/min)**	**Upper Limit (sl/min)**
100% O_2 at 10 l/min	9.0	11.0
100% Air at 10 l/min	9.0	11.0
100% N_2O at 10 l/min	9.0	11.0
100% N_2O at 0.5 l/min	0.45	0.55
100% Air at 0.5 l/min	0.45	0.55
100% O_2 at 0.5 l/min	0.45	0.55

4. Turn off flows that were required for this test.
5. Keep the Mixer outlet tubing disconnected to perform the next two tests.

13.2.12 Alternate O_2 flowmeter tests

Functional Test

1. Turn the machine to Standby, then to On to obtain the User Screen.
2. Verify the machine is connected to an O_2 pipeline or the O_2 cylinder valve is ON.
3. Rotate the Alt O_2 flow control fully clockwise to minimum flow.
4. Press the Alternate O_2 switch to turn on Alternate O_2 flow.
   The Alt O_2 flowmeter should indicate 0.5 to 0.7 l/min.
5. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
6. Rotate the flow control clockwise to minimum flow.
7. Press the Alternate O_2 switch to turn off Alternate O_2 flow;
   push the ComWheel to confirm yes.

Flow Accuracy Test

To perform the test, you must gain access to the mixer outlet tubing which is connected to the inlet of the electronic vaporizer.

1. To access the electronic vaporizer, refer to Section 9.8
2. Disconnect the mixer outlet tube at the inlet to the electronic vaporizer.
3. Connect a flowmeter capable of reading 0 to 15 l/min to the mixer outlet tubing.
4. Press the Alternate O_2 switch to turn on Alternate O_2 flow.
5. Adjust the flowmeter so the center of the ball aligns with the selected test point (observe that the ball maintains a steady position for 10 seconds).
6. The test device reading should be between the limits shown for each of the selected settings in the table below.

	Flow Tester Reading	
Flowmeter Setting l/min	**Lower Limit l/min**	**Upper Limit l/min**
minimum (valve fully closed)	0.5	0.7
1	0.5	1.5
3	2.5	3.5
5	4.5	5.5
10	9.0	11.0
maximum (valve fully open)	10.0	13.0

7. Rotate the flow control clockwise to minimum flow.
8. Press the Alternate O_2 switch to turn off Alternate O_2 flow;
   push the ComWheel to confirm yes.
9. Remove the test device.
10. Connect the mixer outlet tubing to the electronic vaporizer.

13.2.13 Auxiliary O_2 flowmeter tests

Functional test

1. Verify the O_2 cylinder valve is ON or machine is connected to an O_2 pipeline.
2. Rotate the flow control clockwise (decrease) to shut off the flow. The ball should rest at the bottom of the flow tube and not move.
3. Rotate the flow control counterclockwise (increase). The ball should rise immediately after rotation is begun. It should rise smoothly and steadily with continued counterclockwise rotation. When a desired flow is set, the ball should maintain in a steady position.
4. Rotate the flow control clockwise to shut off the flow.

Flow Accuracy test

1. Connect the flowmeter capable of reading 0 to 15 l/min to outlet to the flow test device.
2. Adjust the flowmeter so the center of the ball aligns with the selected test point (observe that the ball maintains a steady position for 10 seconds).
3. The test device reading should be between the limits shown for each of the selected settings in the table below.

	Flow Tester Reading	
Flowmeter Setting l/min	**Lower Limit l/min**	**Upper Limit l/min**
1	0.5	1.5
3	2.5	3.5
5	4.5	5.5
10	9.0	11.0
maximum (valve fully open)	12.0	-------

4. Rotate the flow control clockwise to shut off the flow.

13.2.14 Integrated Suction Regulator tests (if equipped)

Note

There are two types of integrated suction systems for the Aisys CS2 anesthesia machine:

- Continuous Vacuum Regulator, Three-Mode, Pipeline Vacuum
- Continuous Vacuum Regulator, Three-Mode, Venturi Derived Vacuum

For Pipeline Vacuum systems:

A vacuum source of at least 500 mmHg (67 kPa or 20 in Hg) is required for testing. The supply open flow must be a minimum of 50 l/min.

For Venturi Derived Vacuum systems:

An O_2 or Air source of at least 282 kPa (41 psi) is required for testing.

Gauge Accuracy

To check gauge accuracy, be sure that the test gauge is capable of measuring 0 to 550 mmHg with an accuracy of ±1% of reading.

1. With the suction regulator turned to the Off position, verify the gauge needle is within the zero range bracket.
2. Connect a test device capable of measuring -550 to 0 mmHg to the suction patient port.
3. Turn the mode selector switch to I (ON).
4. Ensure that the vacuum test gauge is in agreement with the suction vacuum gauge ± 38 mmHg/5 kPa at the following test points.

Test points

Suction vacuum gauge	Test gauge tolerance
100 mmHg (13.3 kPa)	62–138 mmHg (8.3–18.4 kPa)
300 mmHg (40 kPa)	262–338 mmHg (35–45 kPa)
500 mmHg (66.7 kPa)	462-538 mmHg (61.6–71.7) kPa)

Flow Test

1. Connect test device capable of measuring 0 to 30 l/min to the patient port of the suction regulator.
2. Rotate the suction control knob fully clockwise (increase).
3. Turn the mode selector switch to I (ON) and verify that the flow rate is:
   - at least 20 l/min.
4. Disconnect the test flowmeter.

Regulation Test

1. Turn the mode selector switch to I (ON).
2. Occlude the patient port of the suction regulator.
3. Set the vacuum regulator gauge to 100 mmHg/13 kPa.
4. Open and close the patient port several times.
5. With the patient port occluded, the gauge should return to 100 mmHg/13 kPa within a tolerance of ± 10 mmHg/1.3 kPa.

Vacuum Bleed Test

1. Occlude the patient port of the suction regulator.
2. Set the vacuum regulator gauge to 100 mmHg/13 kPa.
3. Turn the mode selector switch to O (OFF) and observe the gauge needle. It must return to the zero range bracket or stop pin within 10 seconds.

Vacuum Leak Test

1. Turn the mode selector switch to O (OFF).
2. Rotate the suction control knob a minimum of two full turns in the clockwise direction (increase suction) to ensure its setting is not at the off position.
3. Occlude the patient port of the suction regulator.
4. Observe the suction gauge, the needle should not move.
5. Rotate the suction control knob fully counterclockwise to ensure its setting is at the fully off position.
6. Turn the mode selector switch to I (ON).
7. Observe the suction gauge, the needle should not move.

Assemble and Install the ABS at this time

13.2.15 Flush Flow test

1. With Bag/Vent switch in Bag, verify case has ended.
2. Set the Bag/Vent switch to Vent.
3. Attach a patient circuit and plug the patient port.
4. For ACGO equipped machines, set the ACGO selector switch to Circle.
5. Ensure that the bellows is completely collapsed.
6. Measure the amount of time it takes to fill the bellows when the O_2 Flush button is fully and continuously depressed.
7. Repeat the above measurement two more times (deflate bellows by removing the plug from the patient port).
    - The bellows should fill in 1.8 to 2.3 seconds.

13.2.16 Calibrating the airway module

Calibrate airway modules once every six months or whenever there are indications of errors in the gas readings. Use a manufacturer approved calibration gas and regulator to calibrate the modules. See “Section 10.1.7” for stock numbers of the calibration gas and regulator.

WARNING Only use manufacturer approved calibration gas. Do not use any other calibration gases or the calibration will not succeed. Dispose of calibration gas containers in accordance with local environmental procedures.

Note The ***Calibration*** menu is not available during ***Checkout*** or during a case.

During gas calibration, % units are used for CO2 regardless of selected measuring units.

1. Turn on the power. Let the module warm up for 30 minutes before starting calibration.
2. Attach the regulator to the calibration gas cylinder.
3. Attach a new sampling line to the water trap. Connect the loose end of the sampling line to the regulator on the calibration gas cylinder.
4. Select the ***System Setup*** button.
5. Select ***Calibration***.
6. Select ***Airway Gas***.
7. Wait until ‘Feed Gas’ appears.
8. For regulators with a numbered gauge, open the regulator until the gauge reads between 5 to 7 psi. For regulators with a non-numbered gauge, open the valve.
9. Feed the calibration gas until ‘Adjust’ appears.
    - If an error occurs during calibration or if no gas is fed, ‘Calibration error’ appears. Push the ComWheel to perform a new calibration.
    - Do not close the regulator until all the adjustments have been made.
10. If a gas needs adjustment, select the gas to be adjusted. Use the ComWheel to change the value until it matches the calibration gas cylinder value. Push the ComWheel to confirm the change.
11. If a gas does not need adjustment, select the gas. Push the ComWheel to confirm the value.
12. Close the regulator.

13.2.17 System checkout

Reinstall the tabletop.

Full Test

The Full Test runs automatically and beeps to indicate when it is finished or if user interaction is required.

Note: When instructed to "Calibrate flow sensors" (remove, reinsert, latch), wait for "NO INSP/EXP FLOW SENSOR" message to appear before reattaching the flow sensors.

The ***Full Test*** does a:

- ***Vent and Gas*** check (Ventilator Circuit),
- ***Circuit Leak*** check (Bag Circuit),
- and a ***Circuit O2 Cell*** check (if circuit O_2 cell is present).

1. Select ***Full Test*** and follow the instructions on the screen.
2. If a check fails, follow the instructions to perform a recheck or accept the results.

Low P Leak (machines with SCGO)

The positive pressure Low P Leak check measures machine leaks before the breathing system and between the gas mixer and the common gas outlet. It measures low pressure pneumatic leaks with a pass/fail limit of 50 ml.

1. Occlude the inspiratory (right-hand) port.
2. Select Start.
3. The display shows the checks being run.
4. Open the inspiratory port and reconnect the breathing circuit.
5. Select another check or select Start Case to go to the Start Case menu.

Low P Leak (machines with ACGO)

The negative low P leak check measures machine leaks before the breathing system and between the gas mixer and the common gas outlet.

1. Make sure the ACGO switch is set to ACGO.
2. Attach the squeeze bulb to the ACGO outlet.
3. Squeeze (collapse) the bulb.
4. If the bulb fully inflates in < 30 seconds, select Fail.
5. If the bulb remains collapsed, select Pass.
6. Remove the squeeze bulb from the ACGO outlet.

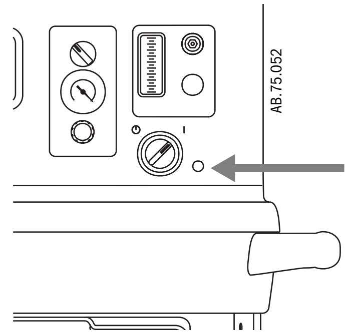
13.2.18 Alarm tests

> **NOTE**: If an Airway Module is installed, ***FiO2*** readings are taken from the module instead of the O_2 sensor in the breathing circuit. When using an Airway Module, a sample line must be connected to the patient circuit for testing the O_2 alarms.

1. Connect a test lung to the patient connection.
2. Start a case.
3. Set the Bag/Vent switch to Vent.
4. Set the O_2 concentration to 30%, and allow the O_2 reading to stabilize.
    - For machines configured to individual gas control, set O_2 flow to approximately 500 ml/min and Air flow to approximately 5 l/min.
5. Test the O_2 alarms:
    - Set the ***FiO2 low*** alarm limit to 50%. Make sure an ***FiO2 low*** alarm occurs.
    - Set the ***FiO2 low*** alarm limit to 21% and make sure that the ***FiO2 low*** alarm cancels.
    - Set the ***FiO2 high*** alarm limit to 50%.
    - Push the O_2 flush button.
    - Make sure the ***FiO2 high*** alarm occurs.
    - Set the ***FiO2 high*** alarm limit to 100%. Make sure that the ***FiO2 high*** alarm cancels.
6. Test the ***MVexp low*** alarm:
    - Go to the ***Alarm Setup*** menu.
    - Set the ***MV low*** alarm limit to greater than the measured minute volume.
    - Make sure that a ***MVexp low*** alarm occurs.
    - Set the ***MV low*** alarm limit to off.
7. Test the ***Ppeak high*** alarm:
    - Set the ***Pmax*** to less than the peak airway pressure.
    - Make sure that the ***Ppeak high*** alarm occurs.
    - Set the ***Pmax*** to the desired level.
8. Test the ***PEEP high. Blockage?*** alarm:
    - Close the APL valve.
    - Set the Bag/Vent switch to Bag. Mechanical ventilation stops.
    - Block the patient connection and push the O_2 flush button.
    - Make sure that the ***PEEP high. Blockage?*** alarm occurs after approximately 15 seconds.
9. Test the ***Ppeak low. Leak?*** alarms:
    - Unblock the patient connection.
    - Set the Bag/Vent switch to Vent.
    - Set the tidal volume and total flow to minimum.
    - Other alarms such as ***MVexp low*** can occur.
    - Make sure that the ***Ppeak low. Leak?*** alarms occur.
10. Set all alarm limits to approved clinical values (normally, user's last settings).

13.2.19 Power failure test

1. Connect the power cord to a wall outlet. The mains indicator on the front panel comes on when AC Power is connected.



2. Set the system switch to On and Start a case.
3. Unplug the power cord with the system turned on.
4. Make sure that the power failure alarm comes on.
5. Make sure the following message is displayed:
   - Plug in power cable. On battery
6. Connect the power cable again.
7. Make sure the alarm cancels.

13.2.20 Electrical Safety Checks

Note Perform electrical Safety Tests every time the cover to a machine is removed.

Note If tests are conducted with power from an isolated electrical power system, conduct the tests as detailed below. Do not use an electrical jumper plug to defeat the isolation of the power system.

Preparation

1. Turn the System Master Switch to the STANDBY position.
2. Disconnect all pipeline hoses from the medical gas outlets.
3. Disconnect all electrical monitors and accessories from the unit under test.
4. Plug the unit under test into the safety analyzer. Plug the analyzer into an AC wall outlet.
5. Set the safety analyzer to measure line voltage. Verify normal polarity is indicated.
6. Connect the grounding clip assembly to the safety analyzer.

Ground Resistance Check

1. Use the electrical safety analyzer to measure the resistance between the ground pin on the line cord plug and any pipeline inlet.
2. The ground resistance must be equal to or less than 0.20 ohms.

Chassis Leakage Current

1. Connect an approved test device (for example; UL, CSA, or AAMI) and verify that the leakage current is less than:

Voltage	Max. Leakage Current
120/100 Vac	300 μAmps
220/240 Vac	500 μAmps

Additional Electrical Test Steps

1. Turn the System Master Switch to the STANDBY position.
2. Remove the electrical safety analyzer.

13.2.21 Final Machine Checks

1. Disconnect all test devices and reconnect pipeline hoses, monitors and accessories.
2. Verify correct operation of the light bar and/or gooseneck light (if equipped).
3. Ensure the following:
   - The APL valve is open (minimum setting, fully counterclockwise).
   - All panels and tray tops are attached.
   - The pipeline hoses are connected.
   - All cylinder supply readings are at zero.
   - All units are plugged into an appropriate power source.
4. Place the appropriate labels on the machine advising that routine service has taken place and that the controls have been adjusted.

Notes

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