Service Manual

A7™

Anesthesia System

mindray

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Foreword

This Service Manual is intended as a guide for technically qualified personnel performing repair and calibration procedures.

Warnings, Cautions, and Notes

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

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

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

A NOTE is provided when additional general information is applicable.

Warnings

WARNING: Whenever using anesthetic gases, nitrous oxide, oxygen, or any hospital gas, always follow the appropriate agent evacuation/ collection procedures. Use the hospital gas evacuation system.

WARNING: Use only an approved lubricant on any O-ring in contact with oxygen. Krytox® is the recommended oxygen service lubricant.

WARNING: For continued protection against fire hazard, replace all fuses with the specified type and rating.

WARNING: In order to prevent an electric shock, the machine (protection class I) may only be connected to a correctly grounded mains connection (socket outlet with grounding contact).

WARNING: Remove all accessory equipment from the shelf before moving the anesthesia machine over bumps or on any inclined surface. Heavy top loading can cause the machine to tip over causing injury.

WARNING: Possible explosion hazard. Do not operate machine near flammable anesthetic agents or other flammable substances. Do not use flammable anesthetic agents (e.g., ether or cyclopropane.)

WARNING: The use of anti-static or electrically conductive respiration tubes, when utilizing high frequency electric surgery equipment, may cause burns and is therefore not recommended in any application of this machine.

WARNING: Possible electric shock hazard. The machine may only be opened by authorized service personnel.

WARNING: **Compressed gasses are considered Dangerous Goods/Hazardous Materials per I.A.T.A (International Air Transport Association). and D.O.T. (Department Of Transport) regulations. It is a violation of federal and international law to transport dangerous goods without the packages being appropriately identified, packed, marked, classified, labeled and documented according to D.O.T. and I.A.T.A. regulations. Please refer to the applicable I.A.T.A. Dangerous Goods Regulations and /or the Code of Federal Regulations 49 (Transportation, Parts 171-180) for further information.**

WARNING: **Avoid exposure to respiratory gases by always directing the fresh gas flow from the fresh gas outlet to the waste gas scavenger.**

WARNING: **When using the AG module to perform AG measurements on the patients who are receiving or have recently received anesthetic agents,connect the outlet to the waste gas disposal system to prevent the medical staff from breathing in the anesthetic agents.**

WARNING: **Remove the airway sampling line from the patient's airway and seal the sample port while nebulized medications are being delivered.Nebulized medications interfere with accuracy gas reading.**

WARNING: **Before connecting the exhaust line to the sample gas outlet on the compact airway module,ensure the other end is connected to the sample gas return port on the anesthesia machine.Incorrect connections may cause patient injury.**

WARNING: **Perform factory calibration in the working environment after completion of anesthesia machine assembling.Contact us if factory calibration is required during system use.**

WARNING: **Do not perform testing or maintenance on A7 anesthesia machine while it is being used on a patient.Possible injury can result.**

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

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

Cautions

CAUTION: **This device uses high pressure compressed gas. When attaching or disconnecting backup gas cylinders, always turn the cylinder valves slowly. Use the A7 flow meters to bleed down the pressure, watching the cylinder gauge indicate the depleting cylinder pressure, before disconnecting the cylinder from the yoke. Always open and close cylinder valves fully.**

CAUTION: **This device operates using compressed gas at high pressures from the hospital central supply. When connecting gas supply lines attach the hose connection to the machine before connecting the quick disconnect fitting to the hospital source. Disconnect the supply hose from the hospital source connection prior to disconnecting it from the A7 gas connection fittings.**

CAUTION: **Refer to section 3.3 Periodical Maintenance Schedule for assistance when performing scheduled periodic maintenance.**

CAUTION: **Do not leave gas cylinder valves open if the pipeline supply is in use and the system master switch is turned to 'ON'. If used simultaneously, cylinder supplies could be depleted, leaving an insufficient reserve supply in the event of pipeline failure.**

CAUTION: **Use cleaning agent sparingly. Excess fluid could enter the machine, causing damage.**

CAUTION: **This machine must only be operated by trained, skilled medical staff.**

CAUTION: **Perform the electrical safety inspection as the last step after completing a repair or after routine maintenance. Perform this inspection with all covers, panels, and screws installed.**

CAUTION: **After changing the CO2 absorbent, carry out a vaporizer and system leak test.**

CAUTION: **Only Selectatec™ compatible vaporizers with Interlock-System may be used with the A7 unit.**

CAUTION: **After each exchange of a vaporizer, carry out a system Leak test.**

CAUTION: **Do not clean the machine while it is on and/or plugged in.**

CAUTION: **Pressing "cancel" at any time during the procedure will cancel the session's settings and reload the previously-stored calibration coefficients.**

CAUTION: **Depleted sodalime changes color. Replace the sodalime if approximately 2/3 of the absorber content is discolored. CO2 absorbent can be safely changed without stopping mechanical ventilation.**

CAUTION: **This equipment contains parts sensitive to damage by electrostatic discharge (ESD). Use ESD precautionary procedures when touching, removing, or inserting parts or assemblies.**

CAUTION: **The watertrap collects water drops condensed in the sampling tube and therefore prevents them from entering the AG module.If the collected water reaches a certain amount, you should drain it to avoid airway blockage.**

CAUTION: **The watertrap has a filter preventing bacterium,vapor and patient secretions from entering the module.After a long-term use,dust or other subtances may compromise the performance of the filter or even block the airway.In the case, replace the watertrap.Replacing the watertrap once a month is recommended.**

CAUTION: **Strong scavenging suction on the AG monitor exhaust port nay change the operating presure of the monitor and cause inaccurate readings or internal damage.**

Notes

NOTE: **Unauthorized servicing may void the remainder of the warranty. Check with the factory or with a local authorized distributor to determine the warranty status of a particular instrument.**

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1.0 Theory of Operation

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1.1 Introduction

The A7 Anesthesia System is a simple and convenient anesthetic gas delivery system that produces anesthesia gas and controls delivery of anesthesia gas by using a configured vaporizer. It supports automatic and manual ventilation. It can also monitor various parameters of patients, such as the airway pressure, inspired tidal volume and expired tidal volume.

The A7 fresh gas electronic flow metering system inherits the features of a traditional anesthesia system and moreover is enhanced in ease of use. The dual-tube electronic flow meter displays more precise readouts. A knob guard prevents inadvertent movement of the flow control knobs. Gas supply gauges indicate the pipeline and cylinder gas supply pressures in real time. An auxiliary O2 flow meter is placed on the upper left to make it convenient to read the O2 flow rate. The O2 flush button is in the traditional position near the front left corner of the table top.

Safety systems within the A7 work to prevent hypoxic mixtures from being delivered to the patient. Nitrous oxide will not be delivered unless oxygen pressure is present.

The heating system of the A7 patient breathing circuit minimizes condensed water and sends warm and humidified gas back to the patient. The pressure gauge, APL valve and manual breathing bag of the patient breathing circuit support fast plug and unplug to facilitate their installation and maintenance. The APL valve has a rotary knob that provides a clear view of the manual breathing pressure setting. The sodalime absorber canister can be opened and closed quickly through a handle. It can absorb sodalime in standard Pre-paks or loose-fill sodalime. A drainage valve is configured for the sodalime absorber canister.

Two flow sensors are configured on the patient breathing circuit to monitor the flow of inspired and expired gases and monitor the airway pressure. The operator can rotate and fix the patient breathing circuit as required. In addition, the patient breathing circuit is equipped with a side plug for gas leakage detection. The Anesthesia Gas Scavenging System (AGSS) connectors are at the rear of the A7.

When the A7 uses AC power supply, the A7 power management system supplies power for its main system while charging its internal battery. In case of an AC power failure, the A7 operates on battery power, two new batteries supporting normal running in a minimum of 90 minutes. The main system switch can power on and off the system. The four auxiliary AC sockets on the A7 at the rear of the machine operate independent of the main system switch.

NOTE: The warmer for the patient breathing circuit system does not operate when the A7 is working on battery power.

NOTE: If the main switch is set to OFF, the O2 supply is turned off.

1.2 Electrical and Pneumatic Connections

1.2.1 Electrical Connections

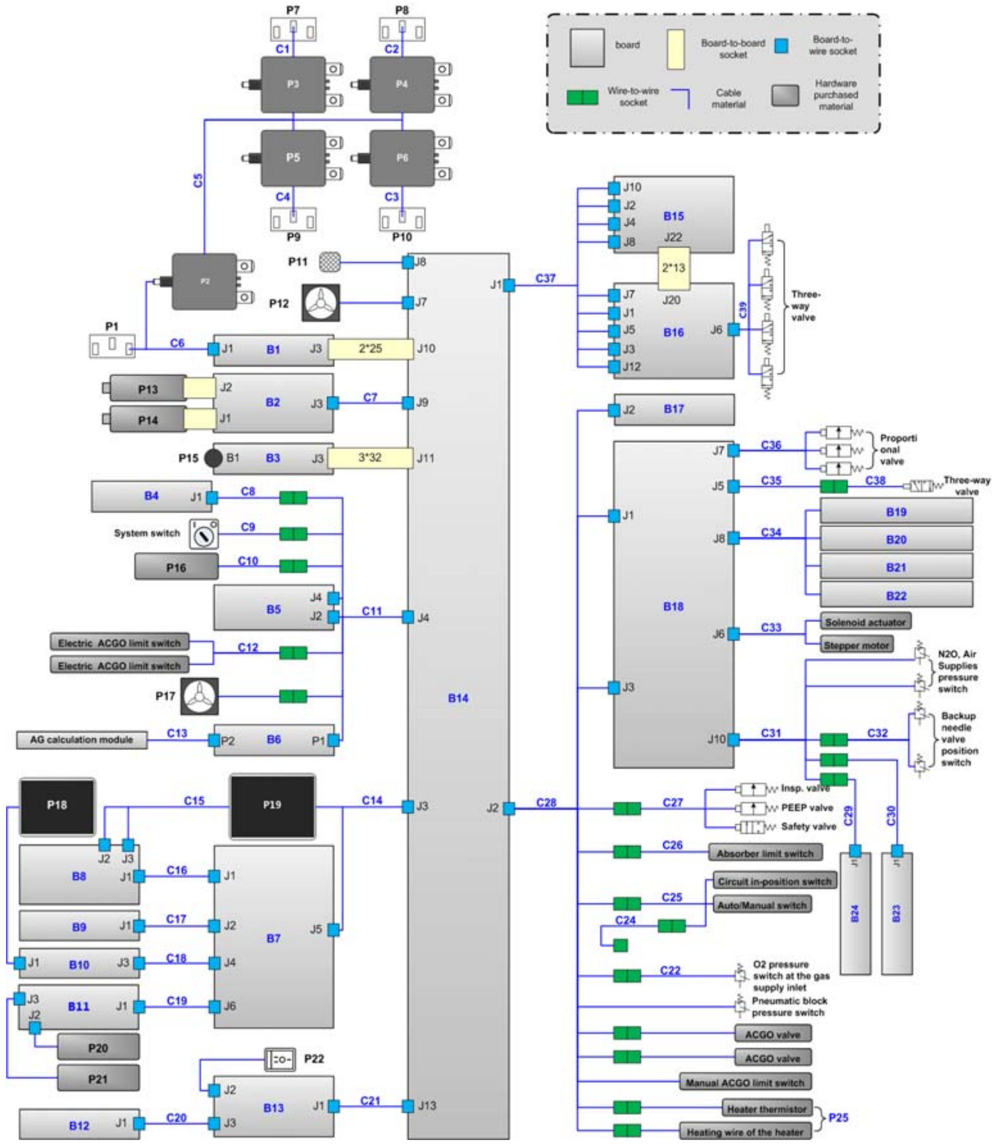


FIGURE 1-1

No.	Description	P/N
B1	Power Board (A7)	115-018145-00
B2	Battery Interface Board	801-0631-00109-00
B3	CPU Board	115-040636-00 (EPSON) 115-052903-00 (DSP) 115-056939-00 (EPSON, New) 115-056942-00 (DSP, New)
B4	IndicatorLight Board	051-001257-00
B5	Infrared Communication Board	801-0621-00165-00
B6	Anesthesia Signal Interface Board	801-0613-00033-00
B7	Display Interface Board	051-001258-00
B8	Backlight Inverter Board	051-001519-00 (old) 051-002583-00 (new)
B9	Warning Light Board	801-0631-00019-00
B10	Touchscreen Control Board	801-0631-00018-00
B11	Encoder Board	051-001260-00
B12	Flow Meter Lighting Board	Part of 115-018165-00(FDA) Part of 115-018166-00(Canadian)
B13	Top Lighting Board	801-0631-00039-00
B14	Mother Board	051-001259-00 051-002950-00 (VGA)
B15-16	Ventilator Control Board	801-0631-00027-00 (EPSON) 115-058771-00 (DSP)
B17	Sensor Interface Board	801-0631-00089-00 (EPSON)
B18	Electronic Flow Control System (EFCS) Control Board	115-018150-00
B19	Air Flow Sensor Interface Board	051-002721-00
B20	Nitrous Oxide Flow Sensor Interface Board	051-002721-00
B21-22	O2 Flow Sensor Interface Board	051-002721-00
B23	Total Flow Meter Backlight Board	Part of 115-014479-00
B24	BFCS Position Board	051-001286-01
P1	Filter Power 250VAC 15A Panel Mount	801-0631-00029-00
P2	Breaker(10.0A)	801-0631-00030-00
P3-6	Breaker(3.0A)	801-0631-00031-00
P7-10	Auxiliary Output Socket	801-0631-00032-00
P11	Speaker and Connecting cable	801-0631-00038-00
P12	Hardware Box Fan	801-0631-00028-00
P13-14	Lithium-ion Battery	115-018012-00
P15	Button Cell	M05-010R03---
P16	Touchpad	801-0631-00052-00
P17	Gas Bench Fan	024-000407-00

No.	Description	P/N
P18	Touch Screen	801-0631-00014-00
P19	LCD	115-039181-00
P20-21	Rotary Encoder	010-000150-00
P22	Cable, Lighting Switch	009-000981-00
P23	Circuit Heater	115-034450-00
C1-4	Cable, Power, AC Internal	009-000985-01
C5	Cable, Auxiliary Outlet	009-000984-00
C6	Cable, AC power	009-000983-00
C8	Cable, Indicator	009-000977-00
C9	Cable, System Switch	009-001776-00
C10	Cable, Touchpad	009-000972-00
C11	Cable, Patient Monitor	009-002927-00
C12	Cable, ACGO Valve Status	009-002940-00
C13	Cable, Internal AG Module	009-003131-00
C14	Cable, Display	009-000973-00
C15	0631 inverter control high-voltage lines (old) 0632 screen backlight output cable (new)	009-000974-00 (old) 009-006731-00 (new)
C16	0631 inverter cable B (old) 0635 screen LED backlight input cable (new)	009-000988-00 (old) 009-006382-00 (new)
C17	Cable, Alarm	009-000976-00
C18	Cable, Touch Screen	009-000978-00
C19	Cable, Encoder Board	009-002932-00
C20	Cable, Display Lighting	009-000986-00
C21	Cable, Top Lighting A	009-000982-00
C22	Cable, O2 Pressure Switch	0621-20-69588
C24	2-pin O2 Sensor Pedestal	801-0631-00067-00
C25	Cable, Circuit Switch	0621-20-78593
C26	Cable, Sodalime Canister Switch Cable	009-000987-00
C28	Cable, Breathing System	009-002928-00
C29	Cable, BFCS Position Switch	009-002930-00
C30	Cable, Total Flowmeter Backlight	009-002931-00
C31	Cable, Flowmeter Switch Signal	009-002929-00
C32	Cable, Backup Needle Valve Switch(without N2O)	009-005146-00
C34	Cable, Flow Sensor	009-002481-01
C35	Cable, Flowmeter 3 way Valve B	009-002937-00
C37	Cable, Ventilator	009-000979-00
C39	Cable, Three Way Valve(ACGO)	009-002592-00

1.2.2 Pneumatic Connections (A7)

NOTE: The green tube in the tube diagram needs to paste the oxygen label.

NOTE: The orange tube in the tube diagram needs to paste the air label.

NOTE: The blue tube in the tube diagram needs to paste the N2O label.

NOTE: The black tube in the tube diagram needs to paste the neutral label.

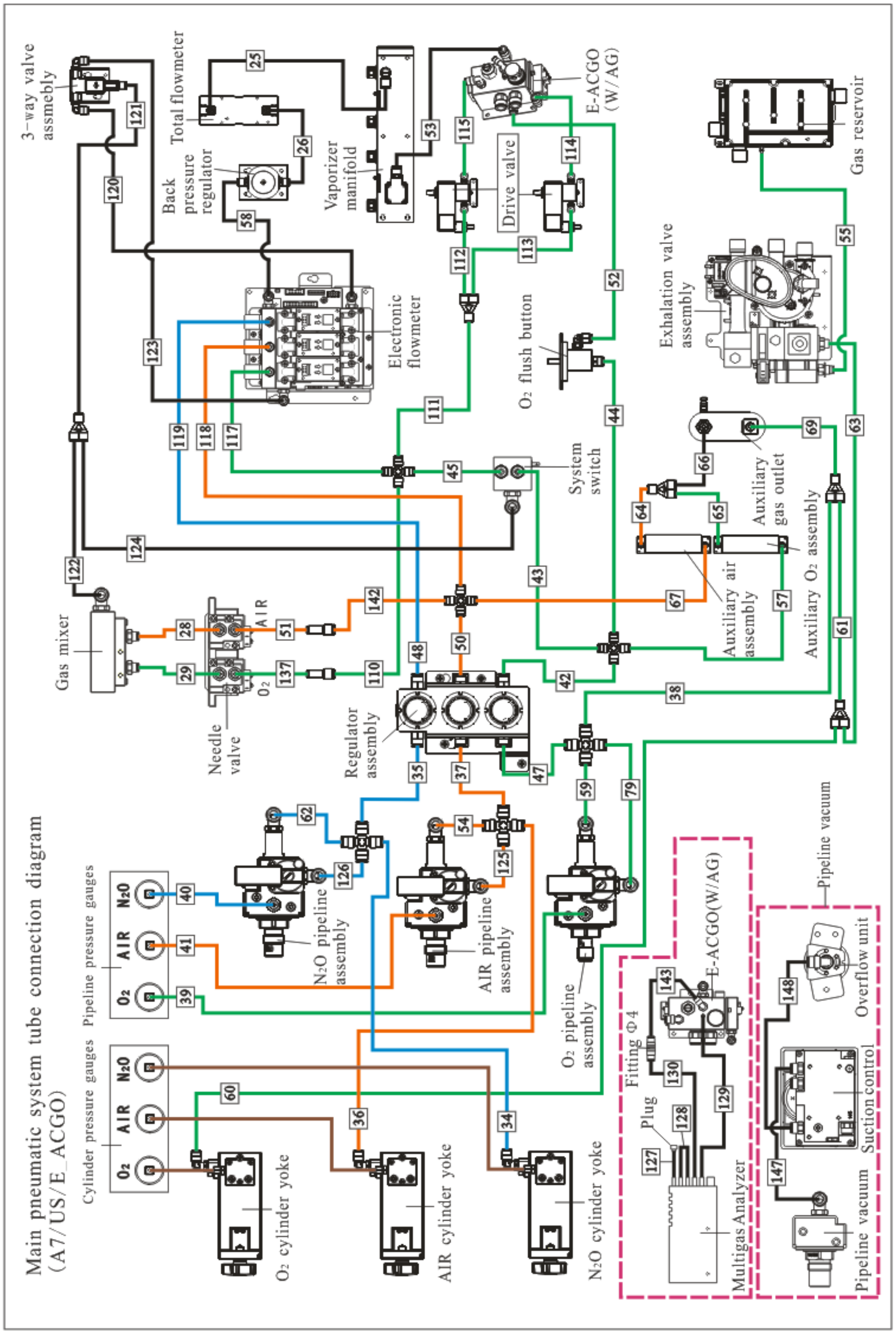


FIGURE 1-2 EPSON Platform

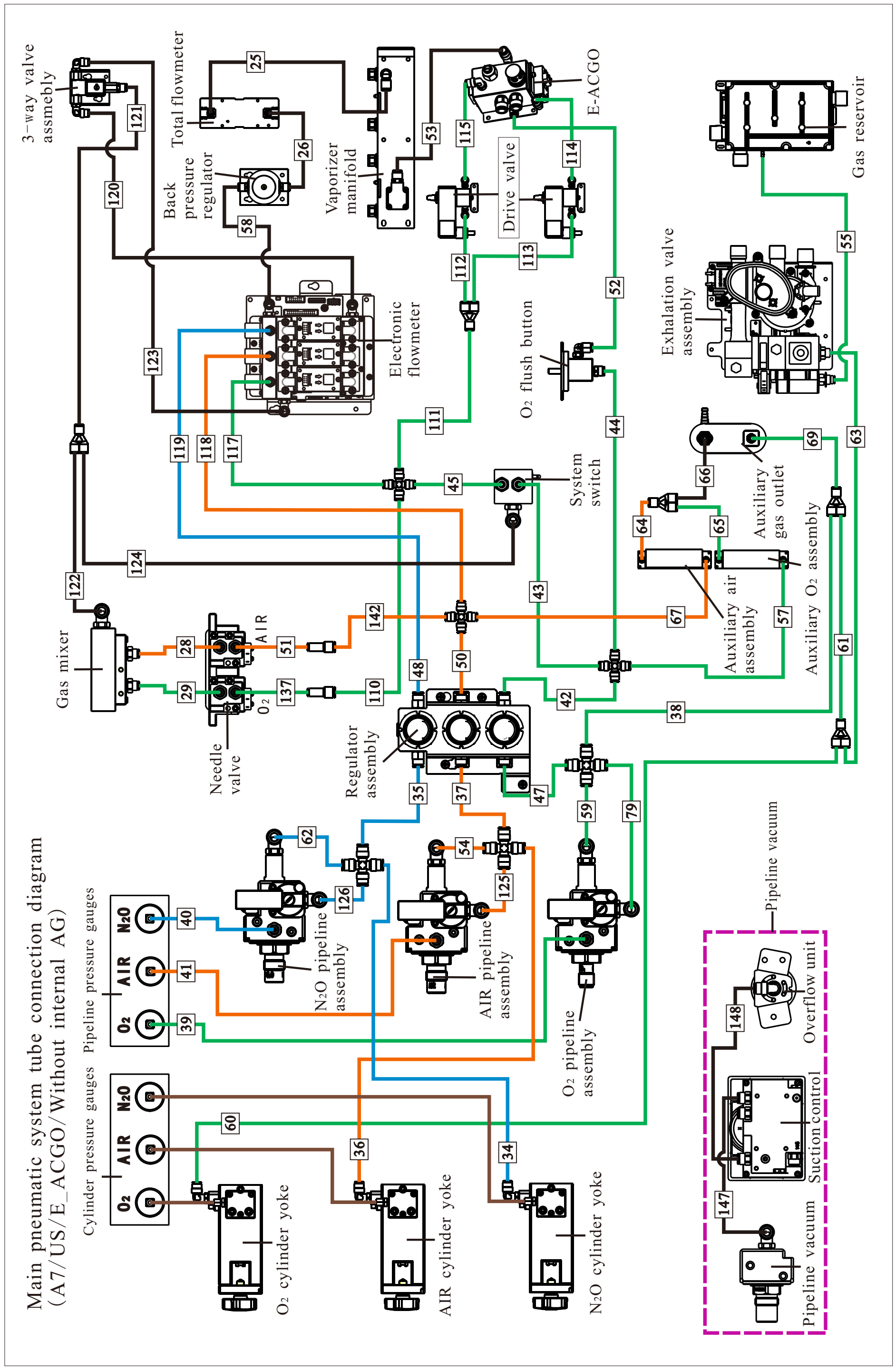


FIGURE 1-3 DSP Platform

S/N	From	To	P/N
25	Total Flow Meter	Vaporizer Manifold	M6G-020045---
26	Back Pressure Regulator	Total Flow Meter	M6G-020045---
28	AIR Needle Valve	Gas Mixer	082-000518-00
29	O2 Needle Valve	Gas Mixer	082-000523-00
34	N2O Cylinder Yoke	Y4	M6G-020045---
35	Y4	N2O Regulator	M6G-020045---
36	Air Cylinder Yoke	Y1 or Y4	M6G-020045---
37	Y4	Air Regulator	M6G-020045---
38	Y4	Y1	M6G-020045---
39	O2 Pipeline Pressure Gauge	O2 Pipeline Assembly	082-000523-00
40	N2O Pipeline Pressure Gauge	N2O Pipeline Assembly	082-000516-00
41	Air Pipeline Pressure Gauge	AIR Pipeline Assembly	082-000518-00
42	O2 Regulator	Y5	082-000522-00
43	Y5	System Switch	082-000522-00
44	Y5	O2 Flush Button	082-000522-00
45	System Switch	Y5	082-000522-00
47	Y4	O2 Regulator	M6G-020045---
50	Air Regulator	Y5	082-000520-00
51	Y6	Air Needle Valve	082-000518-00
52	O2 Flush Button	ACGO Assembly(Electric)	082-000522-00
53	Vaporizer Manifold	ACGO Assembly(Electric)	M6G-020045---
54	Y4	Air Pipeline Assembly	M6G-020045---
55	Exhalation Valve Assembly	Gas Reservoir	082-000522-00
57	Y5	Auxiliary O2 Assembly	082-000522-00
58	Electronic Flowmeter	Back Pressure Regulator	M6G-020045---
59	Y4	O2 Pipeline Assembly	M6G-020045---
60	O2 Cylinder Yoke	Y1	M6G-020045---
61	Y1	Y1	M6G-020045---
62	Y4	N2O Pipeline Assembly	M6G-020045---
63	Y1	Exhalation Valve Assembly	M6G-020045---
64	Auxiliary Air Assembly	Y2	082-000520-00
65	Auxiliary O2 Assembly	Y2	082-000522-00
66	Y2	Auxiliary Gas Outlet	M6G-020026---
67	Y5	Auxiliary Air Assembly	082-000520-00
69	Y1	Auxiliary Gas Outlet	M6G-020045---
79	Y4	O2 Pipeline Assembly	M6G-020045---
110	Y5	Y6	082-000522-00
111	Y5	Y2	082-000522-00
112	Y2	Drive Valve(UP)	082-000522-00
113	Y2	Drive Valve(DOWN)	082-000522-00
114	Drive Valve(DOWN)	ACGO Assembly(Electric)	082-000522-00
115	Drive Valve(UP)	ACGO Assembly(Electric)	082-000522-00

S/N	From	To	P/N
117	Y5	Electronic Flowmeter	082-000522-00
118	Y5	Electronic Flowmeter	082-000520-00
119	N2O Regulator	Electronic Flowmeter	082-000516-00
120	Electronic Flowmeter	3-way Valve Assembly	M6G-020045---
121	Y1	3-way Valve Assembly	M6G-020045---
122	Gas Mixer	Y1	M6G-020045---
123	3-way Valve Assembly	Electronic Flowmeter	M6G-020045---
124	Y1	System Switch	M6G-020045---
125	Y4	AIR Pipeline Assembly	M6G-020045---
126	Y4	N2O Pipeline Assembly	M6G-020045---
127	Multigas Analyzer	Plug	9200-10-10556
128	Multigas Analyzer	Multigas Analyzer	9200-10-10556
129	Multigas Analyzer	Gas-out Connector of ACGO Connector	9200-10-10557
130	Fitting Φ4	Multigas Analyzer	115-059063-00
137	Y6	O2 Needle Valve	082-000523-00
142	Y5	Y6	082-000520-00
143	Gas-out Connector of ACGO Connector	Fitting Φ4	082-002600-00
147	Pipeline Vacuum	Suction Control	M6G-020045---
148	Suction Control	Over flow Unit	M6G-020045---
Y1	Three-way Connector 8	\	082-000583-00
Y2	Three-way Connector 6	\	082-000582-00
Y4	Four-way Connector 8	\	082-001197-00
Y5	Four-way Connector 6	\	082-001201-00
Y6	Two-way Connector 6 to 4	\	082-001285-00

1.2.3 Connections Between Pneumatic Circuit, Breathing System and Ventilator Control Board

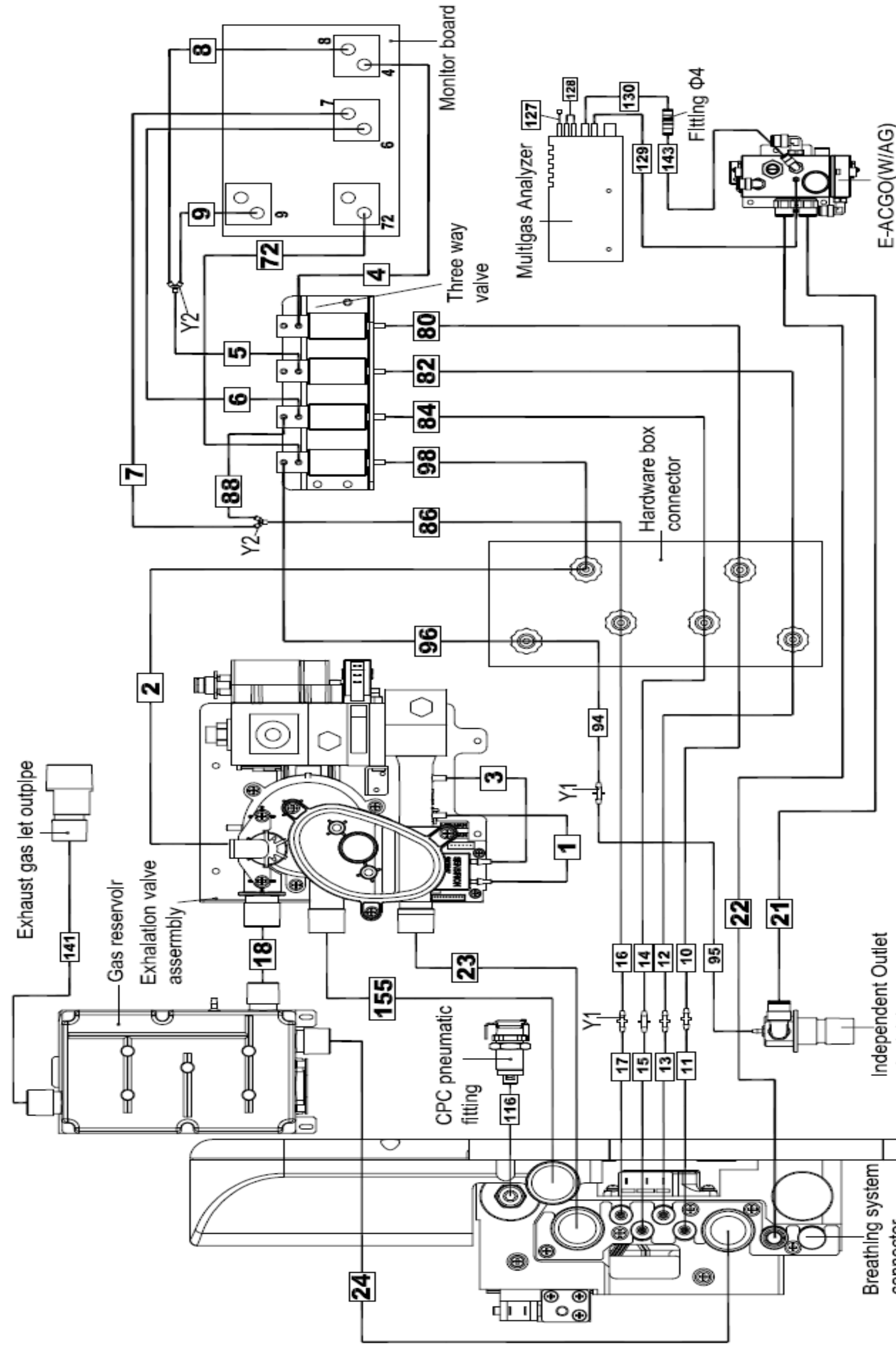


FIGURE 1-4 EPSON Platform

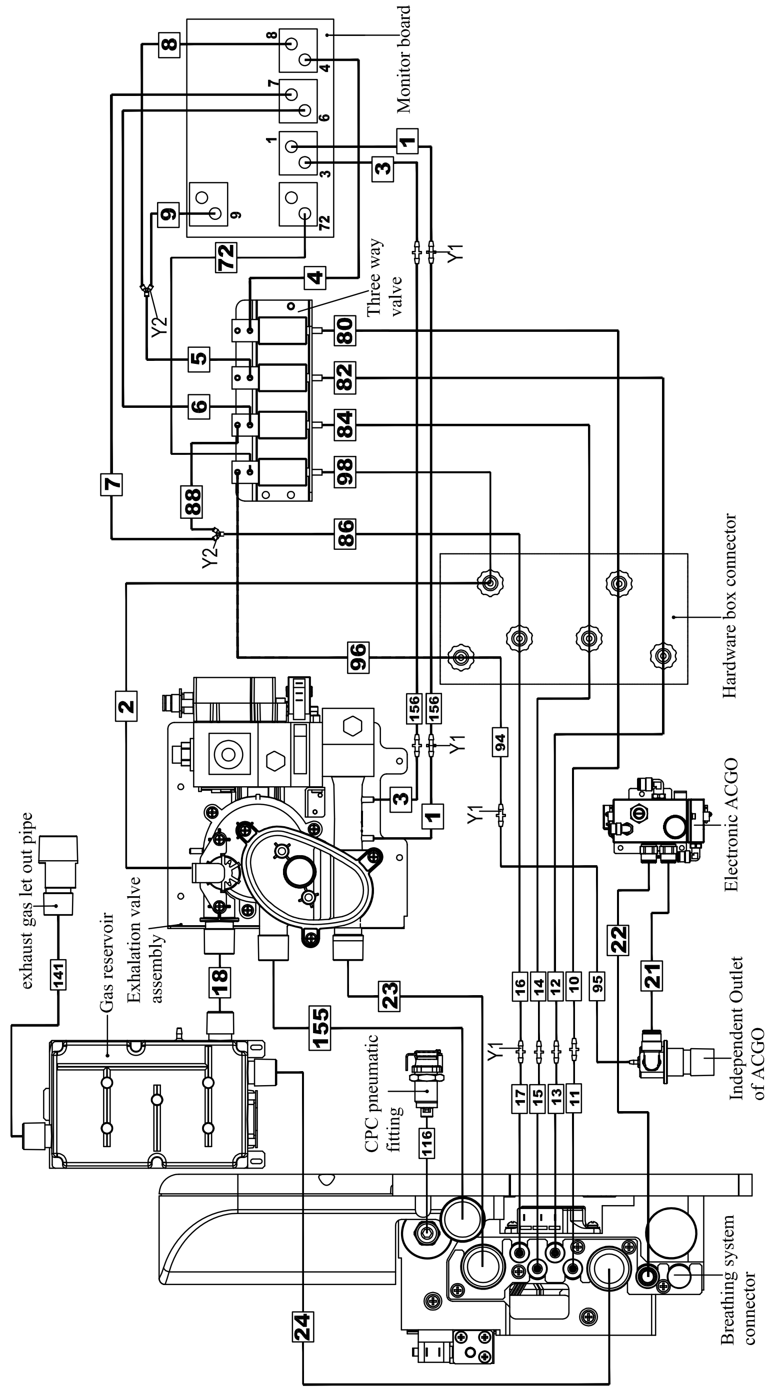


FIGURE 1-5 DSP Platform

S/N	From	To	P/N
1	Exhalation Gas Assembly	Flow Sensor connector	A21-000007---
2	Exhalation Gas Assembly	Hardware Box Connector	A21-000007---
3	Exhalation Gas Assembly	Flow sensor connector	A21-000007---
4	Three-way Valve	Ventilator Control Board	A21-000007---
5	Three-way Valve	Y2	A21-000007---
6	Three-way Valve	Ventilator Control Board	A21-000007---
7	Three-way Valve	Y2	A21-000007---
8	Y2	Ventilator Control Board	A21-000007---
9	Y2	Ventilator Control Board	A21-000007---
10	Hardware Box Connector	Y1	A21-000007---
11	Y1	Breathing System Connector	M6G-020046---
12	Hardware Box Connector	Y1	A21-000007---
13	Y1	Breathing System Connector	M6G-020046---
14	Hardware Box Connector	Y1	A21-000007---
15	Y1	Breathing System Connector	M6G-020046---
16	Hardware Box Connector	Y1	A21-000007---
17	Y1	Breathing System Connector	M6G-020046---
18	Exhalation Gas Assembly	Gas Reservoir	082-002365-00
21	Gas-out Connector of ACGO Connector	Independent Outlet of ACGO	082-000519-00
22	Gas-out Connector of ACGO Connector	Fresh Gas	082-000519-00
23	Breathing System Connector	Exhalation Gas Assembly	115-037606-00
24	Breathing System Connector	Gas Reservoir	115-034449-00
72	Hardware Box Connector	Ventilator Control Board	A21-000007---
80	Hardware Box Connector	Ventilator Control Board	A21-000007---
82	Hardware Box Connector	Ventilator Control Board	A21-000007---
84	Hardware Box Connector	Ventilator Control Board	A21-000007---
86	Hardware Box Connector	Y2	A21-000007---
88	Y2	Three-way Valve	A21-000007---
94	Y1	Hardware Box Connector	A21-000007---
95	Independent Outlet of ACGO	Y1	M6G-020046---
96	Hardware Box Connector	Three-way Valve	A21-000007---
98	Hardware Box Connector	Three-way Valve	A21-000007---
116	CPC Connector	Breathing System Connector	M6G-020026---
141	Gas Reservoir	Exhaust Gas Letout Pipe	082-002365−00
155	Breathing System Connector	Exhalation Gas Assembly	115-037605-00
Y1	Two-way Connector	\	M02A-10-25945
Y2	Three-way Connector	\	M90-100030---
156	Y1	Y1	M6G-020046---

1.3 Gas Flow

1.3.1 Pneumatic Circuit Diagram

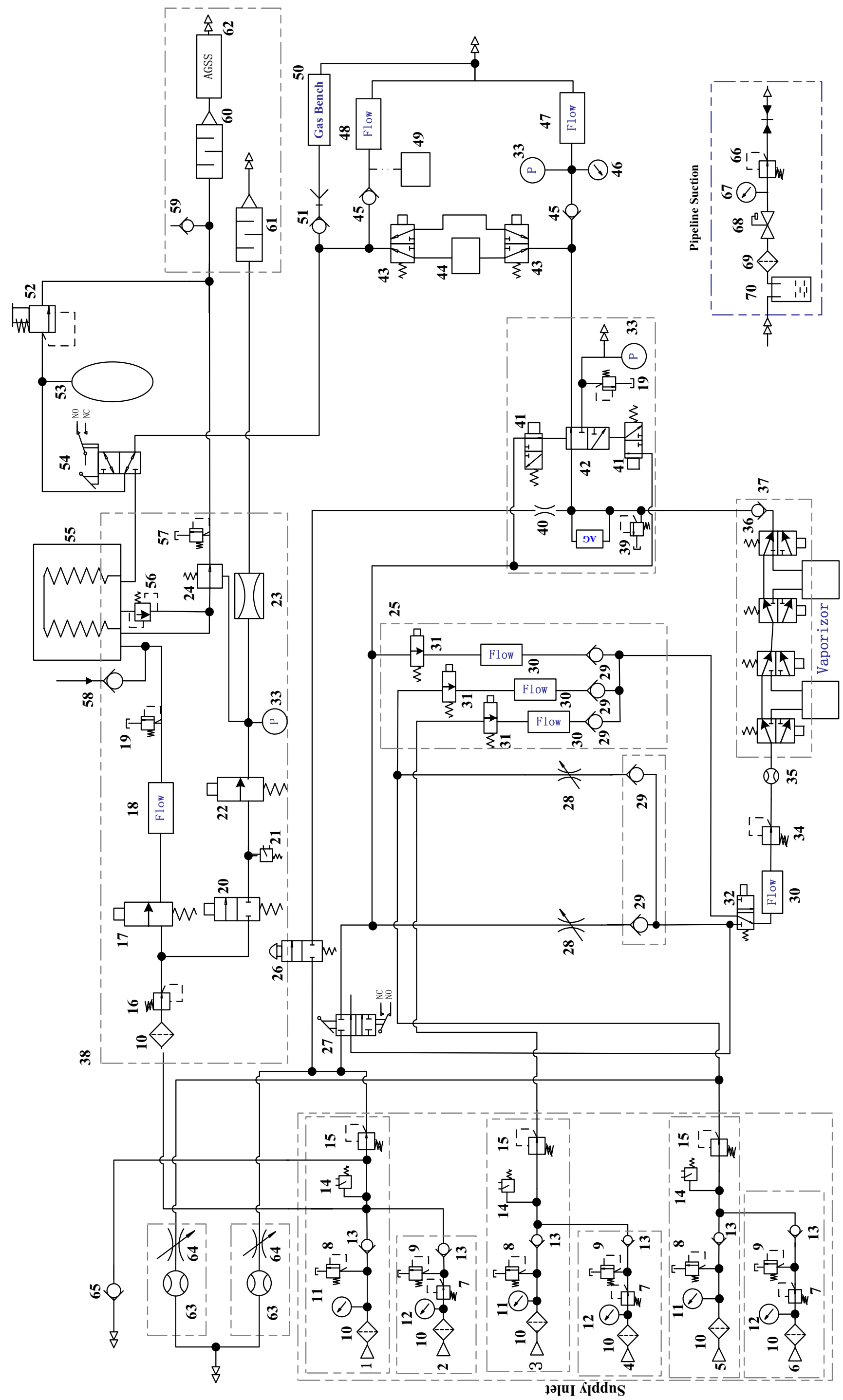


FIGURE 1-6

1.3.2 Parts List

1.	O_2 Gas Pipeline Connection	36.	Check Valve3
2.	O_2 Gas Cylinder Connection	37.	Dual Vaporizer Block
3.	N_2O Gas Pipeline Connection	38.	Ventilator
4.	N_2O Gas Cylinder Connection	39.	Pressure Relief Valve (37.9kPa)
5.	Air Gas Pipeline Connection	40.	Flow Restrictor
6.	Air Gas Cylinder Connection	41.	Latching Valve
7.	Gas Cylinder Pressure Regulator (360kPa)	42.	Electronic ACGO valve
8.	Pressure Relief Valve (758kPa)	43.	Bypass
9.	Pressure Relief Valve (Regulator)	44.	CO2 Absorber Canister
10.	Drive Gas Inlet Filter	45.	Inspiratory Check Valve
11.	Gas Pipeline Pressure Gauge	46.	Airway pressure gauge
12.	Gas Cylinder Pressure Gauge	47.	Inspiratory Flow Sensor
13.	Check valve1	48.	Expiratory Flow Sensor
14.	Pressure Switch (220kPa)	49.	Watertrap
15.	Pressure Regulating Valve (200kPa)	50.	Gas Bench
16.	Pressure Regulator (200kPa)	51.	Check valve
17.	Inspiratory Flow Control Valve	52.	APL valve
18.	Inspiratory Flow Sensor	53.	Breathing Bag
19.	Safety Valve (110 cmH2O)	54.	Auto/Manual Bag Switch
20.	PEEP Safety Valve	55.	Bellows
21.	Drive Gas Pressure Switch (140kPa)	56.	Pop-off Valve
22.	PEEP Proportional Valve	57.	Pressure Relief Valve (1kPa,10cmH2O)
23.	Flow Restrictor	58.	Negative Pressure Check Valve
24.	Exhaust Valve	59.	Negative Pressure Check Valve (1cmH2O)
25.	Electronic Flow Control System	60.	Gas Container1
26.	O2 Flush Valve	61.	Gas Container2
27.	System Switch	62.	AGSS
28.	Needle Valve	63.	Auxiliary Air Flowmeter
29.	Check Valve2	64.	Auxiliary Flow Needle Valve
30.	Flow Sensor	65.	Auxiliary O2 Gas Power Outlet
31.	Proportional Valve	66.	Suction Regulator
32.	3-way Valve	67.	Vacuum Gauge
33.	Pressure Sensor	68.	Overflow Safety Trap
34.	Backpressure Valve	69.	Filter
35.	Total Flowmeter	70.	Collection Container

1.3.3 Key to Symbols

	Filter		Regulator
	Pressure Gauge		Check Valve
	Gas Supply Connector		Pressure Relief Valve
	Flowmeter		Flow Control Valve
	Pressure Switch		Flow Restrictor

1.3.4 Description

1.3.4.1 Anesthetic Gas Delivery System

The anesthetic gas delivery system is connected to the gas supply, anesthetic gas delivery device (vaporizer) and breathing system. The system inputs N2O, O2 and AIR from the gas supply assembly and outputs gas mixture of the three gases and anesthetic agent (fresh gas), pure O2 (high-pressure O2 output , auxiliary O2 supply and flushing O2), or AIR-O2 mixture. The following figure shows the pneumatic circuit of the anesthetic gas delivery system.The ACGO is configured in electrical modes

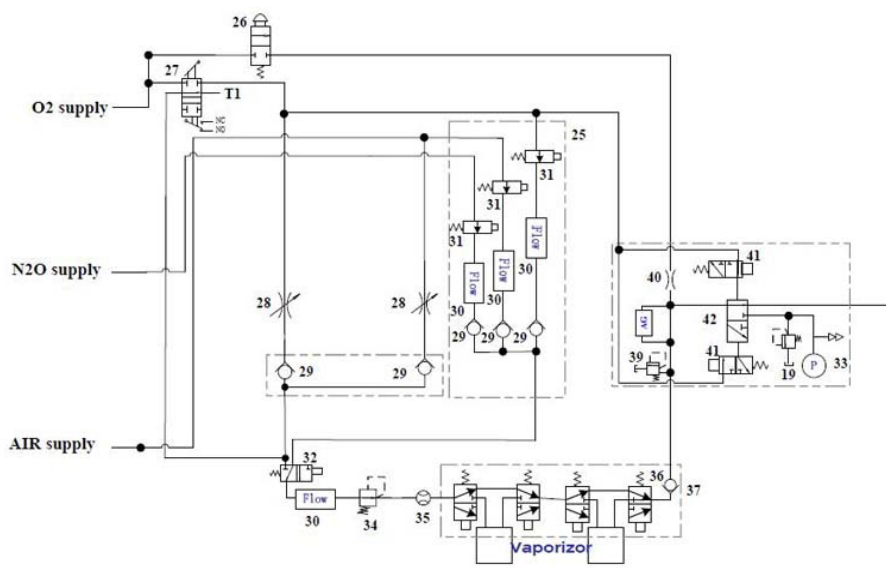
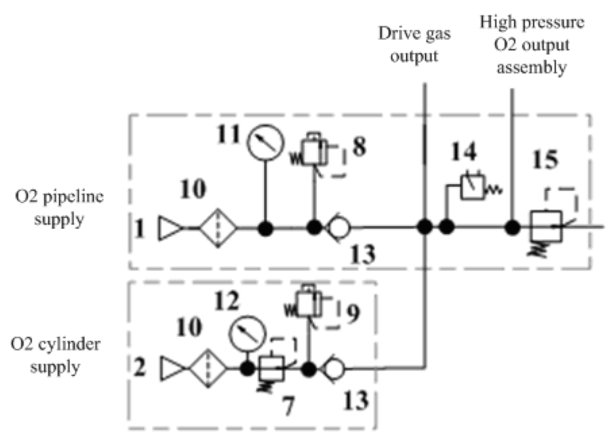


FIGURE 1-7

1.3.4.2 Gas Supplies

The A7 anesthesia machine supports three gas supplies: O2, N2O and AIR. All the gas supply interfaces are designed based on IEC 60601-2-13, which prevents misconnection between different gases. The A7 gas supply inlet assemblies comprise the pipeline gas supply inlet assembly and cylinder gas supply inlet assembly.

The following describes the O2 gas flow. The difference between the O2 and the AIR/N2O limbs lies in that the drive gas output and high-pressure O2 output are available at the upstream end of the regulator (15) on the O2 limb. The configurations of other components are the same. The O2 pipeline supply inlet assembly includes filter 10, pressure gauge 11, pressure relief valve 8, check valve 13, pressure switch 14 and regulator 15. The cylinder gas supply inlet assembly includes the filter (10), pressure gauge (12), pressure reducing valve (7), pressure relief value (9), check valve (13), pressure switch (14) and regulator (15). Where, the pressure switch (14) and regulator (15) are shared by the pipeline and cylinder gas supply limbs. The following figure is the block diagram.



The following table lists parameters of key components.

Name	Supplier	Description of Functions	Key Index
Regulator	Camozzi	Adjusts pressure and ensures constant output pressure at the regulator outlet.	Applied to compressed air, O2 and N2O .
			Pressure range: 0.05 to 1 MPa (7 to 145 psi)
			Flow: 160 L/min (At 10 bar (145 psi) inlet pressure, 4bar (58 psi) outlet pressure, with 0.5bar (7 psi) drop)
Pressure switch	AIR LOGIC	Reports an alarm when the gas supply is insufficient. Pressure switches are configured on the O2, N2O and air limbs.	Precision: 0.5 to 100 PSI, +/- 0.5 tolerance on the initial starting pressure
			Alarm type: an alarm will be reported when the gas supply pressure reduces to 32 PSI.
			Pressure resistance: 300 PSI
Pressure relief valve	Mindray	Prevents gas pressure too high.	Startup pressure: 758 kPa±20 kPa (110 psi ± 2.9 psi) Leakage volume requirement: The leakage volume should be smaller than 5 ml/min for a 600 kPa pressure relief valve.

The following figure shows the physical pipeline gas supply inlet assembly of the system, including the gas supply inlet assembly and regulators. The gas supply inlet assembly integrates the filter, pressure relief valve, pressure switch and check valve. Gases regulated by the regulator will be output to the flow control systems EFCS and BFCS.

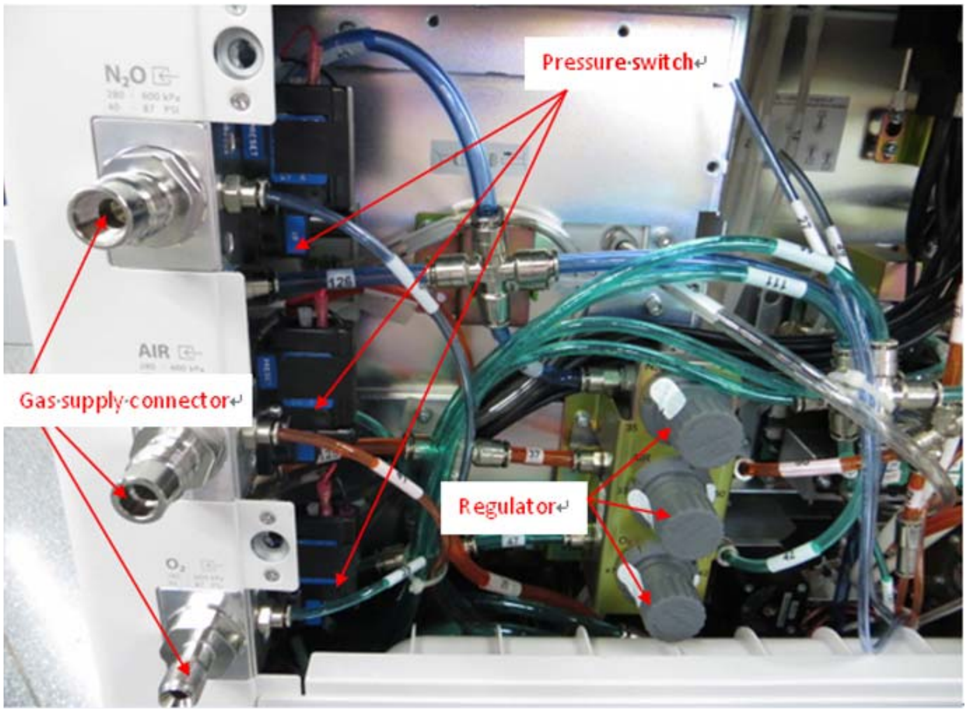


FIGURE 1-8

The following figure shows the models of the gas supply inlet assembly and regulator. The gas from the pipeline gas supply (280~600 kPa) enters the system through the gas supply connector. After being cleaned by the internal filter of the inlet assembly, the gas is output to the regulator and degraded to about 200 kPa. (The filter can be replaced after the pipeline gas supply connector is removed).

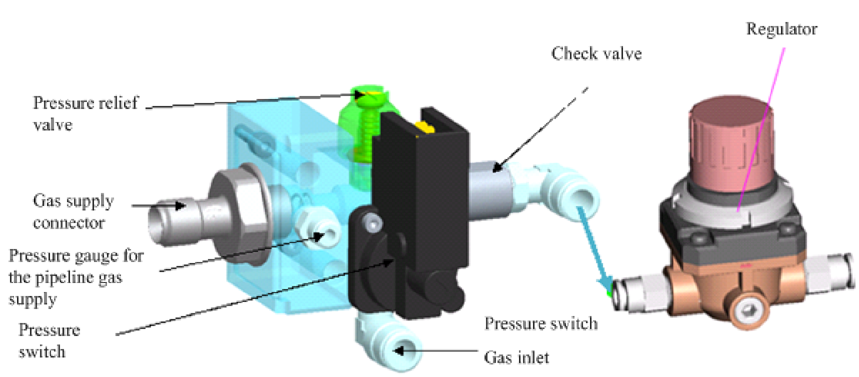


FIGURE 1-9

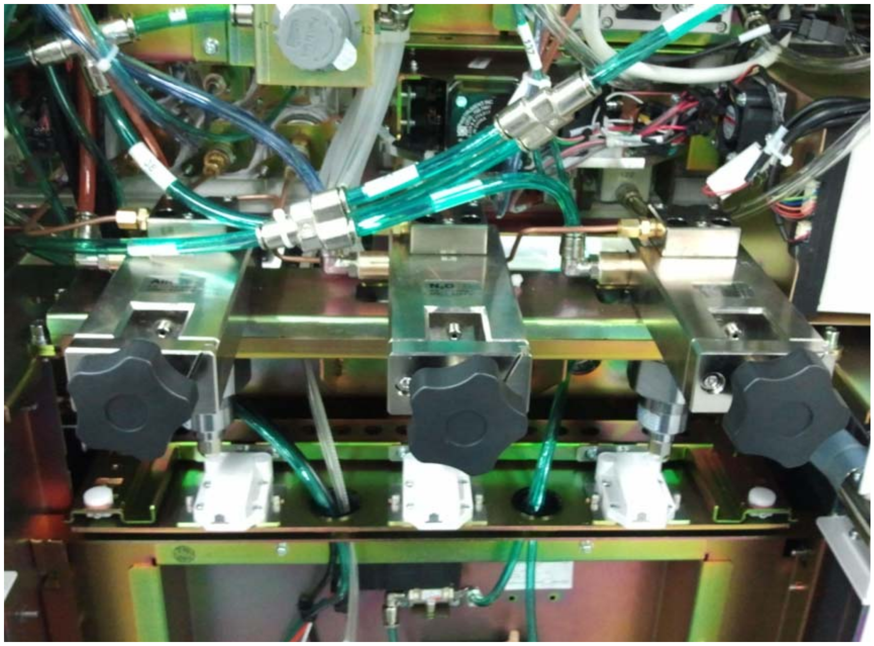


FIGURE 1-10

As shown in the following figure, the gas from the cylinder gas supply is divided into two limbs after being cleaned by the filter. One limb is directly connected to the high pressure gauge and the other limb is degraded to 440 kPa by the high pressure reducing valve and then output from the check valve. After the gas from the cylinder gas supply is mixed with the gas from the pipeline gas supply, the gas mixture is output to the regulator. Currently, the system provides only a cylinder connector. The connector complies with CGA V-1. Cylinders of the E size are supported. The capacity of a cylinder is limited; therefore, it is recommended that the cylinder gas supply is used as the backup gas supply to prevent gas supply exhaustion.

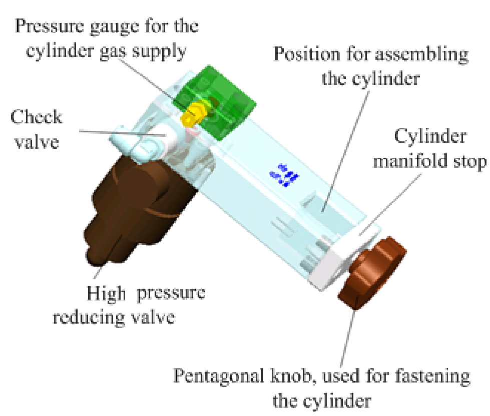


FIGURE 1-11

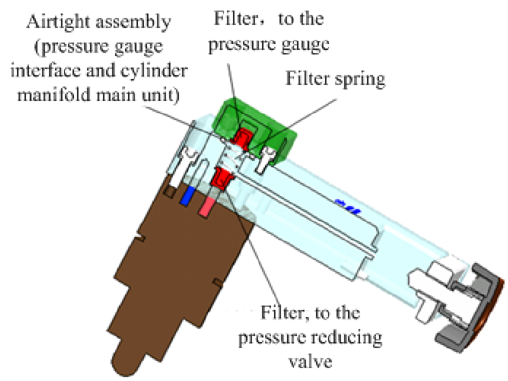


FIGURE 1-12

1.3.4.3 System Switch Assembly

The system switch assembly is the pneumatic circuit on-off valve of the breathing system. It controls the on and off of the pneumatic circuit and provides system power-off signal when the pneumatic circuit is switched on, implementing synchronous on/off control on the pneumatic and electrical circuits of the system. When the system switch knob is rotated clockwise, the valve stem pushes the valve core to switch on the pneumatic circuit and triggers the tact switches on the system switch assembly to switch on the electrical circuit at the same time. When the system switch knob is rotated counterclockwise, the pneumatic and electrical circuits will be switched off at the same time. There is an exhaust limb on the system switch, which functions to exhaust the residual gas in the backup limb at power-off to prevent the residual gas in the backup limb from lifting the float of the total flowmeter.

The system switch assembly is equipped with two tact switches, providing the same functions and located at symmetrical positions. This design is only used to ensure that one tact switch can operate properly when the other tact switch fails. When the two PINs of either tact switch are shorted, the system power supply will be switched on.

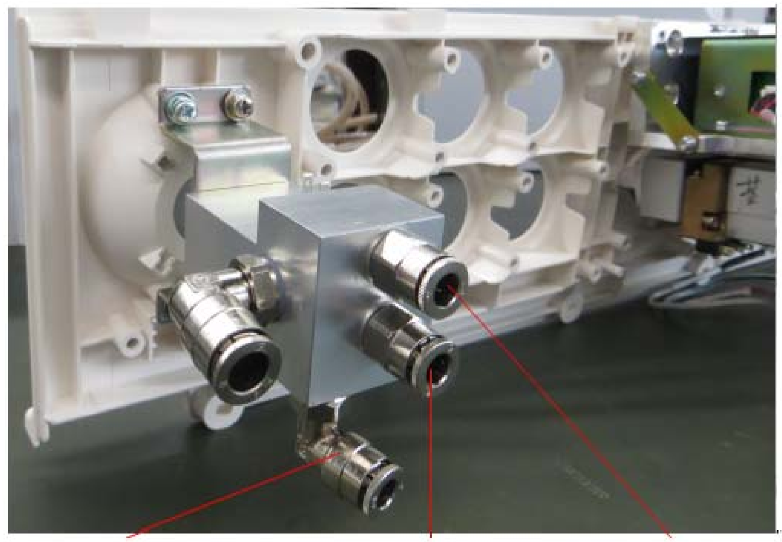


FIGURE 1-13

1.3.4.4 Flow Control System - EFCS

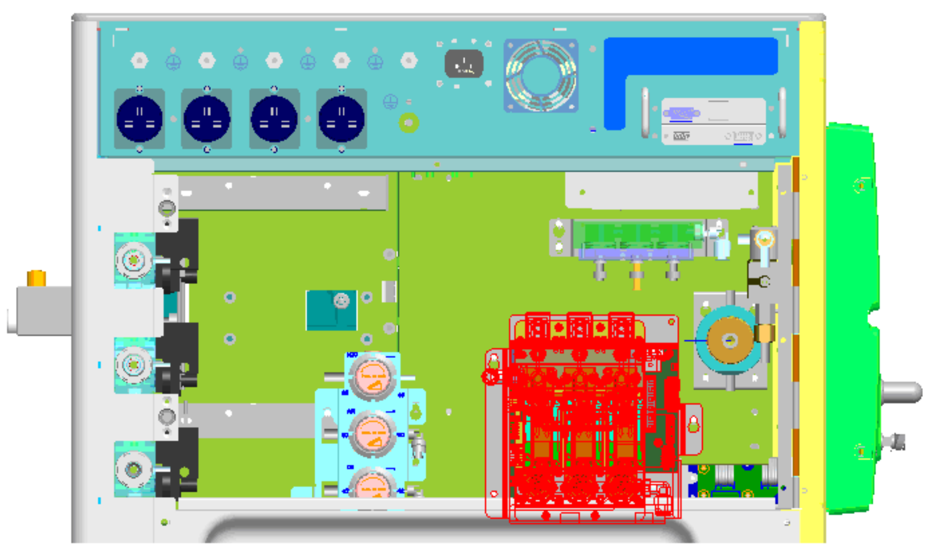


FIGURE 1-14

The following figure shows the pneumatic block structure of the EFCS. The three gases, after being regulated, go through the proportional valves, through limb sensors, through the gas mixing chamber, and into the three-way valve. Then, the gas mixture returns to the total flow sensor and finally output to the mechanical float flow meter. Hardware boards and various hardware interfaces are available under the pneumatic block.

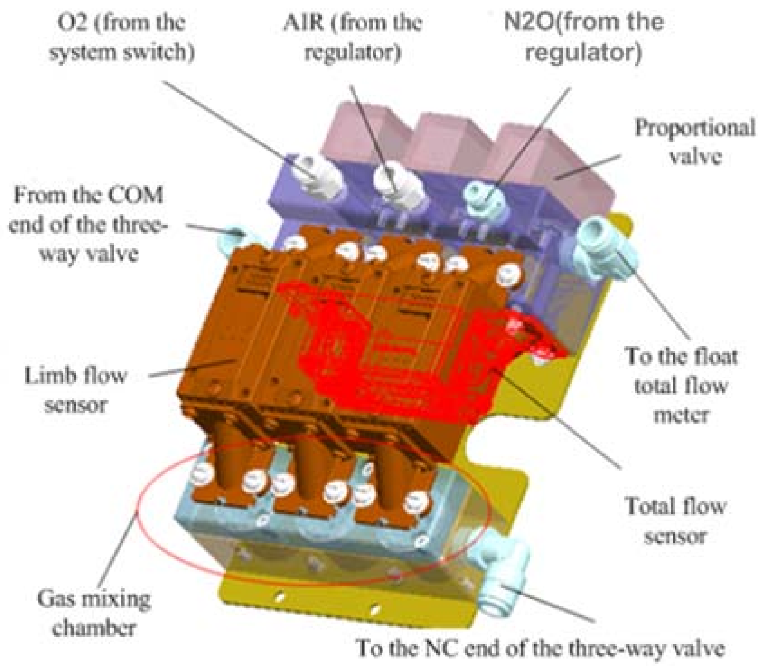


FIGURE 1-15

1.3.4.5 Flow Control System - BFCS

The BFCS of the A7 comprises two mechanical needle valves that are used to control the flow of the O2 and air limbs and control the O2-AIR ratio. After passing through the two independent check valves in the mixing chamber, the gases of the two limbs are mixed and finally output.

1.3.4.5.1 BFCS - Motor

The motor of the BFCS provides the force for withdrawing the backup needle valve assembly, and locates and fastens the backup needle valve assembly by using electromagnet.

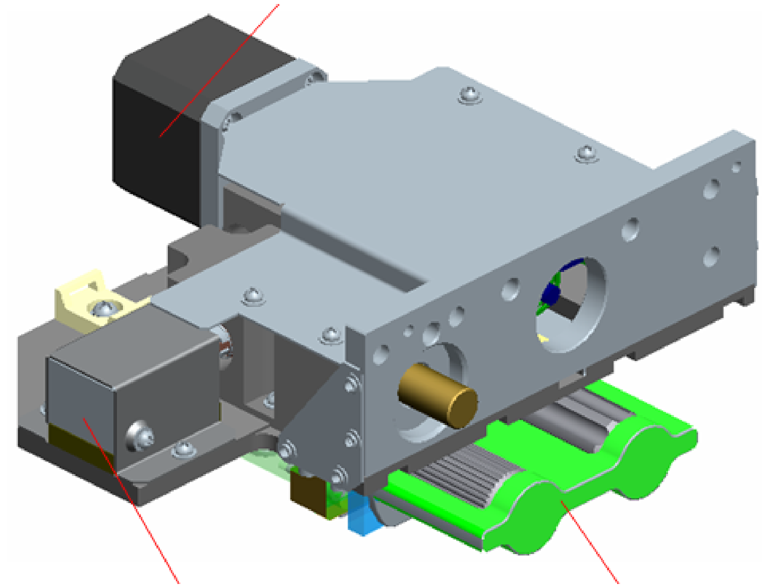


FIGURE 1-16

1.3.4.5.2 BFCS - Needle Valves

The needle valve assembly controls the valve port openness by converting the rotation movement of the knobs into the linear movement of the valve core and thus controls the gas flow. The needle valve assembly is configured with a tact switch. When a needle valve is closed, the valve core triggers the tact switch to monitor the close status of the needle valve and feed back the status to the control unit.

The following figure is a model of the BFCS backup needle valve module.

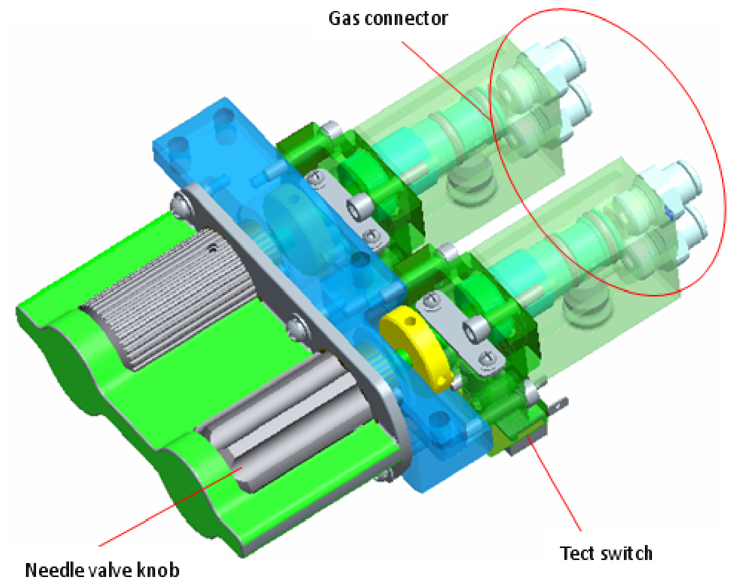


FIGURE 1-17

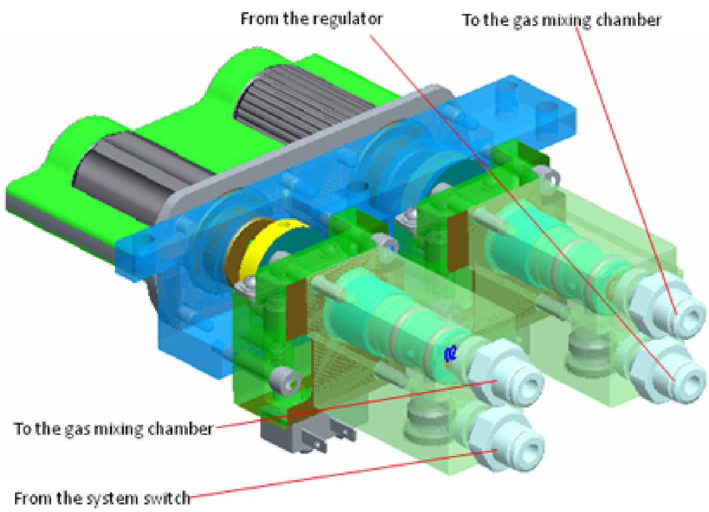
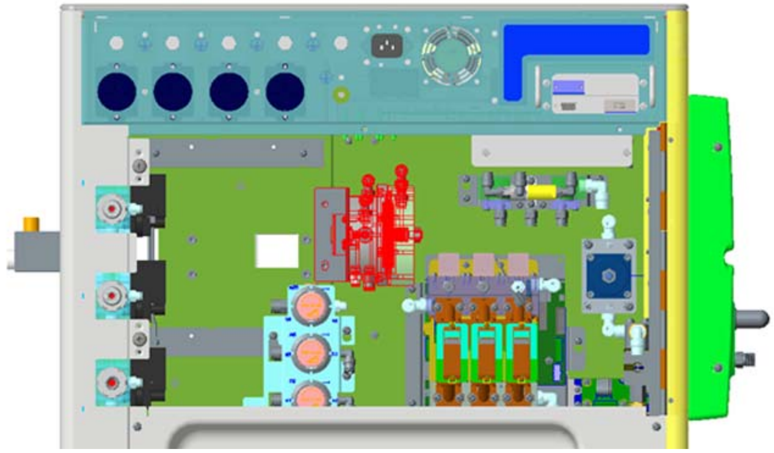


FIGURE 1-18

1.3.4.5.3 Back Pressure Valve



The back pressure valve stabilizes the pressure at the upstream inlet and prevents continual fluctuation of the system flow due to load changes. The following figure shows the position of the back pressure valve in the system.

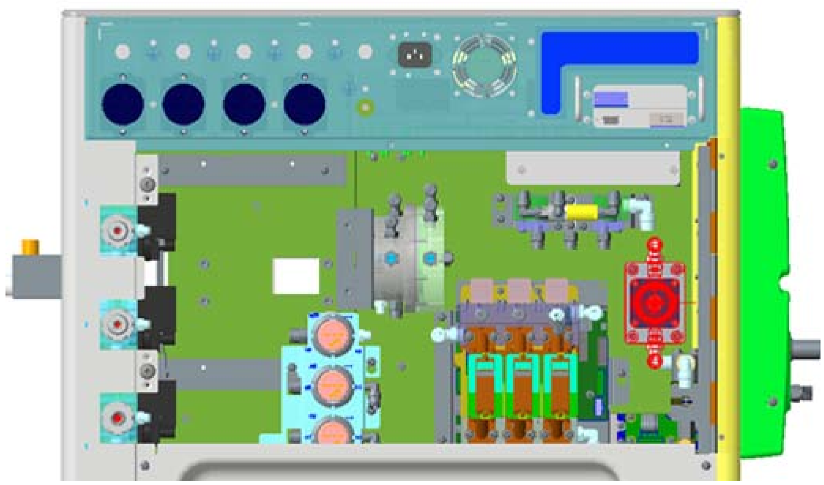


FIGURE 1-19

The following figure shows the structure model and the corresponding interface information.

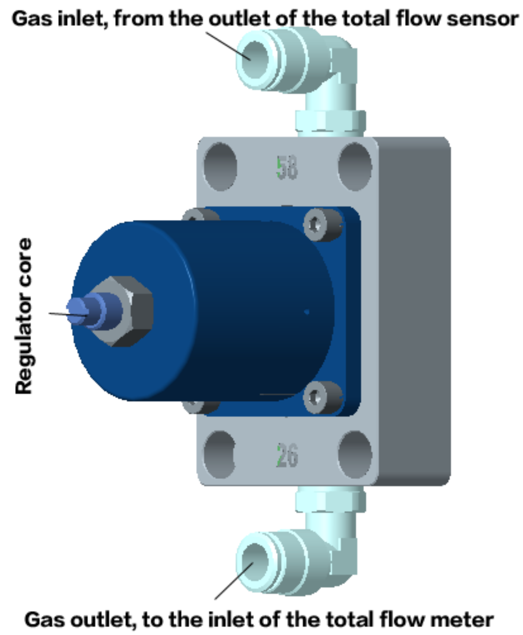


FIGURE 1-20

1.3.4.6 Three-way Valve

The three-way valve is a two-position three-way solenoid valve with two inlets and one outlet. The two inlets are connected to the outputs of the EFCS and BFCS respectively, whereas the outlet is connected to the total flow meter. The three-way valve implements pneumatic circuit switching between the EFCS and BFCS. Upon power-on, the EFCS limb is switched on and the BFCS limb is switched off; upon power-off, the EFCS limb is switched off and the BFCS limb is switched on. The following figure shows the position of the three-way valve in the system.

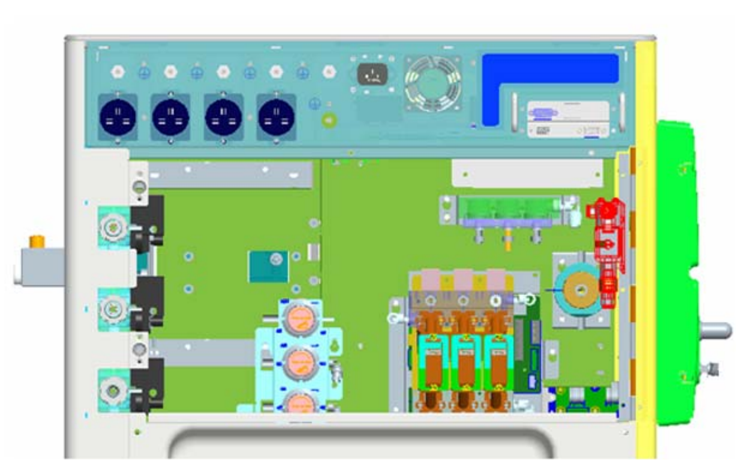


FIGURE 1-21

The following figure shows the structure model and the corresponding interface information.

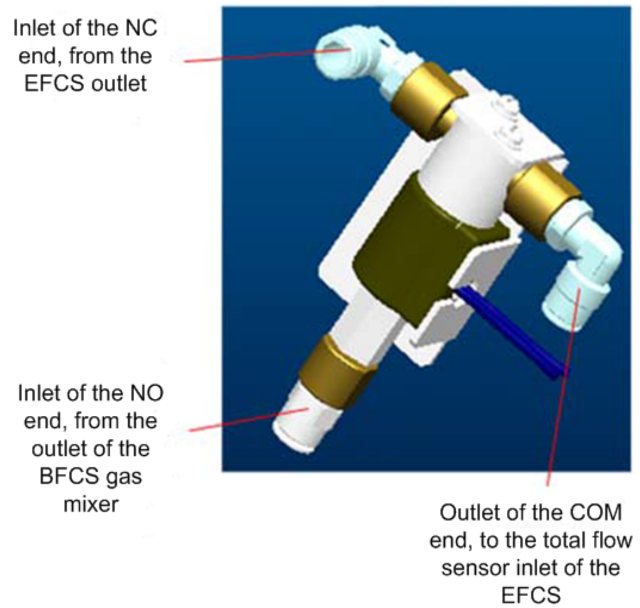


FIGURE 1-22

1.3.4.7 Total Flow Meter

The mechanical float flow meter (range: 10 L/min, based on the central line of the float (steel ball)) monitors the fresh gas flow. Located on the main limb of the pneumatic circuit, the total flow meter can monitor the total flow of the EFCS or BFCS. The following figure shows the position of the total flow meter in the system.

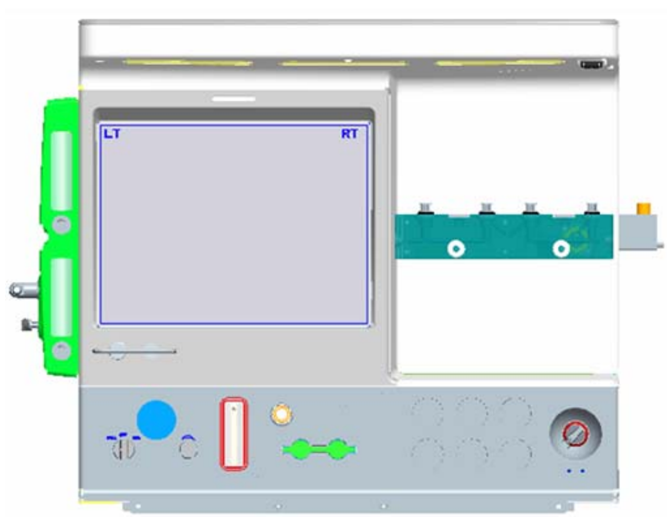


FIGURE 1-23

The following figure shows the structure model and the corresponding interface information.

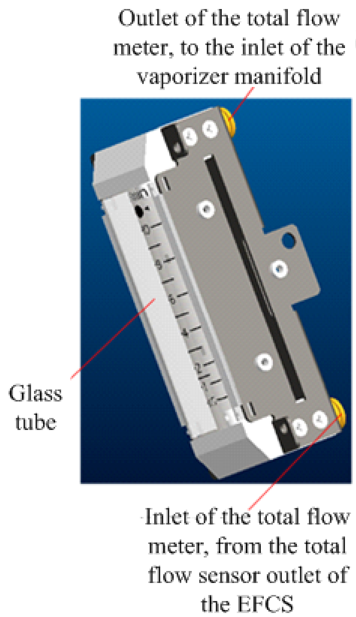


FIGURE 1-24

1.3.4.8 Vaporizer Manifold

The vaporizer manifold (installation type: Selectatec) is used to bear the vaporizers and provide an airtight chamber. In the chamber, the gas mixture and anesthetic gas converge into the fresh gas and output to the downstream ACGO assembly. Each column on the manifold is a two-position three-way valve. When no vaporizer is installed, the columns are at the original positions and the gas mixture is delivered to the downstream through the bypass inside the manifold. When vaporizers are installed, the columns are bended and the gas mixture is delivered to the manifold and output to the downstream. The following figure shows the position of the vaporizer manifold in the system.

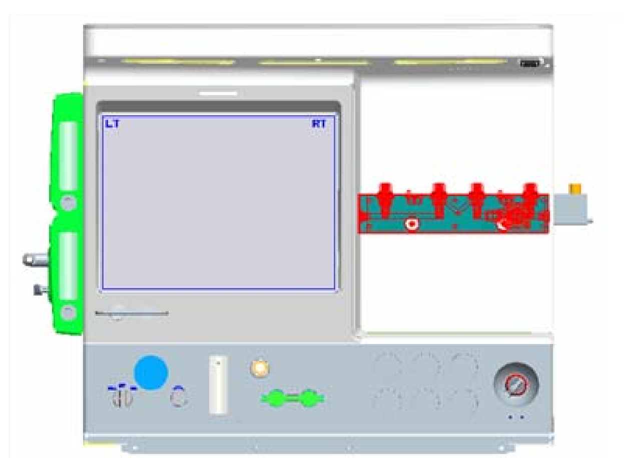


FIGURE 1-25

The following figure shows the structure model and the corresponding interface information.

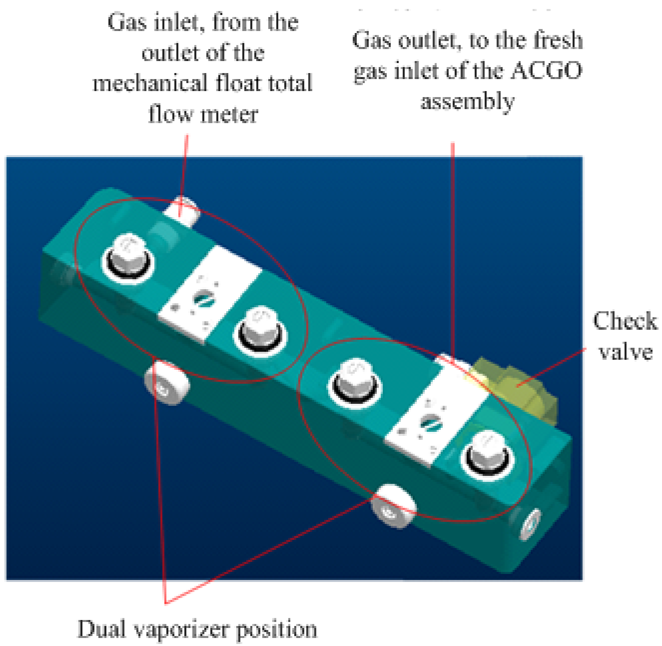


FIGURE 1-26

1.3.4.9 ACGO Assembly

The ACGO assembly is used to connect the fresh gas output from the vaporizer manifold and the O2 output from the O2 flush device to the breathing circuit of the anesthesia machine or to an independent outlet. Mechanical and electrical ACGO configurations are available.

The electrical ACGO pushes the valve core by gas pressure after switching on the control gas supply at a corresponding end to switch the ACGO state. The following figure is the diagram. For example, the status needs to be switched to ACGO OFF. When this order is received, the two drive gas control valves (two-position three-way solenoid valves in the upper part of the following figure) of the electrical ACGO switch to the state shown in the following figure. On the left side (as shown in the green arrows), the two connectors on the left and right of the valve are connected and the gas outlet in the middle is closed; on the right side (as shown in the black arrows), the connector on the left is disconnected and the connector on the right and the gas outlet in the middle are connected. In this case, the drive O2 from the system switch passes through the control valve on the left, outputs to the main ACGO valve shown at the lower part of the following figure and drives the valve core in the middle rightwards. At the same time, the residential gas on the left side of the valve core is released to the air through the drive gas control valve on the right side. If the gas on the right side is not released, the drive gas on the left side cannot push the valve core. Therefore, the two states must be available at the same time. The valve core pushes rightwards by the drive gas to implement ACGO state switching. Then, the fresh gas will be output from the patient circuit outlet of the ACGO assembly.

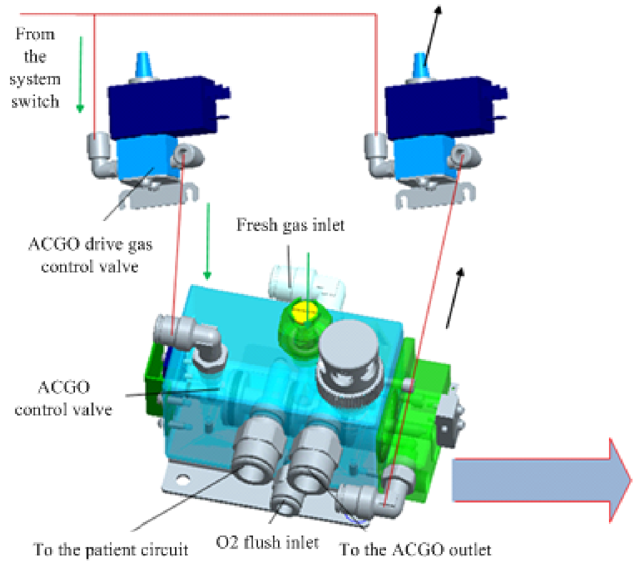


FIGURE 1-27

If the system is configured with the internal AG module, corresponding sampling connectors will be integrated on the ACGO valve block. The positions (under the work surface) of the ACGO assembly with the two configurations in the system are similar, as shown in the following figure.

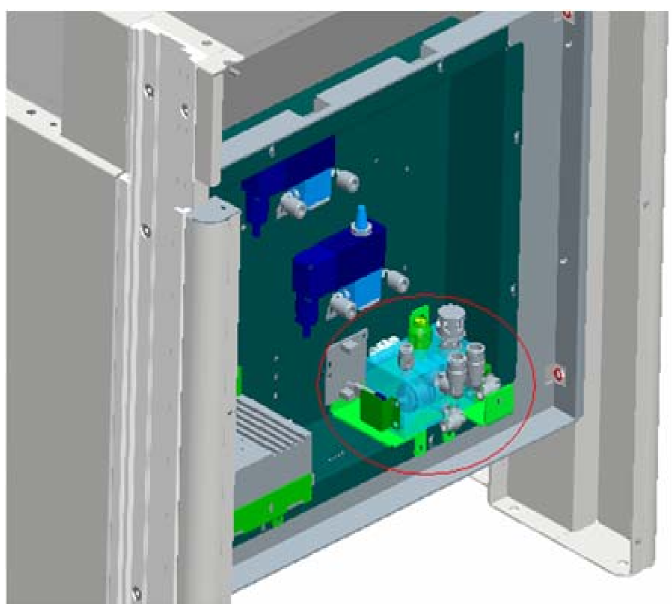


FIGURE 1-28

Independent ACGO Outlet

When the ACGO assembly is switched to the ACGO state, the fresh gas will be output from the independent ACGO outlet. Traditionally, the fresh gas is output from the ACGO limb integrated on the patient circuit. By contrast, the independent ACGO outlet is independent from the patient circuit. The following figure shows the position of the independent ACGO outlet in the system. The gas input is from the ACGO outlet on the ACGO assembly.

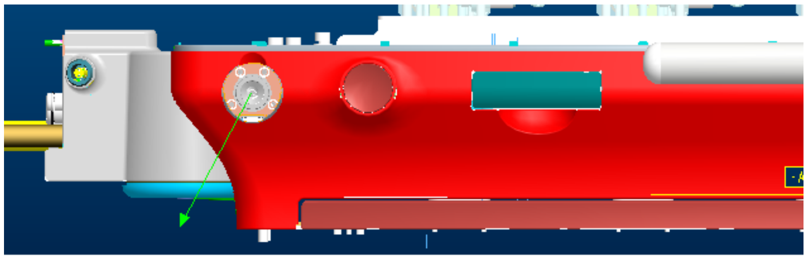


FIGURE 1-29

The following figure shows the structure model and the corresponding interface information.

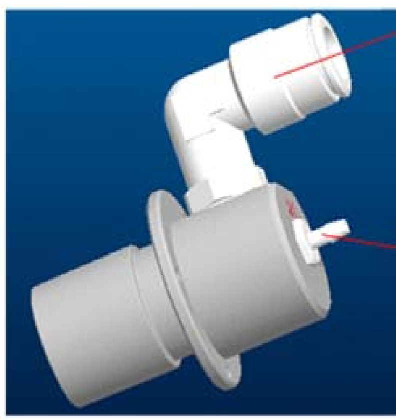


FIGURE 1-30

1.3.4.10 O2 Flush Button Assembly

The O2 flush assembly is located on the work surface. When the O2 flush button is depressed, O2 rushes into the pneumatic circuit, and will be cut off when this button is released. The O2 supply gas is at 0.2 MPa (29 psi), after being regulated, goes through the O2 flush valve and into the O2 flush inlet of the ACGO assembly. The O2 flush assembly is not affected by the system switch. Flushing O2 can be performed as long as O2 supply is normal. The O2 flush valve has a slide valve structure inside that ensures automatic reset each time the valve is depressed and released via the spring. The following figure shows the position of the O2 flush valve in the system.

FIGURE 1-31

The following figure shows the structure model and the corresponding interface information.

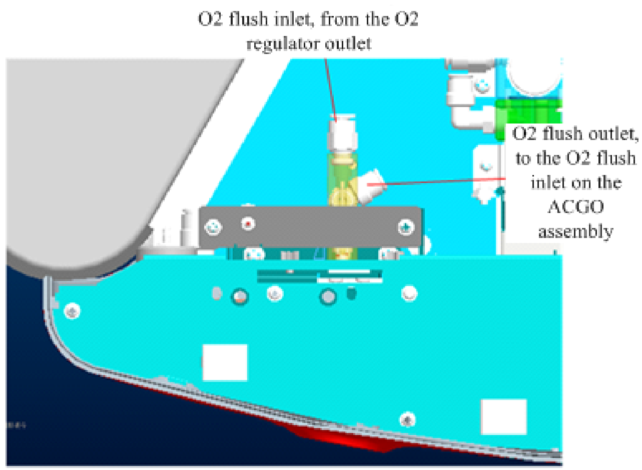


FIGURE 1-32

1.3.4.11 Auxiliary Gas Supply Assembly

The auxiliary gas supply assembly is composed of the oxygen and air limbs. Two needle valves are used to control the flow of the auxiliary oxygen and air supplies, and corresponding glass tube flow meters are used for flow monitoring. After being mixed, the oxygen and air are output. The following figure shows the position of the auxiliary gas supply assembly in the system.

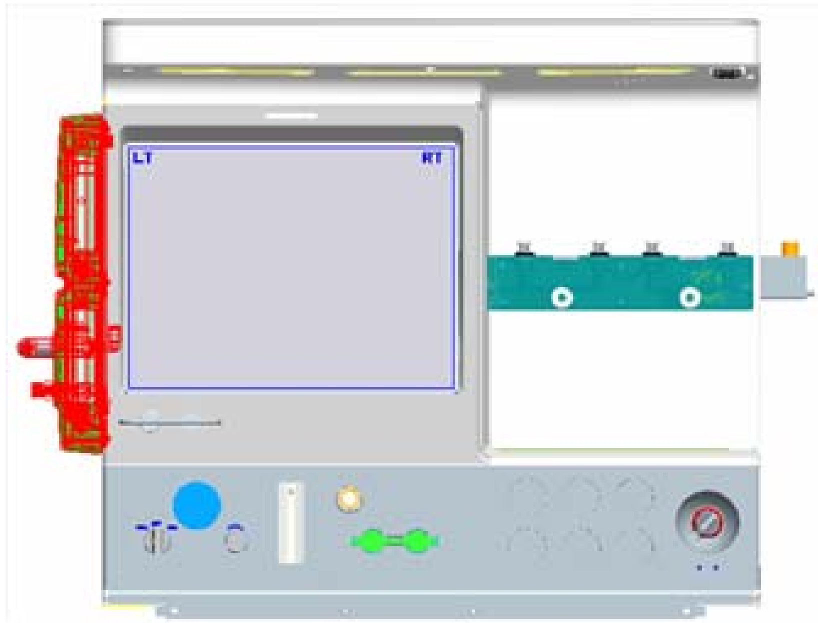


FIGURE 1-33

The following figure shows the structure model and the corresponding interface information.

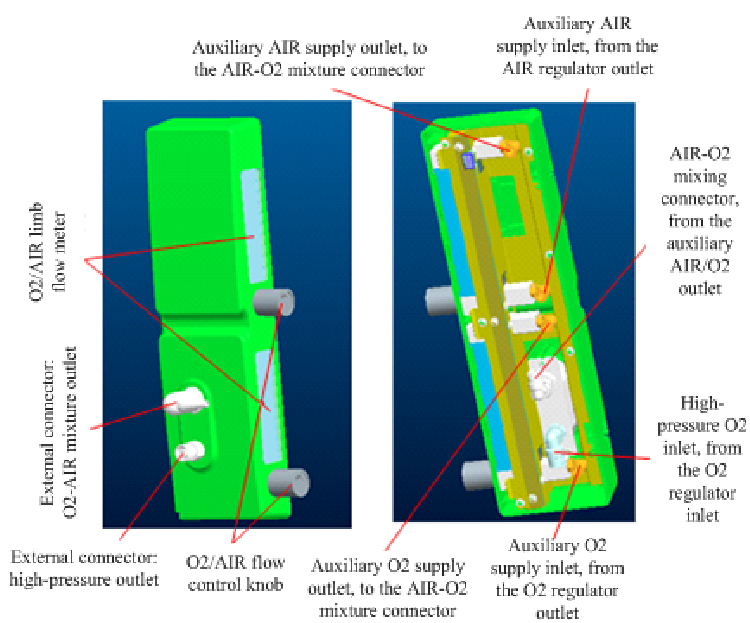


FIGURE 1-34

1.3.4.12 High Pressure O2 Output Assembly

The high pressure O2 input comes from the gas supply (280 to 600 kPa) (40 to 87 psi) directly and provides high pressure O2 for the external ventilation device (jet ventilation devices). See "Auxiliary Gas Supply Assembly" on page 1-32..

1.3.4.13 Pneumatically-Controlled Module of Anesthetic

The pneumatically-controlled module of the anesthetic ventilator provides drive gas for the patient to breathe. O2 (or AIR) from the gas supply inlet assembly enters the anesthetic ventilator and is output in three pathways: drive gas entering the breathing system, drive gas discharged through the AGSS outlet, and drive gas discharged through the PEEP outlet. The ventilator controls drive gas flow to implement various ventilation modes and prevent excessively high pressure inside the pneumatic circuit from injuring the patient. The following figure shows the pneumatic circuit diagram of the anesthetic ventilator.

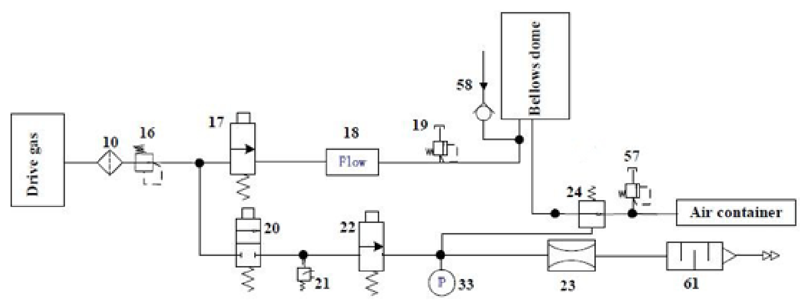


FIGURE 1-35

As shown in the preceding figure, the filter (10) filters drive gas again. The regulator (16) regulates pressure (about 0.2 MPa (29 psi)) inside the pneumatic circuit. The proportional solenoid valve (17) controls the inlet gas flow. Component 18 is a flow sensor of differential pressure type that monitors gas flow in the drive gas circuit. The mechanical overpressure valve (19) ensures that the pressure in the drive gas circuit does not exceed the safety pressure. It releases excess gas when gas pressure exceeds 11 kPa (110 cm H2O). Component 24 is the expiratory valve.

The PEEP function is performed through the expiratory valve. Component 22 is a low-flow proportional solenoid valve. When it opens, gas is bled from the pneumatic resistor (23), forming relatively stable pressure in the pneumatic circuit from component 22 to component 23. Such pressure is exerted on the membrane of the expiratory valve (24) to form PEEP.

To prevent excessively high pressure inside the pneumatic circuit from injuring the patient and damaging the equipment, the pressure relief valve (20), which is a solenoid on-off valve, is placed before the gas pathway of the expiratory valve. Component 21 is a pressure switch. When the drive gas pressure is less than 125 kPa (18.1 psi), an alarm is triggered. Component 33 is a pressure sensor that monitors the pressure at the expiratory valve which is closed. The mechanical pressure relief valve (57) ensures that the tube pressure after the expiratory valve is less than 10 cm H2O.

The following figure is a picture of the pneumatically-controlled module of the anesthetic ventilator.

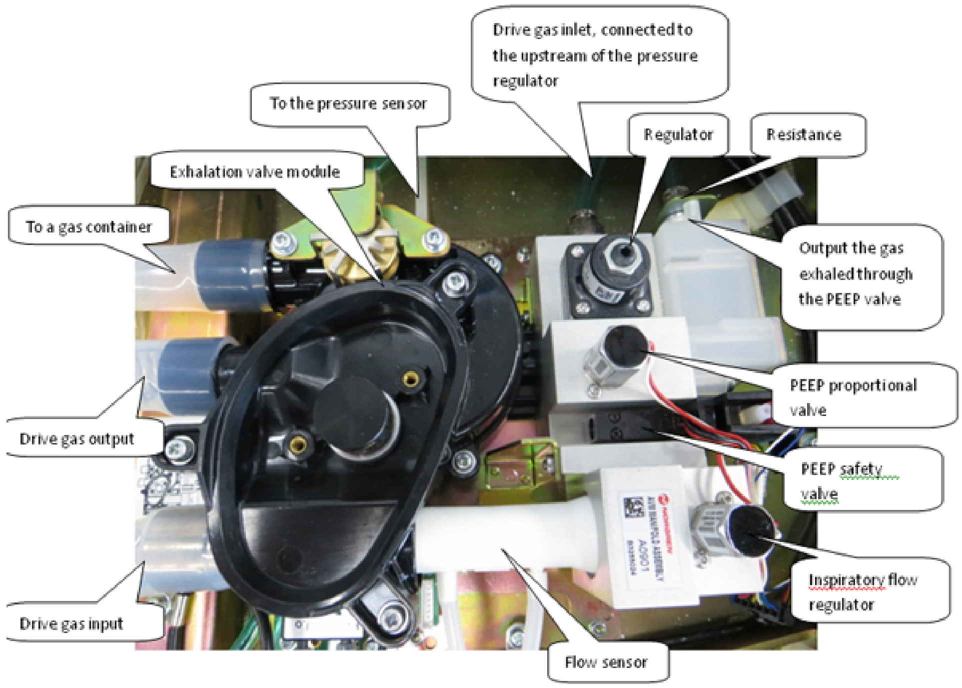


FIGURE 1-36

1.3.4.14 Breathing System

The breathing system provides a closed loop for the anesthetic gas. The expired gas from the patient can be inspired in the inspiration phase to maintain the temperature and humidity conditions of the patient's expired gas. During inspiration, the drive gas depresses the bag inside the bellows to force the inside gas to enter the patient's lung. During expiration, the patient's expired gas goes into the bag inside the bellows. The sodalime absorber canister (integrating 43 and 44) absorbs CO2 that the patient expires. The following figure shows the pneumatic circuit of the breathing system.

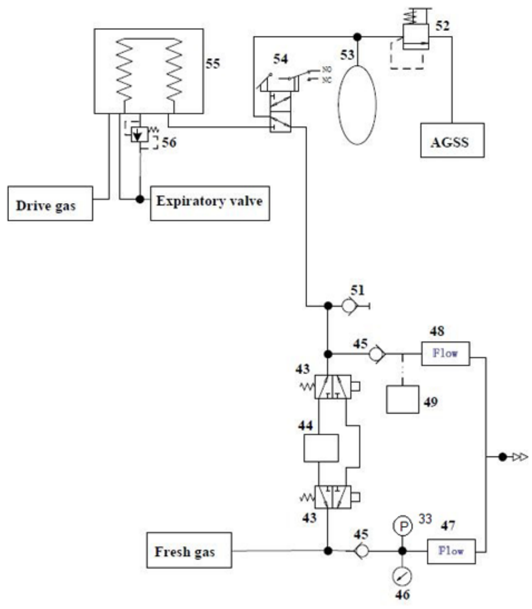


FIGURE 1-37

The breathing system is connected to the anesthesia machine main unit through the circuit adapter. The breathing system is highly integrated, as its tubes are all internal as shown in the following figure.

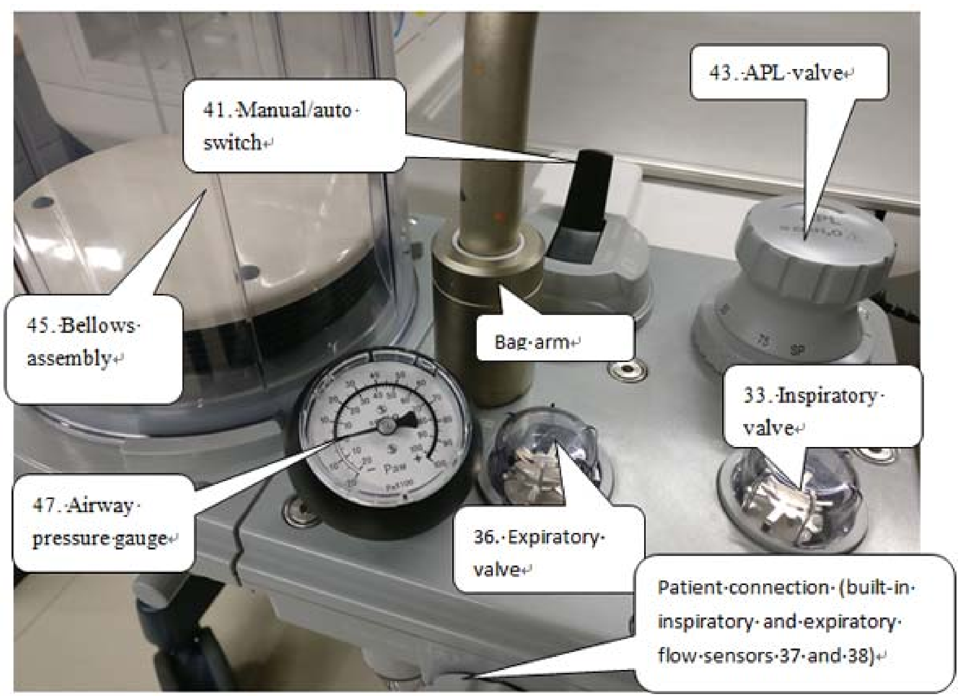


FIGURE 1-38

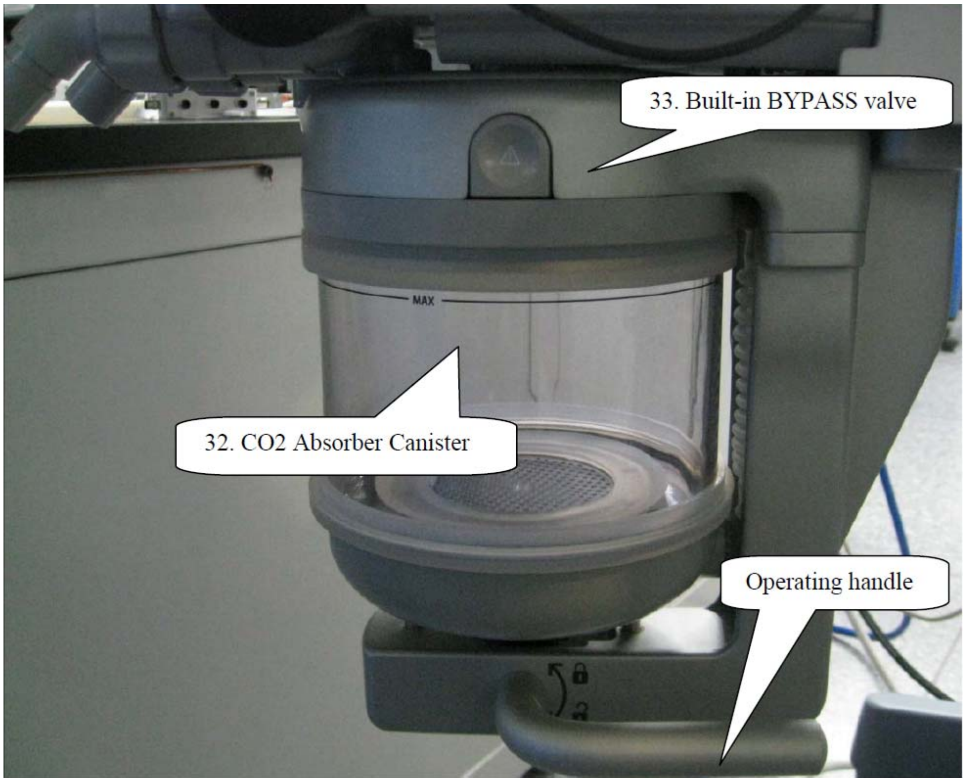


FIGURE 1-39

Mechanical and manual ventilation modes are selected through the Auto/Manual ventilation switch.

Excess water condensed from the exhaled gas is collected in the water collection cup, located on the bottom side of the breathing system.

The breathing system is easily disassembled and is autoclavable at 134^{o}C.

1.3.4.14.1 Mechanical Ventilation

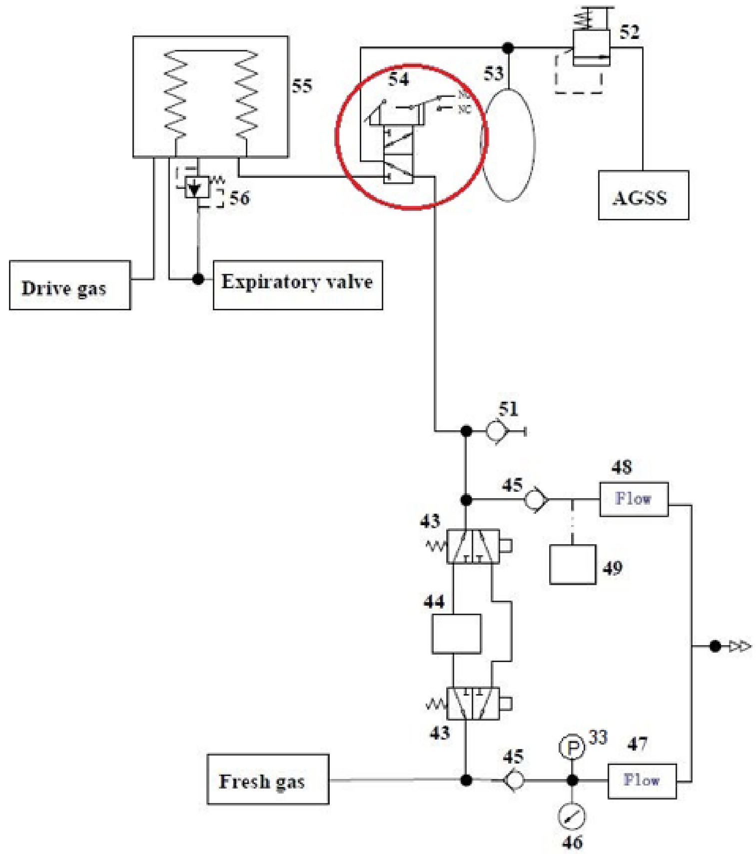


FIGURE 1-40

1.3.4.14.1.1 Drive Gas Path

In case of mechanical ventilation, during inspiration, gas flows through the Auto/Manual ventilation switch (54), sodalime absorber canister (integrating 44 and 43), inspiratory check valve (45), O2 sensor, airway pressure gauge (46), and inspiratory flow sensor (47) to the patient. During expiration, gas flows through the expiratory flow sensor (48), expiratory check valve (45), and Auto/Manual ventilation switch (54) to the bellows. Airway pressure is monitored by the airway pressure gauge (46).

1.3.4.14.1.2 Fresh Gas Path

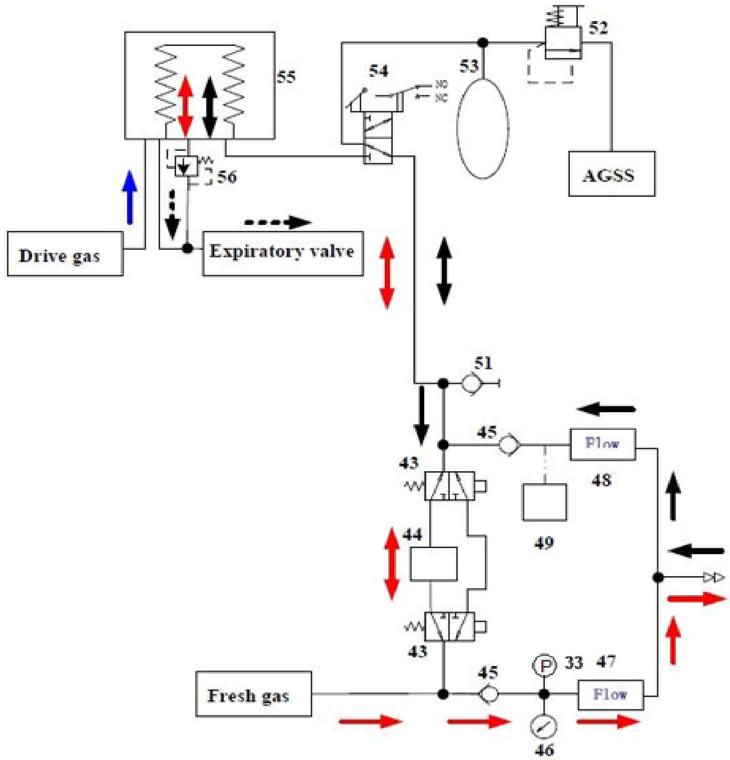


FIGURE 1-41

- Red arrows: direction of the fresh gas.
- Black arrows: direction of the patient's expired gas.
- Blue arrows: input direction of the drive gas.
- Black dotted arrows: output direction of the drive gas.

1.3.4.14.2 Manual Ventilation

1.3.4.14.2.1 Flow Path

When the Auto/Manual switch is set to Manual, the operator squeezes the manual breathing bag (53) to supply gas for the breathing system. The APL valve (52) is used to adjust the pressure inside the pneumatic circuit in case of manual ventilation. When the Auto/Manual switch is set to Auto, the ventilator mechanically assists or replaces the spontaneous breathing of the patient. The ventilator controls the drive gas to depress the bag inside bellows (55) and supply gas for the breathing system according to the selected ventilation mode.

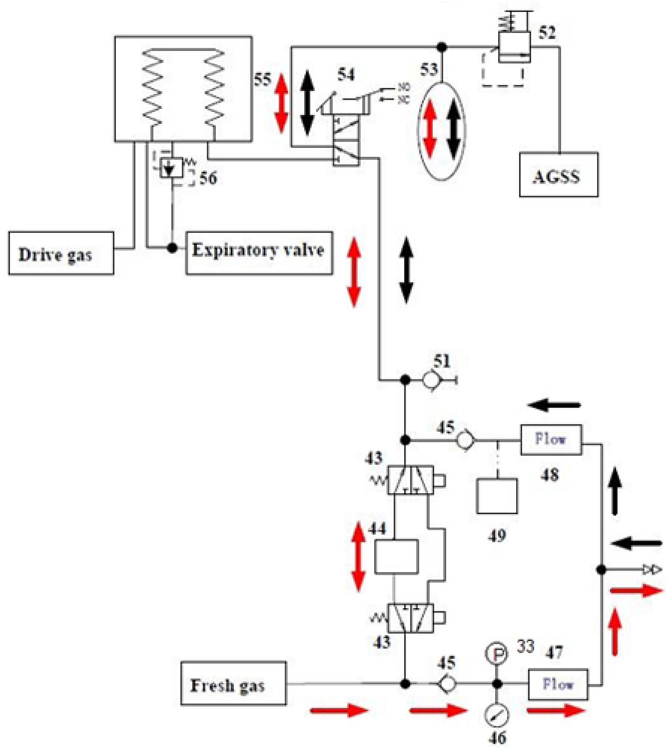


FIGURE 1-42

- Red arrows: direction of the fresh gas.
- Black arrows: direction of the patient's expired gas.

1.3.4.14.3 Gas Bench (Optional Feature)

As shown in the following figure, the gas bench is an internal path for the sample gas to return to the breathing circuit at the patient breathing end. This path must ensure that the waste gas is filtered by the CO2 absorber canister and then arrives at the inspiratory end of the patient. In this way, the waste gas can be recycled, which increases the utilization of the anesthetic gas. In the following figure, the red arrows indicate the direction of the anesthetic gas. Currently, this path is integrated into the main unit of the patient breathing circuit.

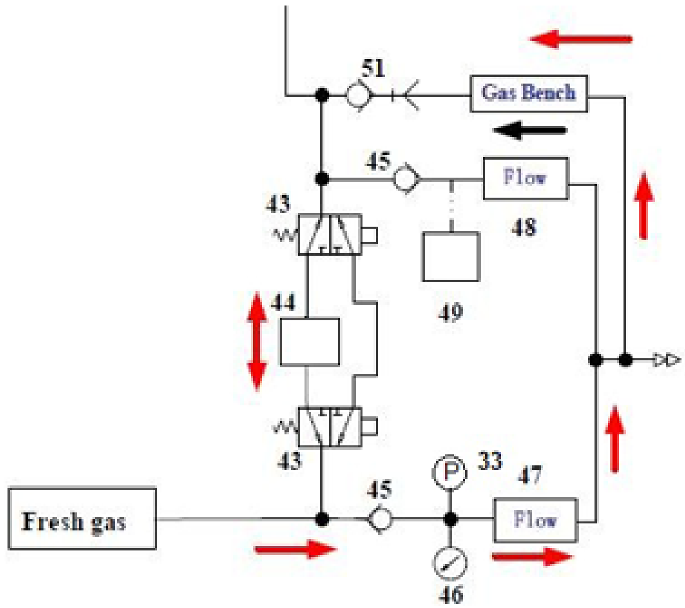


FIGURE 1-43

1.3.4.14.4 Anesthesia Calculation Module

For EPSON platform:

The following figure shows the model for electrical ACGO with sampling for anesthesia calculation.

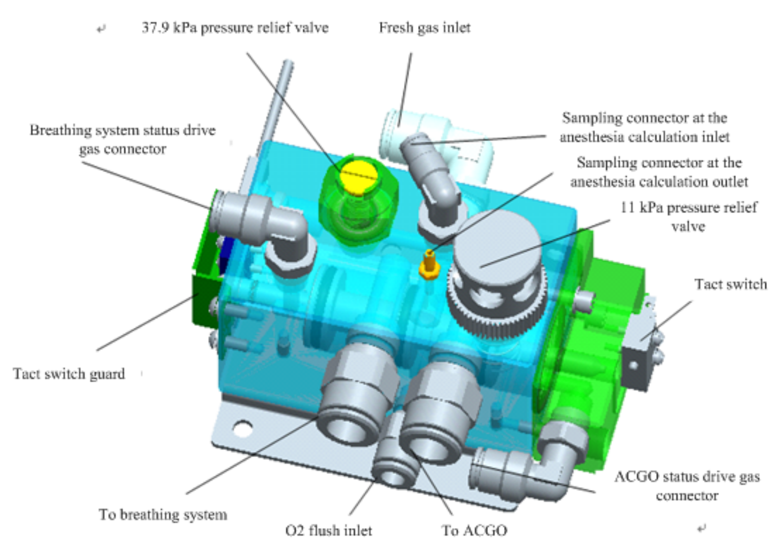


FIGURE 1-44

NOTE: **The anesthesia calculation inlet/outlet sampling connectors are relative to the inlet/outlet of the anesthesia module.**

The following figure shows the tube connection of the anesthesia calculation module.

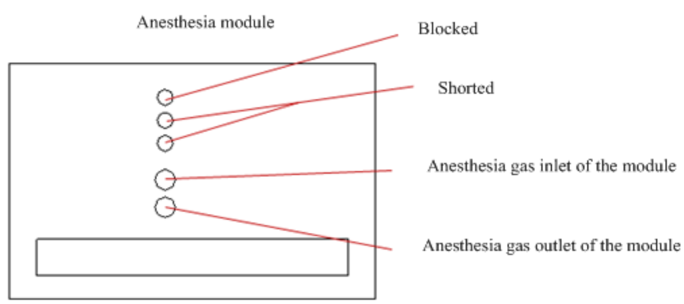


FIGURE 1-45

For DSP platform

The following figure shows the model for electrical ACGO.

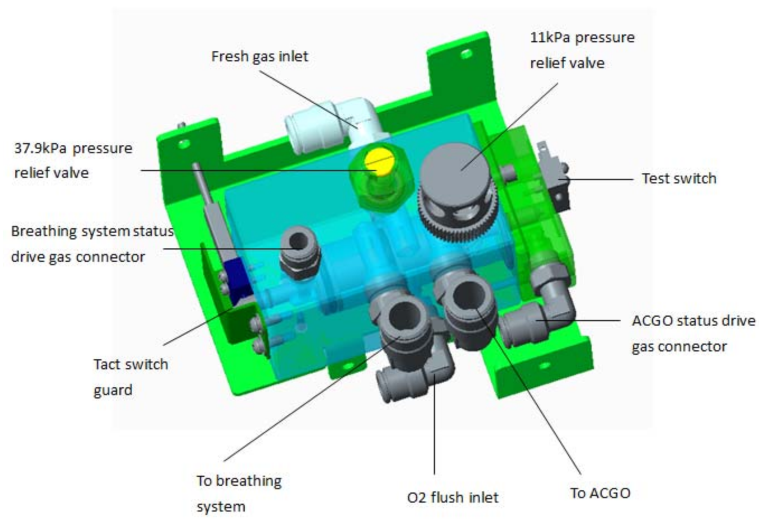


FIGURE 1-46

1.3.4.15 Anesthetic Gas Scavenging System

The Anesthetic Gas Scavenging System (AGSS) is composed of the AGSS transfer system, the AGSS receiving system, and the AGSS disposal system. Waste gas goes from the exhaust port of the anesthesia machine through the AGSS transfer system and the AGSS receiving system to the hospital's waste gas disposal system (AGSS disposal system), as shown below.

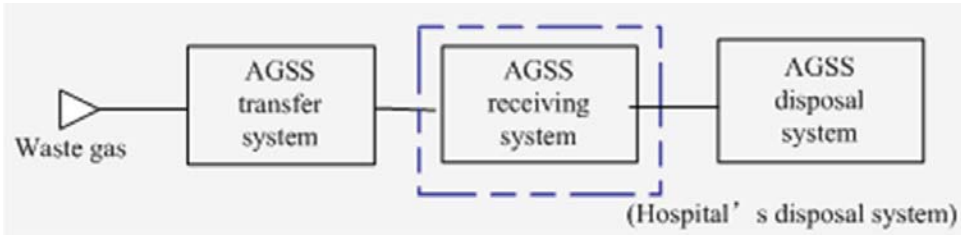


FIGURE 1-47

The following figure shows the operational theory of the AGSS. The throttling holes reduce the effect of negative pressure at the AGSS outlet onto the flow at the entrance. The float helps the user determine if the disposal system meets the requirement for the minimum pump rate. The filter provides for filtering of foreign substances to prevent the disposal system from being occluded. The gas reservoir is connected to the air through pressure compensation openings. When positive or negative pressure occurs inside the gas reservoir, gas is inputted or outputted to ensure pressure balance inside the system.

The AGSS transfer system is a clear tube with 30 mm conical connectors at both ends. The inlet of the transfer system is a female 30 mm conical connector and the outlet a male 30 mm conical connector. The transfer system is connected to the receiving system through the male 30 mm conical connector. The receiving system is connected to the receiving hose through the 30 mm connector. The following picture shows the AGSS structure and the connections between the AGSS transfer system, receiving system, and disposal system.

FIGURE 1-48

1.3.4.16 Dynamic Gas Scavenging System

The Dynamic Gas Scavenging System (DGSS) is composed of the DGSS transfer system, the DGSS receiving system, and the DGSS disposal system. Waste gas goes from the exhaust port of the anesthesia machine through the DGSS transfer system and the DGSS receiving system to the hospital's waste gas disposal system (DGSS disposal system), as shown below.

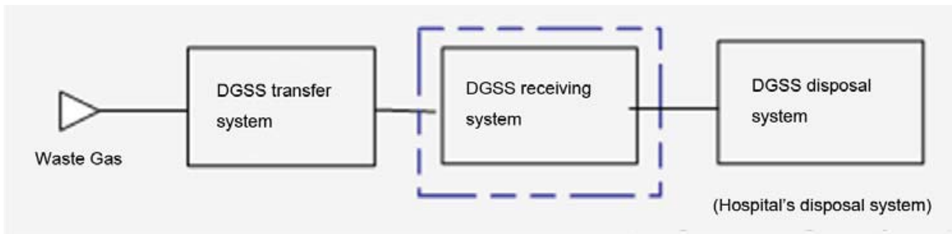


FIGURE 1-49

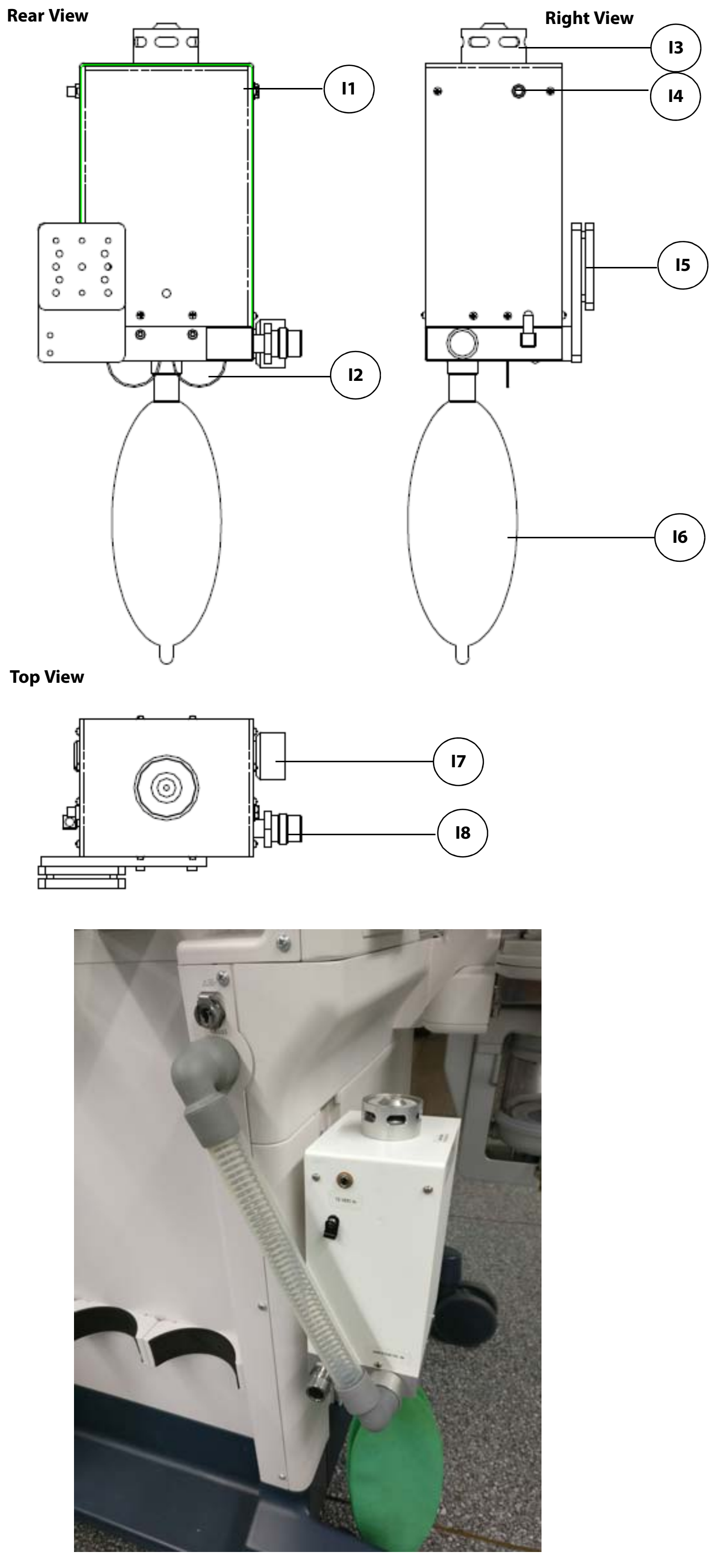


FIGURE 1-50 DGSS

PART(S)		DESCRIPTION
I1	**Power Supply Port**	Connects the DGSS to 12 V DC power supply.
I2	**Negative Pressure Valve**	Ensure there is no great negative pressure in the system.
I3	**Positive Pressure Valve**	Ensure there is no great positive pressure in the system. The positive pressure valve turns on when the pressure exceeds the setting pressure.
I4	**Power Supply Indicator**	Lit when the power supply is connected. Extinguished when the power supply is not connected.
I5	**Mounting Rail Attachment**	Allows the DGSS to be mounted on the side rail.
I6	**Reservoir Bag**	The exhaust gases flow to the reservoir bag. The exhaust gases are evacuated from the reservoir bag when the pressure is up to a threshold.
I7	**Inlet Port**	Intake for exhaust gases from the breathing system**.** The waste gas transfer hose connects the inlet port and the waste gas scavenging connector (see FIGURE 1-3) to transfer the exhaust gases.
I8	**Exhaust Port**	Exhaust port to the hospital's waste gas disposal system.

1.4 Anesthesia System Components

1.4.1 Auxiliary Outlets

The A7 anesthesia system has four 125V 15A Hospital Grade auxiliary outlets. Each outlet has one 250V 3A breaker. Additionally, a main breaker limits the combined current of the four outlets to 10A.

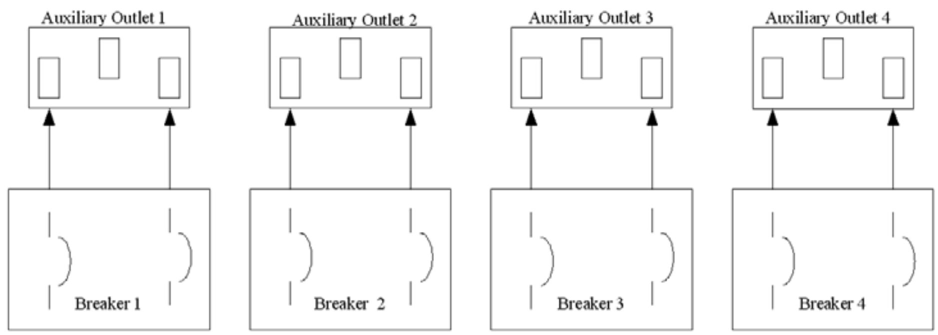


FIGURE 1-51 Auxiliary Outlet Diagram for the A7

1.4.2 Work Light Board

1.4.2.1 Top lighting board

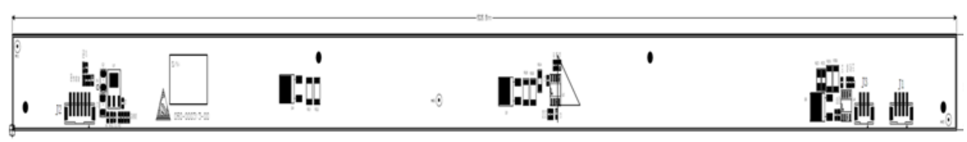


FIGURE 1-52 Top Lighting Board, Top View

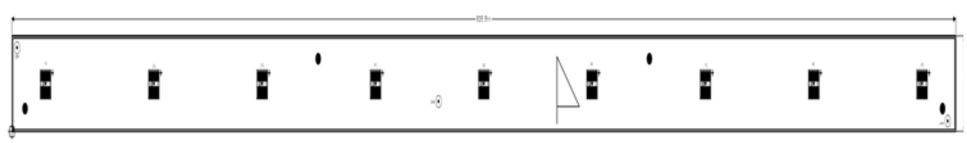


FIGURE 1-53 Top Lighting Board, Bottom View

The Flow Meter Lighting Board Interface, J1

PIN	NAME	FUNCTION
1	12V	12V Power Supply of the Flow Meter Lighting board
2	GND	Ground
3	GND	Ground
4	LIGHT_IN	Flow Meter Lighting Control Signal

Lighting Grade Option Switch Interface, J2

PIN	NAME	FUNCTION
1	HIGH_BRIGHTNESS	High Brightness Grade
2	HIGH_BRIGHTNESS	High Brightness Grade
3	OFF	Close Light Grade
4	OFF	Close Light Grade
5	LOW_BRIGHTNESS	Low Brightness Grade
6	LOW_BRIGHTNESS	Low Brightness Grade

Power Supply Interface, J3

PIN	NAME	FUNCTION
1	12V	12V Power Supply of the Top Lighting Board
2	GND	Ground
3	12V_AUX	The 12V Power Supply of the Flow Meter Lighting Board

1.4.2.2 Flow Meter Lighting Board

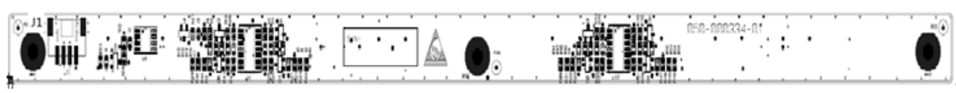


FIGURE 1-54 Flow Meter Lighting Board, Top View

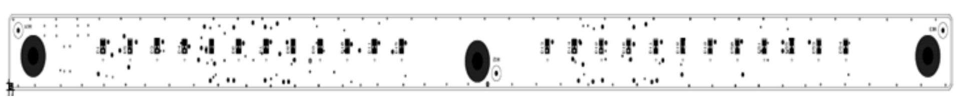


FIGURE 1-55 Flow Meter Lighting Board, Bottom View

Flow Meter Lighting Board Interface, J1

PIN	NAME	FUNCTION
1	12V	12V Power Supply of the Flow Meter Lighting board
2	GND	Ground
3	GND	Ground
4	LIGHT_IN	Flow Meter Lighting Control Signal

1.5 The Breathing System

1.5.1 Brief Introduction

The A7 breathing system supports three operating modes: mechanical ventilation, manual ventilation, and standby. These modes allow the operator to apply proper ventilation strategies based on the patient's needs.

The types of flow paths through the breathing system vary with the operating mode or status.

1.5.2 Automatic Mode, Inspiration

When the Auto/Manual switch is positioned at Auto, the system closes the manual ventilation path. Drive gas pushes down on the bellows. Gas flows from the bellows, through the CO2 absorber canister, and through the inspiratory check valve to the patient.

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

In volume mode, tidal volume is compensated for variations in fresh gas flow to ensure that the volume delivered to the patient meets the set value.

In pressure mode, the inspiratory pressure is regulated both in gas flow and airway pressure to ensure the airway pressure is held at the set inspiratory pressure during the patient inspiration.

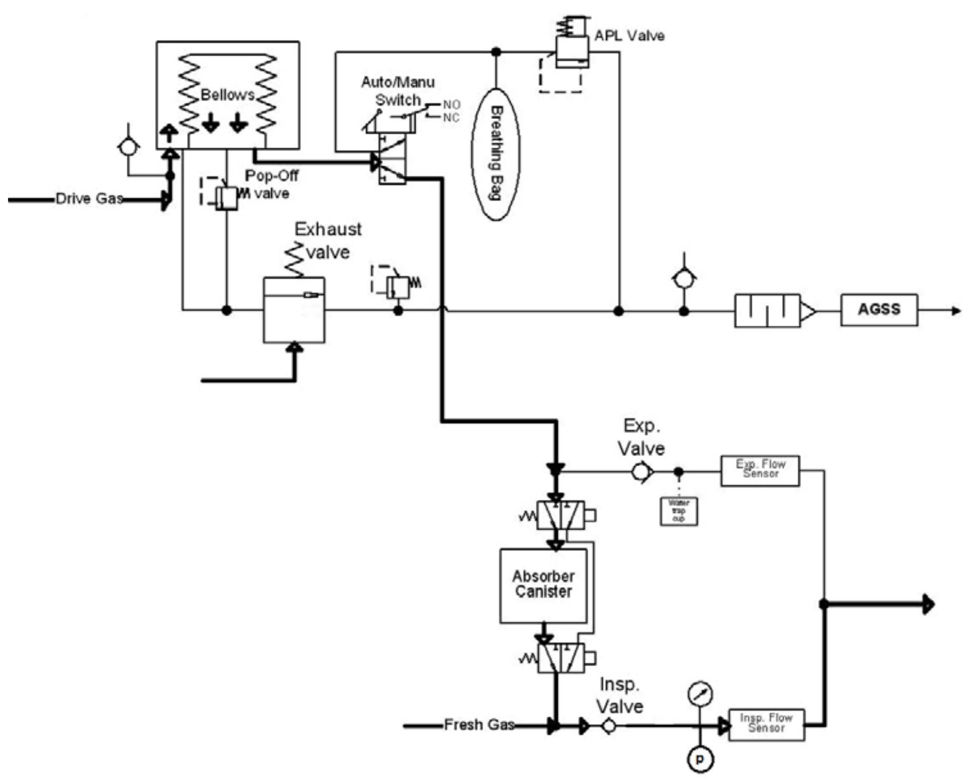


FIGURE 1-56 Automatic Mode, Inspiration Diagram

1.5.3 Automatic Mode, Expiration

When the Auto/Manual switch is set to Auto, the system closes the manual ventilation path. Drive-gas flow stops and the exhaust valve opens. Exhaled gas flows from the patient, through the expiratory check valve, and into the bellows.

Residual drive gas flows out of the bellows dome through the exhaust valve to the scavenging system (AGSS).

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

During exhalation, fresh gas flows backwards through the CO2 absorber into the expiratory limb, downstream of the expiratory check valve.

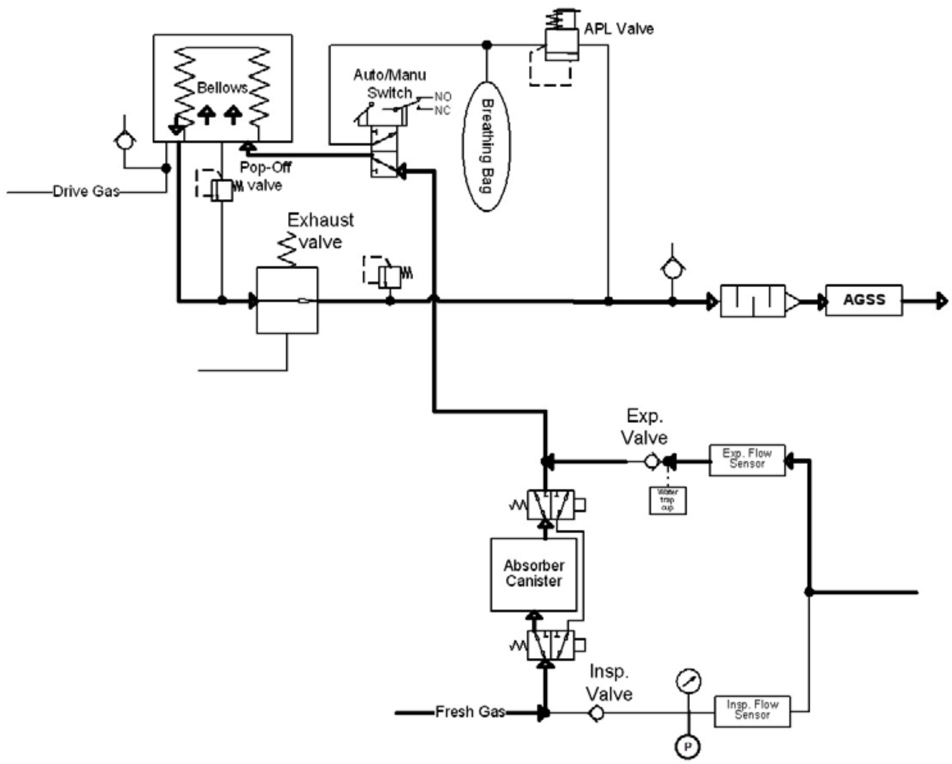


FIGURE 1-57 Automatic Mode, Expiration Diagram

1.5.4 Manual Mode, Inspiration

When the Auto/Manual switch is set to Manual, the system closes the Auto ventilation path. Gas flows from the breathing bag when compressed, through the CO2 absorber canister, into the breathing circuit, and through the inspiratory check valve to the patient.

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

If airway pressure exceeds the set value of the APL Valve, the residual gas will pass through the APL Valve to the scavenging system (AGSS).

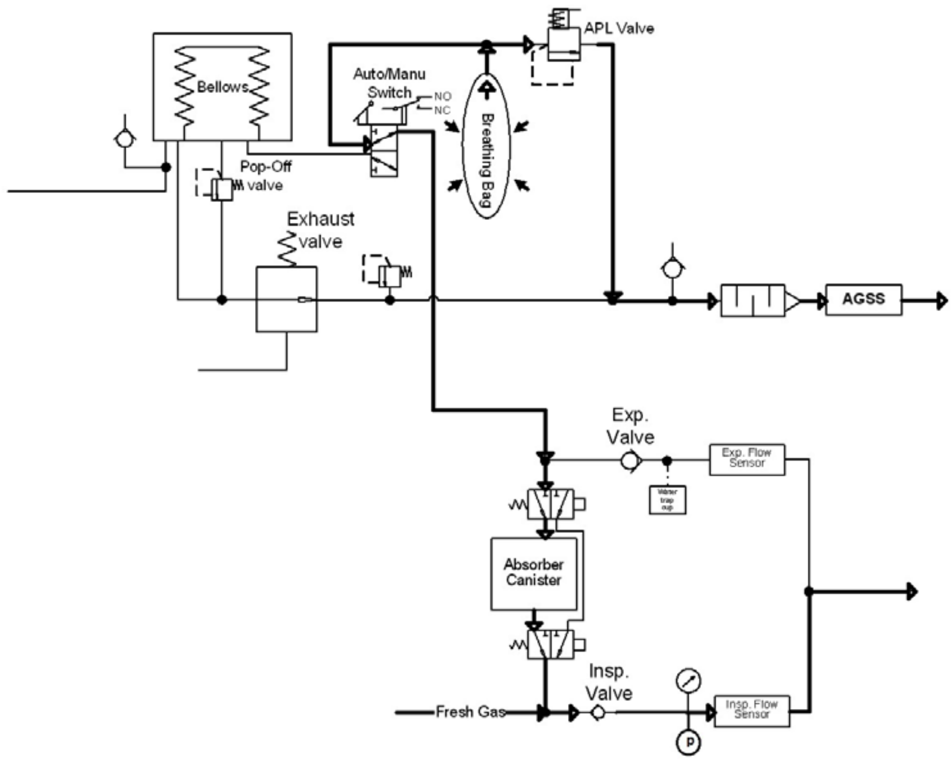


FIGURE 1-58 Manual Mode, Inspiration Diagram

1.5.5 Manual Mode, Expiration

When the Auto/Manual switch is set to Manual, the system closes the Auto ventilation path. Gas flows from the patient, through the expiratory check valve, and into the breathing bag. During exhalation, fresh gas enters the Breathing System. Residual fresh gas passes through the APL valve to the AGSS.

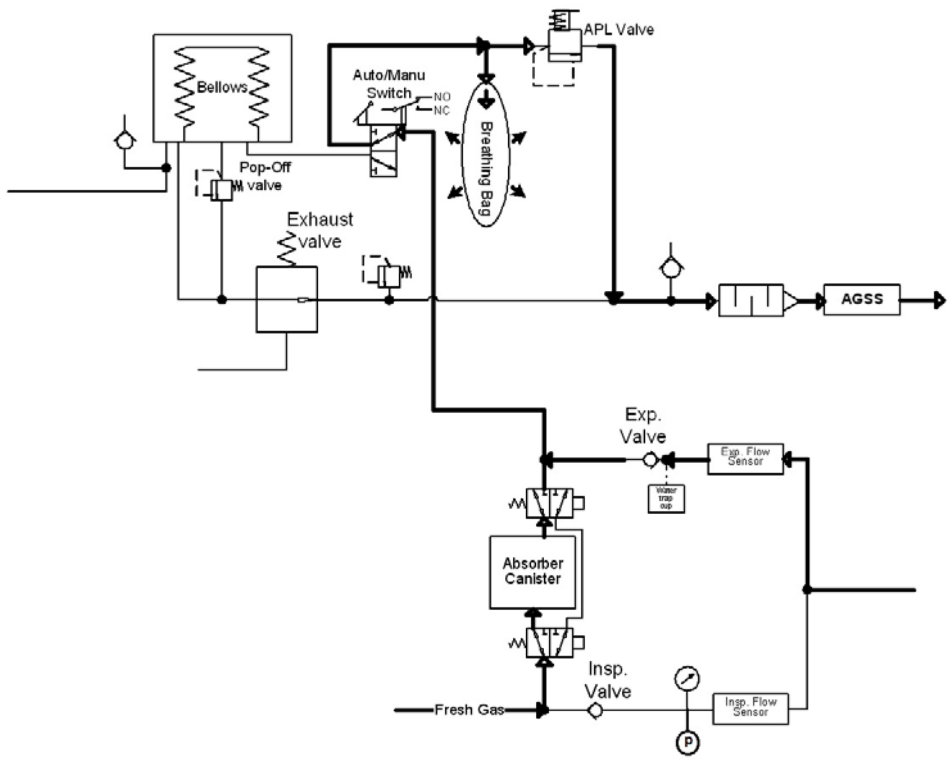


FIGURE 1-59 Manual Mode, Expiration Diagram

1.5.6 Pneumatic PEEP

The PEEP valve regulates the pressure at which the exhaust valve opens. Therefore, if PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level during the automatic ventilation.

1.5.7 Ventilator in Standby

When the anesthesia system is in standby mode, monitoring will be inactive, and automatic ventilation will be unavailable. The patient should not be ventilated when the system is in standby mode.

1.5.8 Breathing System Components

1.5.8.1 Ventilation Bellows System

The ventilator's driving system is a flow generator. Driving gas fills the bellows dome to compress the bellows. The breathing gas is pressed out of the bellows into the patient breathing circuit. The bellows is refilled with fresh gas and the expired gas from the patient.

1.5.8.2 Manual Breathing Bag

In manual mode, this device acts as a normal breathing bag, enabling the user to ventilate the patient manually.

1.5.8.3 CO2 Absorber Canister

The sodalime inside the CO2 absorber canister absorbs the carbon dioxide from the exhaled gas. The CO2 absorber canister accommodates standard sized Pre-paks or loose-fill CO2 absorbent.

1.5.8.4 Inspiratory and Expiratory Valves

To ensure correct gas flow direction to and from the patient, check-valves are integrated in the inspiratory and expiratory limb of the Breathing System.

1.5.8.5 APL (Airway Pressure Limiting) Valve

In manual mode, the APL Valve acts as a normal spring-loaded pressure relief valve, limiting the maximum pressure in the Breathing System.

1.6 Ventilator UI

1.6.1 Display

1.6.1.1 Display Interface Board

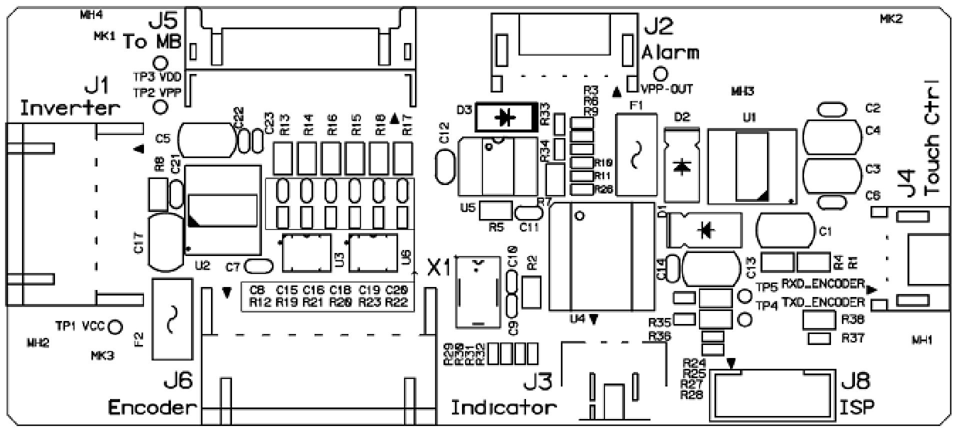


FIGURE 1-60 Display Interface Board, Top View

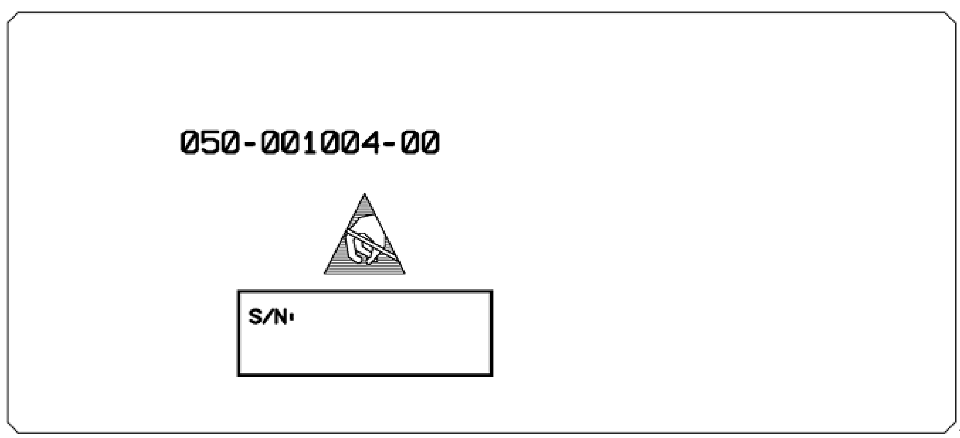


FIGURE 1-61 Display Interface Board, Bottom View

Inverter interface, J1

PIN	NAME	FUNCTION
1	12V	Inverter 12V Power Supply
2	12V	Inverter 12V Power Supply
3	GND	Ground
4	GND	Ground
5	LCD_EN	LCD Backlight Enable
6	LCD_BR	LCD Backlight Brightness Control

Warning Light Board Interface, J2

PIN	NAME	FUNCTION
1	12V	Warning Light Board 12V Power Supply
2	GND	Ground
3	SDA_CPU	CPU Board I2C Data Signal
4	SCL_CPU	CPU Board I2C Clock Signal
5	3_3V	3.3V Power Supply
6	GND	Ground

Touch Screen Control Board interface, J4

PIN	NAME	Function
1	5V	5V Power Supply
2	RXD_TOUCH_PANEL	Touch Screen Control Board Serial Port Receive Signal
3	TXD_TOUCH_PANEL	Touch Screen Control Board Serial Port Transmit Signal
4	GND	Ground

Display Control Signal Interface, J5

PIN	Name	Function
1	LCD_EN	LCD Backlight Enable
2	LCD_BR	LCD Backlight Brightness Control
3	RXD_TOUCH_PANEL	Touch Screen Control Board Serial Port Receive Signal
4	TXD_TOUCH_PANEL	Touch Screen Control Board Serial Port Transmit Signal
5	GND	Ground
6	LED_AC	AC Indicator Light Drive Signal
7	LED_BAT	Battery Indicator Light Drive Signal
8	SDA_CPU	CPU Board I2C Signal
9	SCL_CPU	CPU Board I2C Signal
10	TXD_Encoder	Serial Port Transmit Signal of the Display Interface Board
11	RXD_Encoder	Serial Port Receive Signal of the Display Interface Board
12	Lighting	Lighting Control Signal
13	USB+	USB Signal
14	USB-	USB Signal
15	Lighting_12V	Lighting 12 V Power Supply
16	12V	12V Power Supply
17	12V	12V Power Supply
18	GND	Ground
19	GND	Ground
20	GND	Ground

Display Control Signal Interface, J6

PIN	Name	Function
1	VCC	5 V Power Supply
2	GND	Ground
3	Encoder_A1	Output A of Encoder 1
4	Encoder_B1	Output B of Encoder 1
5	Encoder_Y1	Depress of Encoder 1 (Reserved)
6	Encoder_A2	Output A of Encoder 2
7	Encoder_B2	Output B of Encoder 2
8	Encoder_Y2	Depress of Encoder 2 (Reserved)

1.6.1.2 Warning Light Board

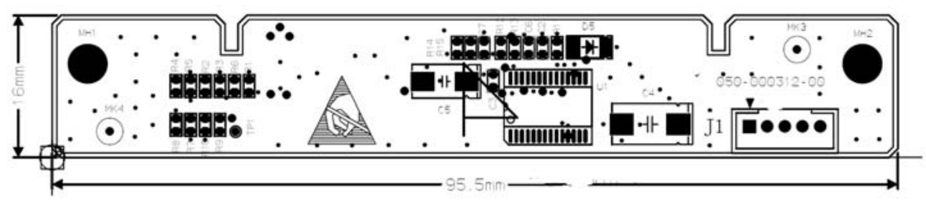


FIGURE 1-62 Warning Light Board, Top View

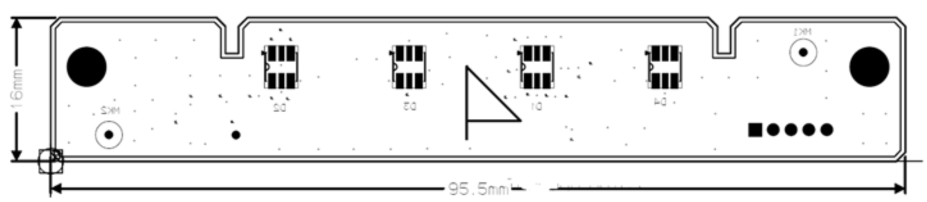


FIGURE 1-63 Warning Light Board, Bottom View

Warning Light Board Interface, J1

PIN	NAME	FUNCTION
1	12V	12V Power Supply
2	GND	Ground
3	MAIN_BRD_SDA	CPU Board I2C Data Signal
4	MAIN_BRD_SCL	CPU Board I2C Clock Signal
5	3_3V	3.3V Power Supply

1.6.1.3 Display and Touchscreen

The anesthesia machine is fitted up with a 15-inch 24-bit 1024x768 LVDS display as the main output component, and a 15-inch touchscreen as the main input component (another touchpad is available on the A7 anesthesia machine).

1.6.1.4 Other Components

The display system also includes the backlight inverter board, warningLight board, touchscreen control board and encoder board. The backlight inverterboard provides backlight for the display; the warninglight board is used for reporting visual alarms on the anesthesia machine; the touchscreen control board controls the inputs through the touchscreen and sends processed touchscreen operation information through a serial port.

1.6.1.5 Backlight Inverter Board

NOTE: System will have a Backlight Inverter Board or a Screen Backlight Board.

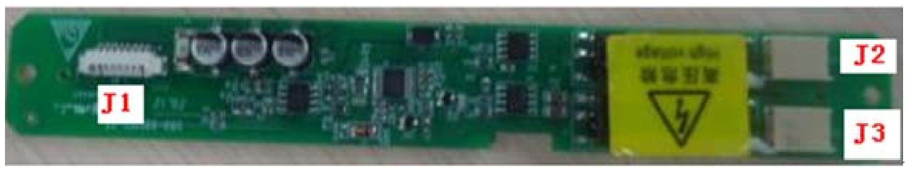


FIGURE 1-64 Backlight Inverter Board, Top View

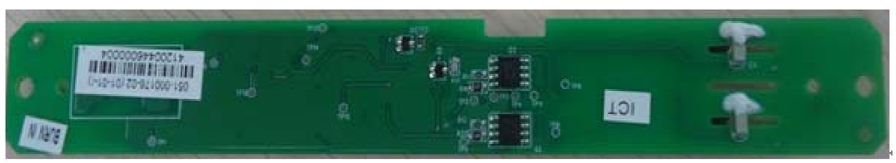


FIGURE 1-65 Backlight Inverter Board, Bottom View

Inverter Board Interface, J1

PIN	NAME	FUNCTION
1	GND	Ground
2	GND	Ground
3	GND	Ground
4	BL_ADJ	Display Brightness Control Signal
5	BL_ON/OFF	Inverter Enable Signal
6	12V	12V Power Supply
7	12V	12V Power Supply
8	12V	12V Power Supply

Inverter Board Interface, J2 and J3

PIN	NAME	FUNCTION
1	High_Voltage	High-Voltage Output of the Inverter
2	Low_Voltage	Low-Voltage Output of the Inverter

1.6.1.6 Screen Backlight Board

NOTE: System will have a Backlight Inverter Board or a Screen Backlight Board.

FIGURE 1-66 Screen Backlight Board, Top View

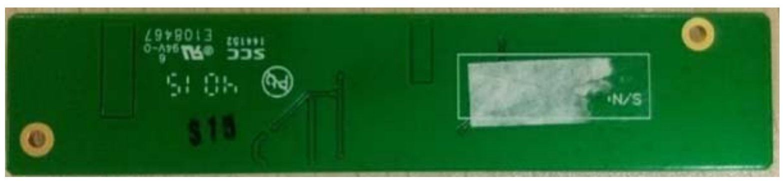


FIGURE 1-67 Screen Backlight Board, Bottom View

Screen Backlight Board Interface, J1

PIN	NAME	FUNCTION
1	VPP	12V Power Supply
2	GND	Ground
3	BCON	Screen Backlight Enable Signal
4	DIMMING	Screen Backlight Control Signal
5	NC	None Connection

Screen Backlight Board Interface, J2

PIN	NAME	FUNCTION
1	GND	Ground
2	PWM	Screen Backlight Control PWM Signal
3	LED_EN	Screen Backlight Enable Signal
4	VPP	12V Power Supply

1.6.1.7 Touchscreen Control Board

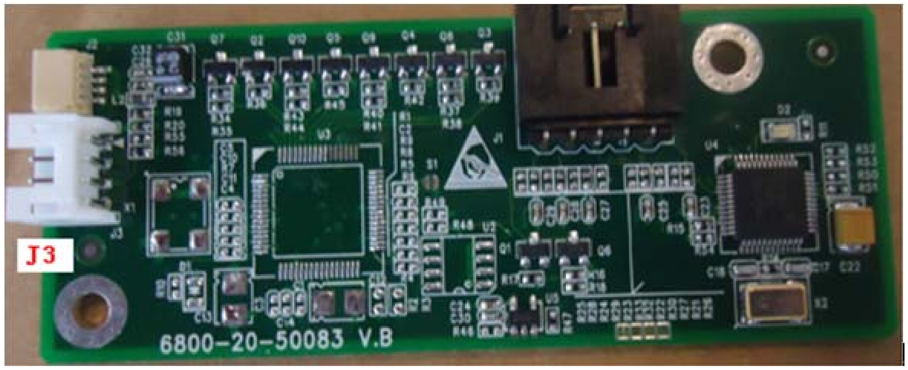


FIGURE 1-68 Touchscreen Control Board, Top View

FIGURE 1-69 Touchscreen Control Board, Top View

Touchscreen Control Board Interface, J3

PIN	NAME	FUNCTION
1	VCC	5 V Power Supply
2	RXD_touch	Serial Port Receive Signal of the Touchscreen Control Board
3	TXD_touch	Serial Port Transmit Signal of the Touchscreen Control Board
4	GND	Ground

1.6.1.8 Encoder Board

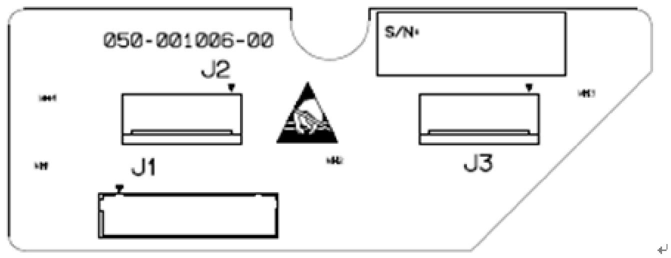


FIGURE 1-70 Encoder Board, Top View

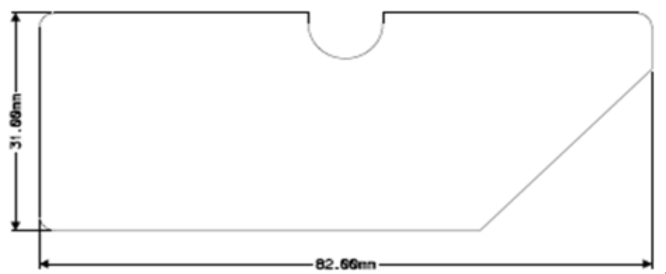


FIGURE 1-71 Encoder Board, Bottom View

Encoder Board Interface, J1

PIN	NAME	FUNCTION
1	VCC	5 V Power Supply (range: 4.75V~5.25V)
2	GND	Ground
3	Encoder_A1	Output A of Encoder 1
4	Encoder_B1	Output B of Encoder 1
5	Encoder_Y1	Depress of Encoder 1 (Reserved)
6	Encoder_A2	Output A of Encoder 2
7	Encoder_B2	Output B of Encoder 2
8	Encoder_Y2	Depress of Encoder 2 (Reserved)

Fresh Flow Sensor Board Interface, J2 and J3

PIN	NAME	FUNCTION
1	VCC	5 V Power Supply
2	Encoder_A	Output A of Encoder
3	Encoder_B	Output B of Encoder
4	Encoder_Y	Depress of Encoder (Reserved)
5	GND	Ground
6	GND	Ground

1.6.1.9 Indicator Light Board

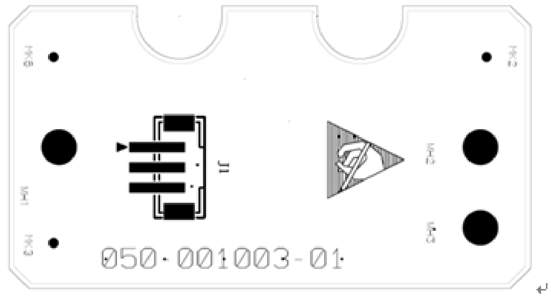


FIGURE 1-72 Indicator Light Board, Top View

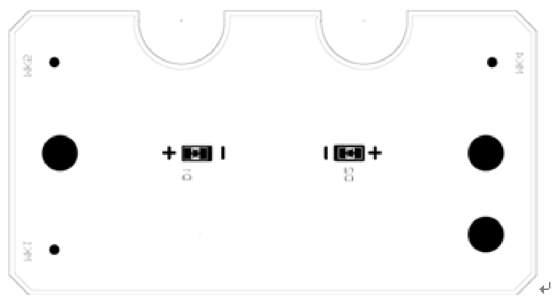


FIGURE 1-73 Indicator Light Board, Bottom View

Indicator Light Board interface, J1

PIN	NAME	FUNCTION
1	LED_BAT	Battery Indicator Light Drive Signal
2	LED_AC	AC Indicator Light Drive Signal
3	GND	Ground

1.6.2 CPU Board

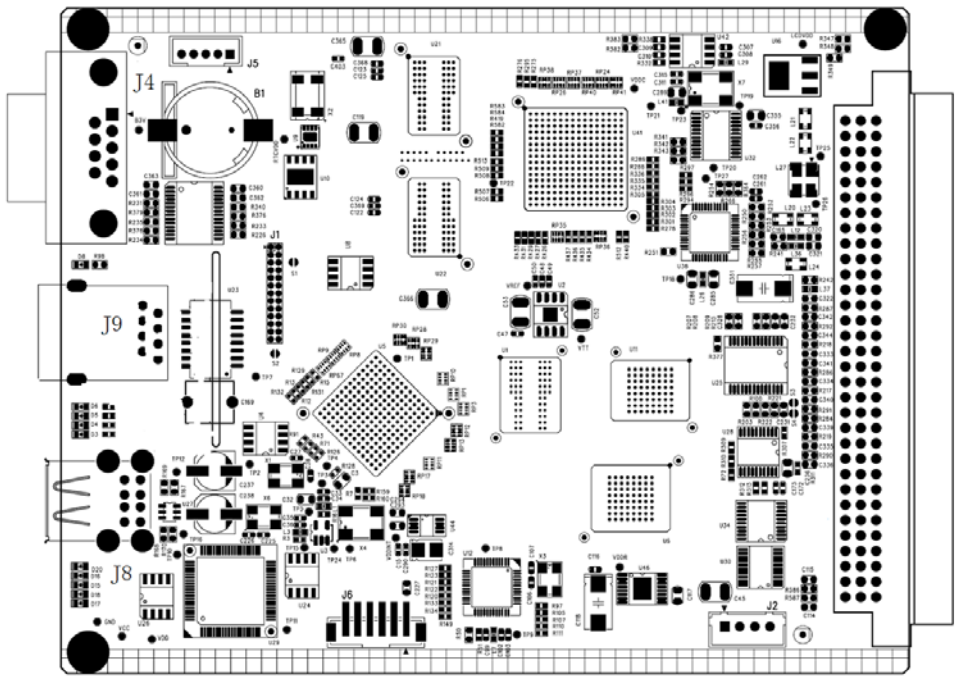


FIGURE 1-74 CPU Board, Top View

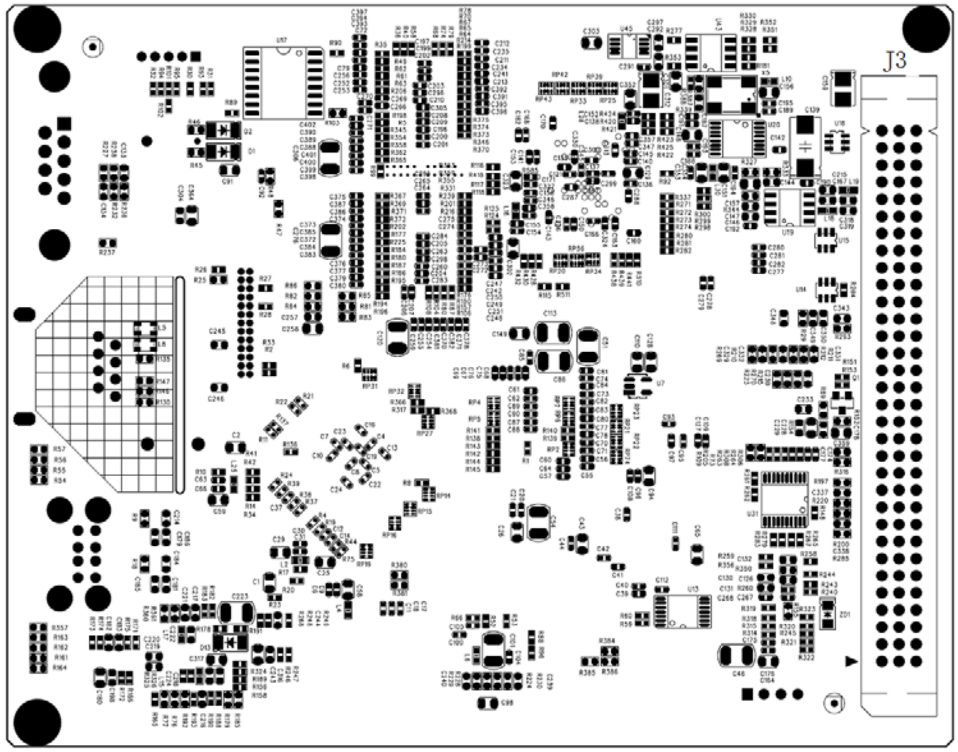


FIGURE 1-75 CPU Board, Bottom View

Network Port, J9

PIN	NAME	FUNCTION
1	TX+	Positive End of Transmit Signal
2	TX-	Negative End of Transmit Signal
3	RX+	Positive End of Receive Signal
4	CT1	No Definition
5	CT1	No Definition
6	RX-	Negative End of Receive Signal
7	CT2	No Definition
8	CT2	No Definition

USB Interface, J8

PIN	NAME	FUNCTION
1	VCC	USB Power Supply
2	DM0	USB Data Signal – (Negative)
3	DP0	USB Data Signal + (Positive)
4	GND	Ground
5	VCC	USB Power Supply
6	DM1	USB Data Signal – (Negative)

PIN	NAME	FUNCTION
7	DP1	USB Data Signal + (Positive)
8	GND	Ground

RS-232 Interface, J4

PIN	NAME	FUNCTION
1	NC	No Connection
2	RXD	RS-232 Receive Signal
3	TXD	RS-232 Transmit Signal
4	NC	No Connection
5	GND	Ground
6	NC	No Connection
7	NC	No Connection
8	NC	No Connection
9	NC	No Connection

1.7 Ventilator Control and Drive

1.7.1 Mother Board

The mother board provides signal interfaces for all boards and electrical components.

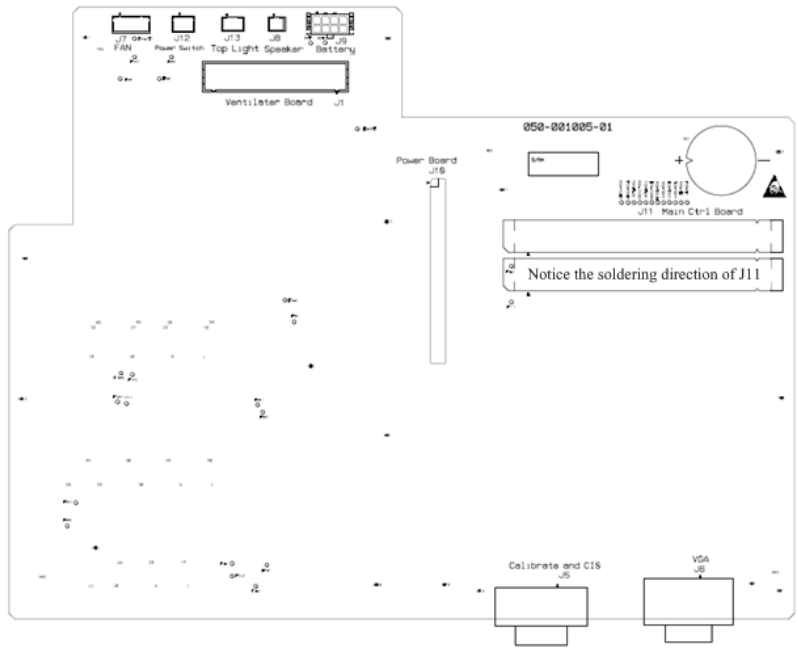


FIGURE 1-76 Mother Board, Top View

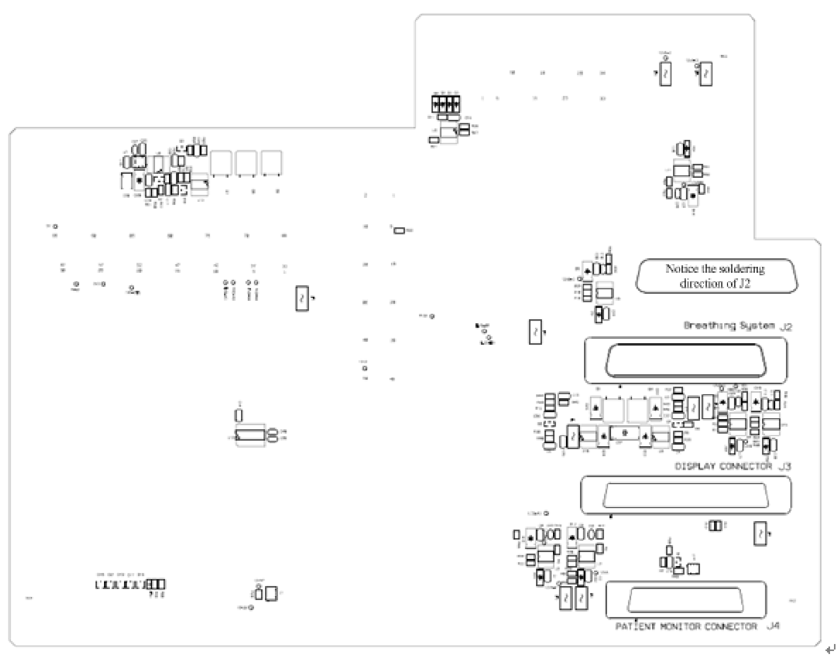


FIGURE 1-77 Mother Board, Bottom View

VCM Interface, J1

PIN	NAME	FUNCTION
1	SAFE_VALVE	Pressure Relief Valve Drive Signal
2	7VIN	Inspiration Valve Drive Signal
3	INSP_VALVE	Inspiration Valve Drive Signal
4	7VIN_or_5VIN	PEEP Valve Drive Signal
5	PEEP_VALVE	PEEP Valve Drive Signal
6	SOLENOID_VALVE1	Three-way Valve 1
7	SOLENOID_VALVE2	Three-way Valve 2
8	SOLENOID_VALVE3	Three-way Valve 3
9	SOLENOID_VALVE4	Three-way Valve 4
10	PNEUM_PRES_SW	Pneumatic Block Pressure Switch Signal
11	NC	No Connection
12	ACGO_SW	ACGO Tact Switch Signal
13	O2_PRE_SW	O2 Pressure Switch Signal at Gas Supply Inlet
14	MANU_AUTO_SW	Auto/Manual Switch Signal
15	GND	Ground
16	CO2_BYPASS_SW	Circuit CO2 Absorber Canister Signal
17	O2+	O2 Concentration Signal
18	O2-	O2 Concentration Signal
19	TXD_AUX_BRD	VPM Serial Port Transmit Signal
20	RXD_AUX_BRD	VPM Serial Port Receive Signal
21	GND	Ground
22	SDA	IIC Data Signal
23	SCL	IIC Clock Signal
24	VT	Thermal Mass Flow Sensor Temperature Signal
25	VF	Differential Pressure Sensor Flow Signal
26	GND	Ground
27	TXD_MON_BRD	VCM Serial Port Transmit Signal
28	RXD_MON_BRD	VCM Serial Port Receive Signal
29	12V	12V Power Supply
30	GND	Ground
31	5V	VCM Close Pressure Relief Valve Signal
32	5V	5V Power Supply
33	TXD_CALIBRATE	Calibration Serial Port Transmit Signal
34	RXD_CALIBRATE	Calibration Serial Port Receive Signal
35	GND	Ground
36	12V	12V Power Supply

Pneumatic Assembly Interface, J2

PIN	NAME	FUNCTION
1	7Vout_or_5Vout	Pressure Relief Valve Power Supply
2	SAFE_VALVE	Pressure Relief Valve Drive Signal

PIN	NAME	FUNCTION
3	7Vout	Inspiration Valve Power Supply
4	INSP_VALVE	Inspiration Valve Drive Signal
5	7Vout_or_5Vout	PEEP Valve Power Supply
6	PEEP_VALVE	PEEP Valve Drive Signal
7	ACGO+	Positive End of the ACGO Valve Drive Signal
8	ACGO-	Negative End of the ACGO Valve Drive Signal
9	VBB1	Electromagnet Power Supply
10	GND	Ground
11	12VB_4	Stepper Motor Power Supply
12	GND	Ground
13	12VB_5	Reserved Three-Way Valve Power Supply
14	VBB2	Power Supply of the EFCS VCM CPU And Total Flow Meter Backlight
15	GND	Ground
16	12VB_2	Power Supply of the EFCS VCM
17	GND	Ground
18	VF	Differential Pressure Sensor Flow Signal
19	12VA_4	12 V Power Supply
20	GND	Ground
21	12VB_3	Proportional Valve Power Supply (range: 10.8V~13.2V)
22	GND	Ground
23	ACGO_switch	ACGO Pressure Switch Signal
24	GND	Ground
25	O2_PRE_SW	O2 Pressure Switch Signal at Gas Supply Inlet
26	GND	Ground
27	PNEUM_PRES_SW	Pneumatic Block Pressure Switch Signal
28	GND	Ground
29	MANU_AUTO_SW	Auto/Manual Switch Signal
30	GND	Ground
31	CO2_BYPASS_SW	Circuit CO2 Absorber Canister Signal
32	GND	Ground
33	NC	No Connection
34	GND	Ground
35	O2+	O2 Concentration Signal
36	O2-	Ground
37	LOOP_SW	Circuit Switch
38	GND	Ground
39	NTC_R11	Signal of Thermistor 1
40	NTC_R12	Signal of Thermistor 2
41	NTC_R21	Signal of Thermistor 1
42	NTC_R22	Signal of Thermistor 2
43	HEA_PWR_15V	Heater Drive Voltage Signal
44	HEA_PWR_15V	Heater Drive Voltage Signal
45	GND	Ground

PIN	NAME	FUNCTION
46	GND	Ground
47	12VA_1	Electronic Flowmeter Power Supply
48	GND	Ground
49	RXD_FLOW_BRD	Electronic Flowmeter Serial Port Receive Signal
50	TXD_FLOW_BRD	Electronic Flowmeter Serial Port Transmit Signal

Display Interface, J3

PIN	NAME	FUNCTION
1	LCD_EN	Inverter Enable Signal
2	LCD_BR	Inverter Brightness Adjustment Signal
3	RXD_TOUCH_PANEL	Touch Screen Control Board Serial Port Receive Signal
4	TXD_TOUCH_PANEL	Touch Screen Control Board Serial Port Transmit Signal
5	NC	No Connection
6	LED_AC	AC Indicator Light Drive Signal
7	LED_BAT	Battery Indicator Light Drive Signal
8	MAIN_BRD_SDA	CPU Board I2C Signal
9	MAIN_BRD_SCL	CPU Board I2C Signal
10	TXD_KEY	Serial Port Transmit Signal of the Display Interface Board
11	RXD_KEY	Serial Port Receive Signal of the Display Interface Board
12	Lighting	Lighting Control Signal
13	USB+	USB Data Signal+
14	USB-	USB Data Signal-
15	Lighting_12V	Lighting 12 V Power Supply (range: 10.8V~13.2V)
16	12V	12V Power Supply
17	GND	Ground
18	GND	Ground
19	VCC_LCD	Optional Backplane Power Supply or CPU Board Power Supply for Display
20	VCC_LCD	Optional Backplane Power Supply or CPU Board Power Supply for Display
21	GND	Ground
22	GND	Ground
23	LVDS_DATA0+	LVDS Data Difference to Positive Signal 0
24	LVDS_DATA0-	LVDS Data Difference to Negative Signal 0
25	GND	Ground
26	LVDS_DATA1+	LVDS Data Difference to Positive Signal 1
27	LVDS_DATA1-	LVDS Data Difference to Negative Signal 1
28	GND	Ground
29	LVDS_DATA2+	LVDS Data Difference to Positive Signal 2
30	LVDS_DATA2-	LVDS Data Difference to Negative Signal 2
31	GND	Ground
32	LVDS_DATA3+	LVDS Data Difference to Positive Signal 3
33	LVDS_DATA3-	LVDS Data Difference to Negative Signal 3

PIN	NAME	FUNCTION
34	GND	Ground
35	LVDS_CLK+	LVDS Clock Difference to Positive Signal
36	LVDS_CLK-	LVDS Clock Difference to Negative Signal
37	GND	Ground

Infrared Module Rack Interface for Patient Monitor, J4

PIN	NAME	FUNCTION
1	LED_AC	AC Indicator Light Drive Signal
2	3V3_Gasbench	3.3V Power Supply
3	12VA_6	12V Power Supply
4	12VA_6	12V Power Supply
5	GND	Ground
6	GND	Ground
7	RXD_Infrared Comm Board	Infrared Comm Board Serial Port Receive Signal
8	TXD_Infrared Comm Board	Infrared Comm Board Serial Port Transmit Signal
9	12VA_5	12V Power Supply
10	Fan_PWM2	PWM Driver Signal for Fan
11	Fan_State2	State Detection Signal for Fan
12	GND	Ground
13	LED_BAT1	Battery Indicator Light Drive Signal
14	ACGO_State1	ACGO State Detection Signal 1
15	ACGO_State2	ACGO State Detection Signal 2
16	PCON+	Power ON/OFF Circuit 3.3V
17	PCON-	Power ON/OFF Signal
18	TOUCHPAD_5V	5V Power Supply
19	TOUCHPAD_GND	Ground
20	TOUCHPAD_USB+	TOUCHPAD_USB Difference to Positive Signal
21	TOUCHPAD_USB-	TOUCHPAD_USB Difference to Negative Signal
22	12VA_1	12V Power Supply
23	GND	Ground
24	RSVDRXD_AG	Built-in AG Module Receive Signal
25	RSVDTXD_AG	Built-in AG Module Transmit Signal

Calibration Interface, J5

PIN	NAME	FUNCTION
1	NC	No Connection
2	NC	No Connection
3	NC	No Connection
4	NC	No Connection
5	NC	No Connection

PIN	NAME	FUNCTION
6	12V	12V Power Supply
7	RXD_CALIBRATE	Calibration Serial Port Receive Signal
8	TXD_CALIBRATE	Calibration Serial port Transmit Signal
9	GND	Ground

Anesthetic Ventilator Cooling Fan Interface, J7

PIN	NAME	FUNCTION
1	12VA_3	12V Power Supply
2	RSVD	Reserved
3	FAN1_STATE	Fan Status Signal
4	GND	Ground

Speaker Interface, J8

PIN	NAME	FUNCTION
1	Speak+	Speaker Positive End
2	Speak-	Speaker Negative End

Battery Adaptation Board Interface, J9

PIN	NAME	FUNCTION
1	BAT1+	Battery Voltage
2	NTC1	Battery Internal Thermistor
3	BC1	Battery In-position Signal
4	GND	Ground
5	BAT2+	Battery Voltage
6	NTC2	Battery Internal thermistor
7	BC2	Battery In-position Signal
8	GND	Ground

Power Board Interface, J10

PIN	NAME	FUNCTION
1	PLAM	Buzzer Drive Signal (drives the buzzer directly)
2	RXD_PWR_BRD	Power Board Serial Port (receives signal)
3	LOOP_SW	Circuit Switch (reflects if the circuit is in position)
4	TXD_PWR_BRD	Power Board Serial Port (transmits signal)
5	NC	Power Board Cooling Fan Drive
6	GND	Ground
7	LED-BAT	Battery Status Indicator Light Drive Output
8	LCD_EN	Backlight Enable Signal
9	LED-AC	AC Status Indicator Light Drive Output
10	LCD_BR	Backlight Brightness Control Voltage

PIN	NAME	FUNCTION (Continued)
11	PCON-	Power ON/OFF Signal, LVTTL Pulse Signal. If this signal is high level, the system is turned on; if this signal is low level, the system is turned off.
12	3.3VBF	3.3V only used for power ON/OFF the machine
13	BAT2+	2# Battery Input, connect to battery positive end
14	GND	Ground
15	BC2F	2# Battery Availability Signal. Low level indicates battery available; high level indicates battery unavailable
16	NTC2	2# Lithium-ion Battery Internal Thermistor Signal
17	BAT1+	1# Battery Input, connect to battery positive end
18	GND	Ground
19	BC1F	1# Battery Availability Signal. Low level indicates battery available; high level indicates battery unavailable
20	NTC1	1# Lithium-ion Battery Internal Thermistor Signal
21	GND	Ground
22	GND	Ground
23	HEA_PWR_15V	Heat Wire Drive Voltage Output
24	HEA_PWR_15V	Heat Wire Drive Voltage Output
25	NTC_R12	Thermistor (for controlling heat wire) Pin 1
26	NTC_R22	Thermistor (for controlling heat wire) Pin 2
27	NTC_R11	Thermistor (for controlling heat wire) Pin 1
28	NTC_R21	Thermistor (for controlling heat wire) Pin 2
29	GND	Ground
30	GND	Ground
31	3V3	3.3V Supply Voltage Output
32	3V3	3.3V Supply Voltage Output
33	5V	5V Supply Voltage Output
34	GND	Ground
35	GND	Ground
36	GND	Ground
37	12VB	#2 12V Power Supply Voltage Output
38	GND	Ground
39	12VB	#2 12V Power Supply Voltage Output
40	12VB	#2 12V Power Supply Voltage Output
41	GND	Ground
42	GND	Ground
43	12VA	#1 12V Power Supply Voltage Output
44	GND	Ground
45	12VA	#1 12V Power Supply Voltage Output
46	12VA	#1 12V Power Supply Voltage Output
47	NC	No Connection
48	15V2	15.2V Supply Voltage Output
49	NC	No Connection
50	15V2	15.2V Supply Voltage Output

CPU Board Interface, J11

PIN	NAME	FUNCTION
A1	LCD_VDD	LCD Power Supply
A2	GND	LCD Ground
A3	NC	No Connection
A4	NC	No Connection
A5	RXD_HW_OR_JH	Infrared Backplane or Patient Monitor Receive Signal
A6	TXD_HW_OR_JH	Serial Port Receive SignalInfrared Backplane or Patient Monitor Transmit Signal
A7	GND	Ground
A8	RXD_AG	Built-in AG Module Receive Signal
A9	TXD_AG	Built-in AG Module Transmit Signal
A10	GND	Ground
A11	UIVCC_USB	USB Power Supply
A12	TOUCHPAD_USB+	TOUCHPAD_USB Data Signal +
A13	TOUCHPAD_USB-	TOUCHPAD_USB Data Signal -
A14	GND	Ground
A15	SCL_CPU	CPU Board I2C Clock
A16	SDA_CPU	CPU Board I2C Data
A17	GND	Ground
A18	MAIN_ACGO_CTRL2	ACGO Control Signal 2
A19	NC	No Connection
A20	ACGO_State1	ACGO State Signal 1
A21	NC	No Connection
A22	FAN_STATE2	Fan State Detected Signal 2
A23	FAN_STATE1	Fan State Detected Signal 1
A24	GND	Ground
A25	3V3	CPU Board Main Power Supply
A26	3V3	CPU Board main Power Supply
A27	GND	Ground
A28	GND	Ground
A29	5V	CPU Board Interface Chip Power Supply
A30	5V	CPU Board Interface Chip Power Supply
A31	GND	Ground
A32	GND	Ground
B1	NC	Not Connected
B2	NC	Not Connected
B3	NC	Not Connected
B4	SPK_OUT+	Speaker Drive Signal +
B5	SPK_OUT-	Speaker Drive Signal -
B6	GND	Ground
B7	VGA_Red	VGA Red Signal
B8	VGA_Green	VGA Green Signal
B9	VGA_Blue	VGA Blue Signal

PIN	NAME	FUNCTION (Continued)
B10	VGA_HSYNC	VGA Line Frequency Signal
B11	VGA_VSYNC	VGA Field Frequency Signal
B12	GND	Ground
B13	TXD_PWR_BRD	Power Board Serial Port Transmit Signal
B14	RXD_PWR_BRD	Power Board Serial Port Receive Signal
B15	GND	Ground
B16	TXD_FLOW_BRD	Fresh Flow Sensor Board Serial Port Transmit Signal
B17	RXD_FLOW_BRD	Fresh Flow Sensor Board Serial Port Receive Signal
B18	GND	Ground
B19	TXD_TOUCH_PANEL	Touch Screen Controller Serial Port Transmit Signal
B20	RXD_TOUCH_PANEL	Touch Screen Controller Serial Port Receive Signal
B21	OUT2	Backup Output
B22	ACGO_State2	ACGO State Signal 2
B23	GND	Ground
B24	NC	No Connection
B25	DISPLAY_USB-	Display Interface Board USB Data Signal-
B26	DISPLAY_USB+	Display Interface Board USB Data Signal+
B27	GND	Ground
B28	NC	No Connection
B29	NC	No Connection
B30	NC	No Connection
B31	NC	No Connection
B32	NC	No Connection
C1	GND	Ground
C2	LVDS-TO0+	LVDS Data Signal
C3	LVDS-TO0-	LVDS Data Signal
C4	GND	Ground
C5	LVDS-TO1+	LVDS Data Signal
C6	LVDS-TO1-	LVDS Data Signal
C7	GND	Ground
C8	LVDS-TO2+	LVDS Data Signal
C9	LVDS-TO2-	LVDS Data Signal
C10	GND	Ground
C11	LVDS-TO3+	LVDS Data Signal
C12	LVDS-TO3-	LVDS Data Signal
C13	GND	Ground
C14	LVDS-TOC+	LVDS Clock Signal
C15	LVDS-TOC-	LVDS Clock Signal
C16	GND	Ground
C17	TXD_MON_BRD	Ventilator Control Board Serial Port Transmit Signal
C18	RXD_MON_BRD	Ventilator Control Board Serial Port Receive Signal
C19	GND	Ground

PIN	NAME	FUNCTION (Continued)
C20	TXD_AUX_BRD	Auxiliary Ventilator Control Board Serial Port Transmit Signal
C21	RXD_AUX_BRD	Auxiliary Ventilator Control Board Serial Port Receive Signal
C22	GND	Ground
C23	RXD_KEY	Serial Port Receive Signal of the Display Interface Board
C24	TXD_KEY	Serial Port Transmit Signal of the Display Interface Board
C25	GND	Ground
C26	TP_PWR_CTRL	Touch Pad Power Supply Control Signal
C27	MAIN_ACGO_CTRL1	ACGO Valve Control Signal 1
C28	FAN_PWM1	Fan Control Signal
C29	FAN_PWM2	Fan Control Signal
C30	IN1	Backup Input Signal
C31	NC	No Connection
C32	NC	No Connection

Debugging Power ON/OFF Interface, J12

PIN	NAME	FUNCTION
1	PCON+	Power ON/OFF Signal
2	PCON-	Power ON/OFF Signal

Test Point Definition

DESIGNATOR	NAME	FUNCTION	RANGE (Unit: V)
T1	BAT1	Lithium-ion Battery Voltage 1	Fully charged 12.6±5%
T2	BAT2	Lithium-ion Battery Voltage 2	Fully charged 12.6±5%
T3	LED_BAT	Battery Indicator Light Drive Signal	With battery: 2.5~3.5; Without battery: 0~0.4
T4	TXD_7024	Auxiliary Ventilator Control Board Serial Port Transmit Signal	High level 2.4~5; Low level 0~0.4
T5	TXD_TOUCH	Touch Screen Controller Serial Port Transmit Signal	High level 2.4~5; Low level 0~0.4
T6	RXD_7024	Auxiliary Ventilator Control Board Serial Port Receive Signal	High level 2.4~5; Low level 0~0.4
T7	RXD_TOUCH	Touch Screen Controller Serial Port Receive Signal	High level 2.4~5; Low level 0~0.4
T8	TXD_33209	VPM Serial Port Transmit Signal	High level 2.4~5; Low level 0~0.4
T9	TXD_FLOW	Fresh Flow Sensor Board Serial Port Transmit Signal	High level 2.4~5; Low level 0~0.4
T10	RXD_33209	VPM Serial Port Receive Signal	High level 2.4~5; Low level 0~0.4
T11	RXD_FLOW	Fresh Flow Sensor Board Serial Port Receive Signal	High level 2.4~5; Low level 0~0.4
T12	TXD_POWER	Power Board Serial Port Transmit Signal	High level 2.4~5; Low level 0~0.4
T13	RXD_POWER	Power Board Serial Port Receive Signal	High level 2.4~5; Low level 0~0.4

DESIGNATOR	NAME	FUNCTION	RANGE (Unit: V)
T14	5V	5V Power Supply	4.75~5.25
T15	3.3V	3.3V Power Supply	3.135~3.465
T16	15V2	15.2V Power Supply	14.44~15.96
T17	12V	12V Power Supply	11.4~12.6
T18	P15V	Heater Power Supply	0~15
T19	LED_AC	AC Indicator Light Drive Signal	With AC: 5~3.5; Without AC: 0~0.4
T20	12V1	12V Power Supply	11.4~12.6
T21	12V2	12V Power Supply	11.4~12.6
T22	12V3	12V Power Supply	11.4~12.6
T23	7V	7V Power Supply	6.65~7.35
T24	LCD_EN	LCD Backlight Enable Signal	High level 3.145~3.465; Low level 0~0.3
T25	LCD_BR	LCD Backlight Brightness Adjustment Signal	Brightest 0~1.5; least bright 4.75~5.25

1.7.2 Ventilator Control and Drive Board

The monitor subsystem performs pressure and flow detection of the anesthetic ventilator and anesthetic breathing system, valve control, status monitoring collection, accuracy monitoring of pressure and flow inside the circuit, and accuracy control of tidal volume. For EPSON systems, the monitor subsystem is composed of four boards: monitor signal detection board, valve drive board, ventilator sensor interface board, and VPM (auxiliary ventilator control board). For DSP systems, the monitor subsystem is composed of two boards: monitor signal detection board and valve drive board.

1.7.2.1 Monitor Signal Detection Board

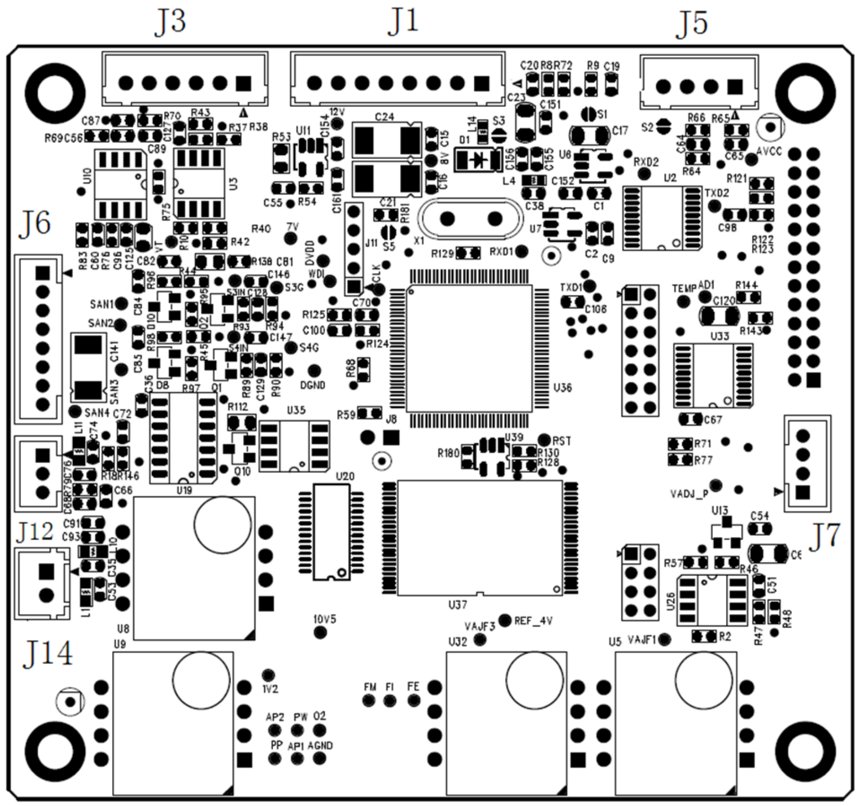


FIGURE 1-78 Monitor Signal Detection Board, Top View

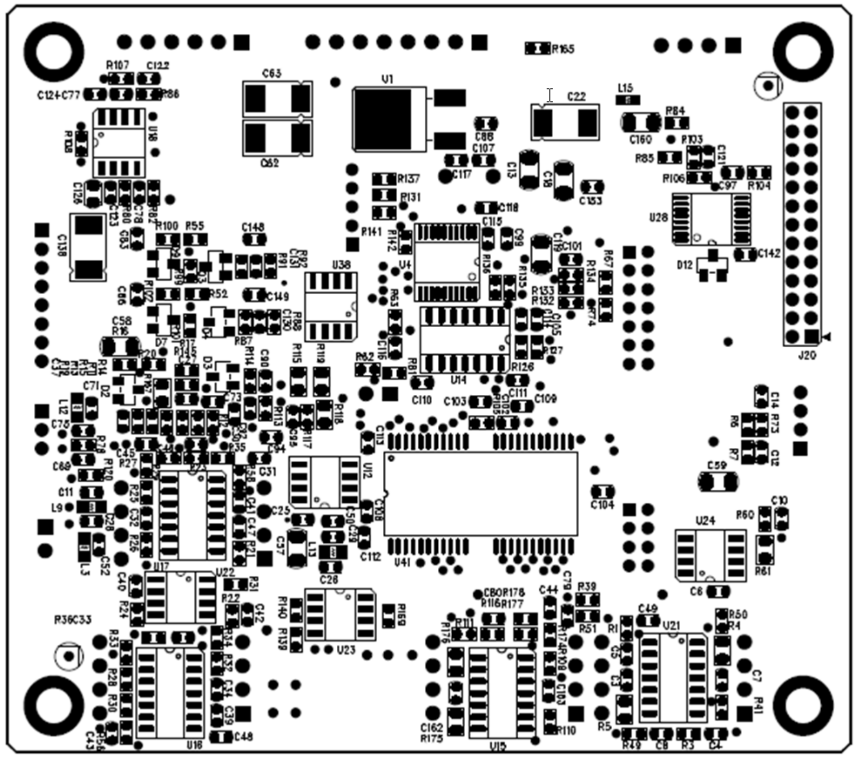


FIGURE 1-79 Monitor Signal Detection Board, Bottom View

Monitor Signal Detection Board Communication Interface, J1

PIN	NAME	FUNCTION
1	TXD	Serial Port Transmit
2	RXD	Serial Port Receive
3	12V	12V Power Supply
4	GND	Ground
5	GND	Ground
6	12V	12V Power Supply
7	PRST	Pressure Relief Valve Control Signal
8	5V	5V Power Supply

Ventilator Sensor Interface, J3

PIN	NAME	FUNCTION
1	SDA	I2C Data Signal
2	SCL	I2C Clock Signal
3	VT	Thermal Mass Flow Sensor Temperature Signal
4	VF	Thermal Mass Flow Sensor Flow Signal
5	12V	Sensor Power Supply
6	GND	Ground

VT Calibration Communication Interface, J7

PIN	NAME	FUNCTION
1	TXD_CALIBRATE	Calibration Serial Port Transmit Signal
2	RXD_CALIBRATE	Calibration Serial Port Receive Signal
3	GND	Ground
4	12V	12V Power Supply

Three-way Valve Control Interface, J6

PIN	NAME	FUNCTION
1	12V	Three-way Valve Power Supply
2	SOLENOID_VALVE1	Three-way Valve Control 1
3	12V	Three-way Valve Power Supply
4	SOLENOID_VALVE2	Three-way Valve Control 2
5	12V	Three-way Valve Power Supply
6	SOLENOID_VALVE3	Three-way Valve Control 3
7	12V	Three-way Valve Power Supply
8	SOLENOID_VALVE4	Three-way Valve Control 4

VPM Communication Interface, J5

PIN	NAME	FUNCTION
1	TXD_AUX_BRD	VPM Serial Port Transmit Signal
2	RXD_AUX_BRD	VPM Serial Port Receive Signal
3	GND	Ground
4	12V	12V Power Supply

O2 Cell Detection Interface, J12

PIN	NAME	FUNCTION
1	O2+	O2 Cell +
2	O2-	O2 Cell -
3	GND	Ground

Test Point Definition

DESIGNATOR	NAME	FUNCTION	RANGE (unit: V)
T1	O2	O2 Concentration Voltage	0~3.5
T2	PP	PEEP Pressure	0.2~4.5
T3	PW	Airway Pressure	0.2~4.5
T6	FM	Ventilator Flow Detection	0.21~5.25
T8	FE	Expiratory Flow Value	0.2~5.5
T9	VAJF3	Offset Voltage	0.602~0.622
T10	10V5	10.5V	10.25~10.75

DESIGNATOR	NAME	FUNCTION	RANGE (unit: V)
T11	REF_4V	4.096V Baseline Power Supply	3.096~4.196
T12	1V2	1.2V Baseline Power Supply	1.1~1.3
T13	VADJ_P	Offset Voltage	0.602~0.622
T14	FI	Inspiratory Flow Value	0.2~5.5
T15	VADJ_FI	Offset Voltage	0.602~0.622
T16	TXD1	Serial Port Transmit Signal (to CPU Board)	0~3.3
T17	RXD1	Serial Port Receive Signal (from CPU board)	0~5
T18	TXD2	Serial Port Transmit Signal (for calibration)	0~3.3
T19	RXD2	Serial Port Receive Signal (for calibration)	0~5
T20	VD	7V	6.8~7.6
T21	DVDD	3.3V Digital Voltage	3.15~3.45
T22	AVCC	5V Analog Voltage	4.75~5.25
T23	WDI	Watchdog Signal	0~3.3
T24	RST	Reset Signal	0~3.3
T25	CLK	Clock Signal	0~3.3
T26	SAN1	Signal of Three-way Valve 1	0~12
T27	SAN2	Signal of Three-way Valve 2	0~12
T28	SAN3	Signal of Three-way Valve 3	0~12
T29	SAN4	Signal of Three-way Valve 4	0~12

1.7.2.2 Valve Drive Board

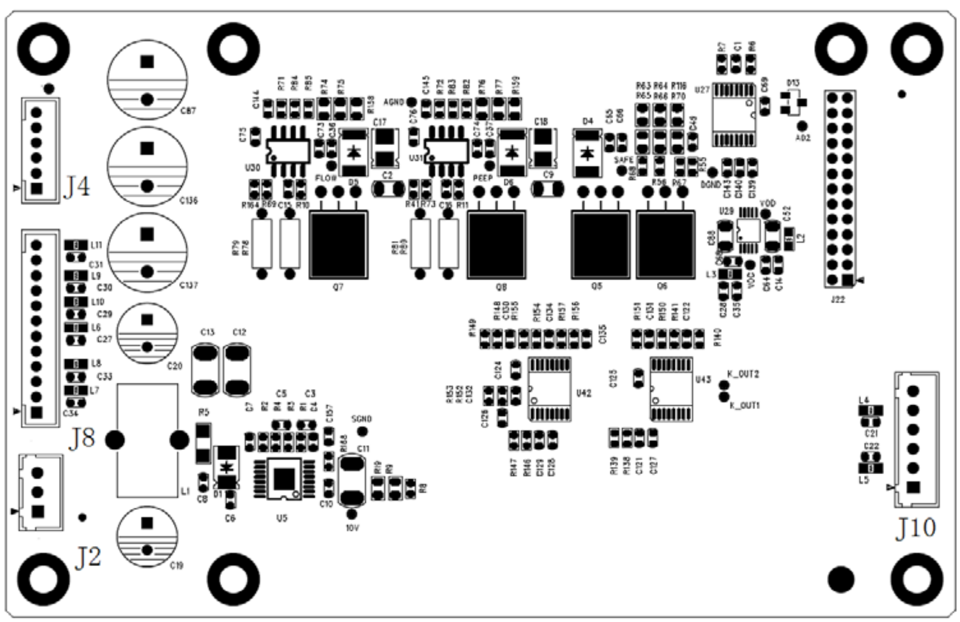


FIGURE 1-80 Valve Drive Board, Top View

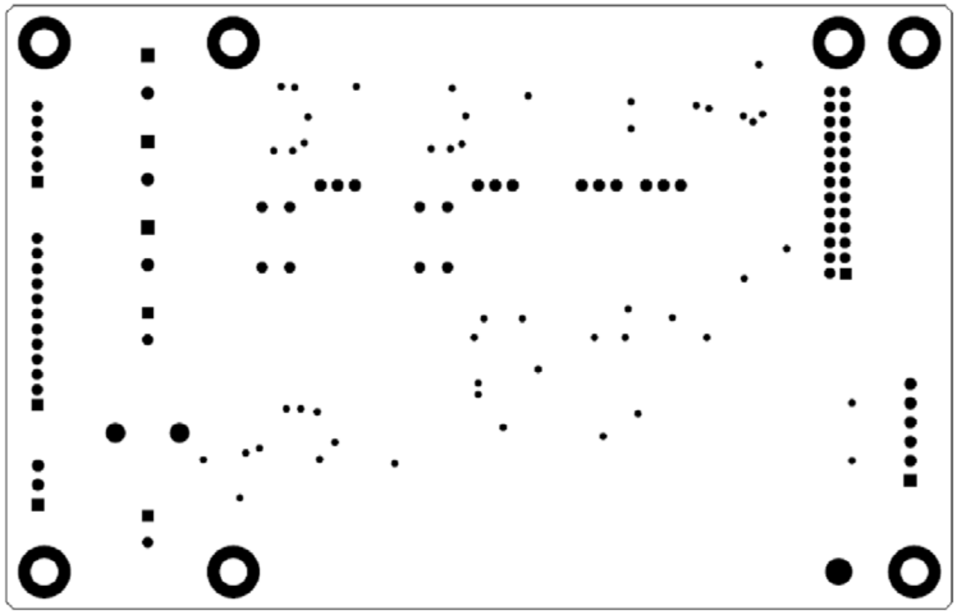


FIGURE 1-81 Valve Drive Board, Bottom View

Proportional Valve and Pressure Relief Valve Drive Interface, J4

PIN	NAME	FUNCTION
1	7V	Pressure Relief Valve Power Supply
2	SAFE_VALVE	Pressure Relief Valve Control Signal
3	7V	Inspiration Valve Power Supply
4	INSP_VALVE	Inspiration Valve Control Signal
5	7V	PEEP Valve Power Supply
6	PEEP_VALVE	PEEP Valve Control Signal

Power Supply Interface, J2

PIN	NAME	FUNCTION
1	GND	Ground
2	GND	Ground
3	12V	12V Power Supply

Status Monitor Detection Interface, J8

PIN	NAME	FUNCTION
1	GND	Ground
2	PNEUM_PRE_SW	Circuit block pressure Switch Signal
3	GND	Ground
4	NC	/
5	GND	Ground

PIN	NAME	FUNCTION
6	QUICK_O2_SW	O2 Flushing Pressure Switch Signal
7	GND	Ground
8	CGO_PRE_SW	CGO Switch Signal
9	GND	Ground
10	O2_PRE_SW	O2 Pressure Switch Signal at Gas Supply Inlet
11	GND	Ground
12	MANU_AUTO_SW	Auto/Manual Switch Signal

Test Point Definition

DESIGNATOR	NAME	FUNCTION	RANGE (unit: V)
T1	K_OUT1	Status Monitor Signal	0~3.45
T2	K_OUT2	Status Monitor Signal	0~3.45
T3	SAFE	Pressure Relief Valve Signal	0~7
T4	VOC	Reserved DA Output Signal	0~1.2
T5	AD2	Analog Channel Output Signal	0~5
T6	FLOW	Inspiration Valve Control Signal	0~7
T7	PEEP	PEEP Valve Control Signal	0~7
T8	10V	12V Input Signal	10~14
T9	7V	Valve Power Supply	6.65~7.35
T10	SGND	Ground	0

1.7.2.3 Sensor Interface Board

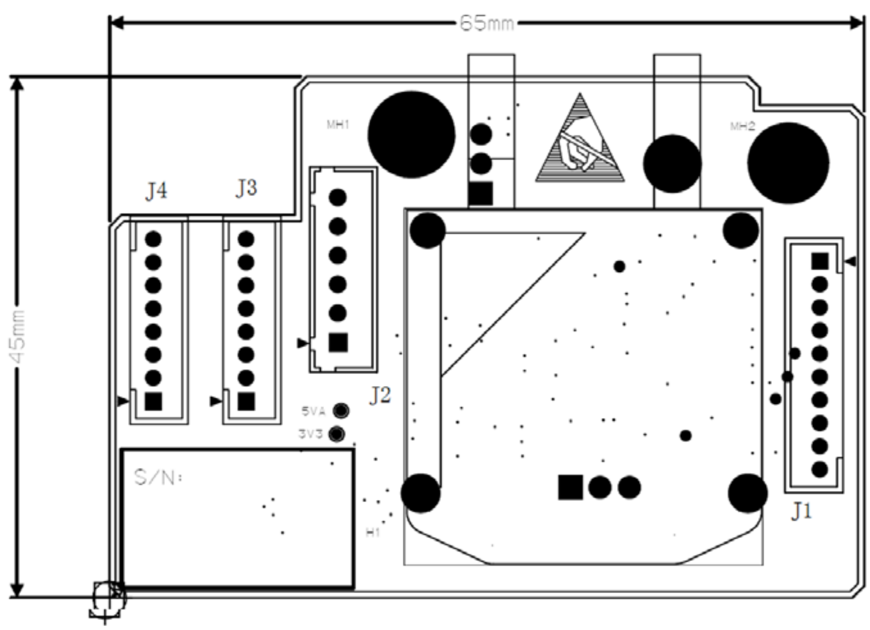


FIGURE 1-82 Sensor Interface Board, Top View

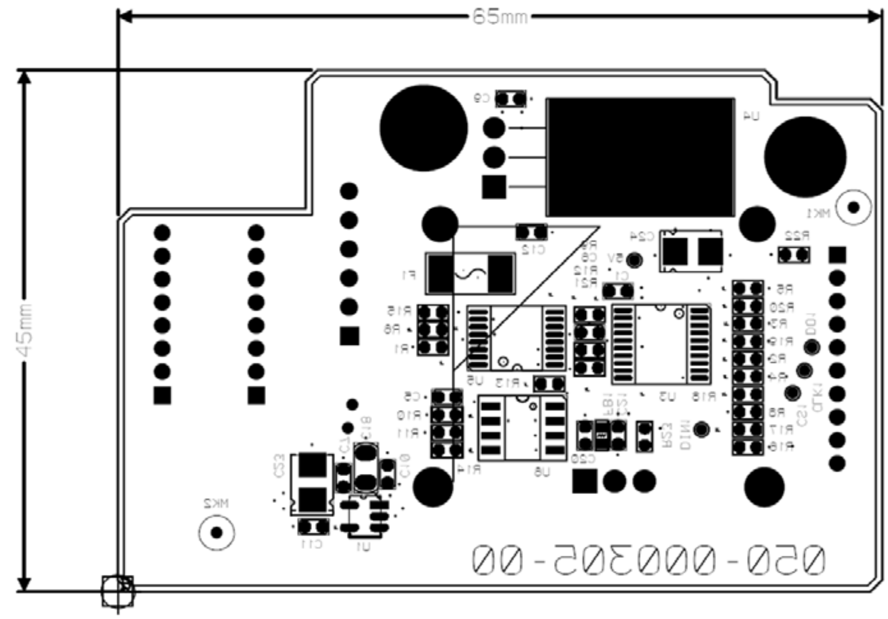


FIGURE 1-83 Sensor Interface Board, Bottom View

Sensor Interface Board Interface, J2

PIN	NAME	FUNCTION
1	MON_BRD_SDA	VCM I2C Data Signal
2	MON_BRD_SCL	VCM I2C Clock Signal
3	VT	Thermal Mass Flow Sensor Temperature Signal
4	VF	Thermal Mass Flow Sensor Flow Signal
5	12V	12V Power Supply
6	GND	Ground

Test Point Definition

PIN	NAME	FUNCTION
TP1	3V3	Test 3.3V Power Supply
TP2	5V	Test 5V Power Supply
TP3	5VA	Test Analog 5V Power Supply

1.7.3 Battery

1.7.3.1 Battery Power

For A7 anesthesia system:

Battery: 11.1V, 4.5Ah×2 Lithium-ion Battery (sealed)

Battery Run Time: 90 minutes (new battery)

Battery Charge Time: 8 hours max from an initial charge of 10%.

1.7.3.2 Battery Adaptation Board

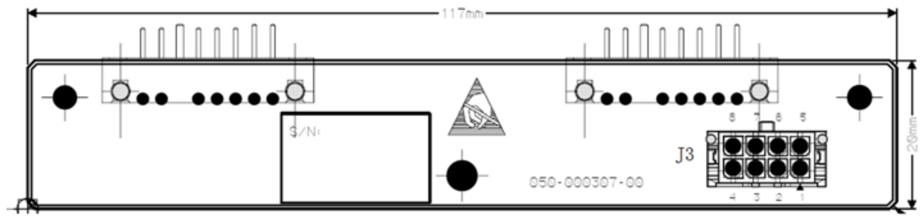


FIGURE 1-84 Battery Adaptation Board, Top View

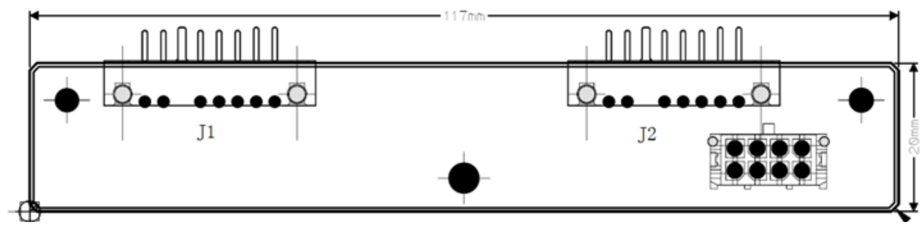


FIGURE 1-85 Battery Adaptation Board, Bottom View

Battery Interface, J1 and J2

PIN	NAME	FUNCTION
1	BAT+	Battery+
2	BAT+	Battery+
3	BC	Battery In-position Signal
4	BAT-	Battery-
5	NTC	Temperature Signal
6	BAT-	Battery-
7	BAT-	Battery-

Battery Cable Interface, J3

PIN	NAME	FUNCTION
1	VBAT1	Battery Voltage
2	NTC1	Battery Internal Thermistor
3	BC1	Battery In-position Signal
4	GND	Ground
5	VBAT2	Battery Voltage
6	NTC2	Battery Internal Thermistor
7	BC2	Battery In-position Signal
8	GND	Ground

1.7.4 Infrared Communication Board

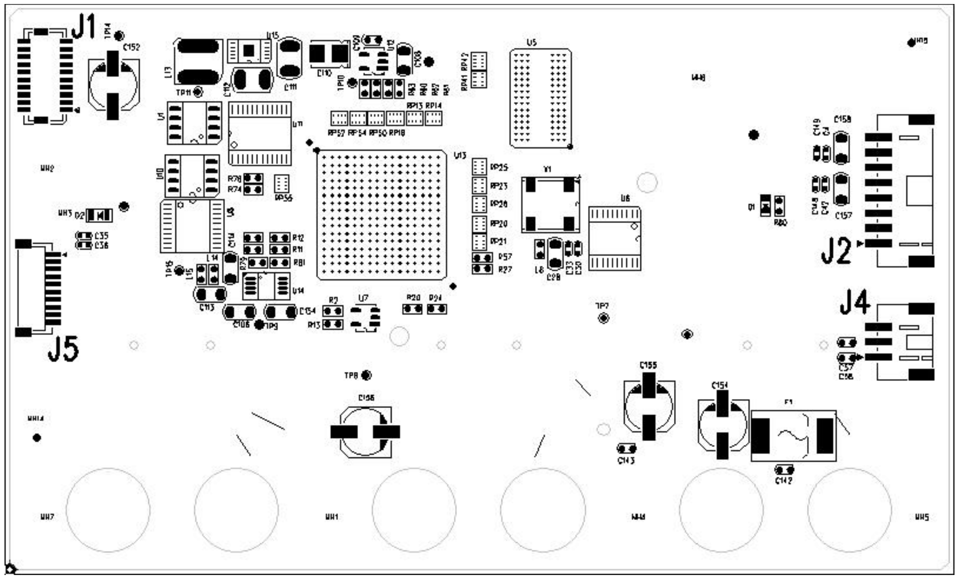


FIGURE 1-86 Infrared Communication Board, Top View

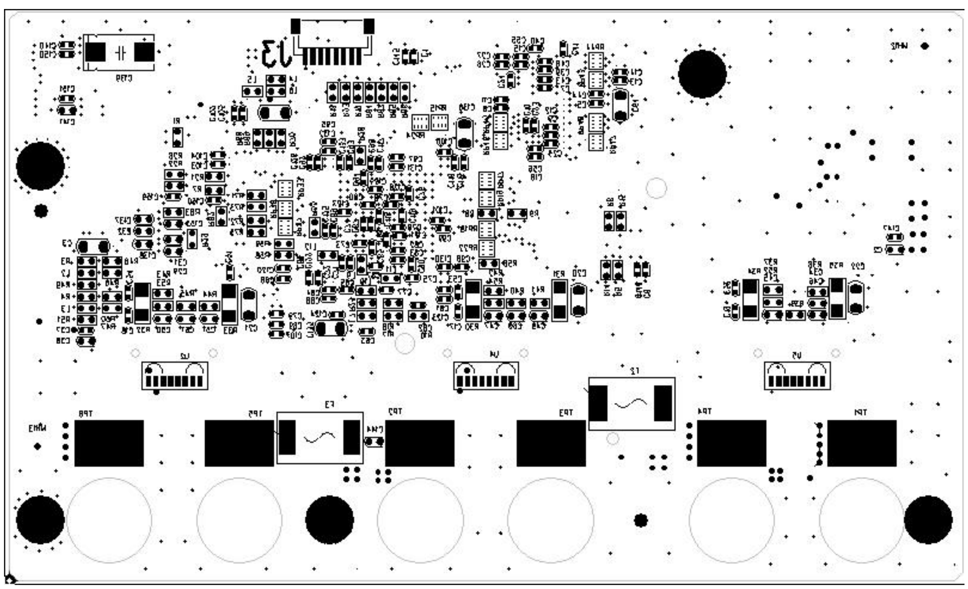


FIGURE 1-87 Infrared Communication Board, Bottom View

Power Supply Interface, J2

PIN	NAME	FUNCTION
1	12V	12V Power Supply
2	12V	12V Power Supply
3	GND	Ground

PIN	NAME	FUNCTION
4	GND	Ground
5	VDD	3.3V Power Supply
6	VDD	3.3V Power Supply
7	GND	Ground
8	GND	Ground

Communication Interface, J4

PIN	NAME	FUNCTION
1	TXD_Infrared Comm Board	Infrared Communication Board Serial Port Transmit Signal
2	RXD_Infrared Comm Board	Infrared Communication Board Serial Port Receive Signal
3	GND	Ground

1.7.5 Anesthesia Signal Interface Board

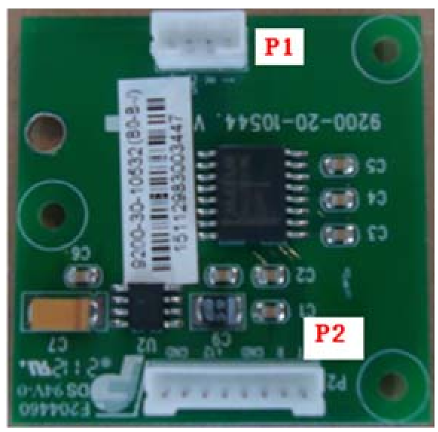


FIGURE 1-88 Anesthesia Signal Interface Board, Top View

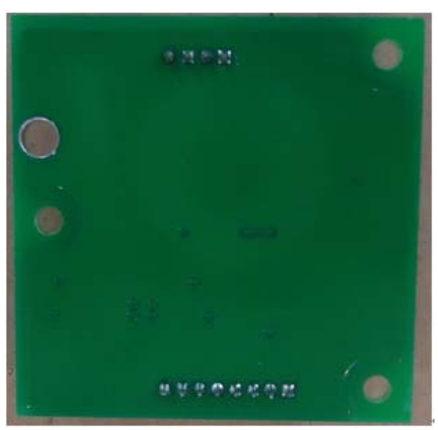


FIGURE 1-89 Anesthesia Signal Interface Board, Bottom View

Anesthesia Signal Interface Board Interface, P1

PIN	NAME	FUNCTION
1	RXD_AG_TTL	AG Module Receive Signal
2	TXD_AG_TTL	AG Module Transmit Signal
3	GND	Ground
4	VPP	12V Power Supply

1.7.6 Breathing System Heater

The anesthesia system heater provides software and hardware dual-protection from overheating. The heater can switch over its operating mode automatically according to the change in ambient temperature.

1.8 Electrical Flow Control System

1.8.1 EFCS Monitoring Board

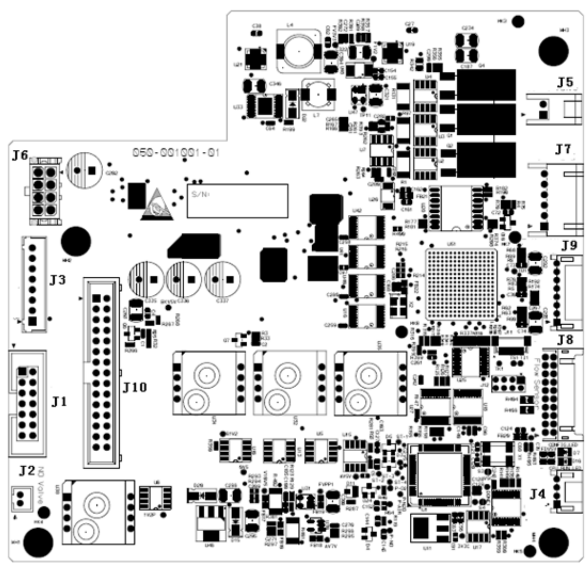


FIGURE 1-90 EFCS Monitoring Board, Top View

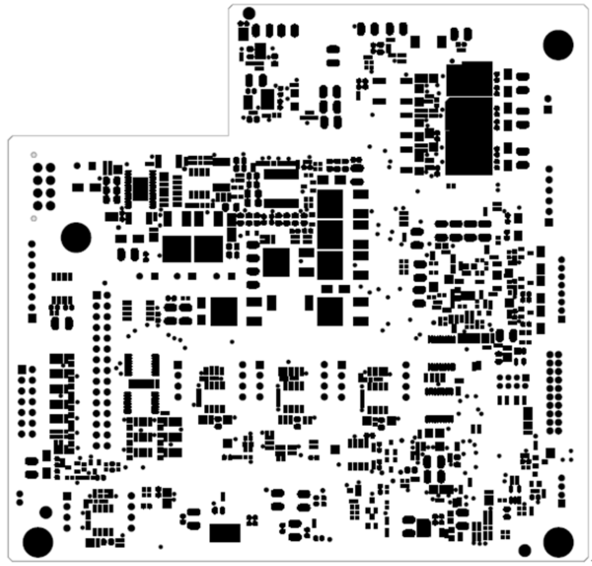


FIGURE 1-91 EFCS Monitoring Board, Bottom View

EFCS Monitoring Board Interface, J1

PIN	NAME	FUNCTION
1	VBB2	CPU Power Supply
2	GND	Ground
3	FPGA_VPP	FPGA, NO and NC Valve Power Supply
4	GND	Ground
5	PROP_VALVE_VPP	Proportional Valve
6	GND	Ground
7	SAN_VPP	Backup Three-Way Power Supply
8	GND	Ground
9	CPU_TXD_MB_BUF	Communication with the CPU Board
10	GND	Ground
11	CPU_RXD_MB	Communication with the CPU Board
12	GND	Ground
13	FPGA_RXD_MB	Backup Communication Between the FPGA and the CPU Board
14	FPGA_TXD_MB_BUF	Backup Communication Between the FPGA and the CPU Board

EFCS Monitoring Board Interface, J3

PIN	NAME	FUNCTION
1	VBB1	Solenoid Magnet Power Supply
2	VBB1	Solenoid Magnet Power Supply
3	GND	Ground
4	GND	Ground
5	STEP_VPP	Stepper Motor Power Supply
6	STEP_VPP	Stepper Motor Power Supply

PIN	NAME	FUNCTION
7	GND	Ground
8	GND	Ground

EFCS Monitoring Board, J4

PIN	NAME	FUNCTION
1	CPU_TXD_DEBUG	7129 Serial Port Transmit
2	CPU_RXD_DEBUG	7129 Serial Port Receive
3	GND	Ground
4	FPGA_VPP	Power Supply

EFCS Monitoring Board, J5

PIN	NAME	FUNCTION
1	NC_VALVE+	Three-Way Valve Power Supply
2	NC_VALVE-	Negative End of the Three-Way Valve

EFCS Monitoring Board Interface, J6

PIN	NAME	FUNCTION
1	SOLENOID_VPP	Positive End of the Electromagnet
2	VA_STEP	Power Supply of the Stepper Motor Drive Chip
3	MOTOR_A1	A1 Connecting Cable of the Stepper Motor
4	MOTOR_A2	A2 Connecting Cable of the Stepper Motor
5	SOLENOID-	Negative End of the Electromagnet
6	GND	Ground
7	MOTOR_B1	B1 Connecting Cable of the Stepper Motor
8	MOTOR_B2	B2 Connecting Cable of the Stepper Motor

EFCS Monitoring Board Interface, J7

PIN	NAME	FUNCTION
1	P_VALVE+	Proportional Valve Power Supply
2	O2_VALVE-	Negative End of the Oxygen Proportional Valve
3	P_VALVE+	Proportional Valve Power Supply
4	AIR_VALVE-	Negative End of the Air Proportional Valve
5	P_VALVE+	Proportional Valve Power Supply
6	N2O_VALVE-	Negative End of the Nitrous Oxide Proportional Valve

EFCS Monitoring Board Interface, J8

PIN	NAME	FUNCTION
1	EE_SCL	IIC Clock Signal
2	C_DVCC	Sensor Power Supply (range: 4.75V~5.25V)

PIN	NAME	FUNCTION
3	EE_SDA	IIC Data Signal
4	C_DVDD	Sensor Signal Conversion Pin
5	GND	Ground
6	GND	Ground
7	FPGA_DVCC	Sensor Power Supply (range: 4.75V~5.25V)
8	O2_SCL	IIC Clock Signal
9	FPGA_3V3	Sensor Signal Conversion Pin
10	O2_SDA	IIC Data Signal
11	AIR_SCL	IIC Clock Signal
12	FPGA_DVCC	Sensor Power Supply (range: 4.75V~5.25V)
13	AIR_SDA	IIC Data Signal
14	FPGA_3V3	Sensor Signal Conversion Pin
15	GND	Ground
16	GND	Ground
17	FPGA_DVCC	Sensor Power Supply (range: 4.75V~5.25V)
18	N2O_SCL	IIC Clock Signal
19	FPGA_3V3	Sensor Signal Conversion Pin
20	N2O_SDA	IIC Data Signal

EFCS Monitoring Board Interface, J10

PIN	NAME	FUNCTION
1	LED1_C_POWER	Power Supply 5 V of the Glass Tube Light (Controlled)
2	GND	Ground
3	LED2_C_POWER	Power Supply 5 V of the Display Indicator (Controlled)
4	GND	Ground
5	NEEDLE_SWITCH1_IN	Needle Valve Position Switch 1
6	GND	Ground
7	NEEDLE_SWITCH2_IN	Needle Valve Position Switch 2
8	GND	Ground
9	NEEDLE_SWITCH3_IN	Needle Valve Position Switch 3
10	GND	Ground
11	NEEDLE_SWITCH4_IN	Needle Valve Position Switch 4
12	GND	Ground
13	NEEDLE_SWITCH5_IN	Needle Valve Position Switch 5
14	GND	Ground
15	NEEDLE_SWITCH6_IN	Needle Valve Position Switch 6
16	GND	Ground
17	BFCS_SWITCH1_IN	BFCS Position Switch 1
18	GND	Ground
19	BFCS_SWITCH2_IN	BFCS Position Switch 2
20	GND	Ground
21	BFCS_SWITCH3_IN	BFCS Position Switch 3
22	GND	Ground

PIN	NAME	FUNCTION
23	BFCS_SWITCH4_IN	BFCS Position Switch 4
24	GND	Ground
25	O2_SWITCH	O2 Supply Pressure Switch
26	GND	Ground
27	Air_SWITCH	AIR Supply Pressure Switch
28	GND	Ground
29	N2O_SWITCH	N2O Supply Pressure Switch
30	GND	Ground

1.8.2 BFCS Position Board

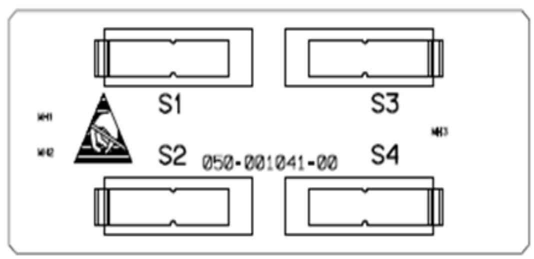


FIGURE 1-92 BFCS Position Board, Top View

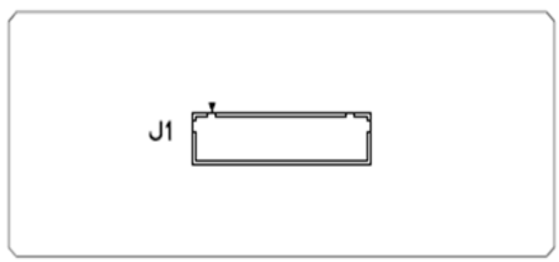


FIGURE 1-93 BFCS Position Board, Bottom View

EFCS Monitoring Board Interface, J1

PIN	NAME	FUNCTION
1	BFCS_Switch1	BFCS Position Switch 1
2	GND	Ground
3	BFCS_Switch2	BFCS Position Switch 2
4	GND	Ground
5	BFCS_Switch3	BFCS Position Switch 3
6	GND	Ground
7	BFCS_Switch4	BFCS Position Switch 4
8	GND	Ground

1.8.3 Total Flow Meter Backlight Board

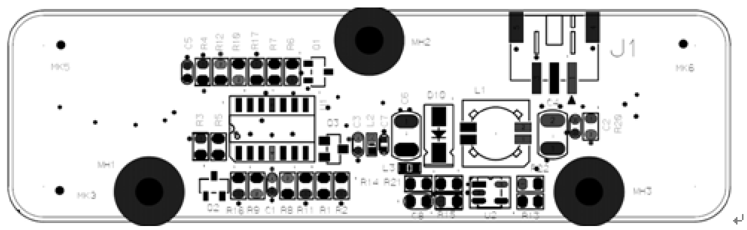


FIGURE 1-94 Total Flow Meter Backlight Board, Top View

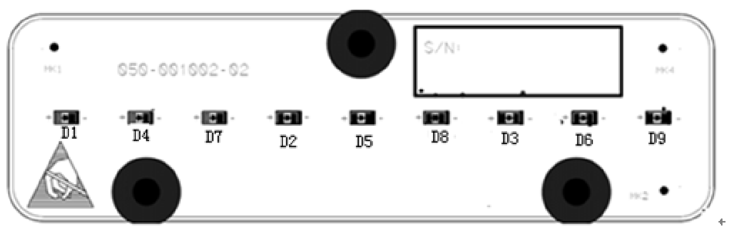


FIGURE 1-95 Total Flow Meter Backlight Board, Bottom View

Total Flow Meter Backlight Board Interface, J1

PIN	NAME	FUNCTION
1	VCC	5 V Power Supply
2	NC	Not Connected Internally
3	GND	Ground

1.8.4 O2/N2O/Air Flow Sensor Interface Board

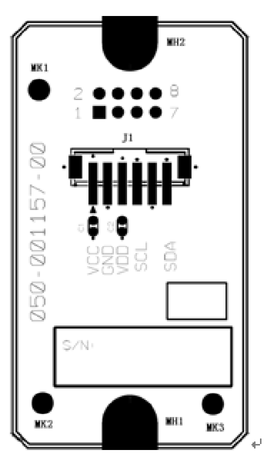


FIGURE 1-96 O2/N2O/Air Flow Sensor Interface Board, Top View

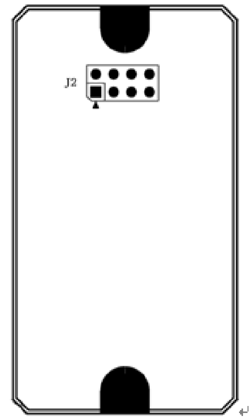


FIGURE 1-97 O2/N2O/Air Flow Sensor Interface Board, Bottom View

Flow Sensor Interface Board Interface, J1

PIN	NAME	FUNCTION
1	VCC	5 V Power Supply
2	GND	Ground
3	VDD	3.3 V Power Supply
4	SCL	Flow Sensor IIC Clock Signal
5	GND	Ground
6	SDA	Flow Sensor IIC Data Signal

Flow Sensor Interface Board Interface, J2

PIN	NAME	FUNCTION
1	VCC	5 V Power Supply
2	NC	Not Connected internally
3	VDD	3.3 V Power Supply
4	GND	Ground
5	SCL	Flow Sensor IIC Clock Signal
6	GND	Ground
7	SDA	Flow Sensor IIC Data Signal
8	GND	Ground

1.9 Ventilator Pneumatic- O2 Drive Gas

1.9.1 Ventilator Pneumatic Drive

Oxygen is the driving gas for the ventilator. In addition to the flow meter block, a high pressure regulator reduces the supply pressure to 200 kPa (29 psi). This pressure represents the drive gas for the ventilator.

The drive pressure regulator is placed ahead of the proportional valve that generates the driving gas flow during the inspiratory phase. This flow fills the bellows dome that surrounds the bellows.

1.9.2 Drive Pressure-High Pressure Regulator (200 kPa, 29 psi)

The drive pressure regulator stabilizes the supply pressure provided to the proportional valve. The flow generated by the proportional valve is therefore independent of pressure variations at the supply.

Setting the drive pressure regulator at 200 kPa (29 psi) allows for a maximum inspiratory flow of 110 L/min at the ventilator.

1.9.3 Drive Gas Assembly

The manifold assembly module mainly consists of the inspiratory circuit and PEEP circuit. The inspiratory circuit goes through the normally closed proportional solenoid valve, which generates a gas flow of 0 to 110 L/min by the valve drive board. The gas flow of the PEEP circuit goes through the normally closed proportional solenoid valve, which also generates a gas pressure of 3 to 30 cmH2O by the valve drive board.

1.9.4 Tube Color Coding

All the internal pneumatic tubes used in the anesthesia system are color coded per the United States standard.

GAS	US STANDARD
O2	GREEN
N2O	BLUE
AIR	ORANGE

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2.0 Installation Guide

Preparation - Additional Material Required 2-2
Assembly 2-3
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Vaporizer Accuracy Test 2-69
Electrical Tests 2-70

2.1 Preparation - Additional Material Required

The following additional material are required before installation. The customer is responsible for supplying this material. Missing items may result in delays, incomplete installations, and/or additional service visits.

- Compatible emergency O2, N2O, and AIR cylinders
- Agent vaporizers and key fillers (if not purchased with the anesthesia system)
- Liquid agent medication
- CO2 absorbent Pre-Paks or loose fill
- Active O2, N2O, and AIR lines (280 to 600 kPa (40 to 87 psi))
- Dropdown hoses for ceiling-mounted medical gas utilities that are compatible with quick-disconnect hoses (if not purchased with the anesthesia system)
- Negative pressure source, negative pressure source connection related hoses(if not purchased with the anesthesia system)

2.2 Assembly

NOTE: **The Anesthesia Machine is matched with its Breathing System Block via calibration of its Flow Sensors. If the Breathing System Block is removed, ensure that it is reinstalled on its matching Anesthesia Machine. If a different Breathing System Block is reinstalled, then the Flow Sensors must be recalibrated.**

NOTE: **The breathing system will have a serial number label on it. On the back of the machine, next to the serial number label, there is a serial number label of the breathing system that the unit was calibrated and shipped with.**

2.2.1 Unpacking and Setup

1. When the A7 is delivered, IMMEDIATELY inspect the box for any damage.
   a. If there is NO damage and ALL tip indicators on the box exterior are intact, then sign and date the bill of lading or airway bill to indicate safe receipt of the anesthesia system.
   b. If there is DAMAGE or ANY of the tip indicators on the box exterior have activated, then conditionally accept the delivery and clearly describe the damages on the bill of lading or airway bill. BOTH the carrier and recipient must sign and date the bill of lading or airway bill. Save all damaged factory packaging until further instructed by Mindray. The receiver should immediately contact Mindray Customer Service at 877.913.9663 or 650.316.3199.

NOTE: **When unpacking the unit, keep as much of the plastic covering on the unit as possible. When all parts are unpacked, return the packing material to its original box. Place the smaller box inside the larger box.**

2. Cut, remove, and discard the white shipping straps from the box.

FIGURE 2-1

3. Pull the box top straight up off the box and place on the floor near the unit. The box top will be used later as a ramp when rolling down the A7 onto the floor.

FIGURE 2-2

4. Pull the box straight up and over the unit.

FIGURE 2-3

5. Remove the top foam piece on the A7.

FIGURE 2-4

6. Cut the plastic tie wrap as shown below. Roll down the plastic bag from the unit.

FIGURE 2-5

7. Using a pair of scissors, cut the plastic wrap from the A7 near the back of the unit. Take care to not scratch or otherwise damage the unit. Remove and discard the plastic wrap. Remove the empty box on the tray from the unit.

8. Remove the foam covering up the display and the tray.

FIGURE 2-6

9. After removing the plastic wrap and foam, check that there is one (FDA) box (or there are two (Canada) boxes) on the side of the unit, as shown below.

FIGURE 2-7

FIGURE 2-8 Canada only

10. At the base of the box platform, remove both sets of orange straps.

FIGURE 2-9

11. Remove the piece of wood at the front of the A7. Then, remove the foam packing material from around the front of the unit.

FIGURE 2-10

12. Remove the foam packing material from around the back of the unit.

FIGURE 2-11

13. Create a ramp for the unit by placing the top of the container next to the base of the container as shown. The flat side of the wood should be facing up. The other side of the wood has support to hold up the ramp. Secure the ramp to the container using the hook-and-loop straps.

FIGURE 2-12

NOTE: **Check that there are green beads in the desiccant pack and that they have not turned pink.**

14. Rotate the casters 90° and carefully roll the A7 unit down the ramp. Remove the bag from the unit. Save the bag in case repacking is needed.

15. Open the bottom drawer and remove the Breathing Assembly and the Bag Arm Assembly.

FIGURE 2-13

16. Install the Breathing Assembly on the side of the A7. Align the Assembly carefully, and then push it firmly towards the A7 until the Assembly clicks into place.

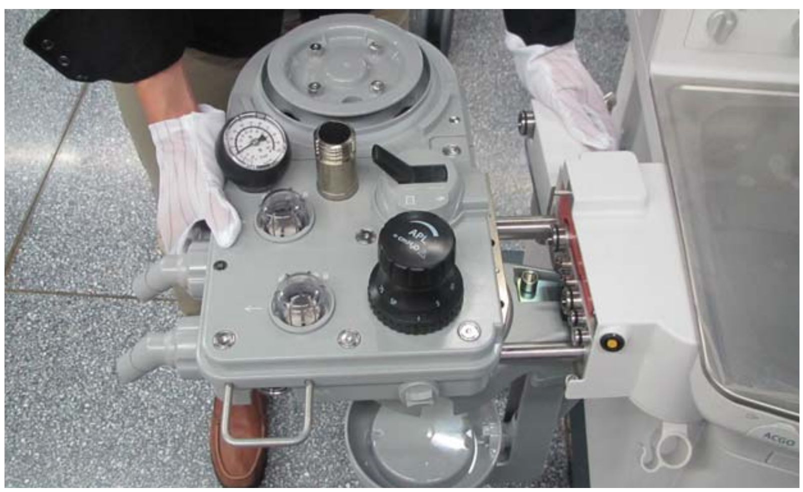

FIGURE 2-14

17. Carefully open the small box that contains the Bellows Assembly and Bellows Dome. Remove the plastic bags from the Assembly. Place the foam pieces and plastic bags in the box.

18. Install the bellows on the Breathing System. Ensure that the bellows is stretched completely around the lip on the breathing system when installed.

FIGURE 2-15

19. Install the bellows dome by placing it down on the breathing system and turning it clockwise to lock it in place (the gradation markings on the bellows dome should face front and be visible to the operator).

FIGURE 2-16

20. Install the Bag Arm Assembly, aligning the keyed features as shown below.

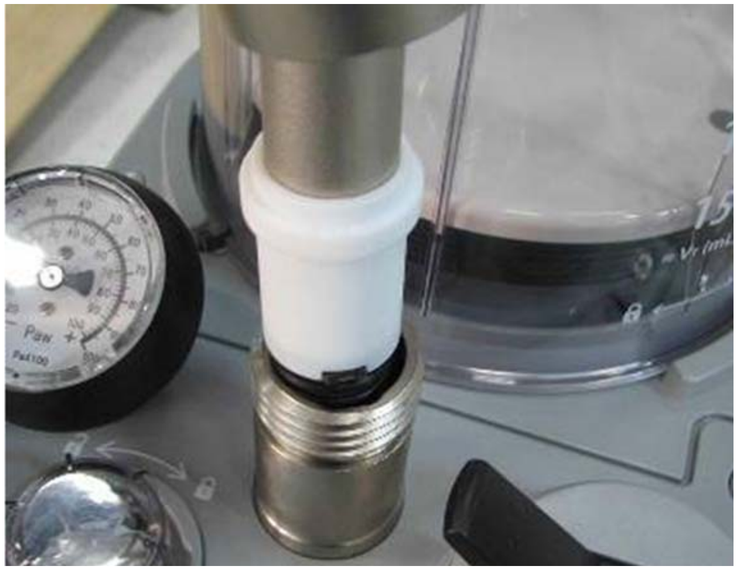

FIGURE 2-17

21. Then, push the Bag Arm Assembly into the Breathing System and tighten the knurled collar as shown below. Install the Paw gauge and the water trap on the breathing system.

FIGURE 2-18

22. Open the middle and bottom drawers and carefully remove the Removable Absorber Assembly, Waste Gas Scavenger Hose and the Waste Gas Scavenger Assembly.

FIGURE 2-19

23. Install the white Absorber hose on the Absorber Assembly. Then, install the Absorber Assembly without the canister in place. Install the lower part first, line up the pins with the holes, and then align the top part. Push the top part in (upward) until both the front and back latches click into place.

FIGURE 2-20

24. Add CO2 absorbent Pre-Pak or loose fill to the canister. Slide the canister into the Absorber Assembly. Turn the locking lever 90° counter-clockwise to lock the canister in place.

FIGURE 2-21

25. (Canada Only) Install the bracket for liquid collection bottle of vacuum suction device onto the proper position on the left side of the machine.

FIGURE 2-22

26. (Canada Only) Place the liquid collection bottle onto the bracket and connect the tubes properly.

FIGURE 2-23

27. Slide the Scavenger Assembly in the track on the lower left side (i.e., same side as the Breathing Assembly) of the A7 and tighten the thumbscrew on the Scavenger Assembly to lock it in place. Install one side of the Scavenger Hose to the Scavenger Assembly and the other side of the Hose to the A7 as shown below.

NOTE: **If a passive scavenger system was ordered with the unit, connect the passive scavenger to the A7 instead of the Scavenger Hose. Follow the installation instructions that come with the passive scavenging kit.**

NOTE: **If a DGSS was ordered with the unit, install that in place of the scavenger assembly.**

FIGURE 2-24

28. Open the top drawer and check that it contains the following contents:

- Auxiliary O2/Air Reference Card (PN: 046-002591-00)
- Preoperative Checkout List (PN: 046-002590-00)
- Sampling return quick connector (PN: 115-052161-00)
- Inspiratory Flow Sensor & Expiratory Flow Sensor (PN: 115-008264-00)
- Gas Cylinder Wrench (PN: 115-033063-00)
- Drawer Keys(PN: 034-000353-00)
- AGSS 3 ways connector assembly (PN: 115-042912-00)
- Suction filter (PN: 082-001327-00)
- Negative pressure suction tube (including filters) (PN: 115-033264-00)
- A Series Cleaning Quick Reference Card (PN: 046-009638-00)
- Seal Washer (PN: 0348-00-0185)
- O2 Cable Assembly (PN: 115-006551-00) (Some unit may not include this assembly)

FIGURE 2-25

29. Open the rear panel and unscrew the thumbscrews to open the battery compartment. Install two batteries with the proper polarity. Close the compartment and tighten the thumbscrews.

30. On the back of the unit, verify the order of the cylinder yokes are from left to right: O2, Air, and N2O.

31. Verify the order of the pipeline fittings are from top to bottom: N2O, Air, O2 and VAC.

32. Install the tank washers.

33. Install the gas cylinders. Ensure that the cylinders are secured to their matching cylinder supply connections, which are labeled "O2," "Air," and "N2O."

34. Connect each gas supply by connecting the hose connectors to the gas supply sockets (DISS type). Turn the connectors clockwise to fasten them securely to the sockets. Verify that the pressure of the gas supply is within the specifications of the machine.

35. Connect the test manual ventilation bag to the bag arm on the breathing system.

36. Connect the test breathing circuit to the inspiratory and expiratory connections.

WARNING: **Use breathing circuits and manual bags in accordance with ASTM F1208 and compatible with standard 22mm male conical fittings per ASTM specifications F 1054.**

37. Connect the hose from the gas scavenger to the operating room's EVAC connector. At the AGSS tank, turn the knob on top of the scavenger until the float is between the Min and Max markings.

NOTE: **Use VAC when EVAC is not available. The knob on the top of the scavenger is meant to adjust the flow from the EVAC. When the knob is fully closed it does not need to completely shut off flow.**

38. Install the O2 Sensor Cover Assembly (P/N: 115-016612-00) instead of the O2 sensor if customer prefers not to use O2 sensor.

39. Install the oxygen sensor (from Topfill) into the stainless steel housing. The O2 Cell should be tightened only enough to compress the o-ring about a 1/4 turn.

40. Screw the O2 Cable housing onto the stainless steel housing until it is snug. Do not overtighten.

41. Connect the oxygen sensor external cable between the oxygen sensor and the side of the A7, aligning the yellow marks on the cable and connector.

42. Plug the mains cable into a grounded socket. Power up the A7 by turning the main power switch (located on the front of the A7) to the ON position. Wait until the LCD display provides information about the leak test. Observe that the start-up self-test is successful. Do not connect, disconnect or move the breathing circuits or breathing bags while the self-test is in process.

43. Mount the monitors and arms per instructions in the monitoring kit.

WARNING: **Use only Mindray-approved monitors and arms with the A7.**

44. Install the gas module into the module rack on the left side of the unit (optional).

FIGURE 2-26

45. For units with gas module, connect Hose (P/N: 115-052161-00) to the outlet of the gas module and to the Colder fitting at the back of the A7. Place the unused hose in the bottom drawer.

46. When the ACGO circuit needs to scavenge the gas to the AGSS, use the adapter as shown below.

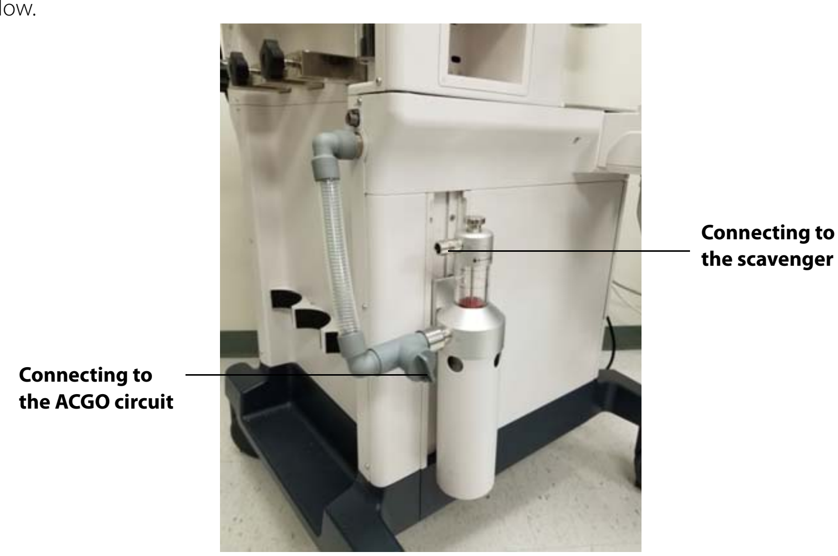

FIGURE 2-27

47. For units with patient monitor, when the gas path of the patient monitor does not meet the biological compatibility standard, the patient monitor needs to scavenge the waste gas to the

AGSS. Use the adapter as shown below.

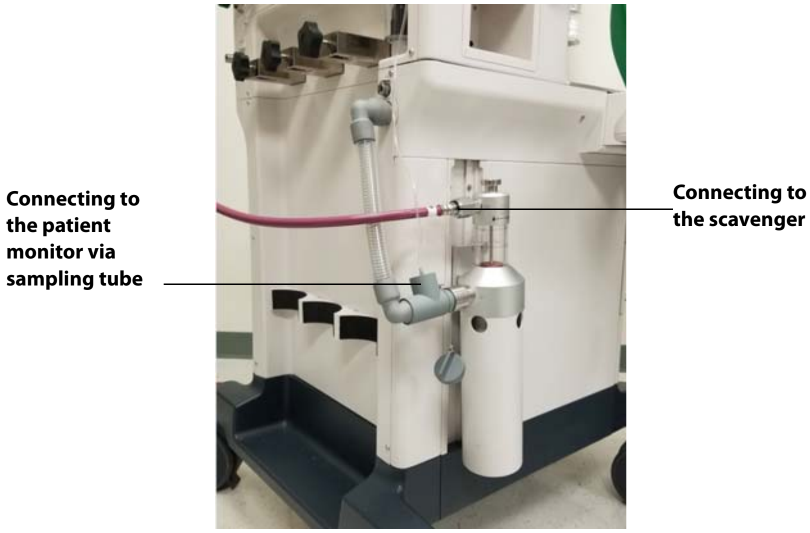

FIGURE 2-28

48. When both the patient monitor and ACGO circuit need to scavenge the gas to the AGSS, use two adapters (one adapter as FIGURE 2-27 and one adapter as FIGURE 2-28) as shown below.

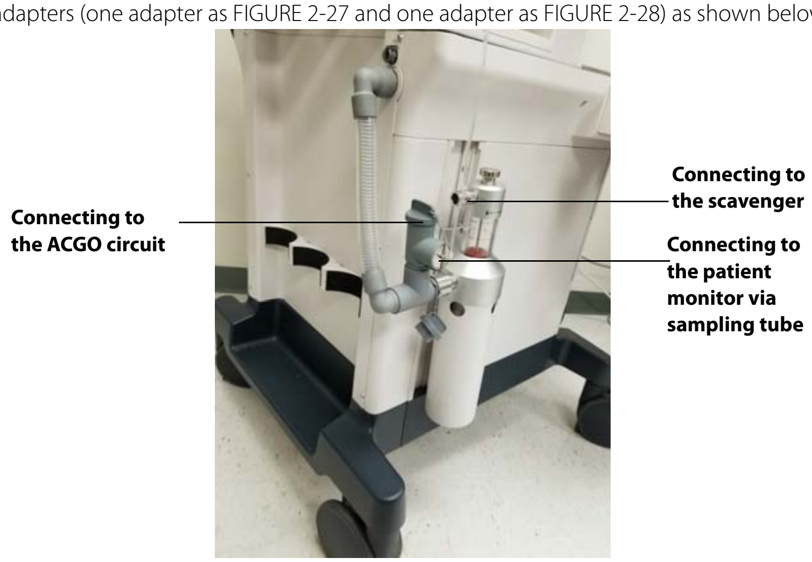

FIGURE 2-29

49. Place the following parts into the bottom drawer:

- A7 Operating Instructions
- Washer, Seal (P/N: 0348-00-0185)
- AGSS 3 ways connector assembly (PN: 115-026796-00)
- Suction filter (PN: 082-001327-00)

50. Hang the Pre-operative Checkout List and the Auxiliary O2/AIR Reference Card to the handle of the A7 unit.

51. Mount the tank wrench on the rear of the A7 so that it can be used to open or close each cylinder without disconnecting it from the machine.

2.2.2 Breathing System and Breathing System Accessories and Checkout Procedures

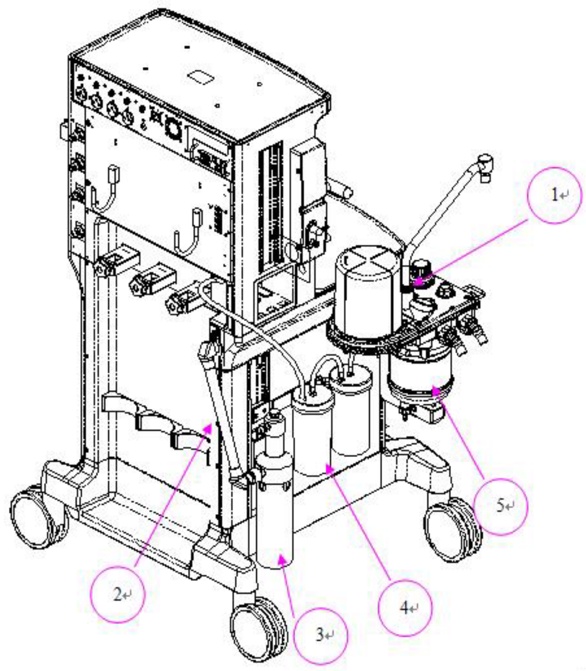

FIGURE 2-30

1. Breathing System
2. AGSS Transfer Hose
3. AGSS
4. Vacuum flask (Canada only)
5. CO2 Absorbent

2.2.3 Vaporizers (if available)

WARNING: If the vaporizer is incompatible with the A7 Anesthesia System, the vaporizer will not work at all. Use vaporizers with Selectatec mounting system that are compliant to ISO 8835-4. Refer to the vaporizer manufacturer's Instructions For Use for filling or draining the vaporizer and other information.

WARNING: The A7 Anesthesia System has a Selectatec mount system which will only allow vaporizers to be mounted that have an interlock system which prevents more than one vaporizer simultaneously being turned on. Do not attempt to override this safety feature.

WARNING: Use care in lifting and manipulating vaporizers during the mounting process as their weight may be greater than expected, based on their size and shape.

NOTE: **The barometric pressure may differ from the calibration pressure of the anesthetic vaporizer. This may cause an inaccurate output of the anesthetic agent. The operator should continuously monitor the concentration of anesthetic agent during system use.**

2.2.3.1 Mount the Vaporizer(s)

1. Mount the vaporizer onto the manifold.
2. Push and turn the locking lever clockwise to lock the vaporizer in position.
3. Ensure that the top of the vaporizer is horizontal. If not, remove the vaporizer and reinstall it.
4. When reinstalling the vaporizer, lift each vaporizer straight up off the manifold rather than pulling forward. Do not rotate the vaporizer on the manifold.
5. If a vaporizer unintentionally lifts off the manifold, install it again and complete steps 1 through 3. If the vaporizer lifts off a second time, do not use the system.

NOTE: **A Desflurane vaporizer may be mounted similarly as other vaporizers, but may require a power cord. For more detailed instructions on installation and proper use, refer to the specific manufacturer's Instructions for Use of the Desflurane vaporizer.**

2.2.3.2 Fill the Vaporizer

NOTE: **The A7 should use vaporizers with Selectatec mounting system that are compliant to ISO 8835-4. Refer to the vaporizer manufacturer's Instructions For Use for filling or draining the vaporizer and other information.**

WARNING: **Ensure that the correct anesthetic agent is used. The vaporizer is designed with the specific anesthetic agent named on it and further indicated by color coded label. The concentration of the anesthetic agent actually output will vary if the vaporizer is filled with the wrong agent.**

2.2.3.3 Drain the Vaporizer

WARNING: **Do not reuse the agent drained from the vaporizer. Treat as a hazardous chemical and follow local regulations for proper disposal.**

NOTE: **The A7 should use vaporizers with Selectatec mounting system that are compliant to ISO 8835-4. Refer to the vaporizer manufacturer's Instructions For Use for filling or draining the vaporizer.**

2.2.4 Monitoring Products Mounting and Electrical Connection (if available)

1. Mount the monitor (if available) according to the manufacturer's monitor assembly instructions.

NOTE: **Use of other monitors and mounting hardware is the responsibility of the installer.**

2. After mounting a monitor to the A7, connect it to one of the AC outlets located on the rear of the A7.
3. Turn on each monitor one at a time. Verify that the circuit breaker holds without tripping.
4. Dress each line cord neatly along the side of the anesthesia machine or tucked inside the monitor arm. Ethernet and power cables can be routed through the clips on the rear door of the A7.

If a Passport 12M / 17M is mounted on the A7 and the user wants to use the AG in the patient monitor, the anesthesia system can get the data from the patient monitor. To initiate this data transfer, perform the following procedure:

1. Connect the network port of the patient monitor to the network port of the A7 using the Ethernet Cable.

FIGURE 2-31 Network Port of Anesthesia System

FIGURE 2-32 Network Port of Passport 12M Patient Monitor

FIGURE 2-33 Network Port of Passport 17M Patient Monitor

2. Select the **Setup** softkey > **System** tab (system password needed) > **Network** button.
3. Select the **Optimizer Source** button and set the **IP Address** and **Multicast Address**.

NOTE: **The IP addresses of the Anesthesia machine and the Patient Monitor must be on the same subnet.**

4. Select the **Accept** button to confirm the change.

5. Ensure the connection is successful. If the connection is successful, the anesthesia system displays the patient monitor's name beside the **Optimizer Source** button. If the connection is failed, the anesthesia system displays **NOT CONNECTED** beside the **Optimizer Source** button.

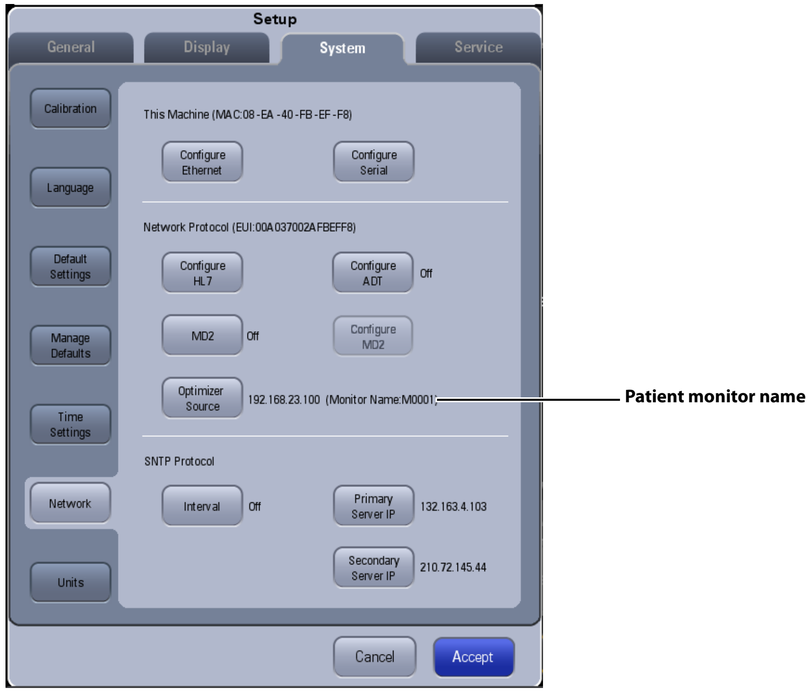

FIGURE 2-34 Optimizer Source (Patient Monitor Connected)

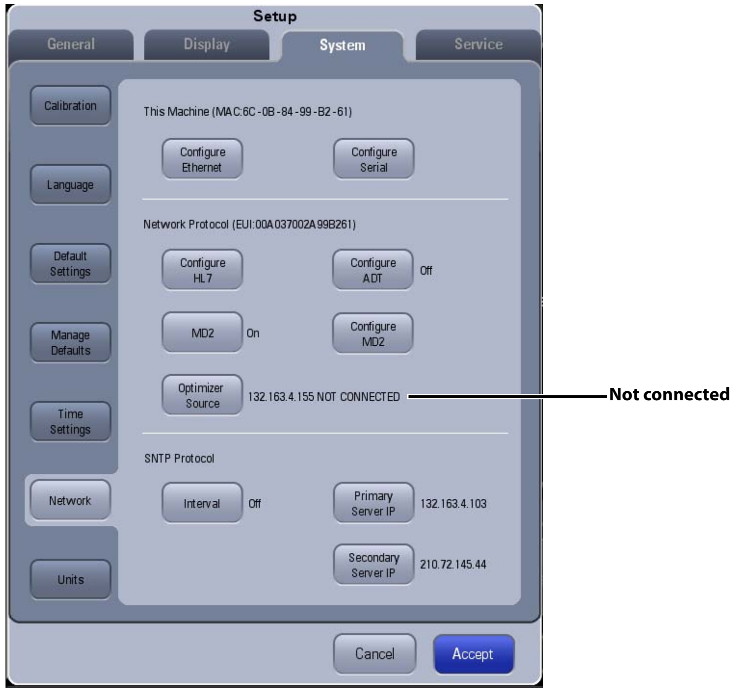

FIGURE 2-35 Optimizer Source (Patient Monitor Not Connected)

2.3 Software and License Key Installation

1. Upload software to the desired software if required. See page 5-83 "Software Update and Software Configuration Activation" for instructions.
2. For DSP systems, install license files as required. See page 5-83 "Software Update and Software Configuration Activation" for instructions.

2.4 Functional Tests

Refer to Chapter 4.0 Calibration if any values are out of specification.

NOTE: **The A7 system must be powered on (AC power, not battery) and the Breathing System Warmer set to ON at least an hour before performing the Ventilation Tests described in "VCV Adult Ventilation Mode Test" on page 2-61.**

2.4.1 Breathing System Leak Test

NOTE: **Always perform a leak test after servicing the anesthesia machine, replacing the components, or reconnecting the tubes.**

2.4.1.1 Breathing System Leak Test in Mechanical Ventilation Mode

This test checks the pneumatic circuit for leaks in mechanical ventilation mode. Test items include the bellows, drive gas circuit, CO2 absorber canister, patient tubes, flow sensors, and flow sensor connectors.

To perform the breathing system leak test in mechanical ventilation mode:

1. You can access the automatic circuit leak test screen after the Power-On Self Test has passed. You can also open the Setup in Standby and select Test Leak/Compliance on the General menu to access the automatic circuit leak test screen.The automatic circuit leak test screen is shown below. Set up the machine as per the instructions on the screen. Then, select Continue to execute automatic circuit leak test.

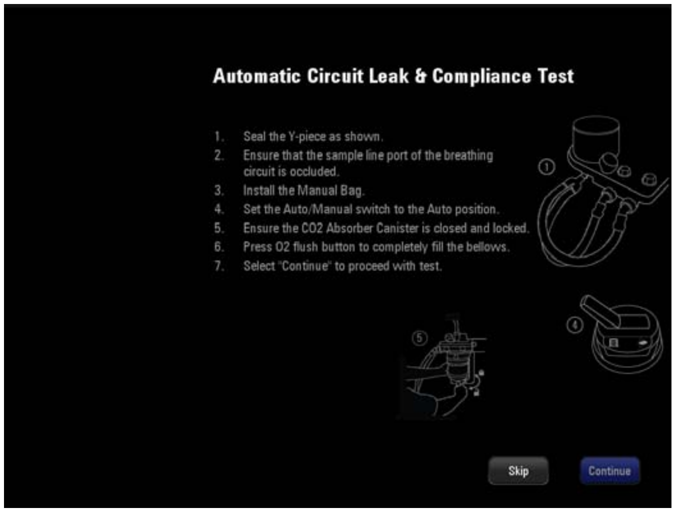

FIGURE 2-36 Automatic Circuit Leak and Compliance Test

The ongoing automatic circuit leak test is as shown below. You can select Cancel to cancel the ongoing leak test.

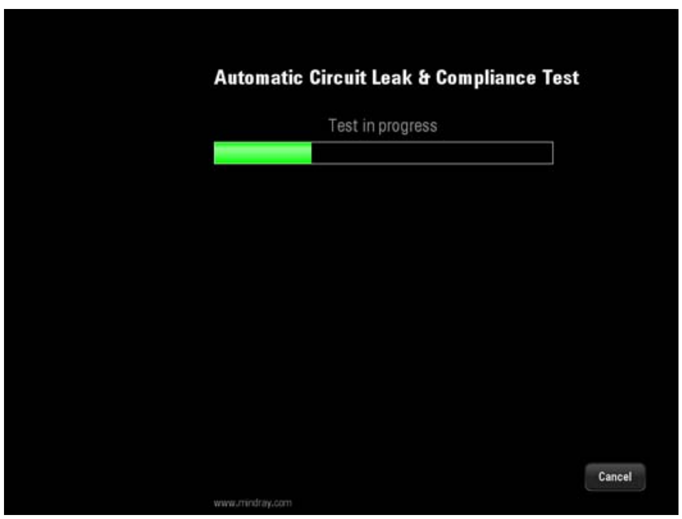

FIGURE 2-37 Automatic Circuit Leak and Compliance Test In Progress

During the automatic circuit leak test, the safety valve control test is also being conducted. The automatic circuit leak test results are listed in the following table.

Test results	System Limitation
Safety valve control failed	The machine cannot be used.
Automatic circuit leak test failed Leak ≥200 mL/min and ≤1000 mL	The user can acknowledge the leak and continue with automatic ventilation

Test results	System Limitation
Automatic circuit leak test failed Leak >1000 mL	Only manual ventilation can be applied
Compliance test failed	Both automatic ventilation and manual ventilation can still be applied using the previous compliance value in the A7 system memory, but may not meet the accuracy of the delivered volume.

The following screen is displayed if the safety valve control test is failed. You can select Service Access and enter the required service password to access service mode. You can select Retry to perform automatic circuit leak test again.

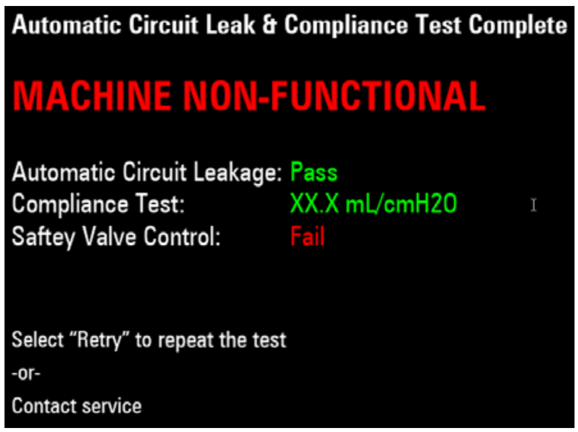

FIGURE 2-38 Machine Non-Functional Screen

The following screen is displayed if the automatic circuit leak test is failed and the Leak ≥200 mL/min and ≤1000 mL. You can select Retry to perform the automatic circuit leak test again or accept the result continue with automatic ventilation.

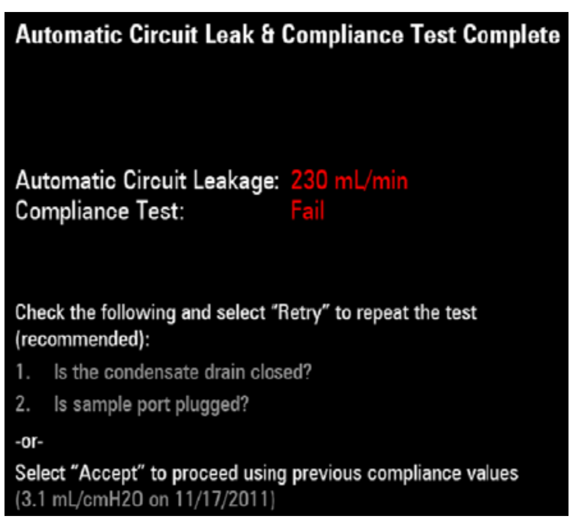

FIGURE 2-39 Automatic Circuit Leak and Compliance Test: Fail

The following screen is displayed if the automatic circuit leak test is failed and the leak >1000 mL. You can select Manual Only to enter Standby mode. But mechanical ventilation is disabled. You can select Retry to perform automatic circuit leak test again.

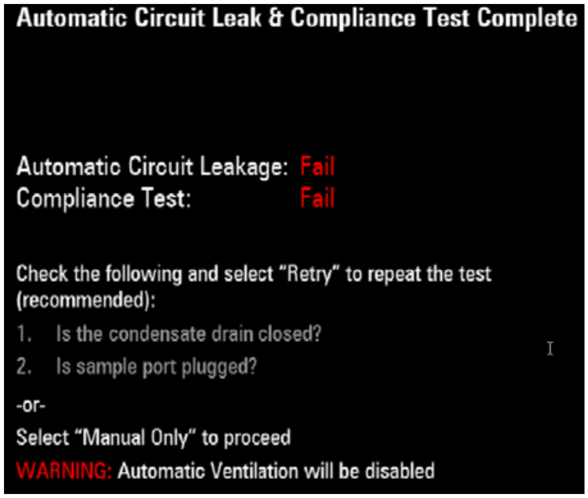

FIGURE 2-40 Automatic Circuit Leak and Compliance Test: Fail

The following screen is displayed if the compliance test is failed. You can select Accept to enter Standby mode.You can select Retry to perform automatic circuit leak test again.

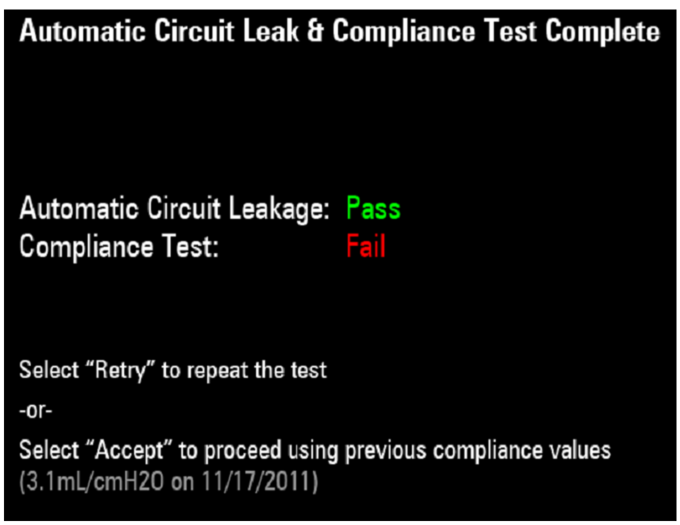

FIGURE 2-41 Compliance Test: Fail

The following screen is displayed if the automatic circuit leak test is completed. Select Continue to enter Standby mode.

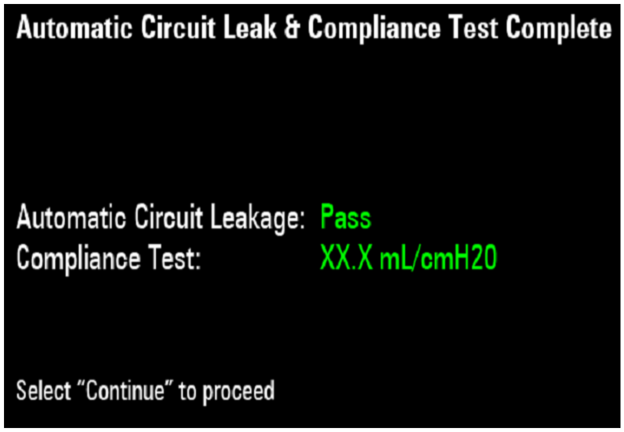

FIGURE 2-42 Automatic Circuit Leak Test Completed

NOTE: **If the leak test fails, check all of the possible leak sources, including the bellows, breathing system tubes, and CO2 absorber canister. Check that they are correctly connected and their connectors are not damaged.**

NOTE: **If there is a leak, check the pneumatic circuit system for leakage and troubleshoot the problems as described in 5.3.4 Breathing System. After the leak has been resolved, repeat the leak test.**

2.4.1.2 Breathing System Leak Test in Manual Ventilation Mode

This test checks the pneumatic circuit for leaks in manual ventilation mode. Test items include the APL valve, check valve, CO2 absorber canister, patient tubes, flow sensors, and flow sensor connectors.

To perform the breathing system leak test in manual ventilation mode:

1. You can access the manual circuit leak test screen after the automatic circuit leak test has passed. The manual circuit leak test screen is shown below.

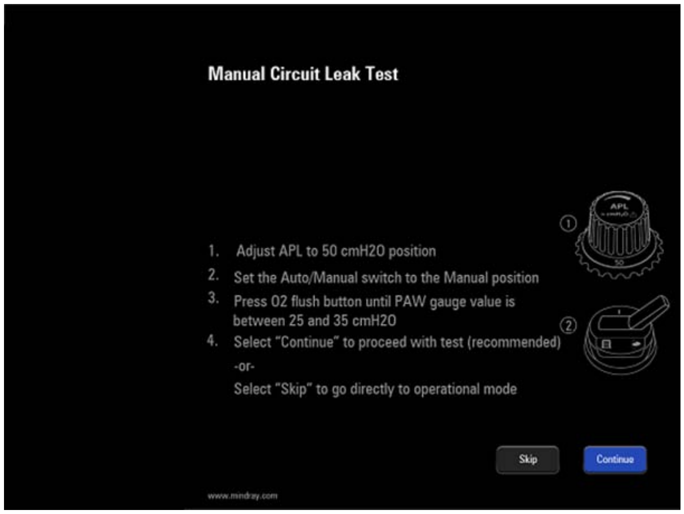

FIGURE 2-43 Automatic Circuit Leak Test Completed

2. Set up the machine as per the instructions on the screen. Then, select Continue to execute manual circuit leak test.
3. The ongoing manual circuit leak test is as shown below. You can select Cancel to cancel the ongoing leak test.

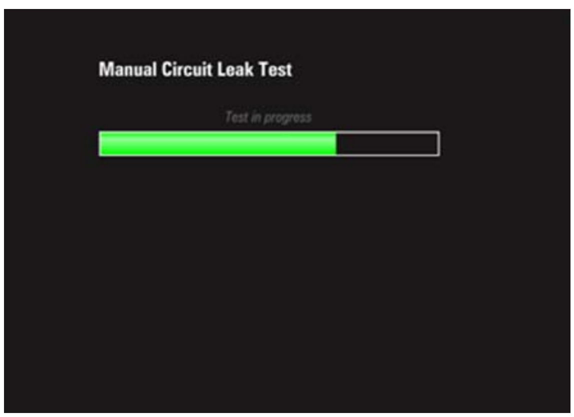

FIGURE 2-44 Manual Circuit Leak Test In Progress

The following screen is displayed if the manual circuit leak test is failed. If so, you must perform the test again.

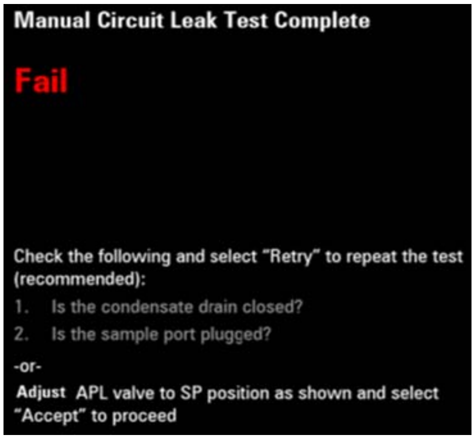

FIGURE 2-45 Manual Circuit Leak Test: Fail

The following screen is displayed if the manual circuit leak test is completed. Select Continue to enter Standby mode.

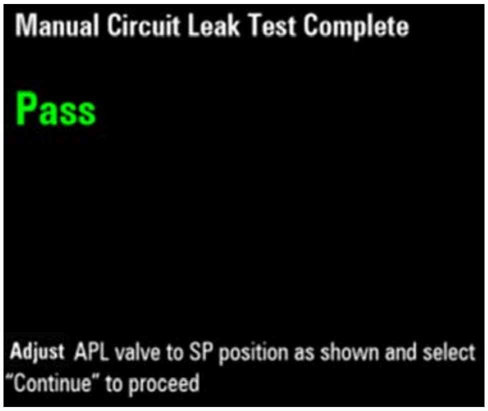

FIGURE 2-46 Manual Circuit Leak Test: Passed

NOTE: **If there is a leak, check the pneumatic circuit system for leakage and troubleshoot the problems as described in 5.3 Pneumatic Circuit System Problems. Repeat the leak test after the source of the failure has been resolved.**

2.4.1.3 Troubleshooting: Leak Test

The following table lists the commonly-encountered problems and recommends actions for the Breathing System Leak Test in Manual Ventilation Mode.

Failure description	Possible cause	Recommended action
Leak test failure is prompted immediately after [Start] is selected (typically, the leak test requires at least 3 minutes).	The Auto/Manual ventilation switch is set to the bag position and the message [Manual Vent.] is prompted.	Set the Auto/Manual ventilation switch to the mechanical ventilation position.
	The reading on the drive gas (O2) pressure gauge indicates drive gas pressure low (lower than 200 kPa) and the alarm of [Drive Gas Pressure Low] is produced.	Replace or connect gas supplies and make sure that the drive gas pressure is at 350 to 450 kPa.
During leak test, the pressure indicated by the airway pressure gauge fails to reach 30 cmH2O.	1. Before the leak test, the bellows is not fully inflated. 2. The Y piece on the breathing tube is not connected to the test plug. 3. The bellows housing is not properly installed.	Check the connections of the pneumatic circuit and re-install the pneumatic circuit.

2.4.2 Automatic Backup Flow Control Test

This test checks whether the automatic backup flow control (BFCS) system work normally. Test items include the Solenoid Actuator, Stepper Motor, Position Sensor, and 3-Way Valve.

To Perform an Automatic Backup Flow Control Test:

1. While powering on the A7, the system calculates the time between the last successful Automatic Backup Flow Control Test time and current time. If the difference between the two is greater than 168 hours, the manual circuit test screen is entered from startup and BFCS knob is not deployed, the system enters first Automatic Backup Flow Control Test screen when manual circuit test is completed. If the test does not appear after the manual leak test, go to SETUP / SERVICE / TEST BFCS to activate the test.

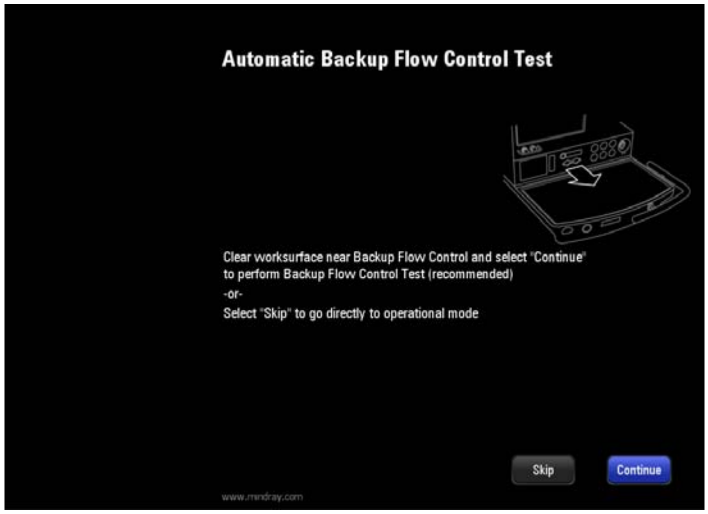

FIGURE 2-47 Automatic Backup Flow Control Test

1. Set up the machine as per the instructions on the screen. Then, select Continue to execute automatic backup flow control test.
2. The ongoing Automatic Backup Flow Control Test is as shown below. You can select **Cancel** to cancel the ongoing test.

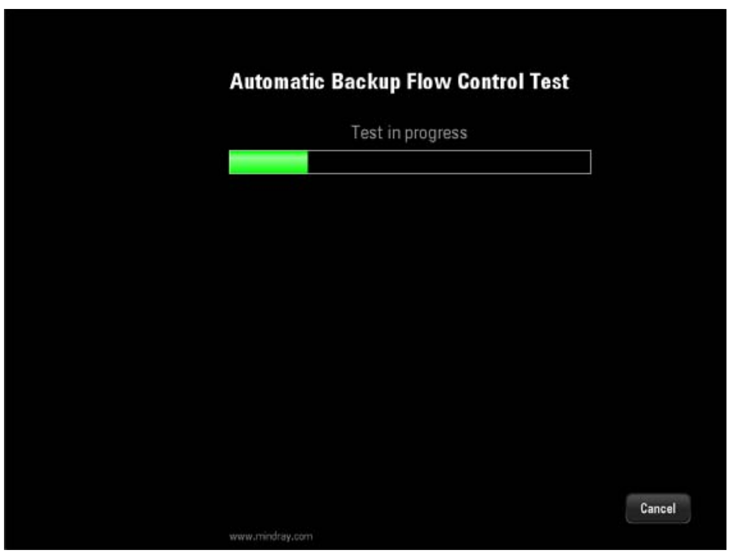

FIGURE 2-48 Automatic Backup Flow Control Test In Progress

The following screen is displayed if the automatic backup flow control test is failed. If so, you can select Retry to repeat the test or accept the result to enter Standby mode.

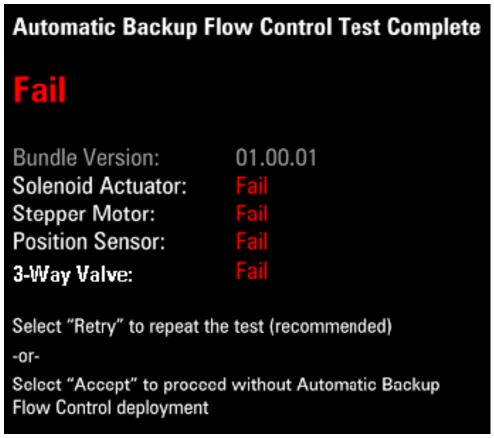

FIGURE 2-49 Automatic Backup Flow Control Test: Fail

NOTE: **If BFCS is retracted at the end of the test, select "Accept" will accept the result to proceed without automatic backup flow control deployment. If BFCS is deployed at the end of the test, select "Accept" will accept the result to proceed using Backup Flow Control.**

The following screen is displayed if the automatic backup flow control test is completed. Select Continue to enter Standby mode.

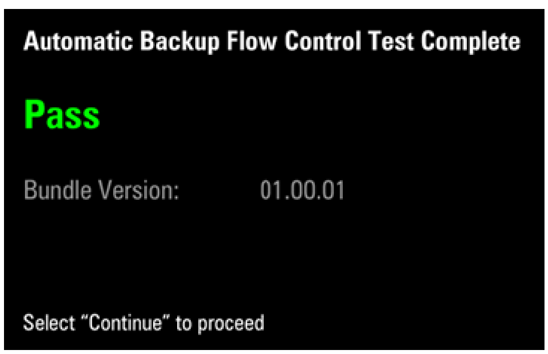

FIGURE 2-50 Automatic Backup Flow Control Test: Passed

2.4.2.1 Troubleshooting: BFCS Test

The following table lists the commonly-encountered problems and recommends actions for the Automatic Backup Flow Control Test.

Failure description	Possible cause	Recommended action
The BFCS fails to deploy during automatic backup flow control test.	The BFCS gets stuck.	Clear the work surface near the backup flow control system and check if the BFCS is stuck.
	The solenoid of BFCS is faulty	1. Re-start the machine. 2. Replace the parts of backup flow control system.

Failure description	Possible cause	Recommended action
The BFCS fails to retract during automatic backup flow control test.	The stepper motor of BFCS is faulty.	1. Re-start the machine. 2. Replace the parts of backup flow control system.
The three-way valve is faulty.	When the three-way valve is switched to BFCS limb during BFCS automatic test, the measured flow of total flow meter is less than 0.2L/min.	1. Check if the gas supply connection and supply gas pressure are normal. 2. Replace the three-way valve.

2.4.3 Display Setup Check

Touch Continue to advance to the Standby screen display. For A7 EPSON systems (Software Bundle Version earlier than 03.01.00) verify that the ventilation modes are VCV, SIMV-VC, PCV (with VG), SIMV-PC, PS and Manual. Make sure in manual mode the following buttons appear: Alarms, Bypass, ACGO, Monitor, and CO2 Alarms. Make sure that the Spirometry tab is present. Make sure that the optimizer is displayed or can be enabled in the System menu.

.

FIGURE 2-51 Display Setup Check, A7 (EPSON)

For A7 DSP systems (Software Bundle Version 03.01.00 and later), check that the standard ventilation modes VCV, SIMV-VC, PCV, PCV-VG, SIMV-PC, CPAP/PS, and Manual are present. Make sure in manual mode the following buttons appear: Alarms, ACGO, Monitor (if AG module is installed), and CO2 Alarms (if AG module is installed). Verify that the options that were activated with the license keys are present.

FIGURE 2-52 Display Setup Check, A7 (DSP with all options enabled)

2.4.4 O2 Sensor Calibration

NOTE: **Both a 21% and 100% O2 calibration MUST BE performed before first use of the A7. The O2 sensor is not calibrated with the machine at the factory.**

NOTE: **Calibrate the O2 sensor when a great deviation of O2 concentration monitored value occurs or when the O2 sensor or ventilator control board is replaced or when prompted by the anesthesia system.**

NOTE: **Before calibration, observe if the O2 sensor displays numerics on the measure screen. If not, check the O2 sensor connection line, or replace the O2 sensor until measure numerics are displayed.**

2.4.4.1 21% O2 Calibration

Follow these steps to calibrate the O2 sensor at 21% O2:

1. Select Setup > System > Calibration >O2 Sensor or Setup > Service > Calibration > O2 Sensor to access the screen as shown below. The General tab shows only 21% O2 Sensor calibration; the System and Service tabs require passwords and show both 21% and 100% O2 Sensor calibration. Set up the machine as per the instructions on the screen. Select Begin to start calibration.

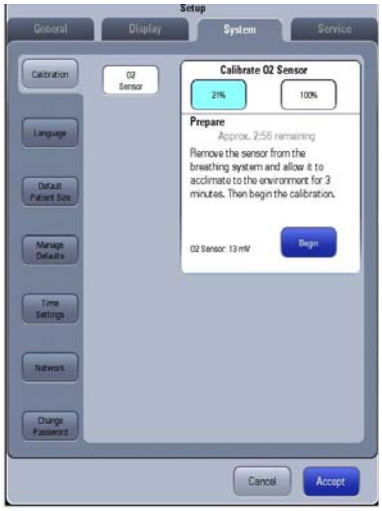

FIGURE 2-53 O2 Sensor Calibration

2. The calibration screen as shown below is displayed when Begin is selected. During the calibration, you can select Cancel to cancel the calibration.

FIGURE 2-54 O2 Sensor Calibration in Progress

3. The screen shown below is displayed if the ongoing calibration is canceled. Select Try Again to repeat the calibration. Select Done to exit the calibration screen.

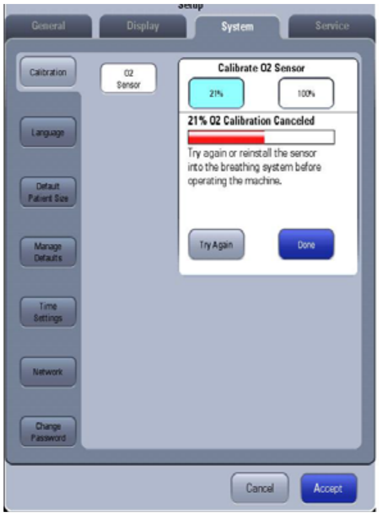

FIGURE 2-55 O2 Sensor Calibration Canceled

4. The screen shown below is displayed if the calibration has failed. A Fail code is displayed in red. Select Try Again to repeat the calibration. Select Done to exit the calibration screen.

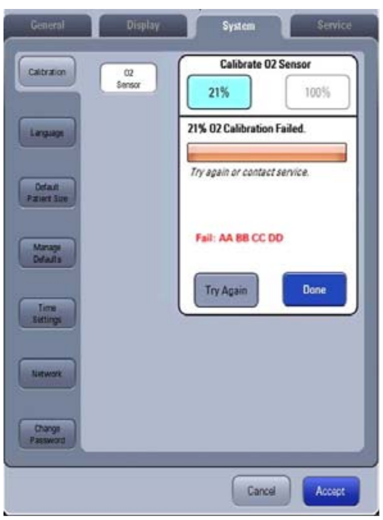

FIGURE 2-56 O2 Sensor Calibration Failed

5. The screen shown below is displayed after a successful calibration. Select Done to exit the calibration screen.

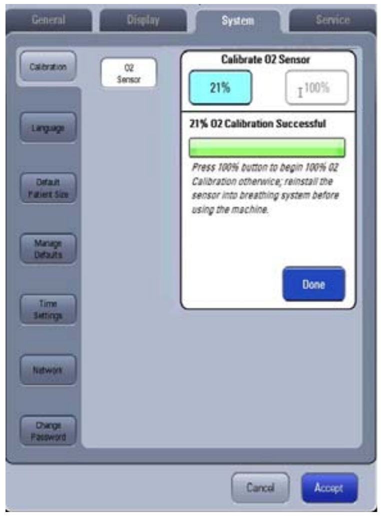

FIGURE 2-57 O2 Sensor Calibration Successful

2.4.4.2 100% O2 Calibration

NOTE: **100% O2 calibration must be performed in standby mode.**

NOTE: **100% O2 calibration can be performed only after a successful 21% O2 calibration.**

NOTE: **IMake sure that the manual bag is in position in manual mode. Otherwise, put the Manual/Auto lever to Auto position.**

Follow these steps to calibrate O2 sensor at 100% O2:

1. Enter Standby.
2. Select Setup > System > Calibration > O2 Sensor or Setup > Service > Calibration > O2 Sensor. The System and Service tabs require passwords and shows both 21% and 100% O2 Sensor calibration. The calibration screen shown below is displayed when 100% is selected. Set up the machine as per the instructions on the screen and select Next.

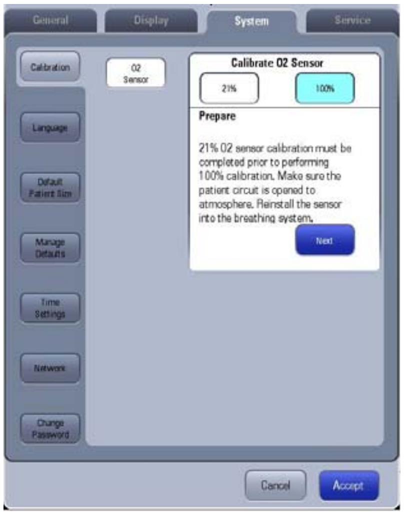

FIGURE 2-58 100% O2 Sensor Calibration

3. The calibration screen shown below is displayed when Next is selected.

FIGURE 2-59 100% O2 Sensor Calibration

4. The calibration screen shown below is displayed when Next is selected. Set up the machine as per the instructions on the screen. Wait 2 minutes to ensure that the O2 cell voltage has stabilized at the maximum value for at least 30s. Select Begin.

FIGURE 2-60 100% O2 Sensor Calibration Preparation

5. The calibration screen as shown below is displayed when Begin is selected. During the calibration, you can select Cancel to cancel the calibration.

FIGURE 2-61 100% O2 Sensor Calibration in Progress

6. The screen shown below is displayed if the ongoing calibration is canceled. Select Try Again to repeat the calibration. Select Done to exit the calibration screen.

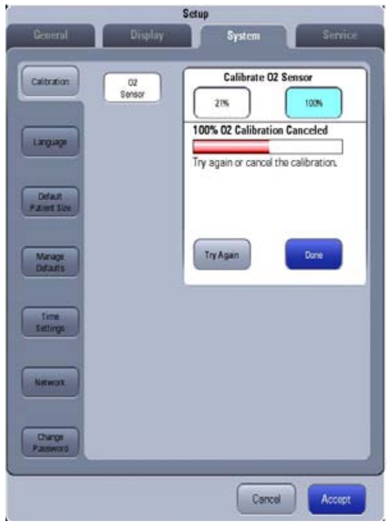

FIGURE 2-62 100% O2 Sensor Calibration Canceled

7. The screen shown below is displayed if the calibration has failed. A Fail code is displayed in red. Select Try Again to repeat the calibration. Select Done to exit the calibration screen.

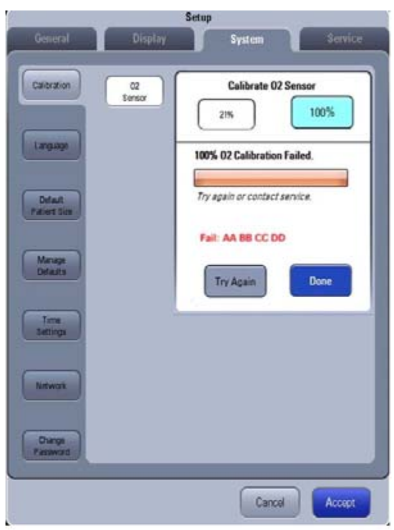

FIGURE 2-63 100% O2 Sensor Calibration Failed

8. The screen as shown below is displayed after a successful calibration. Select Done to exit the calibration screen.

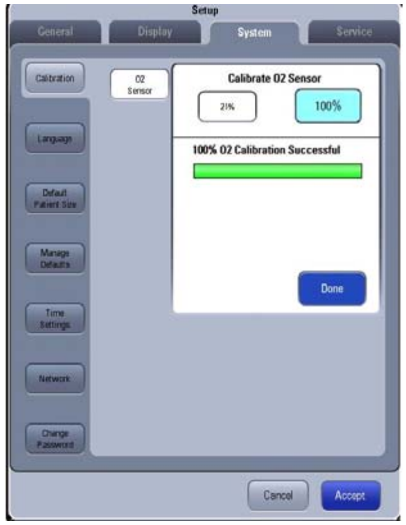

FIGURE 2-64 100% O2 Sensor Calibration Successful

2.4.4.3 Troubleshooting: O2 Sensor Calibration

Failure Description	Possible Cause	Recommended Action
After [Start] is selected, calibration failure is prompted very soon.	If the alarm [O2 Sensor Unconnected] is displayed, it indicates that O2 sensor is not connected.	Connect the O2 sensor.
	O2 supply pressure is insufficient (lower than 200 kPa).	Change or connect the gas supply and make sure that O2 supply pressure is sufficient.
	21% O2 calibration is not completed before 100% O2 calibration.	Perform 21% O2 calibration followed by 100% O2 calibration.
Calibration failure is prompted about 3 minutes after calibration is started.	The O2% sampling value is not within the normal range. Namely, the sampling value of 21% O2 concentration is outside the range of 150~500 and the sampling value of 100% O2 concentration is outside the range of 800~2028. Access Setup → Service → Data Monitors → VCV to check the O2% sampling value.	Replace the O2 sensor.

Error Code	Description	Recommended Action
00 00 00 02	O2 supply pressure is low. During 100% calibration process, O2 supply pressure was not sufficient.	. Check that the O2 sensor is connected to the cable correctly. . Check the O2 supply pressure. . Check that the O2 sensor output voltage in the calibration menu is steady. . Replace the O2 sensor.
00 00 00 04	O2 sensor is disconnected. Sampled data is greater than 2900 (AD value).	. Check that the O2 sensor is connected to the cable correctly. . Check that the O2 sensor output voltage in the calibration menu is steady. . Replace the O2 sensor.

Error Code	Description	Recommended Action
00 00 00 08	21% calibration value is outside of the expected range (150~500) (AD value).	. Check that the O2 sensor is connected to the cable correctly. . Check that the O2 sensor is in 21% O2. . Check that the O2 sensor output voltage in the calibration menu is steady. . Replace the O2 sensor.
00 00 00 10	100% calibration value is outside of the expected range (800~2028) (AD value).	. Check that the O2 sensor is connected to the cable correctly. . Check that the O2 sensor is in 100% O2. . Check that the O2 sensor output voltage in the calibration menu is steady. . Replace the O2 sensor.
00 00 00 20	Error writing to EEPROM.	. Repeat the calibration. . Replace the O2 sensor. . Replace the CPU board.

2.4.5 Calibrate the AG Module (Only for A7's with an AG Module)

Prepare the following before doing the external and Internal AG module calibration:

- Gas cylinder, with a certain standard gas or mixture gas. Gas concentration should meet the following requirements: AA≥1.5%, CO2≥1.5%, N2O≥40%, O2≥40%, of which AA represents an anesthetic agent. a/c≤0.01 (a is the gas absolute concentration accuracy; c is the gas concentration).
- T-shape connector
- Tubing

Follow this procedure to perform a calibration:

1. Connect the test system as follows.

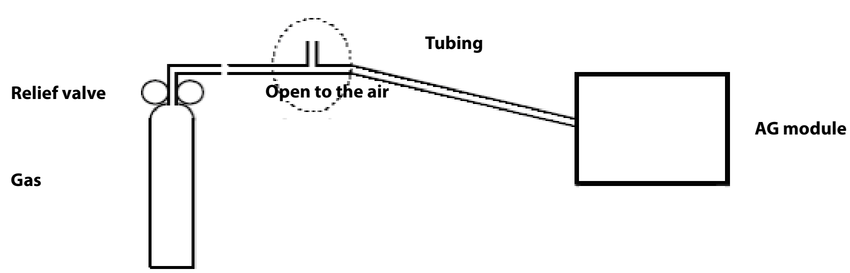

FIGURE 2-65

NOTE: **When calibrating the internal AG module, open the back cover of the machine, disconnect the tubing as shown below and connect the calibration gas to the gas inlet.**

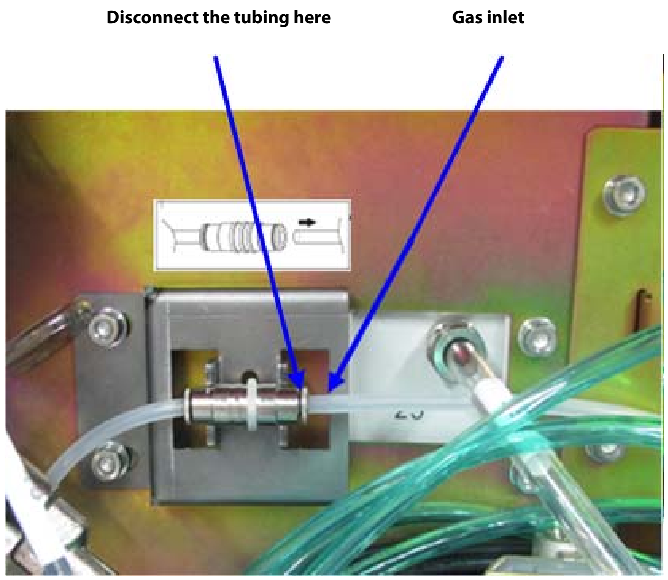

FIGURE 2-66 Connection for the Internal AG module

2. Ensure that the system is **Standby** mode. If not, select the **End Case** button in the Manual tab and follow the on-screen prompts to end the case and enter **Standby** mode.
3. Select **Setup** softkey> **System** tab (system password needed).
4. Select the **Calibration** button.
5. Select the **Internal AG Module** or **External AG Module** button.
6. Wait for the AG module to be fully warmed up
7. Enter the actual concentration of the calibration gas.
8. Turn on the calibration gas canister and the system displays the real-time concentration of calibration gas.
9. Select the **Calibrate** button to start to calibrate the AG Module. The system will display the results of the calibration status when the process is completed.
10. After calibration, select **Done** to close the **Calibration** window.
11. Select Accept to close the Setup window.

NOTE: **If available, both the Internal AG Module and External AG Module have to be calibrated.**

NOTE: **To avoid premature emptying of the the gas canister, always remove the regulator after the completion of the calibrations.**

2.4.6 Gas Module Verification (Only for A7's with an AG Module)

1. Remove and re-insert the AG Module into the module rack.
2. Touch the screen to start the manual ventilation mode and make sure that the gas test screen and CO2 waveform and parameter area are displayed on the screen and that the prompt message **External AG Loaded Successfully** is displayed at the top of the screen.
3. After the AG module is inserted, remove the watertrap, make sure that the alarm **AG No Watertrap** appears. After the watertrap is connected to the module, make sure that the alarm disappears.
4. Wait until the AG module warmup is finished and then use your hand or other objects to completely block the gas inlet of the AG module. An alarm message **AG Airway Occluded** will appear on the screen.
5. Block the gas inlet for another 30 s. If the alarm message does not disappear, it indicates that the module does not leak.

2.4.7 Gas Delivery System Tests

2.4.7.1 O2 Flush Verification

1. Touch the screen to start the manual ventilation mode and set the ACGO button to On.
2. Set the flow to minimum (0.20 L/min). Connect a flow meter to the ACGO port.
3. Verify that the O2 flush flow is between 35 to 50 L/min when pressing the O2 flush button.

2.4.7.2 O2:N2O Ratio Test Under EFCS (Only for A7's with an AG Module)

1. Connect a breathing hose from the ACGO port to the flow analyzer.
2. Connect a breathing hose from the flow analyzer output to the scavenger.
3. If necessary, attach a adapter to the flow analyzer to connect the sampling line from the AG module.

FIGURE 2-67

4. Touch the screen to start the manual ventilation mode and set the **ACGO** button to ON. Set the Fresh Gas Control to Total Flow Mode.
5. Set the O2 concentration to each of the set points in the table below and set the N2O as balance gas, then verify the oxygen concentration at each step.

Test Method	Verification
Set the O2 Concentration to 26%. Set the total flow to 1L/min.	Verify O2 concentration is between 24.7% and 27.3%.
Set the O2 Concentration to 100%. Set the total flow to 1L/min	Verify O2 concentration is 95% or greater
Set the O2 Concentration to 26%. Set the total flow to 5L/min	Verify O2 concentration is between 24.7% and 27.3%
Set the O2 Concentration to 100%. Set the total flow to 5L/min	Verify O2 concentration is 95% or greater

2.4.7.3 O2:N2O Ratio Test Under EFCS (Only for A7's without an AG Module)

1. Using a breathing hose, Connect the bag arm to the expiratory port.
2. Put the Manual/Auto lever to the manual position and set the APL valve to 75.
3. Use a breathing hose to connect the output of the inspiratory port to the scavenger
4. Verify the scavenger is connected at the wall and the floater is between MIN and MAX。
5. Set the O2 concentration to each of the set points in the table below and set the N2O as balance gas, then verify the oxygen concentration at each step.
6. Reconnect the Waste Gas Scavenger Hose..

Test Method	Verification
Set the O2 Concentration to 26%. Set the total flow to 1L/min.	Verify O2 concentration is between 24.7% and 27.3%.
Set the O2 Concentration to 100%. Set the total flow to 1L/min	Verify O2 concentration is 95% or greater
Set the O2 Concentration to 26%. Set the total flow to 5L/min	Verify O2 concentration is between 24.7% and 27.3%
Set the O2 Concentration to 100%. Set the total flow to 5L/min	Verify O2 concentration is 95% or greater

2.4.7.4 Vaporizer Leak Test

1. Set the ventilation Auto/Manual ventilation switch to Manual.
2. Set the APL valve to the SP position.
3. For A7's without an AG module, connect one end of the breathing circuit to the bag arm, one end to the inspiratory port and the Y-piece to the test port (FIGURE 2-68).

4. For A7's with an AG module, connect the tubes according to the methods listed as below:

   a. When the exhaust of the AG module is not connected to the sample gas return port, connect one end of the breathing circuit to the bag arm, one end to the inspiratory port and the Y-piece to the test port. The gas sampling tube should not be connected to the Y piece.

FIGURE 2-68

   b. When the exhaust of the AG module is connected to the sample gas return port, connect one end of the breathing circuit to the bag arm, one end to the inspiratory port and the Y-piece to the test port. Additional, connect gas sampling tube to the Y-piece.

FIGURE 2-69

5. Mount and lock the vaporizer onto the vaporizer mount. (Certain vaporizers need to be set to at least 1% for correct testing. See the vaporizer manufacturer's manual for details.)
6. Set the fresh gas flow to 200 mL/min.
7. Set the APL valve to 75 and verify that the pressure on the airway pressure gauge increases above 30 cmH2O within 2 minutes.

8. Turn off the vaporizer. Set APL valve to SP.
9. Repeat Steps 4, 5, 6, and 7 for the other vaporizer.

NOTE: This test also tests the expiratory check valve.

2.4.7.5 Check Valve Test

1. Set the ventilation Auto/Manual ventilation switch to Manual.
2. Set the APL valve to 75.
3. Connect the breathing bag to the Inspiratory port.
4. Plug the bag arm.
5. Press the FLUSH button until the pressure on the airway pressure gauge reaches 35 cmH2O.
6. Set the APL valve to SP.
7. Verify that the pressure does not drop below 30 cmH2O after 10 seconds.

2.5 Pneumatic Leak Tests

Turn all fresh gas flows to 0 L/min.

2.5.1 Line Pressure Gauges Accuracy Test

1. Open the rear panel and disconnect the pipe supply for all 3 gases (O2, AIR and N2O).
2. Disconnect hose # 47 from the regulator assembly and connect it to your high pressure meter.
3. Reconnect the O2 Pipeline supply.
4. Verify the reading on your pressure meter and the reading on the O2 pipeline pressure gauge are within 5 psi of each other.
5. Disconnect the O2 Pipeline supply and reconnect hose # 47 to the regulator assembly.
6. Disconnect hose # 37 from the regulator assembly and connect it to your high pressure meter.
7. Reconnect the AIR Pipeline supply.
8. Verify the reading on your pressure meter and the reading on the AIR pipeline pressure gauge are within 5 psi of each other.
9. Disconnect the AIR Pipeline supply and reconnect hose # 37 to the regulator assembly.
10. Disconnect hose # 35 from the regulator assembly and connect it to your high pressure meter.
11. Reconnect the N2O Pipeline supply.
12. Verify the reading on your pressure meter and the reading on the N2O pipeline pressure gauge are within 5 psi of each other.
13. Disconnect the N2O Pipeline supply and reconnect hose # 35 to the regulator assembly.
14. Reconnect the pipe supply for all 3 gases (O2, AIR and N2O).

2.5.2 N2O Cylinder Leak Test

1. Remove the N2O line pressure hose from the line pressure inlet on the A7.
2. Mount a full N2O cylinder to the rear panel yoke. If necessary, place a new clean tank washer between the cylinder and the yoke to minimize any leaks at the yoke connection.
3. Open the N2O cylinder until its pressure gauge indicates cylinder pressure.
4. Close the N2O cylinder.

The N2O cylinder pressure gauge should not drop more than 10% of its initial pressure over 1 minute.

2.5.3 O2 Cylinder Leak Test

1. Remove the O2 line pressure hose from the line pressure inlet on the anesthesia system.
2. Mount a full O2 cylinder to the rear panel yoke. If necessary, place a new clean tank washer between the cylinder and the yoke to minimize any leaks at the yoke connection.
3. Open the O2 cylinder until its pressure gauge indicates cylinder pressure.
4. Close the O2 cylinder.

The O2 cylinder pressure gauge should not drop more than 10% of its initial pressure over 1 minute.

2.5.4 AIR Cylinder Leak Test

1. Remove the AIR line pressure hose from the line pressure inlet on the anesthesia system.
2. Mount a full AIR cylinder to the rear panel yoke. If necessary, place a new clean tank washer between the cylinder and the yoke to minimize any leaks at the yoke connection.
3. Open the AIR cylinder until its pressure gauge indicates cylinder pressure.
4. Close the AIR cylinder.

The AIR cylinder pressure gauge should not drop more than 10% of its initial pressure over 1 minute.

2.5.5 Line Pressure Leak Tests

2.5.5.1 BFCS Test

1. Remove the O2, AIR and N2O cylinder from the anesthesia system.
2. Connect the O2, AIR and N2O line pressure hoses to the line pressure inlet on the anesthesia system.
3. Disconnect the hose #26 from the back pressure regulator and plug the connector on the back pressure regulator.
4. Turn the unit on and push the BFCS button to deploy the BFCS.
5. Open the O2 and AIR needle valve fully.
6. Pinch the O2 line pressure hose.
7. Remove the O2 line pressure hose from the line source while keeping the hoses pinched. The pressure measured on the line pressure gauge on the front of the unit should not fall more than 10 psi per 100 seconds (2 psi per 20 sec).
8. Release the O2 line pressure hose.
9. Pinch the AIR line pressure hose.
10. Remove the AIR line pressure hoses from the line source while keeping the hose pinched.
11. The pressure measured on the line pressure gauge on the front of the unit should not fall more than 10 psi per 100 seconds (2 psi per 20 sec).
12. Remove the plug from the back pressure regulator and reconnect hose #26.
13. Close the O2 and AIR needle valves.
14. Reconnect the O2 and AIR line pressure hoses and remove the pinch in the hose.
15. Disable the BFCS.

2.5.5.2 EFCS Test

1. Remove the O2, AIR and N2O cylinder from the anesthesia system.
2. Connect the O2, AIR and N2O line pressure hoses to the line pressure inlet on the anesthesia system.
3. Disconnect the hose #123 from the 3 way valve assembly and plug the connector on the 3 way valve assembly.
4. Turn the unit on and set the A7 in EFCS mode.
5. Enter SERVICE / FCS TESTS:
   - Set 3-Way Valve (CPU) to "H"
   - Set 3-Way Valve (FPGA) to "H"
   - Set O2 Prop Valve DA to "4000"
   - Set N2O Prop Valve DA to "4000"
   - Set AIR Prop Valve DA to "4000"
6. Pinch the O2 line pressure hose.
7. Remove the O2 line pressure hoses from the line source while keeping the hoses pinched. The pressure measured on the line pressure O2 gauge on the front of the unit should not fall more than 10 psi per 100 seconds (2 psi per 20 sec).
8. Release the O2 line pressure hose.
9. Pinch the N2O line pressure hose.
10. Remove the N2O line pressure hoses from the line source while keeping the hoses pinched. The pressure measured on the line pressure N2O gauge on the front of the unit should not fall more than 10 psi per 100 seconds (2 psi per 20 sec).
11. Release the N2O line pressure hose.
12. Pinch the AIR line pressure hose.
13. Remove the AIR line pressure hose from the line source while keeping the hose pinched.
14. The pressure measured on the line pressure gauge on the front of the unit should not fall more than 10 psi per 100 seconds (2 psi per 20 sec).
15. Enter SERVICE / FCS TESTS:
    - Set O2 Prop Valve DA to "0"
    - Set N2O Prop Valve DA to "0"
    - Set AIR Prop Valve DA to "0"
16. Remove the plug from the 3 way valve assembly and reconnect hose #123.
17. Reconnect the O2, AIR and N2O line pressure hoses and remove the pinch in the hose.

2.5.5.3 ACGO Test

1. Turn the unit on and set the A7 in EFCS mode.
2. Set the Auto/Manual switch to Manual position.
3. Plug the ACGO port.
4. Set the O2 flow to 0.2L/min and set the unit to ACGO mode. The pressure must go over 30cmH2O with 1 minute.

2.6 Breathing System Checks

2.6.1 Waste Gas Scavenger Test (if available)

1. Connect one end of the low pressure waste gas hose to the port on the Waste Gas Scavenger Assembly. Connect the other end of the hose to the EVAC port.

NOTE: If operating the anesthesia system with other types of waste gas scavenging, ensure that waste gases are directed from the EVAC port to that scavenging system.

2. Connect the respiratory gas monitor exhaust output to the Colder fitting port on the Waste Gas Scavenger Assembly.
3. Ensure that the waste gas scavenger flow adjustment is able to be set between the MIN and MAX line markings.

For Units with a DGSS:

1. Ensure that all waste anesthetic connections are secure, unused inlets are capped, and that the DGSS® power cord is NOT connected.
2. Set the Auto/Manual ventilation switch to Manual.
3. Set fresh gas flow to 0 and fully open the APL.
4. Occlude the patient end of the circuit and observe the circuit pressure gauge. A value of less than -2 cm H_2O indicates a malfunction.
5. While keeping the patient end of the circuit occluded, press the oxygen flush button on the anesthesia machine for approximately 3 seconds while observing the circuit pressure gauge.
6. Circuit pressures should not exceed 15cm H_2O during this test.
7. Apply power to the DGSS® and repeat steps 2 through 6.
8. Frequent clicking sounds from the DGSS® may be heard during normal operation as the reservoir bag fills and empties.

2.6.2 Internal Gas Connections Test

2.6.2.1 BFCS Test

1. Close and remove all gas cylinders from the anesthesia system.
2. Connect only the O2 line pressure hose to the anesthesia system from the wall supply. Leave all other line pressure hoses disconnected.
3. Turn the unit on and set the A7 in BFCS mode, Rotate the O2 needle valve knob to ensure a continuous flow increase throughout its full range. Set the O2 flow to 2L/min.
4. Fully rotate the AIR needle valve knob and verify that there is no increase of total flow. Close the AIR valve.
5. Disconnect the O2 line pressure hose from the anesthesia system, and connect the AIR line pressure hose from the wall supply.
6. Rotate the AIR needle valve knob to ensure a continuous flow increase throughout its full range.
7. Set the AIR flow to 2L/min.
8. Fully rotate the O2 needle valve knob and verify that there is no increase of total flow.
9. Close the AIR and O2 valves.
10. Disable Backup Flow Control.

2.6.2.2 EFCS Test (Only for A7's with an AG Module)

1. Connect the O2, AIR and N2O line pressure hoses to the anesthesia system from the wall supply.
2. Connect a breathing hose from the ACGO port to the flow analyzer.
3. Connect a breathing hose from the flow analyzer output to the scavenger.
4. Attach a adapter to the flow analyzer to connect the sampling line from the AG module (if necessary)

FIGURE 2-70

5. Verify the machine is in EFCS mode.
6. Set the Flow Control mode to Direct Flow.
7. Touch the screen to start the manual ventilation mode and set the ACGO button to ON.
8. Set the balance gas to NONE.
9. Rotate the O2 flow control knob to ensure a continuous flow increase throughout its full range. Set the O2 flow to 5 L/min.
10. Verify the that the O2 concentrations reads at least 97% and the N2O concentration reads 0% after 1 minute.
11. Set the balance gas to AIR, and set the O2 flow to 0L/min.
12. Rotate the balance / AIR flow control knob to ensure a continuous flow increase throughout its full range.
13. Set the AIR flow to 5 L/min.
14. Verify the that the O2 concentrations reads between 19% and 23% and the N2O concentration reads 0% after 1 minute.
15. Set the balance gas to N2O.
16. Set the O2 flow to 5 L/min and rotate the N2O flow control knob to ensure a continuous flow increase throughout its full range (N2O flow range: from 0 to 12 L/min).
17. Set the O2 flow to 5 L/min and the N2O flow to 5 L/min.
18. Verify the that the O2 and N2O concentrations reads between 47% and 53% after 1 minute.
19. Set the system to the STANDBY mode by pressing the **End Case** button.

2.6.2.3 EFCS Test (Only for A7's without an AG Module)

1. Using a breathing hose, connect the bag arm to the expiratory port.
2. Put the Manual/Auto lever to the manual position and set the APL valve to 75.
3. Use a breathing hose to connect the output of the inspiratory port to the scavenger
4. Verify the scavenger is connected at the wall and the floater is between MIN and MAX.
5. Verify the machine is in EFCS mode.
6. Set the Flow Control mode to Direct Flow.
7. Set the balance gas to NONE.
8. Rotate the O2 flow control knob to ensure a continuous flow increase throughout its full range. Set the O2 flow to 5 L/min.
9. Verify the that the O2 concentrations reads at least 97% and the N2O concentration reads 0% after 1 minute.
10. Set the balance gas to AIR, and set the O2 flow to 0L/min.
11. Rotate the balance / AIR flow control knob to ensure a continuous flow increase throughout its full range.
12. Set the AIR flow to 5 L/min.
13. Verify the that the O2 concentrations reads between 19% and 23% and the N2O concentration reads 0% after 1 minute.
14. Set the balance gas to N2O.
15. Set the O2 flow to 5 L/min and rotate the N2O flow control knob to ensure a continuous flow increase throughout its full range (N2O flow range: from 0 to 12 L/min).
16. Set the O2 flow to 5 L/min and the N2O flow to 5 L/min.
17. Verify the that the O2 and N2O concentrations reads between 47% and 53% after 1 minute.
18. Set the system to the STANDBY mode by pressing the End Case button.
19. Reconnect the Waste Gas Scavenger Hose.

2.6.2.4 Check the Flow Accuracy of the EFCS

NOTE: Set the Gas Flow Analyzer Correction Mode to Standard settings (21 °C, 101.3 kPa).

1. Connect the O2, AIR and N2O line pressure hoses to the anesthesia system from the wall supply.
2. Connect a breathing hose from the ACGO port to the flow analyzer.
3. Connect a breathing hose from the flow analyzer output to the scavenger.

FIGURE 2-71

Calibration Device Fluke VT Plus

Setup the calibration device as described below:

a. Flow Settings: Press the Flow button on the front control panel of the calibration. You need set Range to Low Flow (when Gas Type is N2O bal O2, you need set Range to High Flow).

b. Gas Settings: Press the Setup button, select Setting->ENTER->Gas Settings->MODIFY->Gas Type->O2 or Air or N2O bal O2.

c. Correction mode: Press the Setup button, select Setting->ENTER->Correction Mode->MODIFY->Correction Mode->STPD21

Calibration Device (TSI Certifier 4070, Cannot be Used for DSP Units)

Setup the calibration device as described below:

a. Flow Setting: Press the to line select key until the top display reads LPM or SLPM. If the display reads LPM, press the DISPLAY UNITS key until the top display reads SLPM.

Calibration Device (CERTIFIER FA PLUS)

a. Touch on the following active areas of the Parameter Screen.

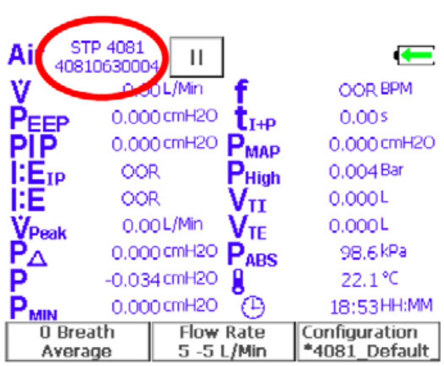

FIGURE 2-72

b. The following window will pop up.

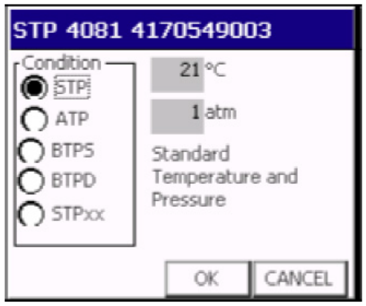

FIGURE 2-73

c. Select STP.

d. Select OK.

4. Verify the machine is in EFCS mode.
5. Set the Flow Control mode to Direct Flow.
6. Touch the screen to start the manual ventilation mode and set the ACGO button to ON.
7. Set the balance gas to NONE.
8. Rotate the O2 flow control knob to set the O2 flow following the table below, then verify the oxygen flow reading of the flow analyzer.

Test Method	Verification (Flow analyzer flow rate)
Set the O2 flow to 0.2 L/min.	**Verify O2 flow is between** 150 mL/min and 250 mL/min.
Set the O2 flow to 1 L/min.	**Verify O2 flow is between** 950 mL/min and 1050 mL/min.
Set the O2 flow to 3 L/min.	**Verify O2 flow is between** 2850 mL/min and 3150 mL/min.
Set the O2 flow to 10 L/min.	**Verify O2 flow is between** 9500 mL/min and 10500 mL/min.
Set the O2 flow to 15 L/min.	**Verify O2 flow is between** 14250 mL/min and 15750 mL/min.

9. Set the balance gas to AIR.
10. Set the O2 flow to 0 L/min.
11. Rotate the air flow control knob to set the air flow following the table below, then verify the air flow reading of the flow analyzer.

Test Method	Verification (Flow analyzer flow rate)
Set the air flow to 0.2 L/min.	**Verify air flow is between** 150 mL/min and 250 mL/min.
Set the air flow to 1 L/min.	**Verify air flow is between** 950 mL/min and 1050 mL/min.
Set the air flow to 3 L/min.	**Verify air flow is between** 2850 mL/min and 3150 mL/min.
Set the air flow to 10 L/min.	**Verify air flow is between** 9500 mL/min and 10500 mL/min.
Set the air flow to 15 L/min.	**Verify air flow is between** 14250 mL/min and 15750 mL/min.

2.6.3 Drive Gas Pressure Loss Alarm, N2O Cutoff Test

1. Close and remove all gas cylinders from the anesthesia system.
2. Connect the O2 and N2O line pressure hose to the anesthesia system from the wall supply. Leave all other line pressure hoses disconnected.
3. Turn the unit on and set the A7 in EFCS mode and set the N2O as balance gas.
4. Set the O2 flow to 2 L/min using the flow control valve.
5. Set the N2O flow to 2 L/min using the flow control valve.
6. Interrupt the O2 supply to the anesthesia system.
7. Verify that the flow of N2O and O2 stops within 2 minutes.
8. Verify the following alarms are activated:
   - **O2 Supply Failure** appears on the screen.
   - An alarm tone sounds.
9. Reconnect the O2 supply and disconnect the N2O line pressure hose
10. Verify the following alarms are activated:
    - **N2O Supply Failure** appears on the screen.
    - An alarm tone sounds.
11. Connect the AIR line pressure hose to the anesthesia system and set the AIR as balance gas.
12. Set the O2 flow to 2 L/min using the flow control valve.
13. Set the AIR flow to 2 L/min using the flow control valve.
14. Interrupt the AIR supply to the anesthesia system.
15. Verify the following alarm is activated:
    - **AIR Supply Failure** appears on the screen.
    - An alarm tone sounds.
16. Reconnect all line pressure hoses.

2.7 Performance Verification

NOTE: Set the Gas Flow Analyzer Correction Mode to BTPS (Body Temperature and Pressure, Saturated). For EPSON systems the mode can be set to ambient temperature and pressure or BTPS.

2.7.1 Manual Mode Ventilation Test

1. Power ON the anesthesia system.
2. Attach a breathing circuit and test lung to the Y-fitting of the breathing circuit.

NOTE: For testing purposes, always use a reusable breathing circuit and make sure the machine is under EFCS.

3. Perform the start up tests per the on-screen instructions. Ensure successful completion.
4. Set the mechanical Auto/Manual switch to MANUAL. Press the screen for the screen to change to manual Mode.
5. Set the APL Valve to approximately 25 cmH2O. Push the O2 Flush button to fill the breathing bag.
6. Set the Total flow to 1 L/min using the flow control valve. This will change the screen to manual Mode.
7. Squeeze the breathing bag once every 3 seconds.
8. Verify the inflation and deflation of the test lung.
9. Verify that an airway pressure waveform and all numeric values appear on screen during bag compressions.
10. Stop squeezing the breathing bag and set the APL Valve to the open position (SP).

2.7.2 APNEA Alarm Test

1. While in the Manual Ventilation Mode, stop ventilating the test lung and set the APL valve to SP.
2. Verify that the following APNEA alarm signals activate at approximately 30 seconds from the last bag compression.
   - APNEA appears on the screen.
   - An alarm tone sounds.

2.7.3 Alarm Silence Test

1. While the APNEA alarm is sounding, press the Silence soft key.
2. Verify the audio portion of the alarm stops and resumes after 2 minutes.

2.7.4 VCV Adult Ventilation Mode Test

1. Set the Fresh Gas Control to Direct Flow Mode.
2. Set the O2 flow to 2 L/min and set the N2O and AIR flow rates to minimum flow.
3. Set the mechanical Auto/Manual switch to AUTO.
4. Set the ventilator controls to:

Ventilator Controls	Ventilator Settings
Ventilation Mode	VCV
Vt	500
Rate	4
I:E	1:3
Tpause	30
PEEP	Off
Plimit	50

5. Verify that the pressure waveform, Tidal Volume, Mean or Plateau Pressure, Resp. rate and minute volume values appear on the screen.
6. Verify the Tidal Volume display on the Vent Tester is within 7% (±35 mL) of the set value within approximately 1 minute from the start of ventilation.
7. Verify the Tidal Volume display is within 9% (±45 mL) of the set value within approximately 1 minute from the start of ventilation.
8. Verify the PEEP on the display and on that the Vent Tester is between 0 and 4 cmH2O.
9. Verify the measured O2 concentration is at least 97% after 5 minutes.
10. Set the AIR flow to 3 L/min and set the N2O and O2 flow rates to minimum flow.
11. Verify the measured O2 concentration is 21% ±3% vol. % after 5 minutes.

2.7.5 VCV Adult Ventilation Mode Test 2

1. Set the O2 flow to 10 L/min and set the N2O and Air flow rates to 0 flow.
2. Set the mechanical Auto/Manual switch to AUTO.
3. Set the ventilator controls to:

Ventilator Controls	Ventilator Settings
Ventilation Mode	VCV
Vt	700
Rate	10
I:E	1:3
Tpause	60
PEEP	OFF
Plimit	80

4. Set the high PEAK Alarm to 80cmH2O.
5. Verify that the pressure waveform, Tidal Volume, Mean or Plateau Pressure, Resp. rate and minute volume values appear on the screen.
6. Verify the Tidal Volume display on the Vent Tester is within 7% (+/- 49 mL) of the set value within approximately 1 minute from the start of ventilation.
7. Verify the Tidal Volume display is within 9% (+/-63 mL) of the set value within approximately 1 minute from the start of ventilation.
8. Verify the PEEP on the display and on the Vent Tester is between 0 and 4 cmH20.

2.7.6 VCV Child Ventilation Mode Test

NOTE: Limit the volume in the test lung to provide sufficient airway pressure to satisfy the Low Peak Pressure alarm. Or reduce the Peak Pressure alarm limit to a lower value to prevent the alarm when using an adult test lung.

1. Set the O2 flow to 1 L/min and set the N2O and AIR flow rates to 0 flow.
2. Set the ventilator controls to:

Ventilator Controls	Ventilator Settings
Ventilation Mode	VCV
Vt	200
Rate	15
I:E	1:2
Tpause	Off
PEEP	Off
Plimit	80

3. Verify that the pressure waveform, Tidal Volume, Mean or Plateau Pressure, Resp. rate and minute volume values appear on the screen.
4. Verify the Tidal Volume display is within 18ml of the set value within approximately 1 minute from the start of ventilation.
5. Verify the delivered volume as measured by a Vent Tester at the expiratory port, is within 15ml of the set value within approximately 1 minute from the start of ventilation.

2.7.7 Airway Disconnect Alarm Test

1. While the ventilator is running, disconnect the expiratory limb from the Expiratory Port on the Breathing System.
2. Verify the following airway pressure disconnect alarm signals activate:
   - Paw Too Low message appears on the screen.
   - An alarm tone sounds.
3. Reconnect the expiratory limb to the expiratory port.

2.7.8 PCV Adult Ventilation Mode Test

1. Set the O2 flow to 3 L/min and set the N2O and AIR flow rates to minimum flow.
2. Set the ventilator controls to:

Ventilator Controls	Ventilator Settings
Ventilation Mode	PCV
VtG (EPSON)	Off
Pinsp	15
Rate	8
I:E	1:2
PEEP	Off
Tslope	0.2
PlimVG	NA

3. Press Set Mode button to begin ventilation.
4. Verify the Peak Pressure reading of the display is within ±2 cmH2O of the set Pinsp.
5. Verify that the pressure waveform, Tidal Volume, Resp. Rate and minute volume values appear on the screen.
6. Verify that the PEAK Value measured with the Vent Tester reaches 15 ±2.5 cmH2O within five breaths from the start of ventilation.

2.7.9 Pressure Support (PS) Ventilation Mode Test

1. Set the O2 flow to 1 L/min and set the N2O and AIR flow rates to minimum flow.
2. Set the ventilator controls to:

Ventilator Controls	Ventilator Settings
Ventilation Mode	PS
Min Rate	4
ΔP	20
Trigger	3
PEEP	Off
Tslope	0.2
ΔP apnea	15 (DSP only)
Apnea Ti	5

3. Press Set Mode button to begin ventilation.
4. Begin triggering breaths by slightly squeezing the test lung and releasing. Maintain a continuous breath rate.
5. Verify that a pressure waveform and all ventilation parameters appear on the screen.
6. Verify that the Peak Pressure reading on the display is ±2 the value of ΔP + PEEP.
7. Stop triggering breaths.
8. Verify that after 15 seconds the ventilator delivers a breath and displays the message Apnea Ventilation.
9. Verify the system ventilates with a frequency of 4 bpm.

2.8 Alarms and Fail safe Functions

2.8.1 Set Up

1. Set the EFCS as Direct Flow Control Mode and select AIR as balance gas. Set the O2 flow to 2 L/min and set the air flow rate to 0 L/min.
2. Set the ventilator controls to:

Ventilator Controls	Ventilator Settings
Ventilation Mode	VCV
Vt	600
Rate	8
I:E	1:2
Tpause	10
PEEP	Off
Plimit	50

3. Press Set Mode button to begin ventilation.

2.8.2 Low O2 Alarm Test

NOTE: For A7s with an installed gas module, disconnect the sample tube from the Y-piece and breath into it until you see a CO2 reading on the screen. Then reconnect the sample tube to the Y-piece. This will activate the gas module alarms.

1. Set the low Insp O2 alarm limit to 50%.
2. Set the air flow to 5 L/min.
3. Set the O2 flow to 0 L/min.
4. Verify the following low Insp O2 alarm signals activate, within three ventilation cycles:
   - FiO2 Too Low message appears on the screen.
   - An alarm tone sounds.
5. Set the low Insp O2 alarm limit to 18%.
6. Verify the FiO2 Too Low message disappears.

2.8.3 High O2 Alarm Test

1. Set the high Insp O2 alarm limit to 50%.
2. Set the O2 flow to 5 L/min.
3. Set the air flow to 0 L/min.
4. Verify the following high Insp O2 alarm signals activate:
   - FiO2 Too High message appears on the screen.
   - An alarm tone sounds.
5. Set the high Insp O2 alarm limit to the highest setting.
6. Verify the FiO2 Too High message disappears.

2.8.4 Peak Pressure Alarms Test

1. Set the PEAK low alarm limit to the lowest setting.
2. Set the PEAK high alarm limit set point about 5 to 8 digits below the Peak Pressure displayed on the screen.
3. Verify the following (high) peak pressure alarms activate:
   - Paw Too High message appears on the screen.
   - An alarm tone sounds.
   - Inspiration ends and expiration begins as the pressure meets the high alarm limit.
4. Set the PEAK high alarm limit to the highest setting.
5. Verify the Paw Too High message disappears.
6. Set the PEAK low alarm limit to 70 (cmH2O).
7. Verify the following (low) peak pressure alarms activate:
   - Paw Too Low message appears on the screen.
   - An alarm tone sounds.
8. Set the PEAK low alarm limit to the lowest setting.
9. Verify the Paw Too Low message disappears.

2.8.5 Minute Volume Alarm Test

1. Set the MV High alarm limit to the highest setting and then set the MV Low alarm limit to the highest setting.
2. Verify the following alarms activate:
   - MV Too Low message appears on the screen.
   - An alarm tone sounds.
3. Set the MV Low alarm limit to the lowest setting.
4. Verify the MV Too Low message disappears.
5. Set the MV High alarm limit to the lowest setting.
6. Verify the following alarms activate:
   - MV Too High message appears on the screen.
   - An alarm tone sounds.
7. Set the MV High alarm limit to the highest setting.
8. Verify that the MV Too High message disappears.
9. Set the mechanical Auto/Manual switch to MANUAL.
10. Set all fresh gas flows to 0.
11. Press **End Case** button to enter the standby mode.

2.9 Miscellaneous Tests

2.9.1 Test the Line Voltage Alarm

1. Interrupt AC line voltage.
2. Verify that the following alarms activate:
   - An alarm tone sounds.
   - Battery in use message appears on the screen.
3. Plug the anesthesia system into AC line voltage.
4. Verify that the alarm signals cease.
5. Verify the presence of the battery charging icon in the upper right corner of the screen.

2.9.2 Top Light and Auxiliary Light Test

1. Turn on the Top light located on the bottom side of the top panel.
2. Verify that it lights in both on positions.

2.9.3 Touchpad Test

Verify that the touchpad is functional.

2.9.4 Module Rack Functional Test (Only for A7's with an AG Module)

1. When the machine is turned on, insert the AG module into the module rack (take care to insert the module gently and depress the self-locking buckle when plugging it out to avoid damaging the module). Make sure that the gas test screen and CO2 waveform and parameter area displayed on the screen and that the prompt message **External AG Loaded Successfully** is displayed at the top of the screen.
2. Set the ventilator to Manual mode.
3. After the AG module is inserted, if the module is not connected with a watertrap, make sure that the alarm **AG No Watertrap** iappears. After the watertrap is connected to the module, make sure that the alarm disappears.
4. Occlude the inlet hose of the AG module and make sure that the alarm **AG Airway Occluded** appears.
5. Depress the self-locking buckle of the module to plug out the module. Make sure that the gas test screen and CO2 waveform and parameter area disappear and that the prompt message **External AG Unloaded Successfully** is displayed at the top of the screen.
6. Select "End Case" to return to Standby mode.

2.10 Vaporizer Interlock Test

2.10.1 For 2 vaporizer Mount

1. Attach two vaporizers to the Vaporizer Mounting Manifold and lock them in place.
2. Rotate either of the vaporizer dial to 3% agent.
3. Verify that the other vaporizer dial cannot be rotated to a setting.
4. Set both vaporizer dials to 0.
5. Rotate the other vaporizer dial to 3%.
6. Verify that the first vaporizer dial cannot be rotated.
7. Rotate both vaporizer dials to T and remove both vaporizers.
8. Verify that the locking spring is intact.
9. Reconnect both vaporizers to the Vaporizer Mounting Manifold.

2.10.2 For 3 vaporizer Mount

1. Attach three vaporizers to the Vaporizer Mounting Manifold and lock them in place.
2. Rotate left vaporizer dial to 3% agent.
3. Verify that the other two vaporizers dial cannot be rotated to a setting.
4. Set all vaporizer dials to 0.
5. Rotate the middle vaporizer dial to 3% agent..
6. Verify that the other two vaporizers dial cannot be rotated to a setting.
7. Set all vaporizer dials to 0.
8. Rotate the right vaporizer dial to 3% agent..
9. Verify that the other two vaporizers dial cannot be rotated to a setting.
10. Rotate the right vaporizer dial to 0.
11. Rotate the center vaporizer dial to T,
12. Remove the center vaporizer leaving 2 vaporizers on the outer positions with the center position being empty.
13. Rotate either of the vaporizer dial to 3% agent.
14. Verify that the other vaporizer dial cannot be rotated to a setting.
15. Set both vaporizer dials to 0.
16. Rotate both vaporizer dials to T and remove all vaporizers.
17. Verify that the locking spring is intact.
18. Reconnect all vaporizers to the Vaporizer Mounting Manifold.

2.11 Vaporizer Accuracy Test

1. Connect the sampling tee of the Gas analyzer to the ACGO port.
2. Use a breathing hose to connect the output of the sampling tee to the scavenger.

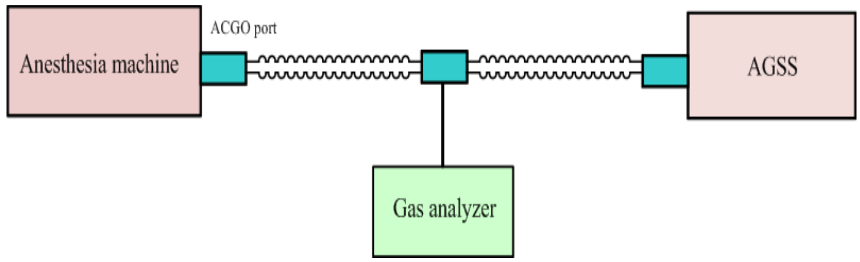

FIGURE 2-74 Vaporizer Accuracy Test Setup

3. Verify the scavenger is connected at the wall and the floater is between MIN and MAX.
4. Mount the vaporizers and fill with anesthetic agent (if necessary).

NOTE: Do not fill past the indicator line on the vaporizer.

5. Turn on the Unit.
6. Set the machine to ACGO mode.
7. Test the vaporizer accuracy per the manufacturer's instructions.
8. Test each vaporizer in turn.
9. Test any vaporizer on the Vaporizer Storage Mount.
10. Remove the measuring equipment.
11. Reconnect the Waste Gas Scavenger Hose.

NOTE: The deviation of the vaporizers due to change of barometric pressure (high altitude) and the deviation of the Riken F-21 gas analyzer are the same. When testing the Vaporizers using the Riken F-21 gas analyzer, the altitude can be ignored as the deviations cancel each other out. If using a different gas analyzer, check the effect of change of barometric pressure before using in high elevations.

2.12 Suction Regulator Test

1. Connect the pipeline suction to the A.7.
2. Plug the tube to the patient.
3. Set the selector knob to **FULL** mode.
4. Check that the gauge shows some negative pressure.
5. Set the selector knob to **OFF** mode and verify the pointer on the suction gauge should come to the zero.
6. Set the selector knob to **REG** mode and turn off the suction regulator knob in clockwise direction.
7. Then turn on the suction regulator knob in counterclockwise direction.
8. Verify the pressure on the suction gauge gradully increase and comes to the pressure that was obtained in full mode.

2.13 Electrical Tests

NOTE: Perform electrical safety inspection after servicing or routine maintenance. Before the electrical safety inspection, make sure all the covers, panels, and screws are correctly installed.

NOTE: The electrical safety inspection should be performed once a year.

2.13.1 Auxiliary Electrical Outlet Test

Verify the mains voltage is present at each auxiliary outlet when the anesthesia machine is connected with power.

2.13.2 Electrical Safety Inspection Test

1. Perform protective earth resistance test:
   a. Plug the probes of the analyzer into the protective earth terminal and equipotential terminal of the AC power cord.
   b. Test the earth resistance with a current of 40 A.
   c. Verify the resistance is less than 0.1ohms (100 mohms).
   d. Plug the probes of the analyzer into the protective earth terminal of the AC power cord and the protective earth terminal of any auxiliary outlet. Repeat steps b and c.
   e. If the resistance is larger than 0.1ohms (100 mohms) but less than 0.2 ohms (200 mohms), disconnect the AC power cord and plug the probe that is previously plugged in the protective earth terminal of the AC power cord into the protective earth contact of the power outlet. Repeat steps a to d.
2. Perform the following earth leakage current tests:
   - normal polarity;
   - reverse polarity;
   - normal polarity with open neutral; and
   - reverse polarity with open neutral.
3. Verify the maximum leakage current does not exceed 300 μA (0.3 mA) in the first two tests. While for the last two tests, verify that the maximum leakage current does not exceed 1000 μA (1 mA).

NOTE: Make sure the safety analyzer is authorized by certificate organizations (UL, CSA, or AAMI etc.). Follow the instructions of the analyzer manufacturer.

2.13.3 Electrical Safety Inspection Form

Location:			Technician:	
Equipment:			Control Number:	
Manufacturer:		Model:	SN:	
Measurement equipment /SN:			Date of Calibration:	
INSPECTION AND TESTING			Pass/Fail	Limit
1	Auxiliary mains socket outlets			

TABLE 2-1

2	Protective Earth Resistance		Ω		Max 0.1 Ω
3	Earth Leakage	Normal condition(NC)	_____μA		Max: NC: 300μA SFC: 1000μA
		Single Fault condition(SFC)	_____μA		

TABLE 2-1

For periodically performance, all the test items included in the ELECTRICAL SAFETY INSPECTION FORM shall be performed. The following table specifies test items to be performed after the equipment is repaired with main unit disassembled.

When neither power supply PCBA, transformer nor patient electrically-connected PCBA is repaired or replaced	Test items: 1, 2
When power supply PCBA or transformer is repaired or replaced	Test items: 1, 2, 3

TABLE 2-2

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3.0

Periodic Maintenance

Maintenance Schedule 3-2

Periodical Maintenance Consumable Parts Kits 3-2

Periodical Maintenance Schedule 3-2

Checklist before surgery 3-3

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3.1 Maintenance Schedule

The following is a list of activities required for periodic maintenance of the A7 Anesthesia System. Physical inspection, replacement of consumables, and performance checks should be periodically performed per the schedule listed below. The manufacturer is not responsible for component failure or loss resulting from the use of stated consumables beyond their recommended replacement interval. These are noted in the Periodic Maintenance Schedule (See "Periodical Maintenance Schedule" on page 3-2).Make records of the parts that have been replaced before the periodical replacement.

NOTE: **To avoid equipment damage or personal injury, replace the parts which need to be replaced periodically even if they are not worn or damaged when the due date arrives.**

3.2 Periodical Maintenance Consumable Parts Kits

Consumable parts are available in the periodical maintenance kits listed below:

- Periodic maintenance kit (12 month), P/N: 121-001549-00
- Periodic maintenance kit (36 months), P/N: 121-001550-00

NOTE: **Touch Screen (P/N: 801-0631-00014-00) is not included in the Consumable Parts Kits. It must be ordered separately.**

3.3 Periodical Maintenance Schedule

Required action	After each service	Every 12 months	Every 36 months
Checklist before surgery		x	x
Visual inspection checklist		x	x
Replacement of consumable parts		x	x
Battery maintenance and replacement			x
Functional tests		x	x
Preoperative checklist	x	x	x

3.4 Checklist before surgery

Before the anesthesia machine at the client end is maintained, some routine tests are required to check if the current status of the anesthesia machine is normal. The following table lists the routine tests.

SN	Test item	Functional description	Test interval
1	Check the mechanical ventilation mode	1. Check if mechanical ventilation is provided normally and if an alarm occurs. 2. Check if the preset values of pressure and TV are same to the measured values. 3. Check if the pressure measured by the pressure sensor is same to that indicated by the airway pressure gauge and if the TV measured by the flow sensor is same to that indicated by the graduation on the bellows housing. 4. Roughly judge if the breathing system has a significant leak by observing how much fresh gas is compensatedt and observing if the folding bag collapses.	After each service or at the time of return visit
2	Breathing system leak test in mechanical ventilation mode	1. Check the pneumatic circuit in mechanical ventilation mode for leaks, including bellows, drive gas circuit, sodalime canister, patient tubes, flow sensors and their connectors. 2. Check the control effectiveness of main control board and auxiliary control board over PEEP safety valve. 3. Check the monitoring effectiveness of auxiliary control module over airway pressure and PEEP path pressure.	After each service or at the time of return visit
3	Breathing system leak test in manual ventilation mode	Check the pneumatic circuit in manual ventilation mode for leaks, including APL valve, check valve, sodalime canister, patient tubes, flow sensors and their connectors.	After each service or at the time of return visit
4	Check the sensors' zero points	Check if the zero points of all the flow sensors and pressure sensors inside the machine are within the normal range so as to determine when to replace the monitor board.	After each service or at the time of return visit
5	Check the flow sensor accuracy	1. Check if the measurements made by the flow sensors inside the machine are the same. 2. Check if the measurement made by any flow sensor inside the machine is accurate. 3. Check the effectiveness of flow calibration (factory) result.	After each service or at the time of return visit
6	Check the pressure sensor accuracy	1. Check if the measurements made by the pressure sensors inside the machine are the same. 2. Check if the measurement made by any pressure sensor inside the machine is accurate. 3. Check the effectiveness of pressure calibration (factory) result.	After each service or at the time of return visit
7	Check the electronic flowmeter accuracy	1. Check if the measurement made by the electronic flowmeter is normal. 2. Check the effectiveness of electronic flowmeter calibration result.	After each service or at the time of return visit
8	Check the AG module accuracy	1. Check if the measurement made by the AG module is normal. 2. Check the effectiveness of AG module calibration result.	After each service or at the time of return visit

3.5 Visual Inspection Checklist

1. Verify that the anesthesia system has no physical damage that would prevent operation.
2. Verify that the breathing circuit and Pre-pak absorber canister are present.
3. Verify that the vaporizers are filled but not overfilled.
4. Verify that the Preoperative Checkout List is attached.
5. Verify that the tank wrench is attached.
6. Verify that the transfer tube of the AGSS is not damaged. Drain any moisture.
7. Verify that the AC power cord is not damaged.

3.6 List of Periodic Maintenance Parts to be Replaced and Checked

The following table lists the parts to be checked or replaced periodically inside the consumable parts kits. The replacement date starts from the date when the machine is assembled.

No.	Consumable Part	Amount	12 Month	36 Month	Part Number
1	Lithium-ion battery	2	Check	Replace	115-018012-00
2	Cell battery Lithium 3V35mAh D12.5*2.0 (for main control board)	1	Check	Replace	M05-010R03---
3	Bellows assembly	1	Check	Replace	0601-30-78968
4	O-ring (for airway pressure gauge)	1	Check	Replace	082-001524-00
5	O-ring 15.54X2.62 (for bag arm)	2	Check	Replace	082-000673-00
6	Gasket, bellows canister base	1	Replace	Replace	049-000243-00
7	O-ring 15.54X2.62 (for O2 cell cover)	1	Replace	Replace	082-000673-00
8	O-ring 14X2.65 (for Vaporizer mount)	6	Replace	Replace	082-000934-00
9	AGSS filter	1	Clean	Replace	082-000506-00
10	O-ring 8.5X2 (for rotating block of breathing circuit)	2	Check	Replace	082-000665-00
11	O-ring 4.7X1.8 (for rotating block of breathing circuit)	4	Check	Replace	082-000667-00
12	O-ring 16X2 (for rotating block of breathing circuit)	3	Check	Replace	M6M-010058---
13	O-ring 27X1.5 (for Check valve dome)	2	Replace	Replace	082-001501-00
14	O-ring 20X1.5 (for Check valve)	2	Replace	Replace	082-001503-00
15	O-ring 6X1 (for Auto/Manual ventilation switch)	2	Check	Check	082-000669-00
16	O-ring 23.47X2.95 (for Water Collection Cup)	1	Replace	Replace	082-001504-00
17	CO2 Absorber Hose	1	Check	Replace	049-000146-00
18	Gasket, absorber canister exterior	1	Check	Replace	049-000143-00
19	Gasket, absorber canister interior	1	Check	Replace	049-000145-00
20	Gasket, CO2 bypass assembly	1	Check	Replace	049-000142-00

No.	Consumable Part	Amount	12 Month	36 Month	Part Number
21	Seal, valve port (for CO2 Bypass shaft)	4	Check	Check	049-000140-00
22	O-ring 23.47X2.95 (for CO2 Bypass Assembly)	2	Check	Replace	082-001504-00
23	O-ring 4.47X1.78 (for CO2 Bypass shaft)	8	Check	Check	082-000679-00
24	Tank Washer	3	Replace	Replace	0348-00-0185
25	O-Ring 52X2 Auto/Manual ventilation switch	1	Check	Check	082-001505-00
26	O-Ring 40X2.2 Auto/Manual ventilation switch	2	Check	Check	082-001520-00
27	O-Ring 30X2 bag arm base	1	Check	Check	082-001499-00
28	O-Ring 8.5X2.0 O2 cell port	1	Check	Replace	082-001525-00
29	Inspiratory Flow Sensor	1	Check	Check	801-0631-00060-00
30	Expiratory Flow Sensor	1	Check	Check	801-0631-00056-00
31	O-ring 18X2.5 Breathing system base	2	Check	Check	049-000813-00
32	Bellow check valve membrane	1	Check	Replace	049-000240-00
33	O-Ring 20.29X2.62 Bellows base	1	Check	Check	082-001508-00
34	O-Ring 29.82X2.62 APL valve	1	Check	Check	082-001515-00
35	O-Ring 25X2 APL valve	1	Check	Check	082-001500-00
36	4.4X1.78 O-ring (used for lower cover assembly)	2	Check	Check	082-000679-00
37	Filter.0.45um (used for built-in AG module)	1	Replace	Replace	082-003044-00
38	Dust filter	1	Check	Replace	045-000241-00
39	O-ring 18X2.5 (for rotating block of breathing circuit)	1	Check	Replace	082-001502-00
40	O-ring, 0.35X1.78 FKM A70	1	Check	Check	082-000676-00
41	Sealed gasket of breathing connector	2	Check	Check	049-000235-00
42	O-ring, 75.87X2.62 A50	1	Check	Check	082-001509-00
43	O-ring, 61.6X2.62 A50	2	Check	Check	082-001511-00
/	Touch screen	1	Check	Replace	801-0631-00014-00

*The gasket comes with extensions on the barbed nibs with are there for as an installation help. The extensions need to be cut off after the gasket has been installed.
**The gasket comes without the metal weight. The metal weight needs to be transferred from the previous gasket.
***The 6 O-Rings are for the 3 vaporizer option. Units with the 2 Vaporizer mount will only require 4 of the 6 O-Rings.

The locations of the O-rings / Gaskets are shown in FIGURE 3-1.

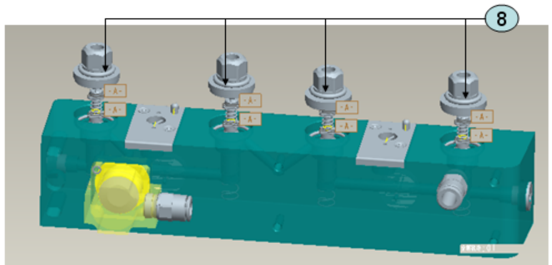


FIGURE 3-1 Locations of the O-rings / gaskets

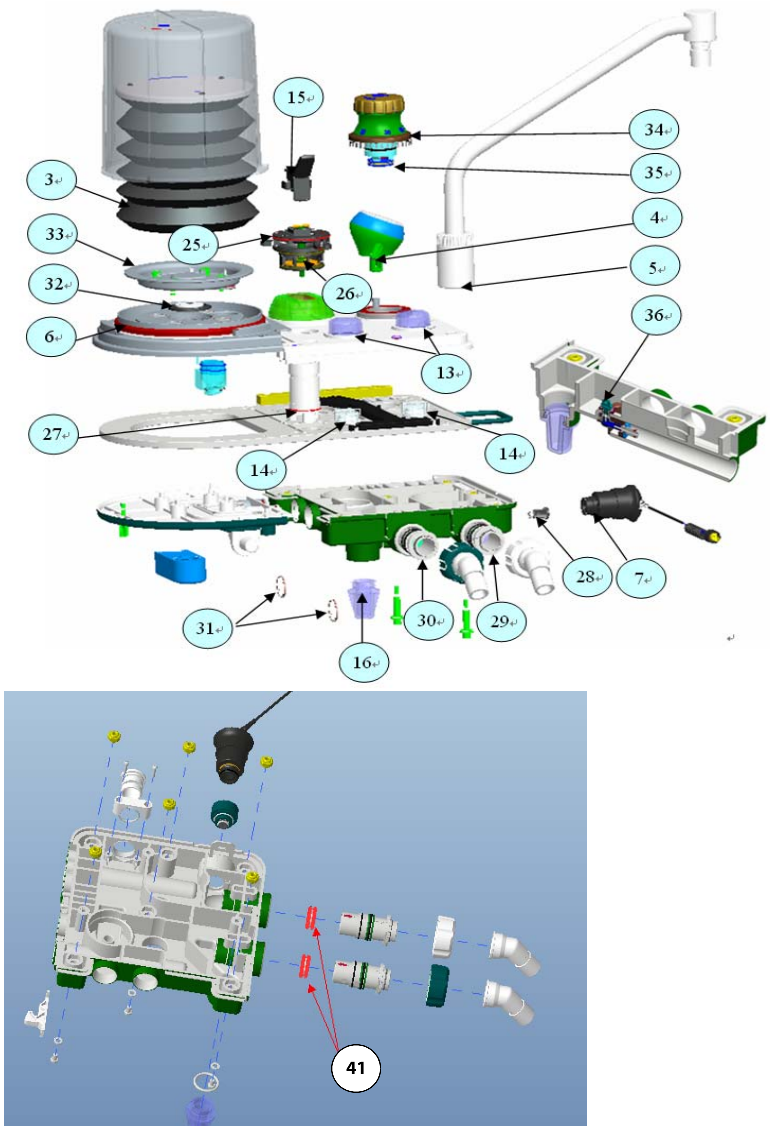


FIGURE 3-2 Breathing System

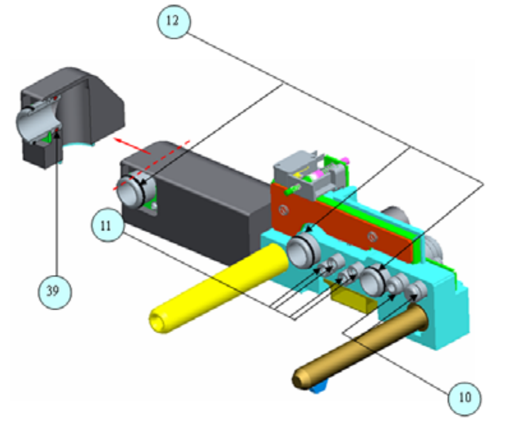


FIGURE 3-3 Breathing System Adapter

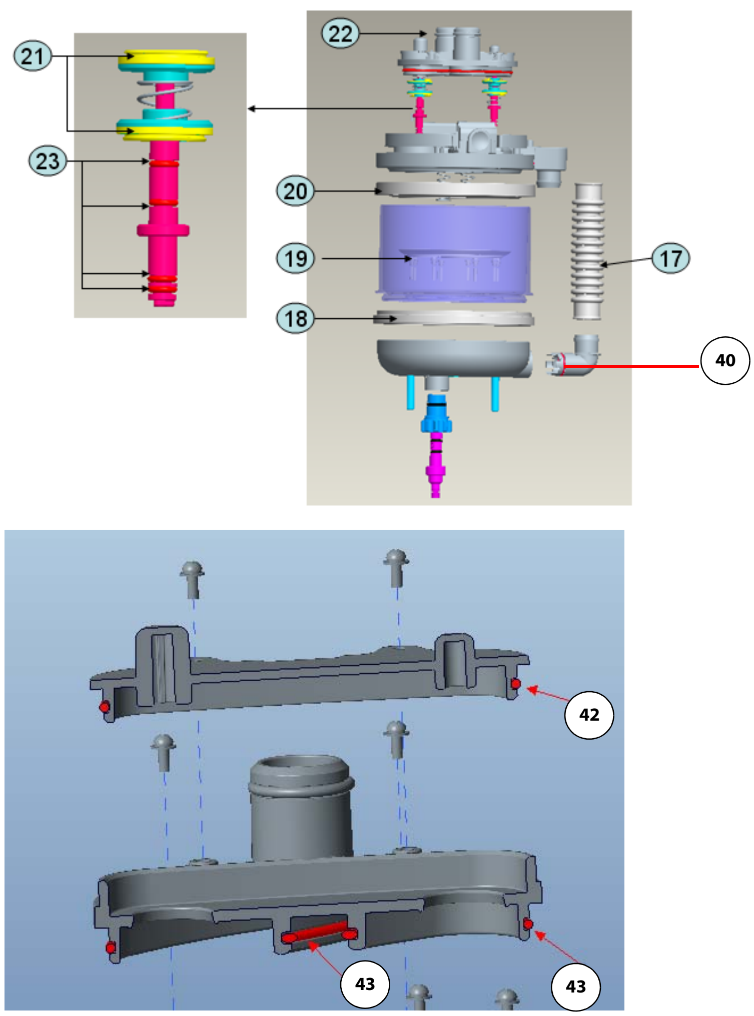


FIGURE 3-4 CO2 Bypass Shaft and CO2 Absorber Assembly

FIGURE 3-5 Internal AG module (EPSON)

FIGURE 3-6 Dust Filter

3.7 Battery Maintenance and Replacement

Maintenance is required for the lithium-ion battery supply in the A7. Replace it every 3 years as follows:

1. Open the rear cover of the anesthesia system.
2. Open the battery box of the anesthesia system.
3. Remove the old battery.
4. Install the new battery.
5. Close the battery box.
6. Close the rear cover.
7. Use only Mindray approved batteries (P/N: 115-018012-00).

3.8 Functional Tests

Refer to Chapter 4.0 Calibration if any values are out of specification.

NOTE: **The A7 system must be powered on (AC power, not battery) and the Breathing System Warmer set to ON at least an hour before performing the Ventilation Tests described in "VCV Adult Ventilation Mode Test" on page 2-44.**

3.8.1 Breathing System Leak Test

NOTE: **Always perform the leak test after servicing the anesthesia machine, replacing the components, or reconnecting the tubes.**

3.8.1.1 Breathing System Leak Test in Mechanical Ventilation Mode

This test checks the pneumatic circuit for leaks in mechanical ventilation mode. Test items include the bellows, drive gas circuit, CO2 absorber canister, patient tubes, flow sensors, and flow sensor connectors.

To perform the breathing system leak test in mechanical ventilation mode:

1. You can access the automatic circuit leak test screen after the Power-On Self Test has passed. You can also open the Setup in Standby and select Test Leak/Compliance on the General menu to access the automatic circuit leak test screen.The automatic circuit leak test screen is shown below. Set up the machine as per the instructions on the screen. Then, select Continue to execute automatic circuit leak test.

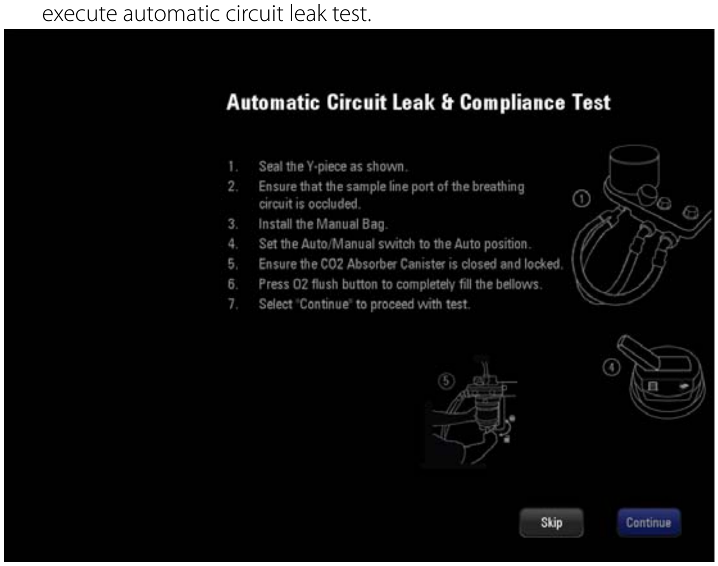


FIGURE 3-7 Automatic Circuit Leak and Compliance Test Screen

2. The ongoing automatic circuit leak test is as shown below. You can select Cancel to stop the ongoing leak test.

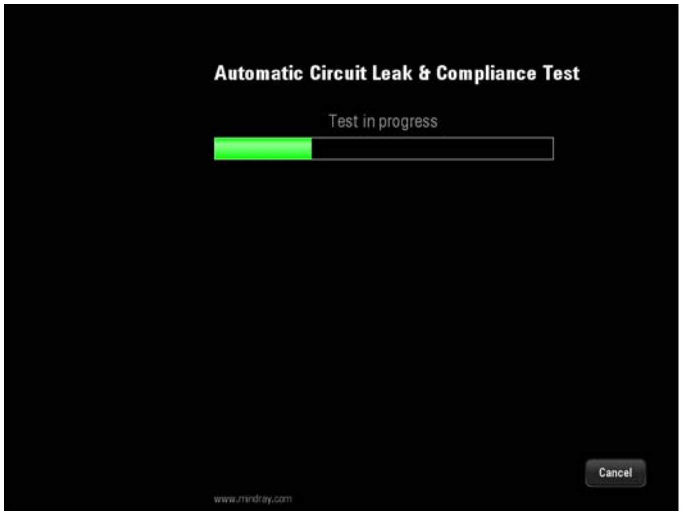


FIGURE 3-8 Automatic Circuit Leak and Compliance Test In Progress

3. During the automatic circuit leak test, the safety valve control test is also being conducted. The automatic circuit leak test results are listed in the following table.

Test Result	System Limitation
Safety valve control failed	The machine cannot be used.
Automatic circuit leak test failed Leak >200 mL/min and ≤1000 mL	The user can acknowledge the leak and continue with automatic ventilation.
Automatic circuit leak test failed Leak >1000 mL	Only manual ventilation can be applied.
Compliance test failed	Both automatic ventilation and manual ventilation can still be applied using the previous compliance value in the A7 system memory, but may not meet the accuracy of the delivered volume.

The following screen is displayed if the safety valve control test is failed. You can select Service Access and enter the required service password to access service mode. You can select Retry to perform automatic circuit leak test again.

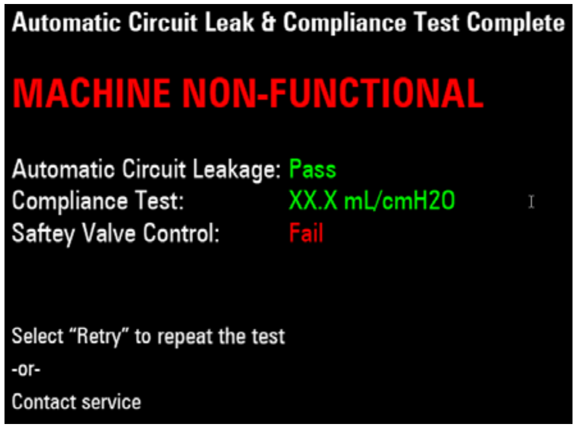


FIGURE 3-9 Machine Non-Functional Screen

The following screen is displayed if the automatic circuit leak test is failed and the Leak >200 mL/min and ≤1000 mL. You can select Retry to perform the automatic circuit leak test again or accept the result continue with automatic ventilation.

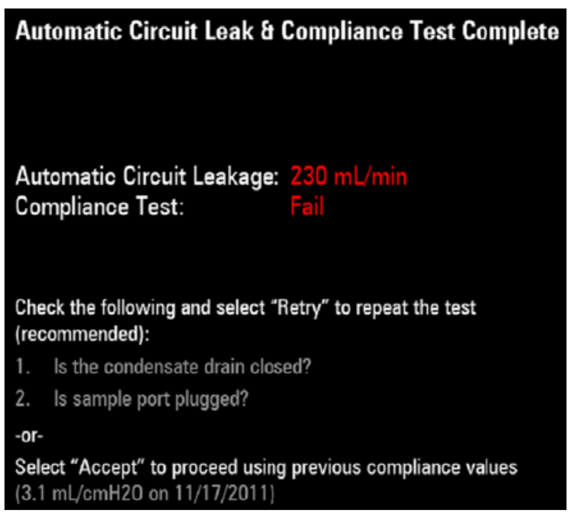


FIGURE 3-10 Automatic Circuit Leak and Compliance Test: Fail

The following screen is displayed if the automatic circuit leak test is failed and the leak >1000 mL. You can select Manual Only to enter Standby mode. But mechanical ventilation is disabled. You can select Retry to perform automatic circuit leak test again.

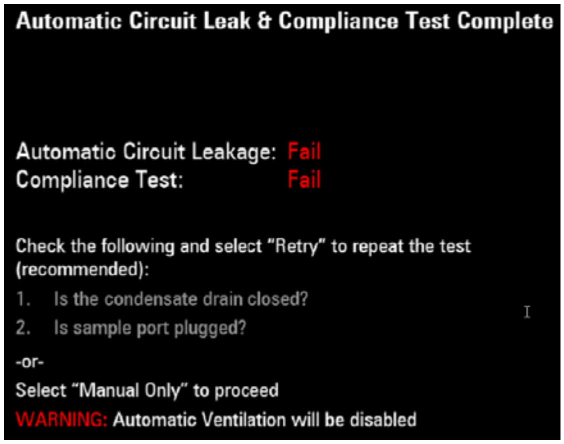


FIGURE 3-11 Automatic Circuit Leak and Compliance Test: Fail

The following screen is displayed if the compliance test is failed. You can select Accept to enter Standby mode.You can select Retry to perform automatic circuit leak test again.

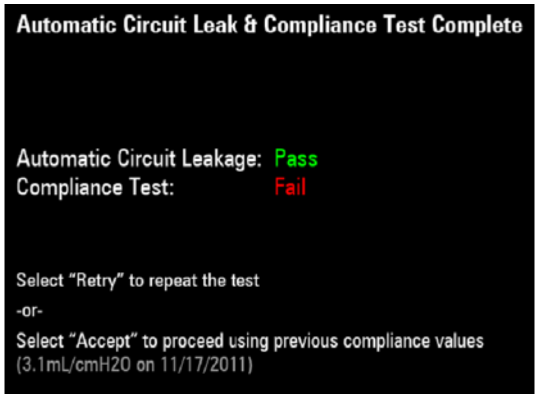


FIGURE 3-12 Compliance Test: Fail

The following screen is displayed if the automatic circuit leak test is completed. Select Continue to enter Standby mode.

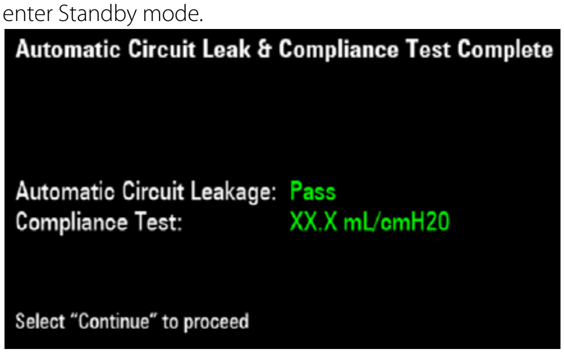


FIGURE 3-13 Automatic Circuit Leak Test Completed

NOTE: **If the leak test fails, check all of the possible leak sources, including the bellows, breathing system tubes, and CO2 absorber canister. Check that they are correctly connected and their connectors are not damaged.**

NOTE: **If there is a leak, check the pneumatic circuit system for leakage and troubleshoot the problems as described in 5.3.4 Breathing System. After the leak has been resolved, repeat the leak test.**

3.8.1.2 Breathing System Leak Test in Manual Ventilation Mode

This test checks the pneumatic circuit for leaks in manual ventilation mode. Test items include the APL valve, check valve, CO2 absorber canister, patient tubes, flow sensors, and flow sensor connectors.

To perform the breathing system leak test in manual ventilation mode:

1. You can access the manual circuit leak test screen after the automatic circuit leak test has passed. The manual circuit leak test screen is shown below

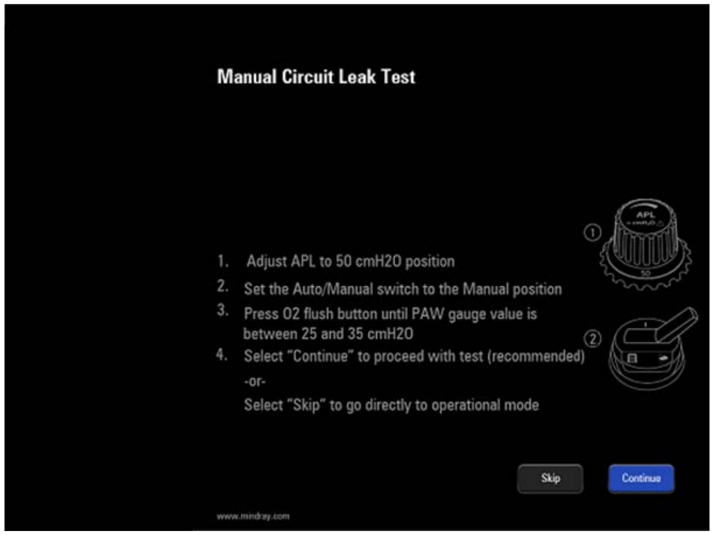


FIGURE 3-14 Automatic Circuit Leak Test Completed

2. Set up the machine as per the instructions on the screen. Then, select Continue to execute manual circuit leak test.

3. The ongoing manual circuit leak test is as shown below. You can select Cancel to cancel the ongoing leak test.

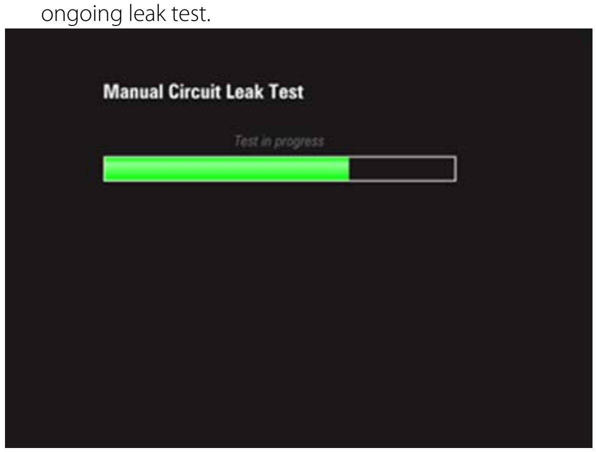


FIGURE 3-15 Manual Circuit Leak Test In Progress

The following screen is displayed if the manual circuit leak test is failed. If so, you must perform the test again.

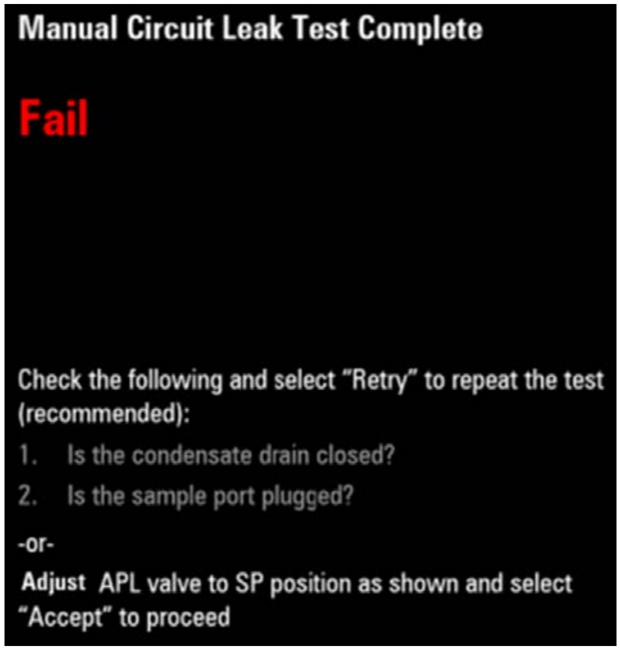


FIGURE 3-16 Manual Circuit Leak Test: Fail

The following screen is displayed if the manual circuit leak test is completed. Select Continue to Standby mode.

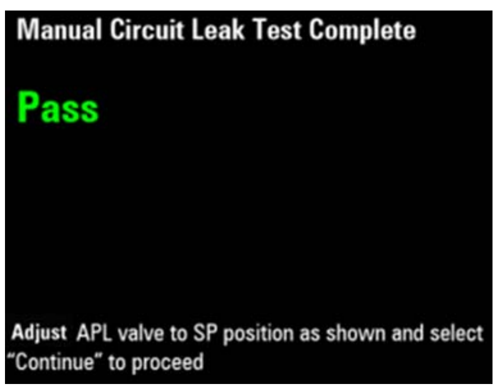


FIGURE 3-17 Manual Circuit Leak Test: Passed

NOTE: **If there is a leak, check the pneumatic circuit system for leakage and troubleshoot the problems as described in 5.3 Pneumatic Circuit System Problems. Repeat the leak test after the source of the failure has been resolved.**

3.8.1.3 Troubleshooting: Leak Test

The following table lists the commonly-encountered problems and recommended actions for Section 3.8.1.2 Breathing System Leak Test in Manual Ventilation Mode.

Failure Description	Possible Cause	Recommended Action
Leak test failure is prompted immediately after [Start] is selected (typically, the leak test requires at least 3 minutes).	The Auto/Manual ventilation switch is set to the bag position and the message [Manual Vent.] is prompted.	Set the Auto/Manual ventilation switch to the mechanical ventilation position.
	The reading on the drive gas (O2) pressure gauge indicates drive gas pressure low (lower than 200 kPa) and the alarm of [Drive Gas Pressure Low] is produced.	Replace or connect gas supplies and make sure that the drive gas pressure is at 350 to 450 kPa.
During leak test, the pressure indicated by the airway pressure gauge fails to reach 30 cmH2O.	1. Before the leak test, the bellows is not fully inflated. 2. The Y piece on the breathing tube is not connected to the test plug. 3. The bellows housing is not properly installed.	Check the connections of the pneumatic circuit and re-install the pneumatic circuit.
During leak test, the pressure indicated by the airway pressure gauge fails to reach 30 cmH2O.	1. Before the leak test, the bellows is not fully inflated. 2. The Y piece on the breathing tube is not connected to the test plug. 3. The bellows housing is not properly installed.	Check the connections of the pneumatic circuit and re-install the pneumatic circuit.

3.8.2 Automatic Backup Flow Control Test

This test checks whether the automatic backup flow control (BFCS) system work normally. Test items include the Solenoid Actuator, Stepper Motor, Position Sensor, and 3-Way Valve.

To Perform an Automatic Backup Flow Control Test:

1. While powering on the A7, the system calculates the time between the last successful Automatic Backup Flow Control Test time and current time. If the difference between the two is greater than 168 hours, the manual circuit test screen is entered from startup and BFCS knob is not deployed, the system enters first Automatic Backup Flow Control Test screen when manual circuit test is completed. If the test does not appear after the manual leak test, go to SETUP / SERVICE / TEST BFCS to activate the test.

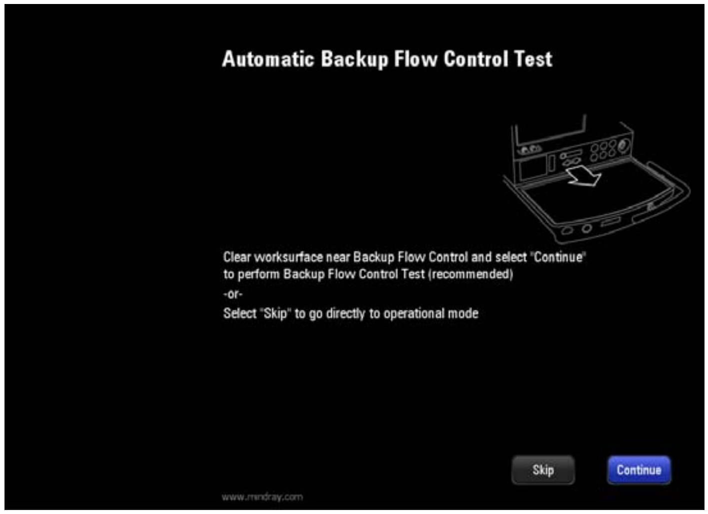


FIGURE 3-18 Automatic Backup Flow Control Test

1. Set up the machine as per the instructions on the screen. Then, select Continue to execute automatic backup flow control test.
2. The ongoing Automatic Backup Flow Control Test is as shown below. You can select **Cancel** to cancel the ongoing test.

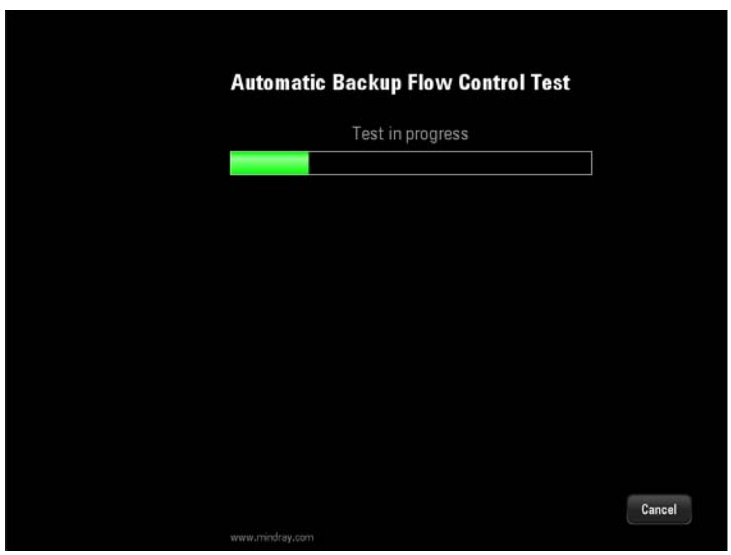


FIGURE 3-19 Automatic Backup Flow Control Test In Progress

The following screen is displayed if the automatic backup flow control test is failed. If so, you can select Retry to repeat the test or accept the result to enter Standby mode.

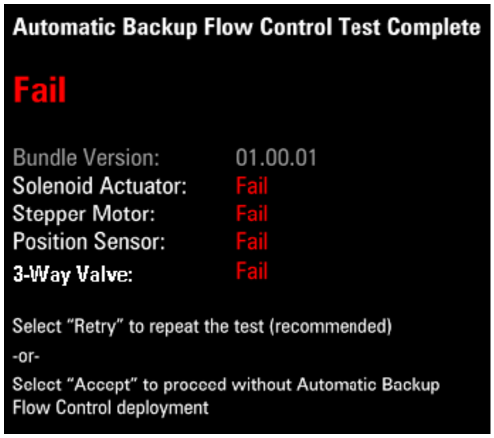


FIGURE 3-20 Automatic Backup Flow Control Test: Fail

NOTE: **If BFCS is retracted at the end of the test, select "Accept" will accept the result to proceed without automatic backup flow control deployment. If BFCS is deployed at the end of the test, select "Accept" will accept the result to proceed using Backup Flow Control.**

The following screen is displayed if the automatic backup flow control test is completed. Select Continue to enter Standby mode.

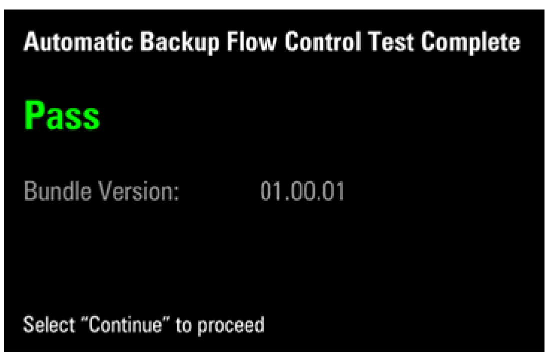


FIGURE 3-21 Automatic Backup Flow Control Test: Passed

3.8.2.1 Troubleshooting: BFCS Test

The following table lists the commonly-encountered problems and recommends actions for the Automatic Backup Flow Control Test.

Failure description	Possible cause	Recommended action
The BFCS fails to deploy during automatic backup flow control test.	The BFCS gets stuck.	Clear the work surface near the backup flow control system and check if the BFCS is stuck.
	The solenoid of BFCS is faulty	1. Re-start the machine. 2. Replace the parts of backup flow control system.

Failure description	Possible cause	Recommended action
The BFCS fails to retract during automatic backup flow control test.	The stepper motor of BFCS is faulty.	1. Re-start the machine. 2. Replace the parts of backup flow control system.
The three-way valve is faulty.	When the three-way valve is switched to BFCS limb during BFCS automatic test, the measured flow of total flow meter is less than 0.2L/min.	1. Check if the gas supply connection and supply gas pressure are normal. 2. Replace the three-way valve.

3.8.3 Check the AG Module Accuracy (Only for A7's with an AG Module)

Prepare the following before checking the External and Internal AG module AG module accuracy:

- Gas cylinder, with a certain standard gas or mixture gas. Gas concentration should meet the following requirements: AA≥1.5%, CO2≥1.5%, N2O≥40%, O2≥40%, of which AA represents an anesthetic agent. a/c≤0.01 (a is the gas absolute concentration accuracy; c is the gas concentration).
- T-shape connector
- Tubing

Follow this procedure to perform checking:

1. Connect the test system as follows.

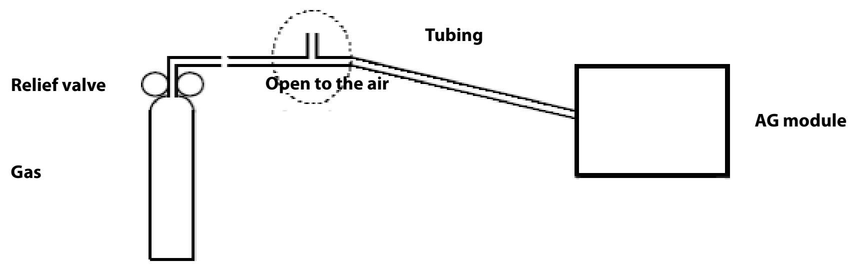


FIGURE 3-22

NOTE: **When checking the internal AG module, open the back cover of the machine, disconnect the tubing as shown below and connect the standard gas to the gas inlet**

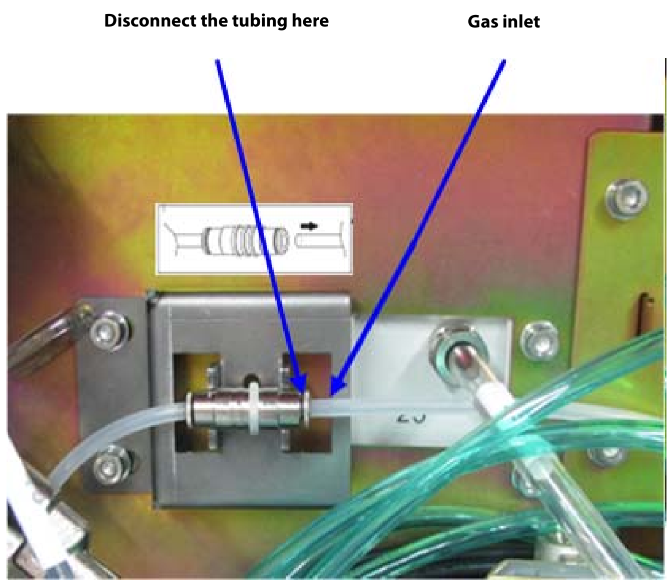


FIGURE 3-23 Connection for internal AG Module

2. Ensure that the system is **Standby** mode. If not, select the **End Case** button in the Manual tab and follow the on-screen prompts to end the case and enter **Standby** mode.
3. Select **Setup** softkey> **System** tab (system password needed).
4. Select the **Calibration** button.
5. Select the **Internal AG Module** or **External AG Module** button.
6. Wait for the AG module to be fully warmed up
7. Enter the actual concentration of the calibration gas.
8. Turn on the calibration gas canister and the system displays the real-time concentration of calibration gas.
9. Verify gases are within tolerances below when compared to the compressed gas mixture on the gas cylinder label (allow the gas to flow for sixty seconds before taking the reading.)

   N2O within 3%,CO2 within 0.3%,O2 within 2%,Desflurane within 0.2%
10. If the difference exceeds the specification, a calibration should be performed by referring to section 4.3.7 (pg. 4-56) "Calibrate the AG Module".

NOTE: **If available, the accuracy of both the internal and external AG module have to be checked.**

NOTE: **To avoid premature emptying of the the gas canister, always remove the regulator after the completion of the calibrations.**

3.8.4 Gas Module Verification (for A7's with an AG Module)

1. Remove and re-insert the AG Module into the module rack.
2. Touch the screen to start the manual ventilation mode and make sure that the gas test screen and CO2 waveform and parameter area are displayed on the screen and that the prompt message **External AG Loaded Successfully** is displayed at the top of the screen.
3. After the AG module is inserted, remove the watertrap, make sure that the alarm **AG No Watertrap** appears. After the watertrap is connected to the module, make sure that the alarm disappears.
4. Wait until the AG module warmup is finished and then use your hand or other objects to completely block the gas inlet of the AG module. An alarm message **AG Airway Occluded** will appear on the screen.
5. Block the gas inlet for another 30 s. If the alarm message does not disappear, it indicates that the module does not leak.

3.8.5 Gas Delivery System Tests

3.8.5.1 O2 Flush Verification

1 Touch the screen to start the manual ventilation mode and set the ACGO button to On.

2. Set the flow to minimum (0.20 L/min). Connect a flow meter to the ACGO port.
3. Verify that the O2 flush flow is between 35 to 50 L/min when pressing the O2 flush button.

3.8.5.2 O2:N2O Ratio Test Under EFCS (for A7's with an AG Module)

1. Connect a breathing hose from the ACGO port to the flow analyzer.
2. Connect a breathing hose from the flow analyzer output to the scavenger.
3. If necessary, attach a adapter to the flow analyzer to connect the sampling line from the AG module.

FIGURE 3-24

4. Touch the screen to start the manual ventilation mode and set the ACGO button to ON. Set the Fresh Gas Control to Total Flow Mode.
5. Set the O2 concentration to each of the set points in the table below and set the N2O as balance gas, then verify the oxygen concentration at each step.

Test Method	Verification
Set the O2 Concentration to 26%. Set the total flow to 1L/min.	Verify O2 concentration is between 24.7% and 27.3%.
Set the O2 Concentration to 100%. Set the total flow to 1L/min	Verify O2 concentration is 95% or greater
Set the O2 Concentration to 26%. Set the total flow to 5L/min	Verify O2 concentration is between 24.7% and 27.3%
Set the O2 Concentration to 100%. Set the total flow to 5L/min	Verify O2 concentration is 95% or greater

3.8.5.3 O2:N2O Ratio Test Under EFCS (Only for A7's without an AG Module)

1. Using a breathing hose, Connect the bag arm to the expiratory port.
2. Put the Manual/Auto lever to the manual position and set the APL valve to 75.
3. Use a breathing hose to connect the output of the inspiratory port to the scavenger
4. Verify the scavenger is connected at the wall and the floater is between MIN and MAX。
5. Set the O2 concentration to each of the set points in the table below and set the N2O as balance gas, then verify the oxygen concentration at each step.
6. Reconnect the Waste Gas Scavenger Hose..

Test Method	Verification
Set the O2 Concentration to 26%. Set the total flow to 1L/min.	Verify O2 concentration is between 24.7% and 27.3%.
Set the O2 Concentration to 100%. Set the total flow to 1L/min	Verify O2 concentration is 95% or greater
Set the O2 Concentration to 26%. Set the total flow to 5L/min	Verify O2 concentration is between 24.7% and 27.3%
Set the O2 Concentration to 100%. Set the total flow to 5L/min	Verify O2 concentration is 95% or greater

3.8.5.4 Vaporizer Leak Test

1. Set the ventilation Auto/Manual ventilation switch to Manual.
2. Set the APL valve to the SP position.
3. For A7's without an AG module, connect one end of the breathing circuit to the bag arm, one end to the inspiratory port and the Y-piece to the test port (FIGURE 3-25).

4. For A7's with an AG module, connect the tubes according to the methods listed as below:

a. When the exhaust of the AG module is not connected to the sample gas return port, connect one end of the breathing circuit to the bag arm, one end to the inspiratory port and the Y-piece to the test port. The gas sampling tube should not be connected to the Y piece.

FIGURE 3-25

b. When the exhaust of the AG module is connected to the sample gas return port, connect one end of the breathing circuit to the bag arm, one end to the inspiratory port and the Y-piece to the test port. Additional, connect gas sampling tube to the Y-piece.

FIGURE 3-26

5. Mount and lock the vaporizer onto the vaporizer mount. (Certain vaporizers need to be set to at least 1% for correct testing. See the vaporizer manufacturer's manual for details.)

6. Set the fresh gas flow to 200 mL/min.

7. Set the APL valve to 75 and verify that the pressure on the airway pressure gauge increases above 30 cmH2O within 2 minutes.

8. Turn off the vaporizer. Set APL valve to SP.
9. Repeat Steps 4, 5, 6, and 7 for the other vaporizer.

NOTE: This test also tests the expiratory check valve.

3.8.5.5 Check Valve Test

1. Set the ventilation Auto/Manual ventilation switch to Manual.
2. Set the APL valve to 75.
3. Connect the breathing bag to the Inspiratory port.
4. Plug the bag arm.
5. Press the FLUSH button until the pressure on the airway pressure gauge reaches 35 cmH2O.
6. Set the APL valve to SP.
7. Verify that the pressure does not drop below 30 cmH2O after 10 seconds

3.8.6 Check the Sensor Zero Point

To check the sensor zero point:

1. Turn off all fresh gases and expose the breathing system to ambient pressure.
2. Make sure that the system is in Standby mode.
3. Select Setup-> Service-> Data Monitors-> Component-> Zero Sensor to access the following menu.

FIGURE 3-27 Data Monitors Menu

4. The second column is the current reading of the sensors and the third column is the zero that is saved in the EEPROM.

DSP Platform (Software Bundle 03.00.00 and Higher) Zero Point Range

The following table lists the normal range of the zero point of A7 pressure and flow sensors.

Sensor Name	Normal Range of Zero Point
Paw sensor	7432 to 16206 **AD Counts**
PEEP pressure sensor	7432 to 16206 **AD Counts**
Inspiratory flow sensor	554 to 26457 **AD Counts**
Expiratory flow sensor	554 to 26457 **AD Counts**
Ventilator internal flow sensor	554 to 26457 **AD Counts**
N2O Flow Sensor (EFCS)	-0.2 to +0.2 L/min
Air Flow Sensor (EFCS)	-0.2 to +0.2 L/min
O2 Flow Sensor (EFCS)	-0.2 to +0.2 L/min

The zero point A/D value of the PAW sensor and PEEP pressure sensor should fall within the normal range of 7432 to 16206.

The zero point A/D value of the inspiratory flow sensor and expiratory flow sensor should fall within the normal range of 554 to 26457.

If there is a great deviation between the current zero point and the factory calibration zero point, it indicates that the sensor is aging but it does not mean that normal measurement cannot be performed.

If the current zero point exceeds the specified normal range, normal measurement is affected and you need to calibrate the zero point again. If the zero point of the flow sensor is not within 554 to 26457, or the zero point of the pressure sensor is not within 7432 to 16206, replace the VCM. For the internal flow sensor, replace the flow sensor interface board.

For the flowmeter sensors (N2O, Air, O2): If the zero point is out of the normal range [-0.2, +0.2], it indicates that the sensor needs to be recalibrated

EPSON Plateau Zero Point Range

The following table lists the normal range of the zero point of the A7 pressure and flow sensors.

Sensor Name	Normal Range of Zero Point
Paw sensor	200 to 800 **AD Counts**
PEEP pressure sensor	200 to 800 **AD Counts**
Inspiratory flow sensor	50 to 1800 **AD Counts**
Expiratory flow sensor	50 to 1800 **AD Counts**
Ventilator internal flow sensor	100 to 400 **AD Counts**
N2O Flow Sensor(EFCS)	-0.2 to +0.2 L/min
Air Flow Sensor(EFCS)	-0.2 to +0.2 L/min
O2 Flow Sensor(EFCS)	-0.2 to +0.2 L/min

The zero point A/D value of the PAW sensor and PEEP pressure sensor should fall within the normal range of 200 to 800.

The zero point A/D value of the inspiratory flow sensor and expiratory flow sensor should fall within the normal range of 50 to 1800.

The zero point A/D value of the internal flow sensor should fall within the normal range of 100 to 400. If there is a great deviation between the current zero point and the factory calibration zero point, it indicates that the sensor is aging but it does not mean that normal measurement cannot be performed.

If the current zero point exceeds the specified normal range, normal measurement is affected and you need to calibrate the zero point again. If the zero point of the flow sensor is not within 0 to 2000, or the zero point of the pressure sensor is not within 0 to 1200, replace the VCM. For the internal flow sensor, replace the flow sensor interface board.

For the flowmeter sensors (N2O, Air, O2): If the zero point is out of the normal range [-0.2, +0.2], it indicates that the sensor needs to be recalibrated.

3.8.7 Check the Flow Sensor Accuracy

NOTE: **You can use any flow meter that has an accuracy of at least ±2% for the accuracy measurement of the flow sensors.**

NOTE: **Set the Gas Flow Analyzer Correction Mode to aBTPS (Body Temperature and Pressure, Saturated). For EPSON systems the mode can be set to ambient temperature and pressure or BTPS.**

To check the measurement accuracy of flow sensors:

1. Remove the bellows dome, then the Bellows and re-install the bellows dome.
2. Remove the water trap.
3. Put the AUTO / MANUAL Lever in the AUTO position.
4. The pneumatic connections between the anesthesia machine and calibration device are as shown in the following picture. You can connect the tube to a high-flow connector or low-flow connector based on the requirements.

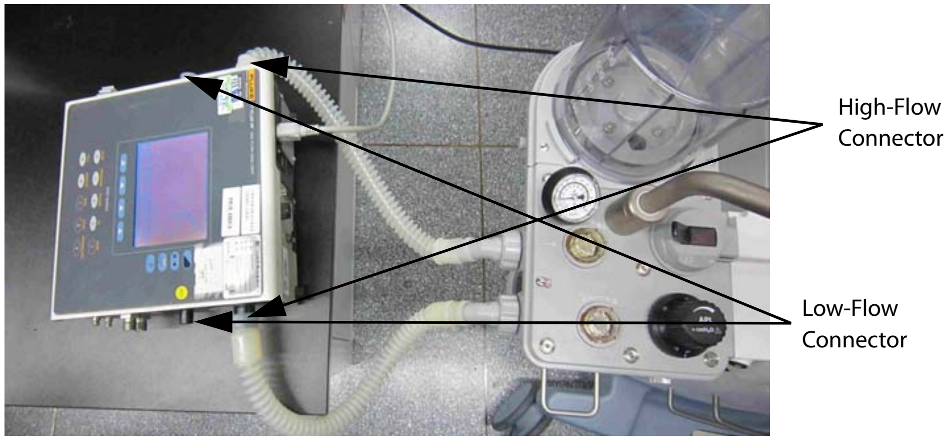


FIGURE 3-28 Pneumatic Connections Between Anesthesia Machine and Calibration Device

5. Setting up the flow meter:

Calibration Device (Fluke VT Plus)

a. Setup the calibration device as described below:

b. Flow Setting: Press the Flow button on the front control panel of the calibration. You can set Range to High Flow or Low Flow as required.

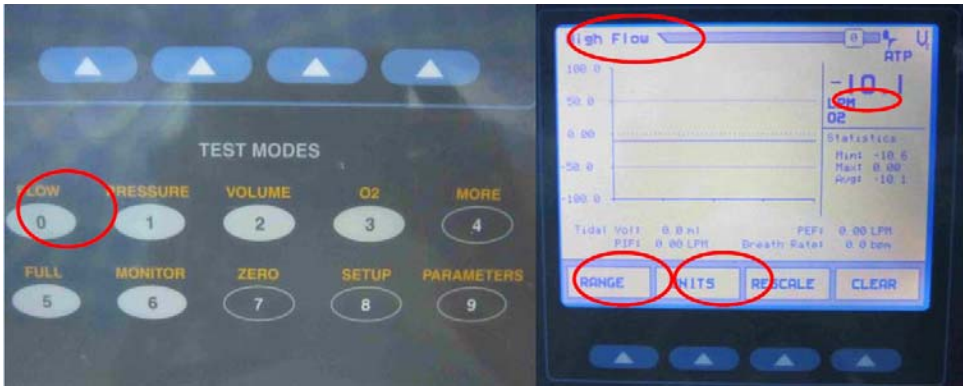


FIGURE 3-29 Calibration Front Control Panel - Flow Setting

c. Gas Settings: Press the Setup button, select Setting->ENTER->Gas Settings->MODIFY->Gas Type->O2.

d. Correction mode: Press the Setup button, select Setting->ENTER->Correction Mode->MODIFY->Correction Mode->BTPS..

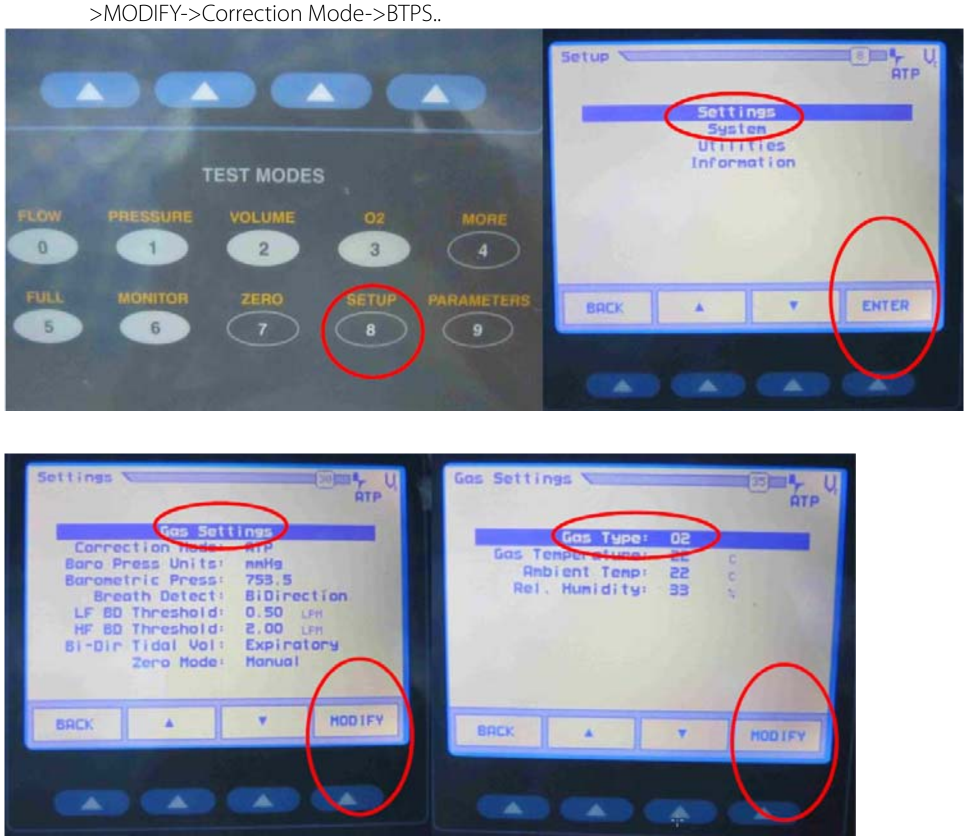


FIGURE 3-30 Calibration Front Control Panel - Gas Settings

e. Select BACK->BACK-> BACK.

FIGURE 3-31 Calibration Front Control Panel - High Flow

Calibration Device (TSI Certifier 4070, Cannot be Used for DSP Units)

a. Setup the calibration device as described below.

b. Flow Setting: Press the to line select key until the top display reads LPM or SLPM. If the display reads SLPM, press the DISPLAY UNITS key until the top display reads LPM.

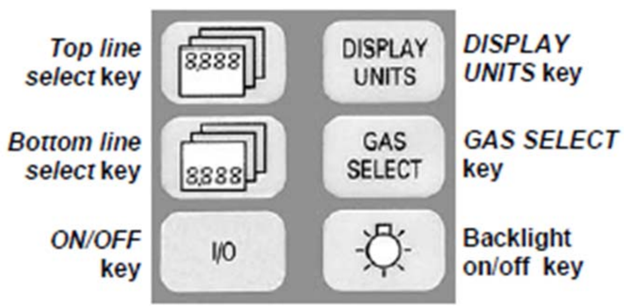


FIGURE 3-32 TSI Certifier 4070 Menu

c. Gas Settings: Press the GAS SELECT key until the bottom left corner reads O2When the system is in Standby.

Calibration Device (CERTIFIER FA PLUS)

a. Touch on the following active areas of the Parameter Screen.

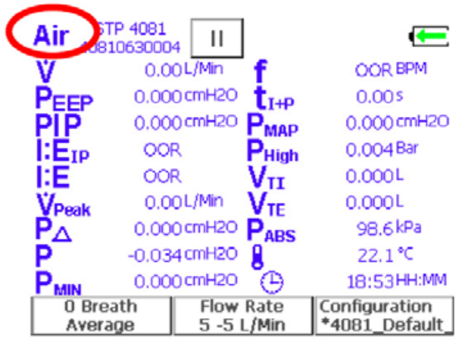


FIGURE 3-33

b. The following window will pop up.

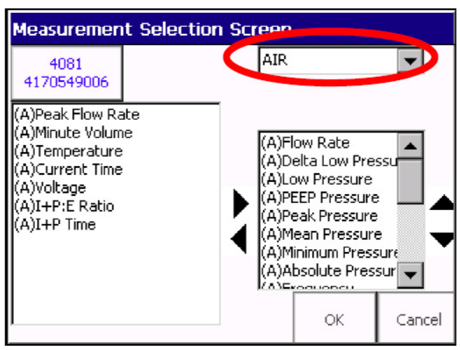


FIGURE 3-34

c. Select O2.

d. Select OK.

e. Touch on the following active areas of the Parameter Screen.

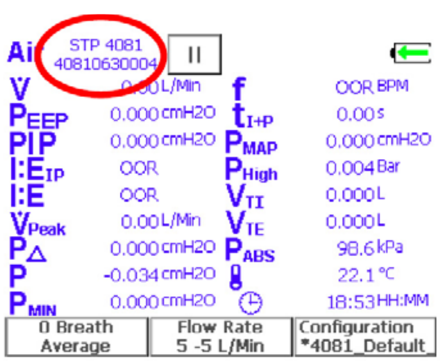


FIGURE 3-35

f. The following window will pop up.

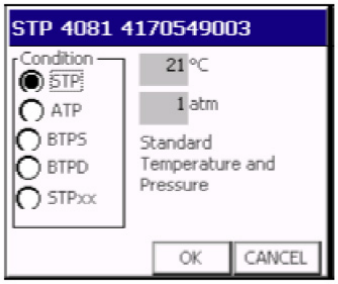


FIGURE 3-36

g. Select BTPS.

h. Select OK.

6. Select the Setup-> Service-> Diagnostic Tests->Valves to access the following menu.

FIGURE 3-37 Diagnostic Tests > Valves Menu

7. Set safety valve to [ON].

8. Set the PEEP valve pressure to 30 cmH2O.

9. Set the Insp Valve Flow to the following values:
3L/min, 10L/min, 20L/min, 30L/min, 60L/min.

Make sure that the deviation between the measured data of the Flow Sensor, Insp Flow Sensor and Exp Flow Sensor does not exceed 1 L/min or 5% of the measured value of the calibration device, whichever is greater. Otherwise, refer to “Flow Calibration (Service)” on page 4-8 to perform flow calibration again.

10. When finished, reinstall the bellows and the water trap.

3.8.8 Check the Pressure Sensor Accuracy

NOTE: **Generally, measurement deviations do not easily occur to pressure sensors. However, in case of replacing the Ventilator Control Board, Solenoid Valve Assembly, or Drive Gas Assembly, you need to perform pressure calibration and check the flow sensors accuracy so as to confirm the effectiveness of calibration.**

NOTE: **You can use any pressure meter that has an accuracy of at least ±2% for the accuracy measurement of the pressure sensors.**

To check the measurement accuracy of pressure sensors:

1. Perform pneumatic connections as follows:
   The following pictures show the four-way device:

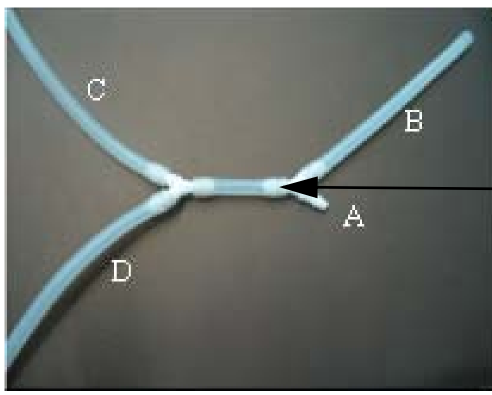


FIGURE 3-38 Pneumatic Connections for Four-Way Device

1. Remove the top cover (3 captive screws).
2. Remove the two tubes marked as #72 and #9 from the pressure sensors (refer to figure below).
3. Connect the four way tube to the pressure sensor P1 of monitor board, pressure sensor P2 of PEEP, the tube marked as #72, and the low pressure port of Fluke VT-Plus. The tube marked as #9 will remain unconnected for this calibration.

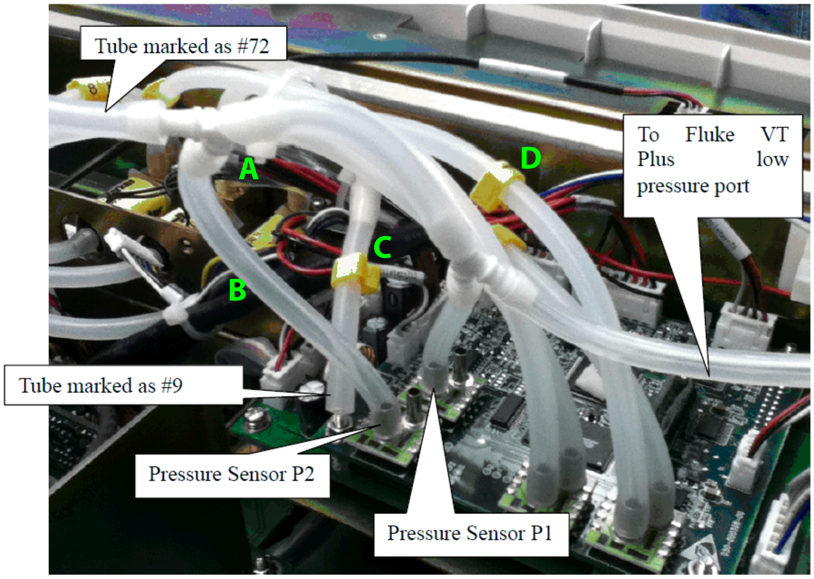


FIGURE 3-39 Pneumatic Connections to Monitor Board

FIGURE 3-40 Calibration Device (VT Plus)

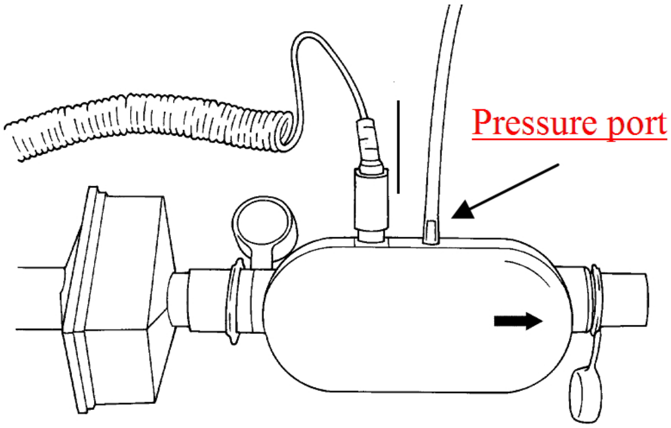


FIGURE 3-41 TSI Certifier 4070

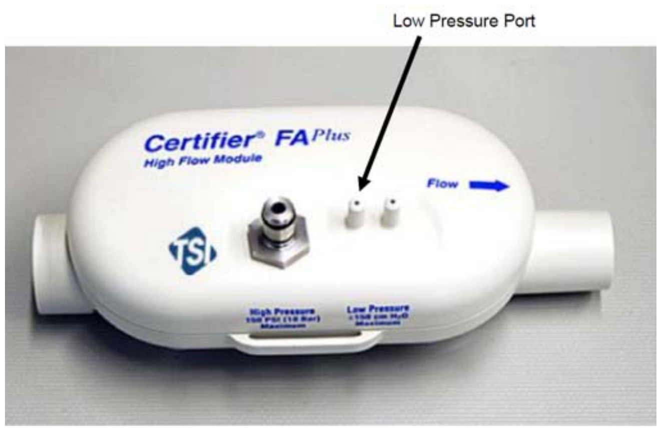


FIGURE 3-42 CERTIFIER FA PLUS

2. Set up the calibration device as described below.

To set the Fluke VT-Plus:

a. Pressure Setting: Press the PRESSURE button on the front control panel of the calibration, select Range and then set it to Low Press.

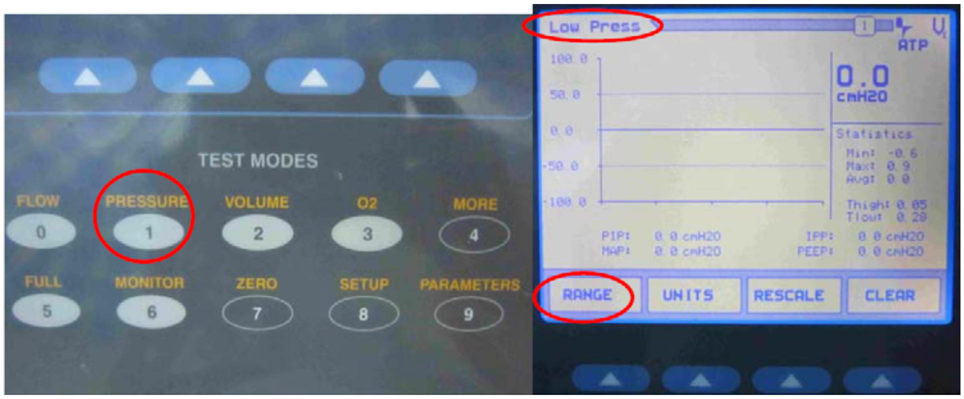


FIGURE 3-43 Calibration Front Control Panel - Pressure Button

b. Gas Settings: Press the Setup button, select Setting->ENTER->Gas Settings->MODIFY->Gas Type->O2.

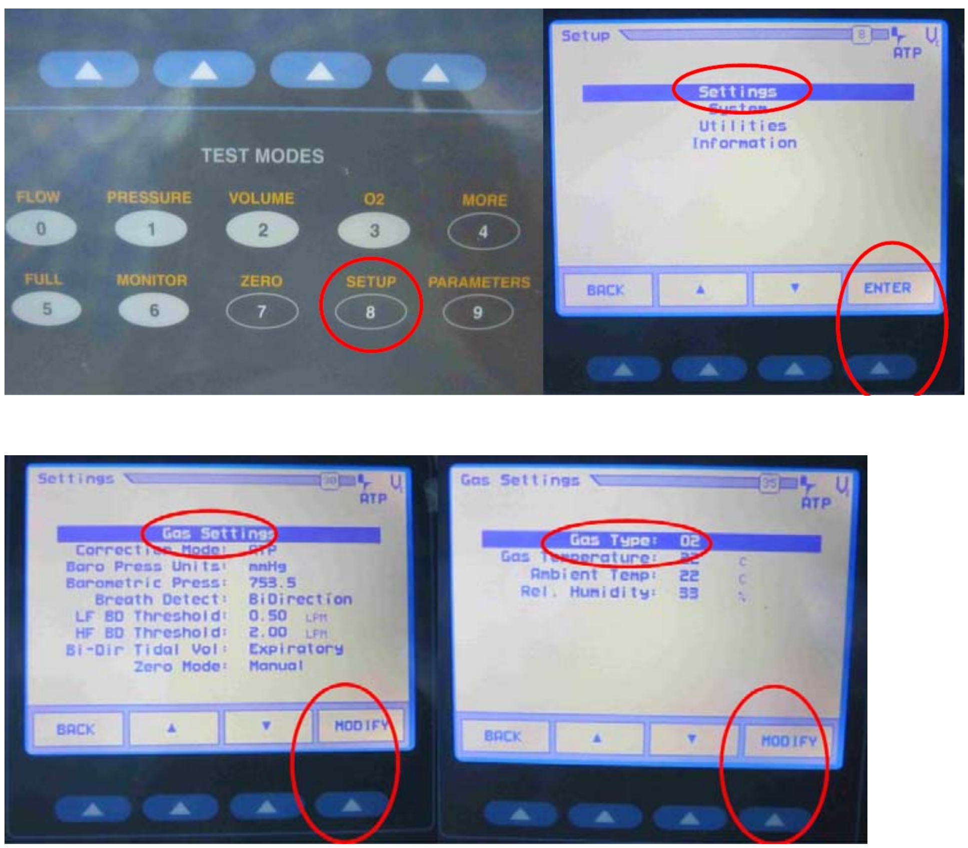


FIGURE 3-44 Calibration Front Control Panel - Gas Settings

c. Select BACK->BACK-> BACK.

FIGURE 3-45 Calibration Front Control Panel - Gas Settings

3. When the system is Standby, select the Setup->Service-> Diagnostic Tests-> Valves to access the following menu.

FIGURE 3-46 Calibration Front Control Panel - Gas Settings

4. Set safety valve to ON.

5. Set the PEEP valve pressure to the following values:
5 cmH2O, 20 cmH2O, 50 cmH2O, 70 cmH2O, 90 cmH2O.

6. Make sure that the deviation between the measured data of the PAW Sensor, PEEP pressure sensor and that of the anesthesia machine calibration device must not exceed 1 cmH2O or 2% of the measured value of the calibration device, whichever is greater. Otherwise, refer to Section 4.3.3 Pressure Calibration (Service) to perform pressure calibration again.

7. Reconnect hoses #9 and #72.

3.8.9 Total Flow Sensor Self Test

NOTE: Perform this test after sensor calibration if the total flow sensor is replaced.

1. Turn on the O2 and N2O supplies, and ensure that O2 and N2O are within the normal input pressure range.
2. If the system has been powered on and N2O has been adjusted, power off and then on the system to ensure that the system is in the initial startup state.
3. Set the system to enter the EFCS mode and set the balance gas to N2O.
4. Adjust the N2O flow to a value (for example, 2 L/min) and retain this value for more than 2 seconds. The N2O flow must not be set to zero in this period.
5. A message "Total Flow Sensor Self Test in Progress" is displayed on the main screen. After the self test is successfully completed, the message disappears and the N2O flow reaches the set value stably.
6. If the self test failed, the BFCS is displayed and an alarm "Electronic Flow Control Error" is reported.

3.9 Pneumatic Leak Tests

Turn all fresh gas flows to 0 L/min. Disconnect pipeline supplies.

3.9.1 Line Pressure Gauges Accuracy Test

1. Open the rear panel and disconnect the pipe supply for all 3 gases (O2, AIR and N2O).
2. Disconnect hose # 47 from the regulator assembly and connect it to your high pressure meter.
3. Reconnect the O2 Pipeline supply.
4. Verify the reading on your pressure meter and the reading on the O2 pipeline pressure gauge are within 5 psi of each other.
5. Disconnect the O2 Pipeline supply and reconnect hose # 47 to the regulator assembly.
6. Disconnect hose # 37 from the regulator assembly and connect it to your high pressure meter.
7. Reconnect the AIR Pipeline supply.
8. Verify the reading on your pressure meter and the reading on the AIR pipeline pressure gauge are within 5 psi of each other.
9. Disconnect the AIR Pipeline supply and reconnect hose # 37 to the regulator assembly.
10. Disconnect hose # 35 from the regulator assembly and connect it to your high pressure meter.
11. Reconnect the N2O Pipeline supply.
12. Verify the reading on your pressure meter and the reading on the N2O pipeline pressure gauge are within 5 psi of each other.
13. Disconnect the N2O Pipeline supply and reconnect hose # 35 to the regulator assembly.
14. Reconnect the pipe supply for all 3 gases (O2, AIR and N2O).

3.9.2 N2O Cylinder Leak Test

1. Remove the N2O line pressure hose from the line pressure inlet on the A7.
2. Mount a full N2O cylinder to the rear panel yoke. If necessary, place a new clean tank washer between the cylinder and the yoke to minimize any leaks at the yoke connection.
3. Open the N2O cylinder until its pressure gauge indicates cylinder pressure.
4. Close the N2O cylinder.
5. The N2O cylinder pressure gauge should not drop more than 10% of its initial pressure over 1 minute.

3.9.3 O2 Cylinder Leak Test

1. Remove the O2 line pressure hose from the line pressure inlet on the A7.
2. Mount a full O2 cylinder to the rear panel yoke. If necessary, place a new clean tank washer between the cylinder and the yoke to minimize any leaks at the yoke connection.
3. Open the O2 cylinder until its pressure gauge indicates cylinder pressure.
4. Close the O2 cylinder.
5. The O2 cylinder pressure gauge should not drop more than 10% of its initial pressure over 1 minute.

3.9.4 AIR Cylinder Leak Test

1. Remove the AIR line pressure hose from the line pressure inlet on the A7.
2. Mount a full AIR cylinder to the rear panel yoke. If necessary, place a new clean tank washer between the cylinder and the yoke to minimize any leaks at the yoke connection.
3. Open the AIR cylinder until its pressure gauge indicates cylinder pressure.
4. Close the AIR cylinder.
5. The AIR cylinder pressure gauge should not drop more than 10% of its initial pressure over 1 minute.

3.9.5 Line Pressure Leak Tests

3.9.5.1 BFCS Test

1. Remove the O2, AIR and N2O cylinder from the anesthesia system.
2. Connect the O2, AIR and N2O line pressure hoses to the line pressure inlet on the anesthesia system.
3. Disconnect the hose #26 from the back pressure regulator and plug the connector on the back pressure regulator.
4. Turn the unit on and push the BFCS button to deploy the BFCS.
5. Open the O2 and AIR needle valve fully.
6. Pinch the O2 line pressure hose.
7. Remove the O2 line pressure hose from the line source while keeping the hoses pinched. The pressure measured on the line pressure gauge on the front of the unit should not fall more than 10 psi per 100 seconds (2 psi per 20 sec).
8. Release the O2 line pressure hose.
9. Pinch the AIR line pressure hose.
10. Remove the AIR line pressure hoses from the line source while keeping the hose pinched.
11. The pressure measured on the line pressure gauge on the front of the unit should not fall more than 10 psi per 100 seconds (2 psi per 20 sec).
12. Remove the plug from the back pressure regulator and reconnect hose #26.
13. Close the O2 and AIR needle valves.
14. Reconnect the O2 and AIR line pressure hoses and remove the pinch in the hose.
15. Disable the BFCS.

3.9.5.2 EFCS Test

1. Remove the O2, AIR and N2O cylinder from the anesthesia system.
2. Connect the O2, AIR and N2O line pressure hoses to the line pressure inlet on the anesthesia system.
3. Disconnect the hose #123 from the 3 way valve assembly and plug the connector on the 3 way valve assembly.
4. Turn the unit on and set the A7 in EFCS mode.
5. Enter SERVICE / FCS TESTS:
   - Set 3-Way Valve (CPU) to "H"
   - Set 3-Way Valve (FPGA) to "H"
   - Set O2 Prop Valve DA to "4000"
   - Set N2O Prop Valve DA to "4000"
   - Set AIR Prop Valve DA to "4000"
6. Pinch the O2 line pressure hose.
7. Remove the O2 line pressure hoses from the line source while keeping the hoses pinched. The pressure measured on the line pressure O2 gauge on the front of the unit should not fall more than 10 psi per 100 seconds (2 psi per 20 sec).
8. Release the O2 line pressure hose.
9. Pinch the N2O line pressure hose.
10. Remove the N2O line pressure hoses from the line source while keeping the hoses pinched. The pressure measured on the line pressure N2O gauge on the front of the unit should not fall more than 10 psi per 100 seconds (2 psi per 20 sec).
11. Release the N2O line pressure hose.
12. Pinch the AIR line pressure hose.
13. Remove the AIR line pressure hose from the line source while keeping the hose pinched.
14. The pressure measured on the line pressure gauge on the front of the unit should not fall more than 10 psi per 100 seconds (2 psi per 20 sec).
15. Enter SERVICE / FCS TESTS:
    - Set O2 Prop Valve DA to "0"
    - Set N2O Prop Valve DA to "0"
    - Set AIR Prop Valve DA to "0"
16. Remove the plug from the 3 way valve assembly and reconnect hose #123.
17. Reconnect the O2, AIR and N2O line pressure hoses and remove the pinch in the hose.

3.9.5.3 ACGO Test

1. Turn the unit on and set the A7 in EFCS mode.
2. Set the Auto/Manual switch to Manual position.
3. Plug the ACGO port.
4. Set the O2 flow to 0.2L/min and set the unit to ACGO mode. The pressure must go over 30cmH2O with 1 minute.

3.10 Breathing System Checks

3.10.1 Waste Gas Scavenger Test (if available)

1. Connect one end of the low pressure waste gas hose to the port on the Waste Gas Scavenger Assembly. Connect the other end of the hose to the EVAC port.

NOTE: If operating the A7 with other types of waste gas scavenging, ensure that waste gases are directed from the EVAC port to that scavenging system.

2. Connect the respiratory gas monitor exhaust output to the barbed fitting port on the Waste Gas Scavenger Assembly.
3. Ensure that the waste gas scavenger flow adjustment is able to be set between the MIN and MAX line markings.

For Units with a DGSS:

1. Ensure that all waste anesthetic connections are secure, unused inlets are capped, and that the DGSS® power cord is NOT connected.
2. Set the Auto/Manual ventilation switch to Manual.
3. Set fresh gas flow to 0 and fully open the APL.
4. Occlude the patient end of the circuit and observe the circuit pressure gauge. A value of less than -2 cm H_2O indicates a malfunction.
5. While keeping the patient end of the circuit occluded, press the oxygen flush button on the anesthesia machine for approximately 3 seconds while observing the circuit pressure gauge.
6. Circuit pressures should not exceed 15cm H_2O during this test.
7. Apply power to the DGSS® and repeat steps 2 through 6.
8. Frequent clicking sounds from the DGSS® may be heard during normal operation as the reservoir bag fills and empties.

3.10.2 Internal Gas Connections Test

3.10.2.1 BFCS Test

1. Close and remove all gas cylinders from the anesthesia system.
2. Connect only the O2 line pressure hose to the anesthesia system from the wall supply. Leave all other line pressure hoses disconnected.
3. Turn the unit on and set the A7 in BFCS mode, Rotate the O2 needle valve knob to ensure a continuous flow increase throughout its full range. Set the O2 flow to 2L/min.
4. Fully rotate the AIR needle valve knob and verify that there is no increase of total flow. Close the AIR valve.
5. Disconnect the O2 line pressure hose from the anesthesia system, and connect the AIR line pressure hose from the wall supply.
6. Rotate the AIR needle valve knob to ensure a continuous flow increase throughout its full range.
7. Set the AIR flow to 2L/min.
8. Fully rotate the O2 needle valve knob and verify that there is no increase of total flow.
9. Close the AIR and O2 valves.
10. Disable Backup Flow Control.

3.10.2.2 EFCS Test (Only for A7's with an AG Module)

1. Connect the O2, AIR and N2O line pressure hoses to the anesthesia system from the wall supply.
2. Connect a breathing hose from the ACGO port to the flow analyzer.
3. Connect a breathing hose from the flow analyzer output to the scavenger.
4. If necessary, attach a adapter to the flow analyzer to connect the sampling line from the AG module.

FIGURE 3-47

5. Verify the machine is in EFCS mode.
6. Set the Flow Control mode to Direct Flow.
7. Touch the screen to start the manual ventilation mode and set the ACGO button to ON.
8. Set the balance gas to NONE.
9. Rotate the O2 flow control knob to ensure a continuous flow increase throughout its full range. Set the O2 flow to 5 L/min
10. Verify the that the O2 concentrations reads at least 97% and the N2O concentration reads 0% after 1 minute.
11. Set the balance gas to AIR and set the O2 flow to 0 L/min.
12. Rotate the balance / AIR flow control knob to ensure a continuous flow increase throughout its full range.
13. Set the AIR flow to 5 L/min.
14. Verify the that the O2 concentrations reads between 19% and 23% and the N2O concentration reads 0% after 1 minute.
15. Set the balance gas to N2O.
16. Set the O2 flow to 5 L/min and rotate the N2O flow control knob to ensure a continuous flow increase throughout its full range (N2O flow range: 0 to 12 L/min).
17. Set the O2 flow to 5 L/min and the N2O flow to 5 L/min.
18. Verify the that the O2 and N2O concentrations reads between 47% and 53% after 1 minute.
19. Set the system to the STANDBY mode by pressing the **End Case** button.

3.10.2.3 EFCS Test (Only for A7's without an AG Module)

1. Using a breathing hose, connect the bag arm to the expiratory port.
2. Put the Manual/Auto lever to the manual position and set the APL valve to 75.
3. Use a breathing hose to connect the output of the inspiratory port to the scavenger
4. Verify the scavenger is connected at the wall and the floater is between MIN and MAX.
5. Verify the machine is in EFCS mode.
6. Set the Flow Control mode to Direct Flow.
7. Set the balance gas to NONE.
8. Rotate the O2 flow control knob to ensure a continuous flow increase throughout its full range. Set the O2 flow to 5 L/min.
9. Verify the that the O2 concentrations reads at least 97% and the N2O concentration reads 0% after 1 minute.
10. Set the balance gas to AIR, and set the O2 flow to 0L/min.
11. Rotate the balance / AIR flow control knob to ensure a continuous flow increase throughout its full range.
12. Set the AIR flow to 5 L/min.
13. Verify the that the O2 concentrations reads between 19% and 23% and the N2O concentration reads 0% after 1 minute.
14. Set the balance gas to N2O.
15. Set the O2 flow to 5 L/min and rotate the N2O flow control knob to ensure a continuous flow increase throughout its full range (N2O flow range: from 0 to 12 L/min).
16. Set the O2 flow to 5 L/min and the N2O flow to 5 L/min.
17. Verify the that the O2 and N2O concentrations reads between 47% and 53% after 1 minute.
18. Set the system to the STANDBY mode by pressing the End Case button.
19. Reconnect the Waste Gas Scavenger Hose.

3.10.2.4 Check the Flow Accuracy of the EFCS

NOTE: Set the Gas Flow Analyzer Correction Mode to Standard settings (21 °C, 101.3 kPa).

1. Connect the O2, AIR and N2O line pressure hoses to the anesthesia system from the wall supply.
2. Connect a breathing hose from the ACGO port to the flow analyzer.
3. Connect a breathing hose from the flow analyzer output to the scavenger.
4. Attach a adapter to the flow analyzer to connect the sampling line from the AG module.

.

FIGURE 3-48

Calibration Device Fluke VT Plus

Setup the calibration device as described below:

- **a.** Flow Settings: Press the Flow button on the front control panel of the calibration. You need set Range to Low Flow (when Gas Type is N2O bal O2, you need set Range to High Flow).
- **b.** Gas Settings: Press the Setup button, select Setting->ENTER->Gas Settings->MODIFY->Gas Type->O2 or Air or N2O bal O2.
- **c.** Correction mode: Press the Setup button, select Setting->ENTER->Correction Mode->MODIFY->Correction Mode->STPD21

Calibration Device (TSI Certifier 4070, Cannot be Used for DSP Units)

Setup the calibration device as described below:

- **a.** Flow Setting: Press the to line select key until the top display reads LPM or SLPM. If the display reads LPM, press the DISPLAY UNITS key until the top display reads SLPM.

Calibration Device (CERTIFIER FA PLUS)

- **a.** Touch on the following active areas of the Parameter Screen.

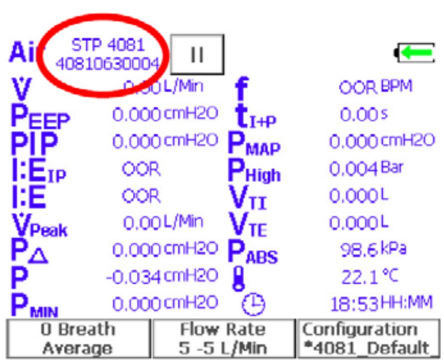


FIGURE 3-49

- **b.** The following window will pop up.

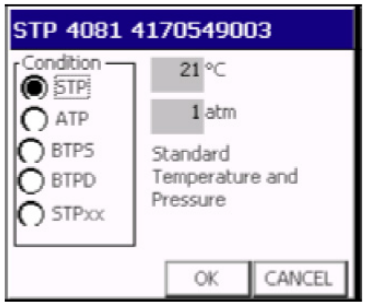


FIGURE 3-50

  c. Select STP.
  d. Select OK.

5. Verify the machine is in EFCS mode.
6. Set the Flow Control mode to Direct Flow.
7. Touch the screen to start the manual ventilation mode and set the ACGO button to ON.
8. Set the balance gas to NONE.
9. Rotate the O2 flow control knob to set the O2 flow following the table below, then verify the oxygen flow reading of the flow analyzer.

Test Method	Verification (Flow analyzer flow rate)
Set the O2 flow to 0.2 L/min.	**Verify O2 flow is between** 150 mL/min and 250 mL/min.
Set the O2 flow to 1 L/min.	**Verify O2 flow is between** 950 mL/min and 1050 mL/min.
Set the O2 flow to 3 L/min.	**Verify O2 flow is between** 2850 mL/min and 3150 mL/min.
Set the O2 flow to 10 L/min.	**Verify O2 flow is between** 9500 mL/min and 10500 mL/min.
Set the O2 flow to 15 L/min.	**Verify O2 flow is between** 14250 mL/min and 15750 mL/min.

10. et the balance gas to AIR.
11. Set the O2 flow to 0 L/min.
12. Rotate the air flow control knob to set the air flow following the table below, then verify the air flow reading of the flow analyzer.

Test Method	Verification (Flow analyzer flow rate)
Set the air flow to 0.2 L/min.	**Verify air flow is between** 150 mL/min and 250 mL/min.
Set the air flow to 1 L/min.	**Verify air flow is between** 950 mL/min and 1050 mL/min.
Set the air flow to 3 L/min.	**Verify air flow is between** 2850 mL/min and 3150 mL/min.
Set the air flow to 10 L/min.	**Verify air flow is between** 9500 mL/min and 10500 mL/min.
Set the air flow to 15 L/min.	**Verify air flow is between** 14250 mL/min and 15750 mL/min.

3.10.3 Drive Gas Pressure Loss Alarm, N2O Cutoff Test

1. Close and remove all gas cylinders from the anesthesia system.
2. Connect the O2 and N2O line pressure hose to the anesthesia system from the wall supply. Leave all other line pressure hoses disconnected.
3. Turn the unit on and set the A7 in EFCS mode and set the N2O as balance gas.
4. Set the O2 flow to 2 L/min using the flow control valve.
5. Set the N2O flow to 2 L/min using the flow control valve.
6. Interrupt the O2 supply to the anesthesia system.
7. Verify that the flow of N2O and O2 stops within 2 minutes.
8. Verify the following alarms are activated:
   - **O2 Supply Failure** appears on the screen.
   - An alarm tone sounds.
9. Reconnect the O2 supply and disconnect the N2O line pressure hose
10. Verify the following alarms are activated:
    - **N2O Supply Failure** appears on the screen.
    - An alarm tone sounds.
11. Connect the AIR line pressure hose to the anesthesia system and set the AIR as balance gas.
12. Set the O2 flow to 2 L/min using the flow control valve.
13. Set the AIR flow to 2 L/min using the flow control valve.
14. Interrupt the AIR supply to the anesthesia system.
15. Verify the following alarm is activated:
    - **AIR Supply Failure** appears on the screen.
    - An alarm tone sounds.
16. Reconnect all line pressure hoses.

3.11 Performance Verification

NOTE: Set the Gas Flow Analyzer Correction Mode to BTPS (Body Temperature and Pressure, Saturated). For EPSON systems the mode can be set to ambient temperature and pressure or BTPS.

3.11.1 Manual Mode Ventilation Test

1. Power ON the anesthesia system.
2. Attach a breathing circuit and test lung to the Y-fitting of the breathing circuit.

NOTE: For testing purposes always use a reusable breathing circuit and make sure the machine is under EFCS.

3. Perform the start up tests per the on-screen instructions. Ensure successful completion.
4. Set the mechanical Auto/Manual switch to MANUAL. Press the screen for the screen to change to manual Mode.
5. Set the APL Valve to approximately 25 cmH2O. Push the O2 Flush button to fill the breathing bag.
6. Set the AIR flow to 1 L/min using the flow control valve. This will change the screen to manual Mode
7. Squeeze the breathing bag once every 3 seconds.
8. Verify the inflation and deflation of the test lung.
9. Verify that an airway pressure waveform and all numeric values appear on screen during bag compressions.
10. Stop squeezing the breathing bag and set the APL Valve to the open position (SP).

3.11.2 APNEA Alarm Test

1. While in the Manual Ventilation Mode, stop ventilating the test lung and set the APL valve to SP.
2. Verify that the following APNEA alarm signals activate at approximately 30 seconds from the last bag compression.
   - APNEA appears on the screen.
   - An alarm tone sounds.

3.11.3 Alarm Silence Test

1. While the APNEA alarm is sounding, press the Silence soft key.
2. Verify the audio portion of the alarm stops and resumes after 2 minutes.

3.11.4 VCV Adult Ventilation Mode Test

1. Set the Fresh Gas Control to Direct Flow Mode.
2. Set the O2 flow to 2 L/min and set the N2O and AIR flow rates to minimum flow.
3. Set the mechanical Auto/Manual switch to AUTO.
4. Connect a Vent Tester to the breathing system. Unidirectional Vent Testers need to be connected to the expiratory limb.
5. Set the ventilator controls to the following:

Ventilator Controls	Ventilator Settings
Ventilation Mode	VCV
Vt	600
Rate	8
I:E	1:2
Tpause	10
PEEP	Off
Plimit	50

6. Verify that the pressure waveform, Tidal Volume, Mean or Plateau Pressure, Resp. rate and minute volume values appear on the screen.
7. Verify the Tidal Volume display on the Vent Tester is within 7% (±42 mL) of the set value within approximately 1 minute from the start of ventilation.
8. Verify the Tidal Volume display is within 9% (±54 mL) of the set value within approximately 1 minute from the start of ventilation.
9. Verify the measured O2 concentration is at least 97% after 5 minutes.
10. Set the AIR flow to 3 L/min and set the N2O and O2 flow rates to minimum flow.
11. Verify the measured O2 concentration is 21% ±3% vol. % after 5 minutes.

3.11.5 VCV Child Ventilation Mode Test

1. Set the ventilator controls to:

Ventilator Controls	Ventilator Settings
Ventilation Mode	VCV
Vt	120
Rate	15
I:E	1:2
Tpause	10
PEEP	Off
Plimit	40

2. Verify that the pressure waveform, Tidal Volume, Mean or Plateau Pressure, Resp. rate and minute volume values appear on the screen.
3. Verify the Tidal Volume display is within 18ml of the set value within approximately 1 minute from the start of ventilation.
4. Verify the delivered volume, as measured by a Vent Tester, is within 15ml of the set value within approximately 1 minute from the start of ventilation.

3.11.6 Airway Disconnect Alarm Test

1. While the ventilator is running, disconnect the expiratory limb from the Expiratory Port on the Breathing System.
2. Verify the following airway pressure disconnect alarm signals activate:
   • Paw Too Low message appears on the screen.
   • An alarm tone sounds.
3. Reconnect the expiratory limb to the expiratory port.

3.11.7 PCV Adult Ventilation Mode Test

1. Set the O2 flow to 3 L/min and set the N2O and AIR flow rates to minimum flow.
2. Set the ventilator controls to:

Ventilator Controls	Ventilator Settings
Ventilation Mode	PCV
VtG (EPSON)	Off
Pinsp	15
Rate	8
I:E	1:2
PEEP	Off
Tslope	0.2
PlimVG	NA

3. Press Set Mode button to begin ventilation.
4. Verify the Peak Pressure reading of the display is within ±2 cmH2O of the Peak Pressure measured with the Vent Tester.
5. Verify that the pressure waveform, Tidal Volume, Resp. Rate and minute volume values appear on the screen.
6. Verify that the PEAK Value reaches 15 ±2.5 cmH2O within five breaths from the start of ventilation.

3.11.8 Pressure Support (PS) Ventilation Mode Test

1. Set the O2 flow to 1 L/min and set the N2O and AIR flow rates to minimum flow.
2. Set the ventilator controls to:

Ventilator Controls	Ventilator Settings
Ventilation Mode	PS
Min Rate	4
ΔP	20
Trigger	3
PEEP	Off
Tslope	0.2
ΔP apnea	15 (DSP only)
Apnea Ti	5

3. Press Set Mode button to begin ventilation.
4. Begin triggering breaths by slightly squeezing the test lung and releasing. Maintain a continuous breath rate.
5. Verify that a pressure waveform and all ventilation parameters appear on the screen.
6. Verify that the Peak Pressure reading on the display is ±2 the value of ΔP + PEEP.
7. Stop triggering breaths.
8. Verify that after 15 seconds the ventilator delivers a breath and displays the message Apnea Ventilation.
9. Verify the system ventilates with a frequency of 4 bpm.

3.12 Alarms and Fail safe Functions

3.12.1 Set Up

1. Set the EFCS as Direct Flow Control Mode and select AIR as balance gas. Set the O2 flow to 2 L/min and set the air flow rate to 0 L/min.
2. Set the ventilator controls to:

Ventilator Controls	Ventilator Settings
Ventilation Mode	VCV
Vt	600
Rate	8
I:E	1:2
Tpause	10
PEEP	Off
Plimit	50

3. Press Set Mode button to begin ventilation.

3.12.2 Low O2 Alarm Test

NOTE: For A7s with an installed gas module, disconnect the sample tube from the Y-piece and breath into it until you see a CO2 reading on the screen. Then reconnect the sample tube to the Y-piece. This will activate the gas module alarms.

1. Set the low Insp O2 alarm limit to 50%.
2. Set the air flow to 5 L/min.
3. Set the O2 flow to 0 L/min.
4. Verify the following low Insp O2 alarm signals activate, within three ventilation cycles:
   • FiO2 Too Low message appears on the screen.
   • An alarm tone sounds.
5. Set the low Insp O2 alarm limit to 18%.
6. Verify the FiO2 Too Low message disappears

3.12.3 High O2 Alarm Test

1. Set the high Insp O2 alarm limit to 50%.
2. Set the O2 flow to 5 L/min.
3. Set the air flow to 0 L/min.
4. Verify the following high Insp O2 alarm signals activate:
   - FiO2 Too High message appears on the screen.
   - An alarm tone sounds.
5. Set the high Insp O2 alarm limit to the highest setting.
6. Verify the FiO2 Too High message disappears.

3.12.4 Peak Pressure Alarms Test

1. Set the PEAK low alarm limit to the lowest setting.
2. Set the PEAK high alarm limit set point about 5 to 8 digits below the Peak Pressure displayed on the screen.
3. Verify the following (high) peak pressure alarms activate:
   a. Paw Too High message appears on the screen.
   b. An alarm tone sounds.
   c. Inspiration ends and expiration begins as the pressure meets the high alarm limit.
4. Set the PEAK high alarm limit to the highest setting.
5. Verify the Paw Too High message disappears.
6. Set the PEAK low alarm limit to 70 (cmH2O).
7. Verify the following (low) peak pressure alarms activate:
   a. Paw Too Low message appears on the screen.
   b. An alarm tone sounds.
8. Set the PEAK low alarm limit to the lowest setting.
9. Verify the Paw Too Low message disappears.

3.12.5 Minute Volume Alarm Test

1. Set the MV High alarm limit to the highest setting and then set the MV Low alarm limit to the highest setting.
2. Verify the following alarms activate:
   • MV Too Low message appears on the screen.
   • An alarm tone sounds.
3. Set the MV Low alarm limit to the lowest setting.
4. Verify that the MV Too Low message disappears.
5. Set the MV High alarm limit to the lowest setting.
6. Verify the following alarms activate:
   • MV Too High message appears on the screen.
   • An alarm tone sounds.
7. Set the MV High alarm limit to the highest setting.
8. Verify that the MV Too High message disappears.
9. Set the mechanical Auto/Manual switch to MANUAL.
10. Set all fresh gas flows to 0.
11. Press **End Case** button to enter the standby mode.

3.13 Miscellaneous Tests

3.13.1 Test the Line Voltage Alarm

1. Interrupt AC line voltage.
2. Verify that the following alarms activate:
   - An alarm tone sounds.
   - Battery in use message appears on the screen.
3. Plug the anesthesia system into AC line voltage.
4. Verify that the alarm signals cease.
5. Verify the presence of the battery charging icon in the upper right corner of the screen.

3.13.2 Top Light and Auxiliary Light Test

1. Turn on the Top light located on the bottom side of the top panel.
2. Verify that it lights in both on positions.

3.13.3 Touchpad Test

Verify that the touchpad is functional.

3.13.4 Module Rack Functional Test

1. When the machine is turned on, insert the AG module into the module rack (take care to insert the module gently and depress the self-locking buckle when plugging it out to avoid damaging the module). Make sure that the gas test screen and CO2 waveform and parameter area are displayed on the screen and that the prompt message **External AG Loaded Successfully** is displayed at the top of the screen.
2. Set the ventilator to Manual mode.
3. After the AG module is inserted, if the module is not connected with a watertrap, make sure that the alarm **AG No Watertrap** appears. After the watertrap is connected to the module, make sure that the alarm disappears.
4. Occlude the inlet hose of the AG module and make sure that the alarm **AG Airway Occluded** appears.
5. Depress the self-locking buckle of the module to plug out the module. Make sure that the gas test screen and CO2 waveform and parameter area disappear and that the prompt message **External AG Unloaded Successfully** is displayed at the top of the screen.
6. Select "End Case" to return to Standby mode.

3.14 Vaporizer Interlock Test

3.14.1 For 2 vaporizer Mount

1. Attach two vaporizers to the Vaporizer Mounting Manifold and lock them in place.
2. Rotate either of the vaporizer dial to 3% agent.
3. Verify that the other vaporizer dial cannot be rotated to a setting.
4. Set both vaporizer dials to 0.
5. Rotate the other vaporizer dial to 3%.
6. Verify that the first vaporizer dial cannot be rotated.
7. Rotate both vaporizer dials to T and remove both vaporizers.
8. Verify that the locking spring is intact.
9. Reconnect both vaporizers to the Vaporizer Mounting Manifold.

3.14.2 For 3 vaporizer Mount

1. Attach three vaporizers to the Vaporizer Mounting Manifold and lock them in place.
2. Rotate left vaporizer dial to 3% agent.
3. Verify that the other two vaporizers dial cannot be rotated to a setting.
4. Set all vaporizer dials to 0.
5. Rotate the middle vaporizer dial to 3% agent..
6. Verify that the other two vaporizers dial cannot be rotated to a setting.
7. Set all vaporizer dials to 0.
8. Rotate the right vaporizer dial to 3% agent..
9. Verify that the other two vaporizers dial cannot be rotated to a setting.
10. Rotate the right vaporizer dial to 0.
11. Rotate the center vaporizer dial to T,
12. Remove the center vaporizer leaving 2 vaporizers on the outer positions with the center position being empty.
13. Rotate either of the vaporizer dial to 3% agent.
14. Verify that the other vaporizer dial cannot be rotated to a setting.
15. Set both vaporizer dials to 0.
16. Rotate both vaporizer dials to T and remove all vaporizers.
17. Verify that the locking spring is intact.
18. Reconnect all vaporizers to the Vaporizer Mounting Manifold.

3.15 Vaporizer Accuracy Test

1. Connect the sampling tee of the Gas analyzer to the ACGO port.
2. Use a breathing hose to connect the output of the sampling tee to the scavenger.

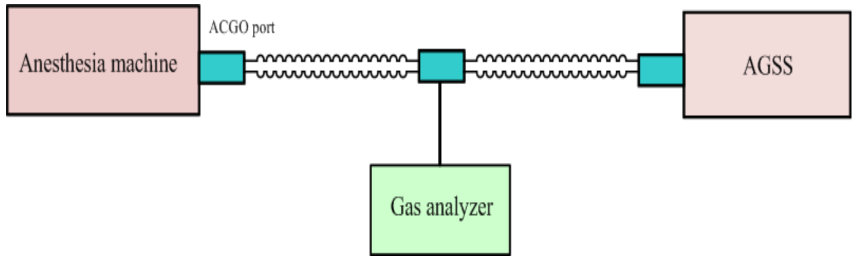


FIGURE 3-51 Vaporizer Accuracy Test Setup

3. Verify the scavenger is connected at the wall and the floater is between MIN and MAX.
4. Mount the vaporizers and fill with anesthetic agent (if necessary).

NOTE: **Do not overfill by filling past the indicator line on the vaporizer.**

5. Turn on the unit.
6. Set the machine to ACGO mode.
7. Test the vaporizer accuracy per the manufacturer's instructions.
8. Test each vaporizer in turn.
9. Test any vaporizer on the Vaporizer Storage Mount.
10. Remove the measuring equipment.
11. Reconnect the Waste Gas Scavenger Hose.

NOTE: **The deviation of the vaporizers due to change of barometric pressure (high altitude) and the deviation of the Riken F-21 gas analyzer are the same. When testing the Vaporizers using the Riken F-21 gas analyzer, the altitude can be ignored as the deviations cancel each other out. If using a different gas analyzer, check the effect of change of barometric pressure prior to use when working in high elevations.**

3.16 Suction Regulator Test

1. Connect the pipeline suction to the A.7.
2. Plug the tube to the patient.
3. Set the selector knob to **FULL** mode.
4. Check that the gauge shows some negative pressure.
5. Set the selector knob to **OFF** mode and verify the pointer on the suction gauge should come to the zero.
6. Set the selector knob to **REG** mode and turn off the suction regulator knob in clockwise direction.
7. Then turn on the suction regulator knob in counterclockwise direction.
8. Verify the pressure on the suction gauge gradully increase and comes to the pressure that was obtained in full mode.

3.17 Electrical Tests

NOTE: Perform electrical safety inspection after servicing or routine maintenance. Before the electrical safety inspection, make sure all the covers, panels, and screws are correctly installed.

NOTE: The electrical safety inspection should be performed once a year.

3.17.1 Auxiliary Electrical Outlet Test

Verify the mains voltage is present at each auxiliary outlet when the anesthesia machine is connected with power.

3.17.2 Electrical Safety Inspection Test

1. Perform protective earth resistance test:
   - a. Plug the probes of the analyzer into the protective earth terminal and equipotential terminal of the AC power cord.
   - b. Test the earth resistance with a current of 40 A.
   - c. Verify the resistance is less than 0.1ohms (100 mohms).
   - d. Plug the probes of the analyzer into the protective earth terminal of the AC power cord and the protective earth terminal of any auxiliary outlet. Repeat steps b and c.
   - e. If the resistance is larger than 0.1ohms (100 mohms) but less than 0.2ohms (200 mohms), disconnect the AC power cord and plug the probe that is previously plugged in the protective earth terminal of the AC power cord into the protective earth contact of the power outlet. Repeat steps a to d.
2. Perform the following earth leakage current tests:
   - normal polarity;
   - reverse polarity;
   - normal polarity with open neutral; and
   - reverse polarity with open neutral.
3. Verify the maximum leakage current does not exceed 300 μA (0.3 mA) in the first two tests. While for the last two tests, verify that the maximum leakage current does not exceed 1000 μA (1 mA).

NOTE: Make sure the safety analyzer is authorized by certificate organizations (UL, CSA, or AAMI etc.). Follow the instructions of the analyzer manufacturer.

3.17.3 Electrical Safety Inspection Form

Location:				Technician:	
Equipment:				Control Number:	
Manufacturer:		Model:		SN:	
Measurement equipment /SN:				Date of Calibration:	
INSPECTION AND TESTING				Pass/Fail	Limit
1	Auxiliary mains socket outlets				
2	Protective Earth Resistance		Ω		Max 0.1 Ω
3	Earth Leakage	Normal condition(NC)	_____μA		Max: NC: 300μA SFC: 1000μA
		Single Fault condition(SFC)	_____μA		

TABLE 3-1

For periodically performance, all the test items included in the ELECTRICAL SAFETY INSPECTION FORM shall be performed. The following table specifies test items to be performed after the equipment is repaired with main unit disassembled.

When neither power supply PCBA, transformer nor patient electrically-connected PCBA is repaired or replaced	Test items: 1, 2
When power supply PCBA or transformer is repaired or replaced	Test items: 1, 2, 3

TABLE 3-2

4.0 Calibration

Introduction 4-2

Calibration Warnings, Precautions, and Notes 4-2

System Calibration 4-3

4.1 Introduction

This section provides detailed information required to properly test and calibrate the A7 anesthesia system. Calibration consists of making mechanical and electrical adjustments with the proper test equipment. The instrument should be tested and calibrated after repairs have been completed or at regular intervals as part of a periodic maintenance procedure.

NOTE: Both calibration and a functional test must be performed to verify complete and proper operation.

Ensure that all testing materials, including drive gas, breathing circuits, test fixtures, tools and documents are available and current, calibrated and in good working order prior to beginning.

4.2 Calibration Warnings, Precautions, and Notes

4.2.1 Warnings

WARNING: For continued protection against fire hazard, replace all fuses with the specified type and rating.

WARNING: In order to prevent an electric shock, the machine (protection class I) may only be connected to a correctly grounded mains connection (socket outlet with grounding contact).

WARNING: Remove all accessory equipment from the shelf before moving the anesthesia machine over bumps or on any inclined surface. Heavy top loading can cause the machine to tip over causing injury.

WARNING: Possible explosion hazard. Do not operate machine near flammable anesthetic agents or other flammable substances. Do not use flammable anesthetic agents (i.e., ether or cyclopropane.)

WARNING: The use of anti-static or electrically conductive respiration tubes, when utilizing high frequency electric surgery equipment, may cause burns and is therefore not recommended in any application of this machine.

WARNING: Possible electric shock hazard. The machine may only be opened by authorized service personnel.

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

4.2.2 Cautions

CAUTION: Refer to the "Periodical Maintenance Schedule" on page 3-2 for assistance when performing scheduled periodic maintenance.

CAUTION: **Do not leave gas cylinder valves open if the pipeline supply is in use and the system master switch is turned to 'ON'. If used simultaneously, cylinder supplies could be depleted, leaving an insufficient reserve supply in the event of pipeline failure.**

CAUTION: **Use cleaning agent sparingly. Excess fluid could enter the machine, causing damage.**

CAUTION: **This machine must only be operated by trained, skilled medical staff.**

4.2.3 Notes

NOTE: **Only bacterial filters with a low flow resistance must be connected to the patient module and/or the patient connection.**

NOTE: **Use surgical gloves whenever touching or disassembling valves or other internal components of the Breathing System.**

NOTE: **Ensure that the gas supply of the machine always complies with the technical specification.**

NOTE: **The APL Valve and PAW gauge marker are for reference only. Calibrated patient airway pressure is available on the ventilator screen.**

NOTE: **If the machine should show faults during the initial calibration or testing, the machine should not be operated until the fault has been repaired by a qualified service technician.**

NOTE: **After servicing, functional, sensor and system tests must be carried out before clinical use.**

NOTE: **To accommodate additional monitors and other equipment the anesthesia offers up to two vertical mounting tracks. Use of unauthorized mounting accessories is not recommended.**

NOTE: **Always secure any equipment placed on the top shelf of anesthesia**

4.3 System Calibration

NOTE: **The anesthesia machine drive gas and calibration device drive gas type setttings should be consistent with the actual drive gas type configured for the anesthesia machine.**

NOTE: **Perform the corresponding calibration if any test item of the system test about measurement accuracy is failed.**

NOTE: **Fluke VT Plus: The zero reading (offset) of the pressure measurements may drift slightly with time and temperature. A zeroing function is provided for the user to zero the offset drift. Typically, this is done when a non-zero reading occurs when there is zero applied pressure. However, it is good practice to zero the respective signal before any measurement is taken.**

NOTE: **You can select VT Plus to perform automatic calibration of pressure sensors or flow sensors, or any other calibration devices that fulfills the accuracy requirements to perform manual calibration.**

The anesthesia machine provides the function of monitoring volume, pressure, FiO2 and etc. When these measured values have great deviations, it is very likely that measurement offset occurs to the relevant measurement parts. In this case, you need to perform calibration again. After equipment service, such as replacing the ventilator control board, expiratory valve assembly or solenoid valve assembly, you need to calibrate the flow sensors or pressure sensors.

The following table lists the possible calibration items and calibration time.

SN	Calibration item	Functional description	Calibration time
1	Flow calibration (user)	Calibrate the flow sensors of the breathing system.	1. The TV measurement deviation is greater (more than 9% compared with the setting value) after the flow sensors in the patient circuit have been used for a long time. 2. The flow sensor in the patient circuit has been replaced.
2	Flow calibration (Service)	Calibrate the flow sensors and inspiratory valve of the anesthesia machine.	1. The expiratory valve assembly is replaced. 2. The ventilator control board is replaced. 3. The deviation between the measured value of the ventilator flow sensor and that of the flow measurement device exceeds more than 5% of the reading or 1 L/min, whichever is greater.
3	Pressure calibration (Service)	Calibrate the pressure sensors and PEEP valve of the anesthesia machine.	1. The ventilator control board is replaced. 2. The expiratory valve assembly is replaced. 3. The deviation between the measured value of the machine's pressure sensor and that of the standard pressure gauge exceeds more than 5% of the reading or 2 cmH2O, whichever is greater.
4	Pressure and flow zeroing (Service)	Calibrate the deviation from zero point of the ventilator control board and auxiliary ventilator control board.	Flow or Paw waveforms deviates from the baseline.
5	EFCS flowmeter zeroing (user)	Calibrates zero offset in the EFCS flowmeter..	Zero offset exists in the EFCS flowmeter. The EFCS flowmeter still displays a non-zero flow reading after all fresh gas supplies are turned off.

4.3.1 O2 Sensor Calibration

NOTE: **Calibrate the O2 sensor again when a great deviation of O2 concentration monitored value occurs or when the O2 sensor or ventilator control board is replaced.**

NOTE: **Before calibration, observe if the O2 sensor displays numerics on the measure screen. If not, confirm that the O2 measure switch is turned on, check the O2 sensor connection line, or replace the O2 sensor until measure numerics are displayed.**

NOTE: **Perform O2 sensor calibration only for units with galvanic O2 cell.**

4.3.1.1 21% O2 Calibration

Follow these steps to calibrate O2 sensor at 21% O2.

1. Select Setup > General > Calibrate O2 Sensor or Setup > System > Calibration> O2 Sensor or Setup > Service > Calibration > O2 Sensor to access the screen as shown below. The General tab shows only 21% O2 Sensor calibration; the System and Service tabs require passwords and show both 21% and 100% O2 Sensor calibration. Set up the machine as per the instructions on the screen. Select Begin to start calibration.

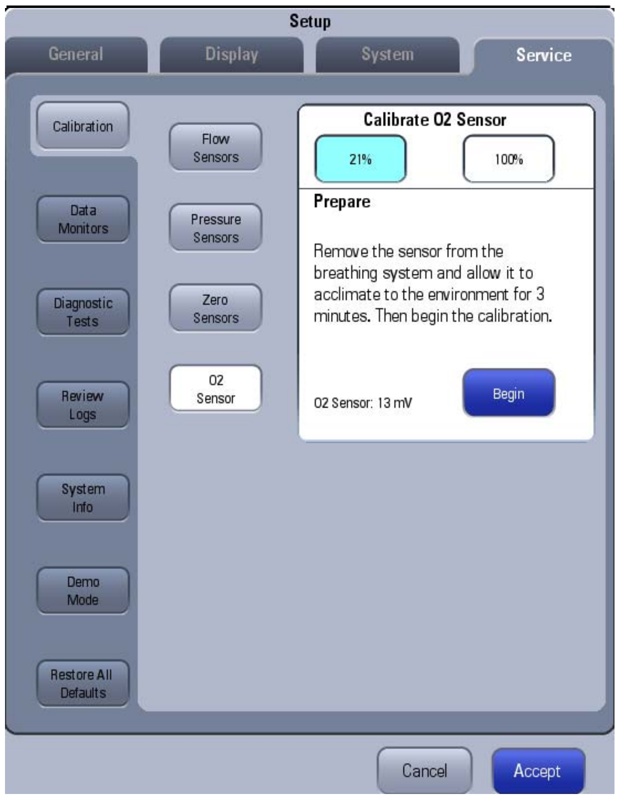


FIGURE 4-1

2. The calibration screen shown below is displayed when Begin is selected. During the calibration, you can select Cancel to cancel the calibration.

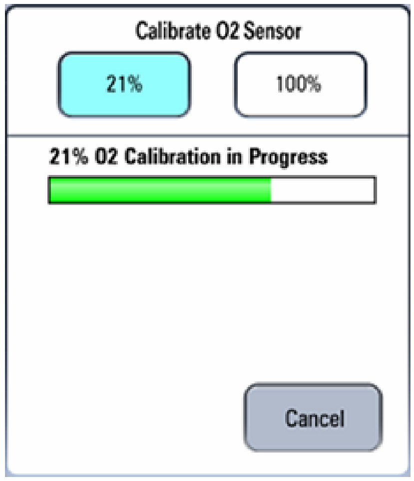


FIGURE 4-2

3. The screen shown below is displayed if the ongoing calibration is canceled. Select Try Again to do the calibration again.Select Done to exit the calibration screen.

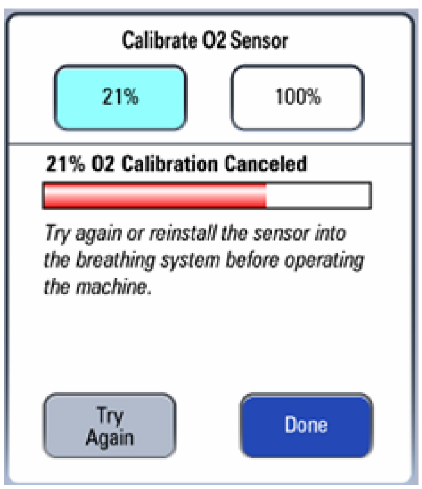
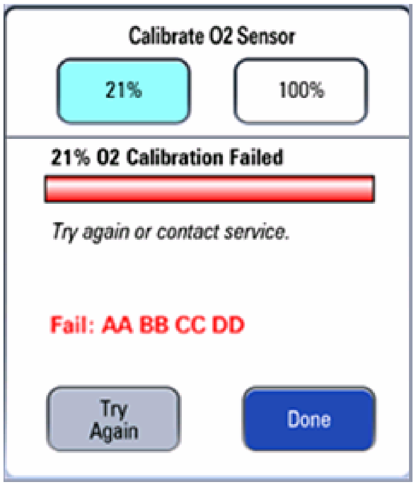


FIGURE 4-3

4. The screen shown below is displayed if the calibration has failed. Select Try Again to do the calibration again.Select Done to exit the calibration screen.



5. The screen shown below is displayed after a successful calibration . Select Done to exit the calibration screen.

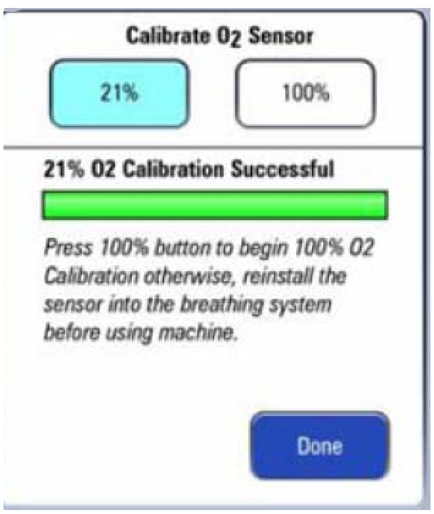


FIGURE 4-4

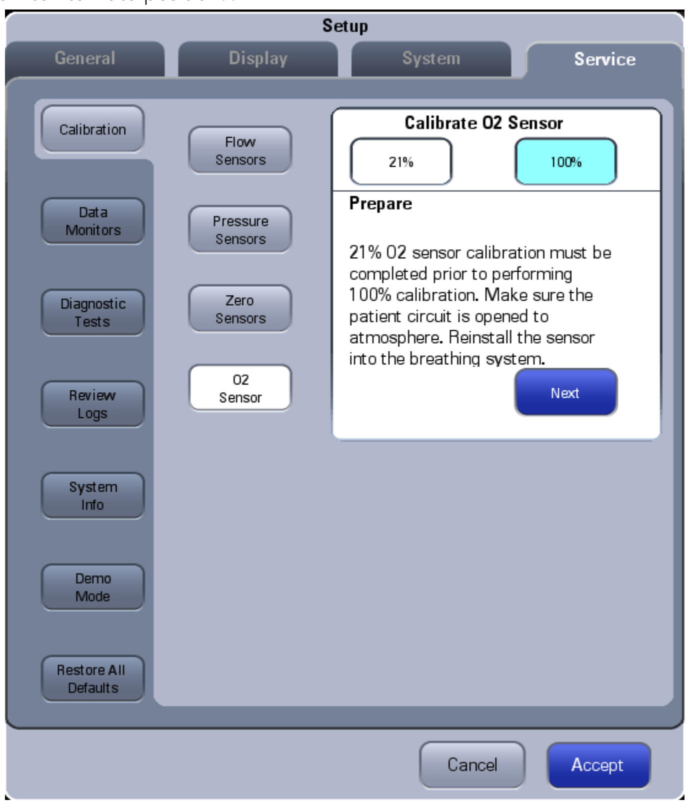
4.3.1.2 100% O2 Calibration

NOTE: 100% O2 calibration must be performed in standby mode.

NOTE: 100% O2 calibration can be performed only after a successful 21% O2 calibration.

Follow these steps to calibrate O2 sensor at 100% O2.

1. Enter Standby.
2. Access the 100% O2 Calibration screen via Setup > System > Calibration >O2 Sensor or Setup > Service > Calibration > O2 Sensor. The System and Service tabs require passwords and shows both 21% and 100% O2 Sensor calibration. The calibration screen shown below is displayed when 100% is selected. Set up the machine as per the instructions on the screen and select Next. In case of manual mode, make sure that the manual bag is in position. Otherwise, set the switch to Auto position. .



3. Select Next and the calibration screen as shown below is displayed. Set up the machine as per the instructions on the screen.

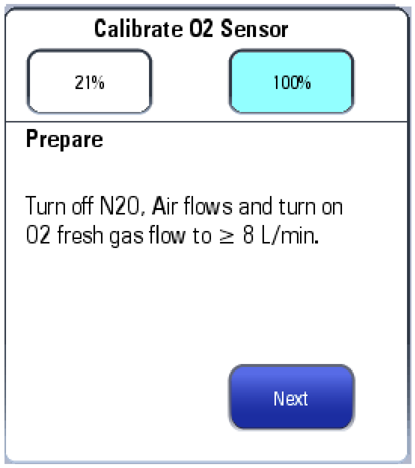


FIGURE 4-5

4. Select Next and the calibration screen as shown below is displayed. Set up the machine as per the instructions on the screen. Wait at least 2 minutes and ensure that O2 cell voltage has stabilized at the maximum value for at least 30s. Select Begin.

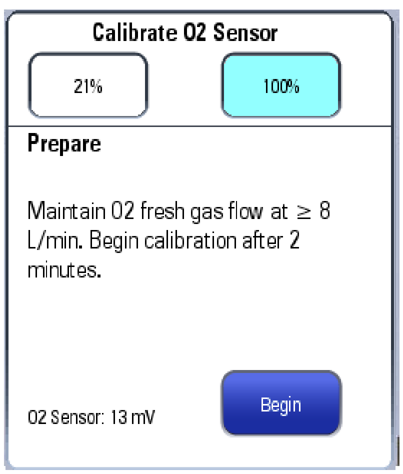


FIGURE 4-6

5. The calibration screen shown below is displayed when Begin is selected. During the calibration, you can select Cancel to cancel the calibration.

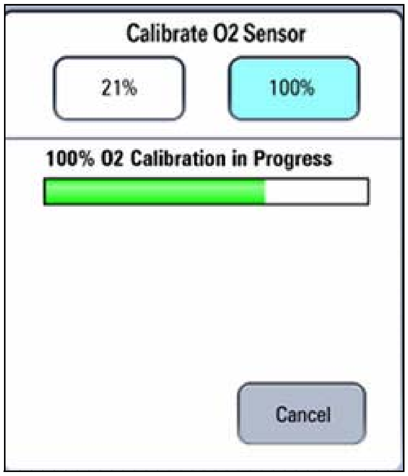


FIGURE 4-7

6. The screen shown below is displayed if the ongoing calibration is canceled. Select Try Again to do the calibration again.Select Done to exit the calibration screen.

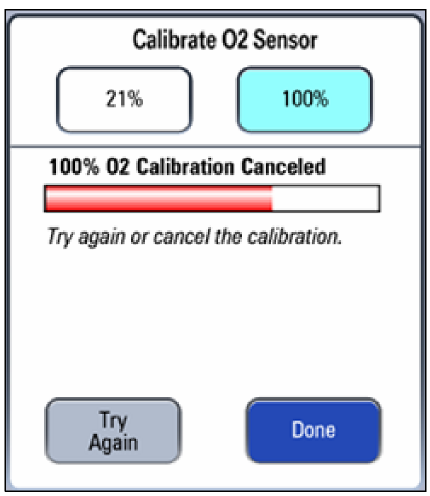


FIGURE 4-8

7. The screen shown below is displayed if the calibration has failed. Select Try Again to do the calibration again.Select Done to exit the calibration screen.

Version 02.01.00 and higher – A Fail code (e.g., AA BB CC DD) is displayed if 100% O2 Calibration has failed.

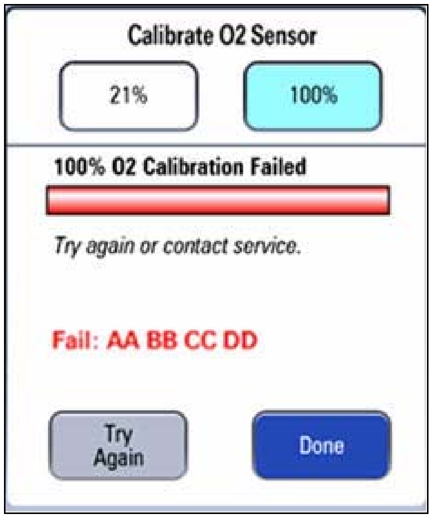


FIGURE 4-9

8. The screen shown below is displayed after a successful calibration. Select Done to exit the calibration screen.

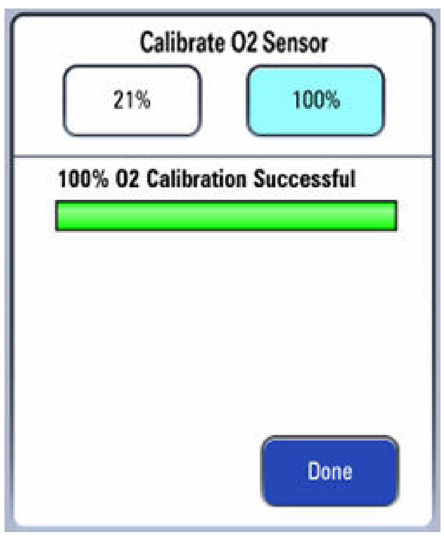


FIGURE 4-10

4.3.1.3 Commonly-encountered Problems and Recommended Actions

Failure Description	Possible Cause	Recommended Action
After [Start] is selected, calibration failure is prompted very soon.	If the alarm [O2 Sensor Unconnected] is displayed, it indicates that O2 sensor is not connected.	Connect the O2 sensor.
	O2 supply pressure is insufficient (lower than 200 kPa).	Change or connect the gas supply and make sure that O2 supply pressure is sufficient.
	21% O2 calibration is not completed before 100% O2 calibration.	Perform 21% O2 calibration followed by 100% O2 calibration.
Calibration failure is prompted about 3 minutes after calibration is started.	The O2% sampling value is not within the normal range. Namely, the sampling value of 21% O2 concentration is outside the range of 150~500 and the sampling value of 100% O2 concentration is outside the range of 800~2028. Access Setup?Service?Data Monitors?VCM to check the O2% sampling value.	Replace the O2 sensor.

Error Code	Description	Recommended Action
00 00 00 02	O2 supply pressure is low. During 100% calibration process, O2 supply pressure was not sufficient.	. Check that the O2 sensor is connected to the cable correctly. . Check the O2 supply pressure. . Check that the O2 sensor output voltage in the calibration menu is steady. . Replace the O2 sensor.
00 00 00 04	O2 sensor is disconnected. Sampled data is greater than 2900 (AD value).	. Check if the alarm [O2 Sensor Disconnected] is displayed. If yes, Check that the O2 sensor is connected to the cable correctly. . Check that the O2 sensor output voltage in the calibration menu is steady. . Replace the O2 sensor.
00 00 00 08	21% calibration value is outside of the expected range (150~500) (AD value).	. Check that the O2 sensor is connected to the cable correctly. . Check that the O2 sensor is in 21% O2. . Check that the O2 sensor output voltage in the calibration menu is steady. . Replace the O2 sensor.
00 00 00 10	100% calibration value is outside of the expected range (800~2028) (AD value).	. Check that the O2 sensor is connected to the cable correctly. . Check that the O2 sensor is in 100% O2. . Check that the O2 sensor output voltage in the calibration menu is steady. . Replace the O2 sensor.
00 00 00 20	Error writing to EEPROM.	. Repeat the calibration. . Replace the O2 sensor. . Replace the CPU board.

4.3.2 Flow Calibration (User)

NOTE: **The flow sensors must be recalibrated after replacing or reinstalling the flow sensors.**

NOTE: **This calibration is only intended for the user. A trained technician should always perform the flow calibration in the service mode when a calibration is required.**

NOTE: **The measurements performed by the flow sensors may be affected by the environment where the sensors are used. After the sensors have been used for a long time, great deviations may occur to the measurement results and tidal volume control as well. This problem can be fixed through flow sensor calibration.**

NOTE: **Before calibration, perform leak test of the breathing system in mechanical ventilation mode first and make sure that the test is passed.**

NOTE: **During calibration, make sure that the drive gas pressure is kept within specifications. Failure to do so may lead to calibration failure.**

NOTE: **Set the machine to work in EFCS mode for flow calibration.**

This calibration is only intended for the flow sensors in the breathing circuit. The inspiratory flow sensor and expiratory flow sensor in the breathing system are calibrated through the built-in flow measurement reference.

When great deviations (more than 9% compared with the setting value) occur to tidal volume measurement due to sensor ageing or environmental factors or the user replaces flow sensors, you need to re-calibrate flow sensors.

Follow these steps to calibrate flow sensors.

1. Enter Standby.

2. Select Setup-> General-> Calibrate Flow Sensor to access the screen shown below.

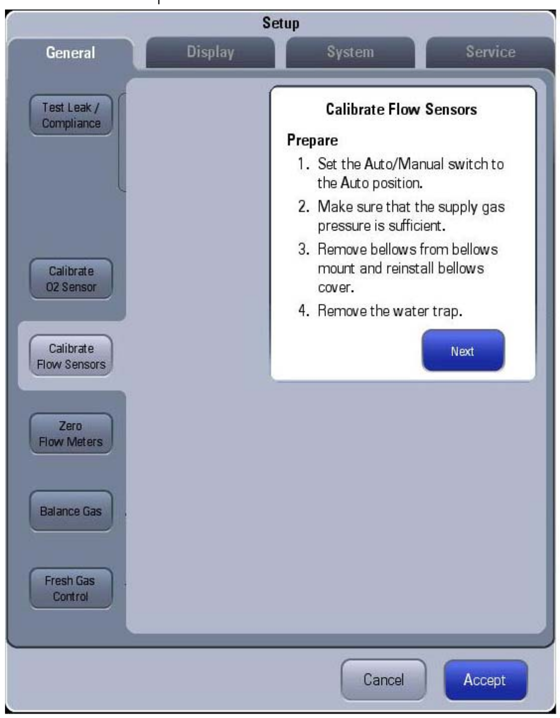


FIGURE 4-11

3. Set up the machine as per the instructions on the screen and select Next to open the menu shown below.

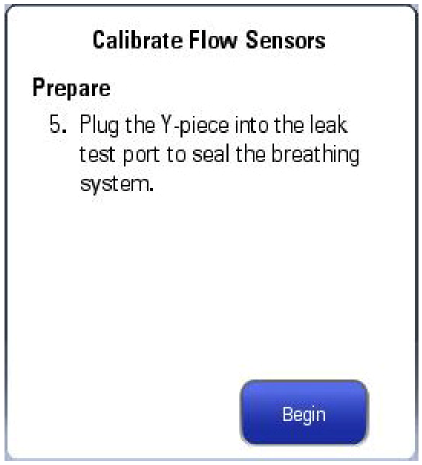


FIGURE 4-12

4. Select Begin to calibrate flow sensors. During the calibration, you can select Cancel to cancel the calibration.

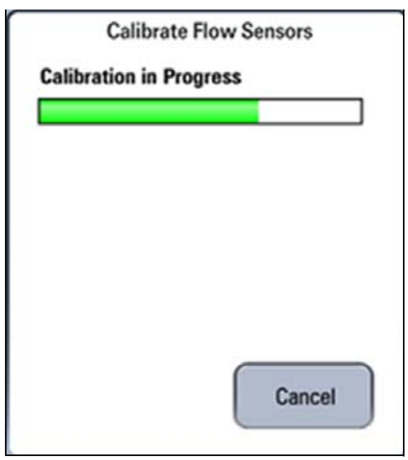


FIGURE 4-13

5. The screen shown below is displayed if the ongoing calibration is canceled. Select Try Again to do the calibration again. Select Done to exit the calibration screen.

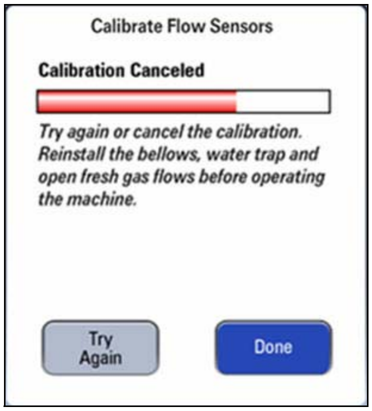


FIGURE 4-14

6. The screen shown below is displayed if the flow sensor calibration is failed. Select Try Again to do the calibration again. Select Done to exit the calibration screen.

FIGURE 4-15

7. The screen shown below is displayed after a successful flow sensor calibration. Select Done to exit the calibration screen.

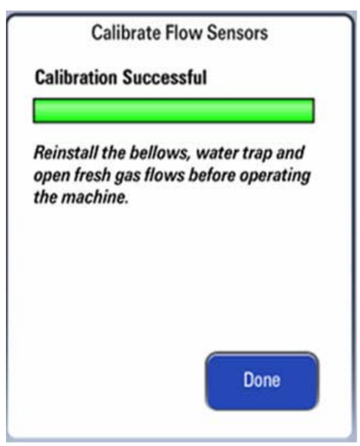


FIGURE 4-16

NOTE: **If measurement deviations are not corrected after multiple flow sensor calibrations, the user is recommended to replace the flow sensor and then perform calibration. If the problem persists, factory maintenance is necessary.**

4.3.3 Flow Calibration (Service)

NOTE: **Flow Calibration (Service) is necessary in case of replacing the ventilator control board, drive gas assembly or solenoid valve assembly.**

NOTE: **When a great deviation is detected between the measured value of the built-in flow sensor and that of the standard flow measurement device, you need to perform Flow Calibration (Service).**

This calibration is intended for the flows sensors in the breathing circuit, ventilator flow sensor, and also inspiratory valve. The standard flow measurement device is used to calibrate the flow sensors and inspiratory valve.

4.3.3.1 Calibration Procedures

NOTE: **Make sure that the tubes are not leaking when connected.**

NOTE: **Do not move or press the tubes during calibration.**

NOTE: **When connecting calibration tubes, make sure that gas flows in the correct direction, which is from the inspiration connector of the breathing system, through high flow inlet of the anesthesia machine calibration device, anesthesia machine calibration device, high flow outlet of the anesthesia machine calibration device, and to the expiration connector of the breathing system.**

NOTE: **Before calibration, make sure that no sensor or valve related technical alarms occurred.**

NOTE: **During calibration, make sure that the drive gas pressure is enough. Failure to do so may lead to calibration failure.**

NOTE: **You can select VT Plus for auto calibration. You can also select flow calibration device which satisfies the accuracy requirement for manual calibration.**

NOTE: **For calibration device with high flow channel and low flow channel, flow channel switch over is required during auto or manual calibration.**

NOTE: **Set the machine to work in EFCS mode for flow calibration.**

4.3.3.2 Auto Calibration

For EPSON Platform (Software Bundle 02.12.01 and below)

Follow these steps to calibrate flow sensors.

1. Enter Standby.
2. Select Setup-> Service-> Calibration-> Flow Sensors to access the screen as shown.

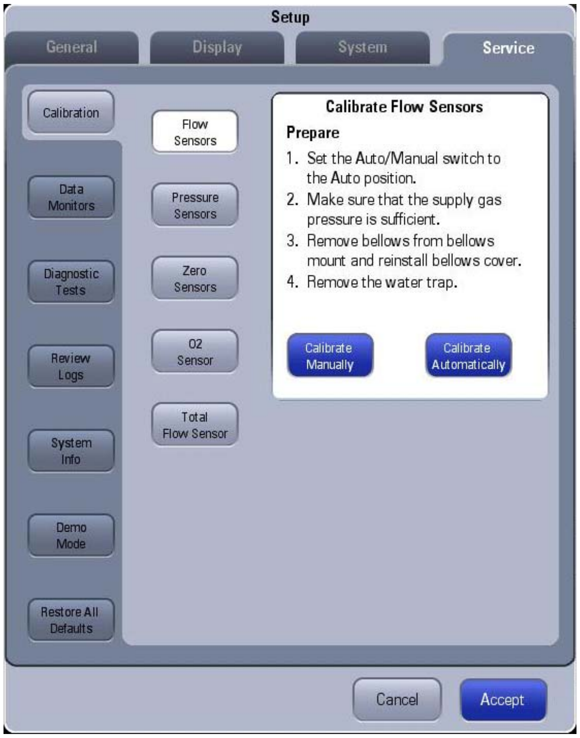


FIGURE 4-17

3. Select Calibrate Automatically button to open the menu shown below. Then select the desired calibration device.

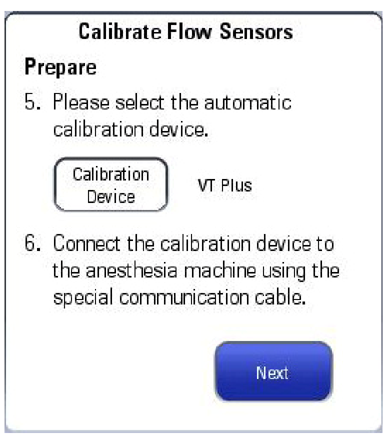


FIGURE 4-18

4. Connect the calibration device with the anesthesia machine using a communication cable (P/N: 801-0631-00121-00).

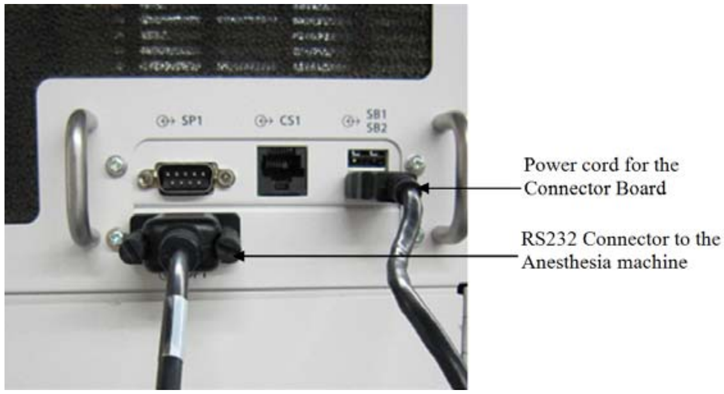


FIGURE 4-19 Cable connections at the anesthesia machine end

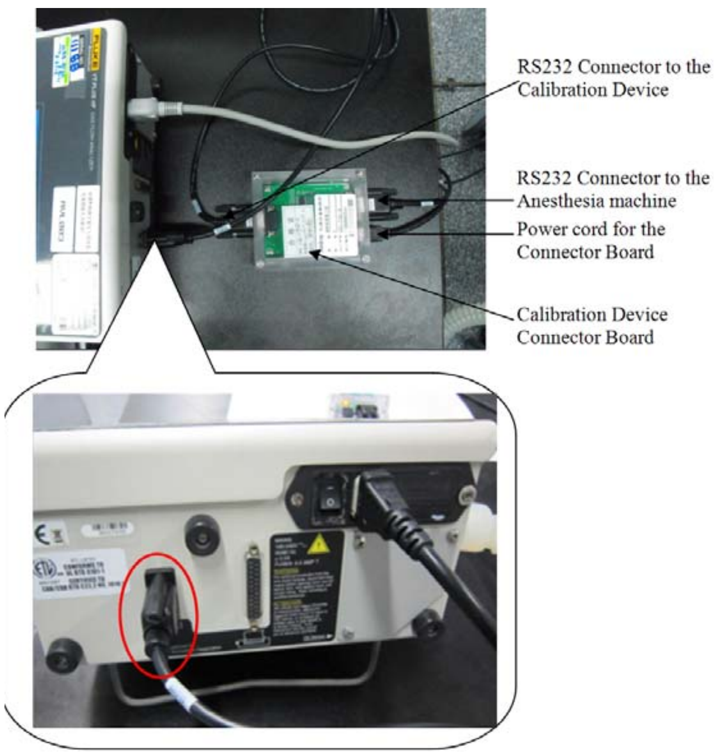


FIGURE 4-20 Cable connections at the calibration device (VT Plus) end

5. Set up the calibration device as described below.

To set the VT-Plus:

a. Gas Settings: Press the Setup button, select Setting->ENTER->Gas Settings->MODIFY->Gas Type->O2->BACK->BACK.

FIGURE 4-21

b. Correction mode: Press the Setup button, select Setting->ENTER->Correction Mode->MODIFY->Correction Mode->BTPS.

FIGURE 4-22

c. Zero Mode Settings: Press the Setup button, select Setting->ENTER->Zero Mode->Manual->BACK->BACK.

FIGURE 4-23

d. Serial Mode Settings: Press the Setup button, select Setting->System->Enter->Serial Mode ->OTIS Ctrl->BACK->BACK.

FIGURE 4-24

e. After setting up the calibration device, the calibration enters the serial mode screen shown below.

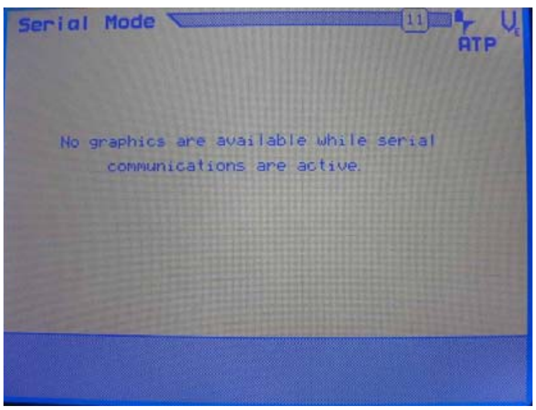


FIGURE 4-25

6. Press the Next button to open the menu shown below.

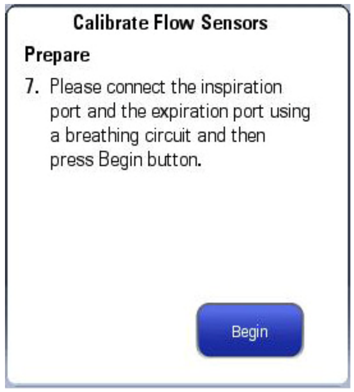


FIGURE 4-26

7. Connect the inspiration port and expiration port of the anesthesia machine following the on-screen instructions, shown below.

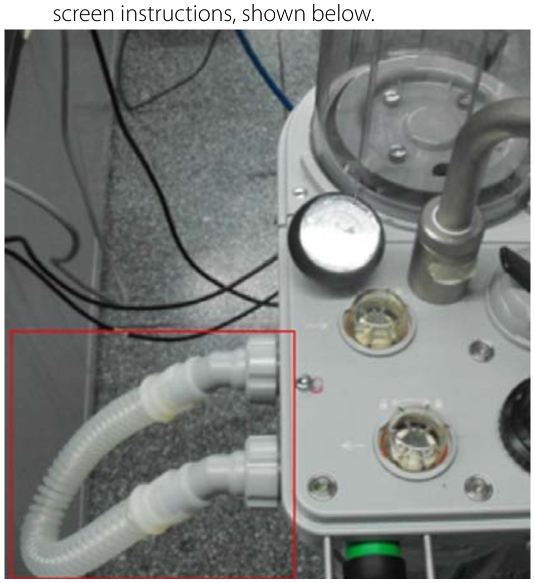


FIGURE 4-27

8. Press the Begin button to open the menu shown below.

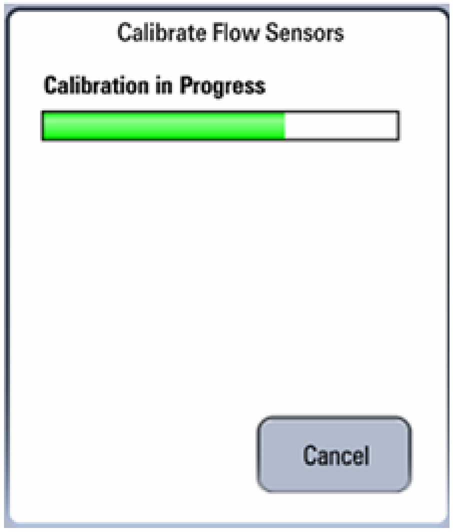


FIGURE 4-28

9. The menu shown below is displayed after the above steps are completed.

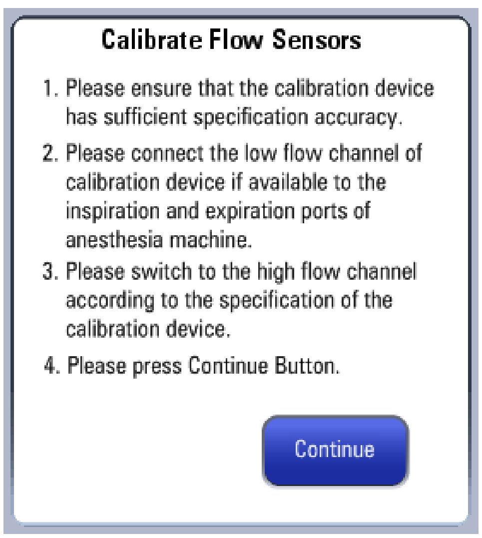


FIGURE 4-29

10. Connect the pneumatic circuit of calibration device with that of anesthesia machine following the on-screen instructions. Connect the low flow channel of the calibration device first, shown below.

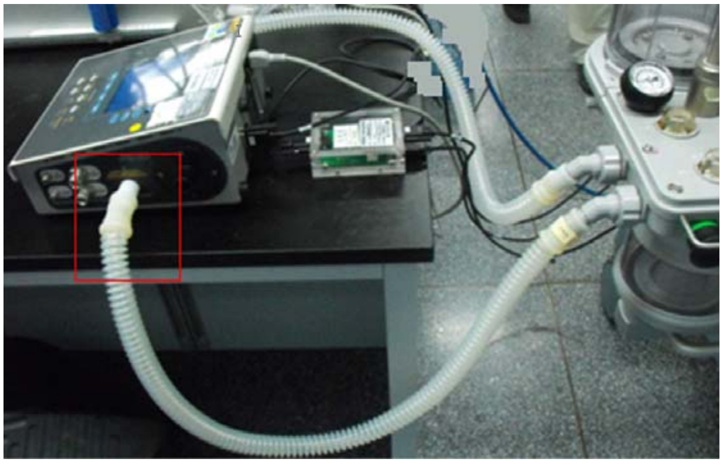


FIGURE 4-30 Pneumatic connection with the calibration device (VT Plus)

11. Press the Continue button to open the menu shown below.

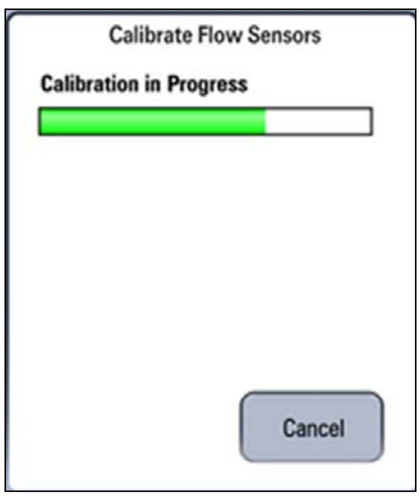


FIGURE 4-31

12. The menu shown below is displayed after the low flow channel calibration is completed.

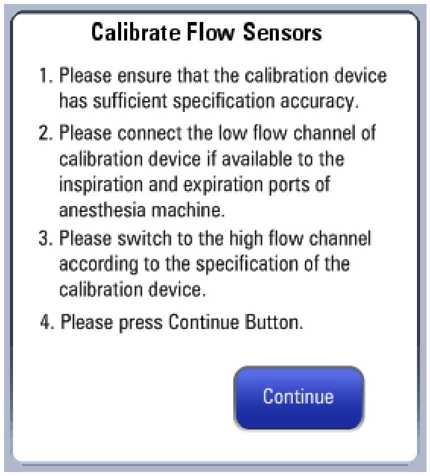


FIGURE 4-32

13. Connect the high flow channel of the calibration device following the on-screen instructions shown below.

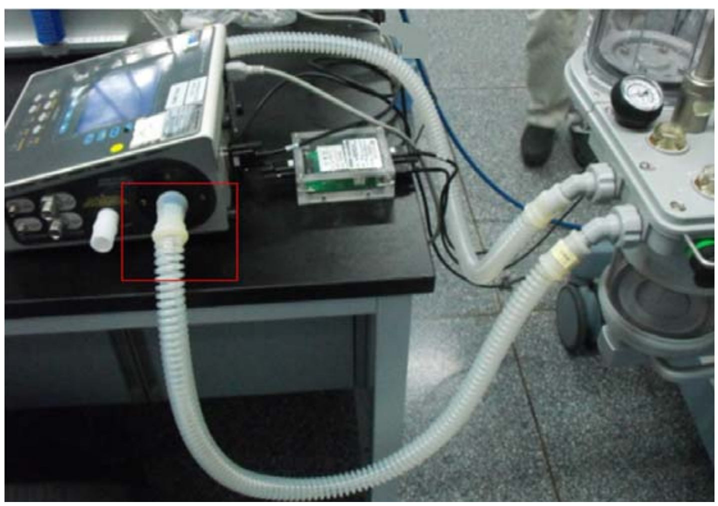


FIGURE 4-33 Pneumatic connection with the calibration device (VT Plus)

14. Press the Continue button to open the menu shown below.

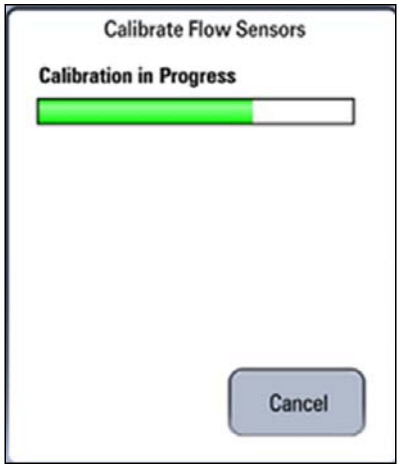


FIGURE 4-34

15. The screen shown below is displayed after the calibration is completed.

- The screen shown below is displayed if the flow sensor calibration has failed. When the calibration has failed, read the screen of the calibration device for further information on the cause of the failure. Select Try Again to do the calibration again. Select Done to exit the calibration screen.

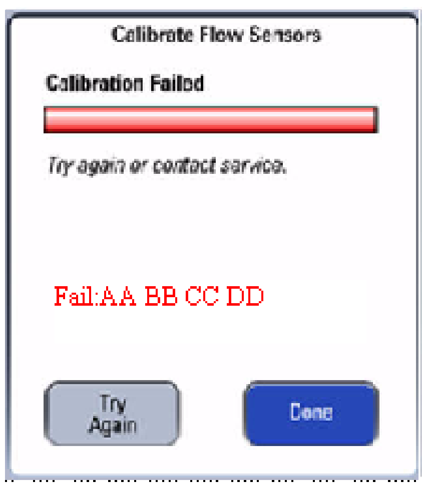


FIGURE 4-35

- The screen shown below is displayed after a successful flow sensor calibration. Select Done to exit the calibration screen.

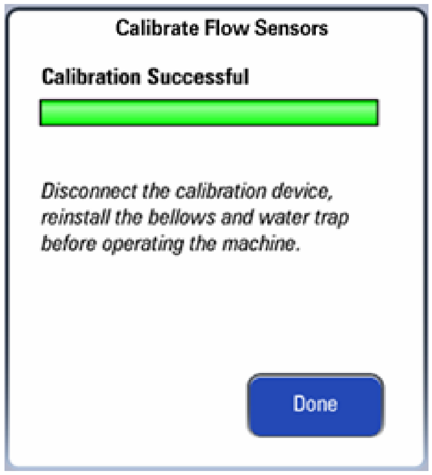


FIGURE 4-36

16. The screen shown below is displayed if the ongoing calibration is canceled. Select Try Again to do the calibration again. Select Done to exit the calibration screen.

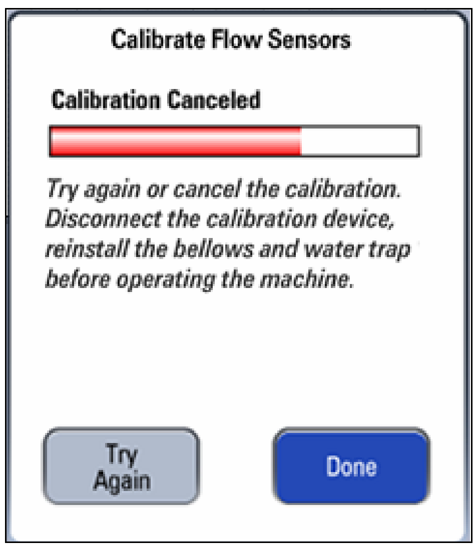


FIGURE 4-37

For DSP Platform (Software Bundle 03.00.00 and Higher)

Follow these steps to calibrate flow sensors.

1. Enter Standby.
2. Select Setup-> Service-> Calibration-> Flow Sensors to access the screen as shown.

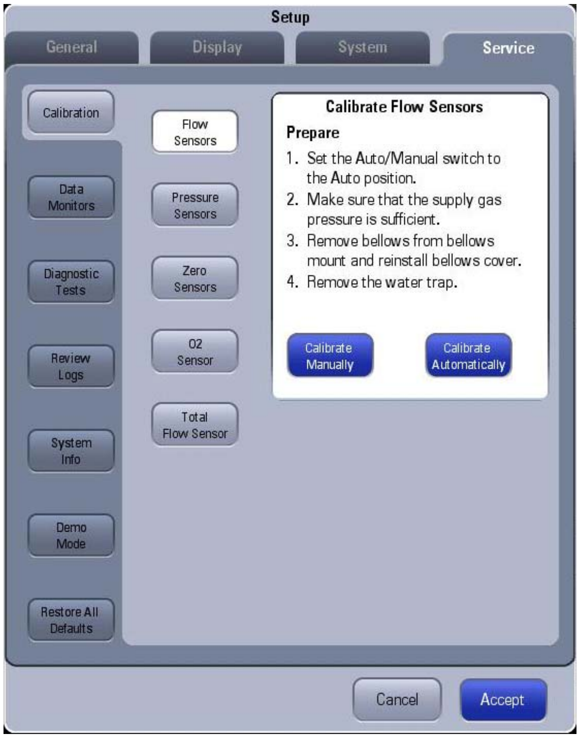


FIGURE 4-38

3. Select Calibrate Automatically button to open the menu shown below. Then select the desired calibration device.

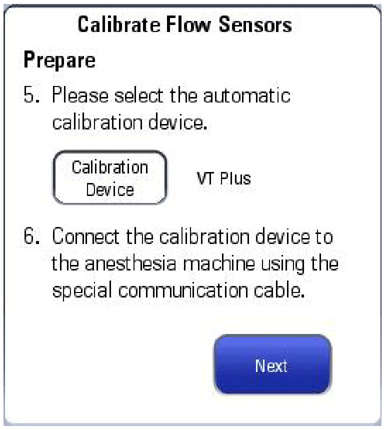


FIGURE 4-39

4. Connect the calibration device with the anesthesia machine using a communication cable (P/N: 801-0631-00121-00).

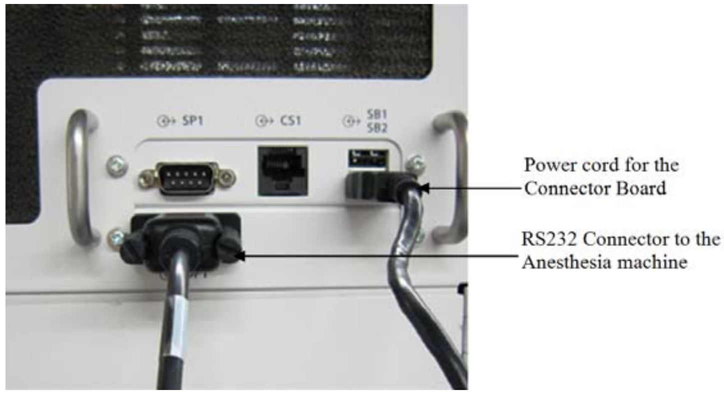


FIGURE 4-40 Cable connections at the anesthesia machine end

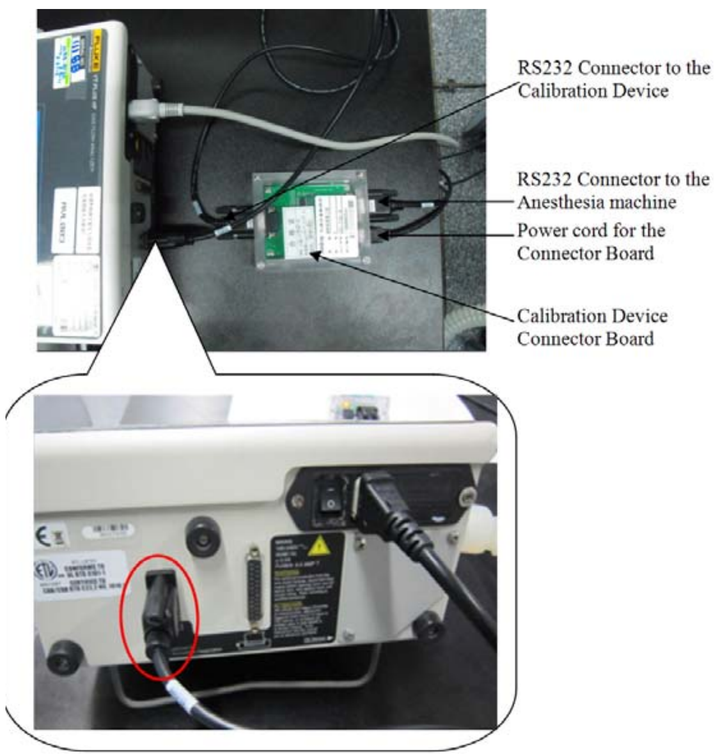


FIGURE 4-41 Cable connections at the calibration device (VT Plus) end

5. Set up the calibration device as described below.

To set the VT-Plus:

a. Gas Settings: Press the Setup button, select Setting->ENTER->Gas Settings->MODIFY->Gas Type->O2->BACK->BACK.

FIGURE 4-42

b. Correction mode: Press the Setup button, select Setting->ENTER->Correction Mode->MODIFY->Correction Mode->BTPS.

FIGURE 4-43

c. Zero Mode Settings: Press the Setup button, select Setting->ENTER->Zero Mode->Manual->BACK->BACK.

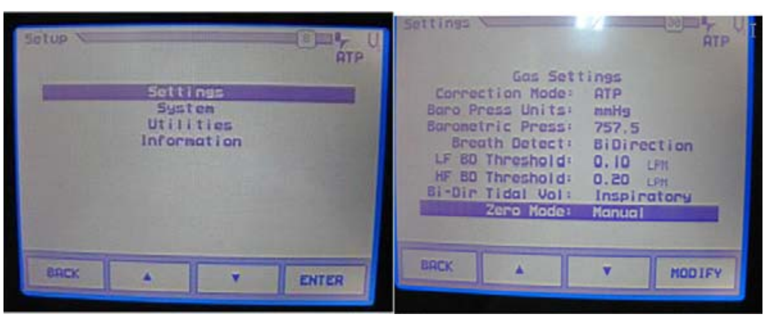


FIGURE 4-44

d. Serial Mode Settings: Press the Setup button, select Setting->System->Enter->Serial Mode ->OTIS Ctrl->BACK->BACK.

FIGURE 4-45

e. After setting up the calibration device, the calibration enters the serial mode screen shown below.

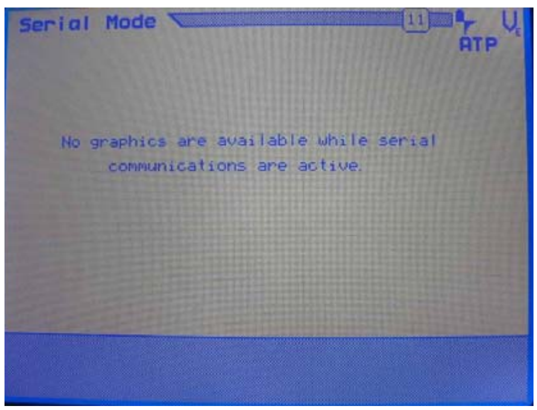


FIGURE 4-46

6. Press the Next button to open the menu shown below.

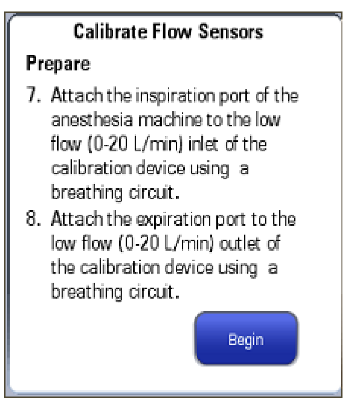


FIGURE 4-47

7. Connect the pneumatic circuit of calibration device with that of anesthesia machine following the on-screen instructions. Connect the low flow channel of the calibration device first, shown below.

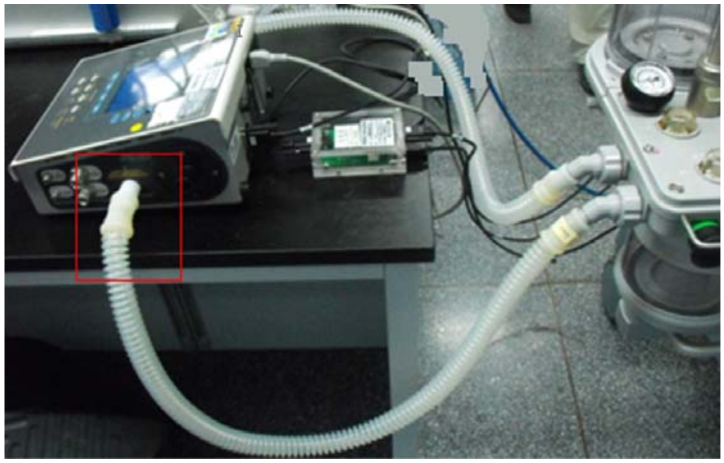


FIGURE 4-48 Pneumatic connection with the calibration device (VT Plus)

8. Press the Begin button to open the menu shown below.

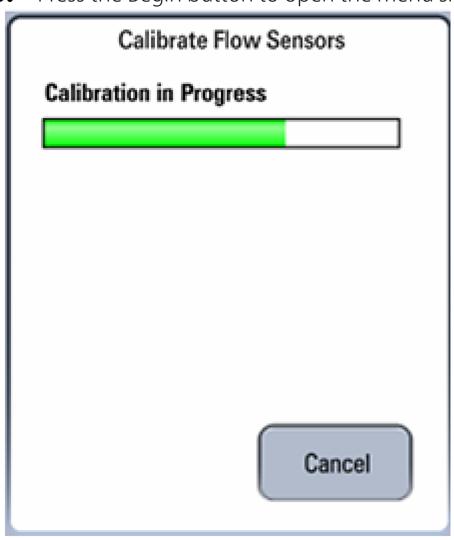


FIGURE 4-49

9. The menu shown below is displayed after the low flow channel calibration is completed.

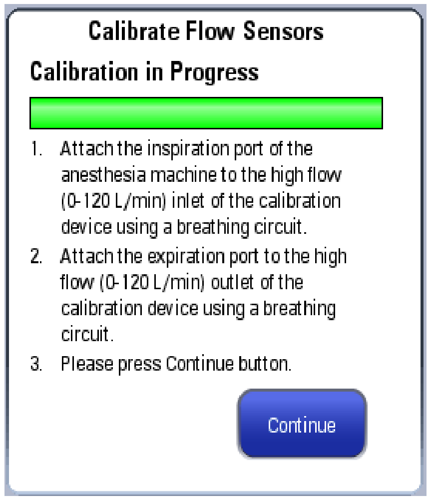


FIGURE 4-50

10. Connect the high flow channel of the calibration device following the on-screen instructions shown below.

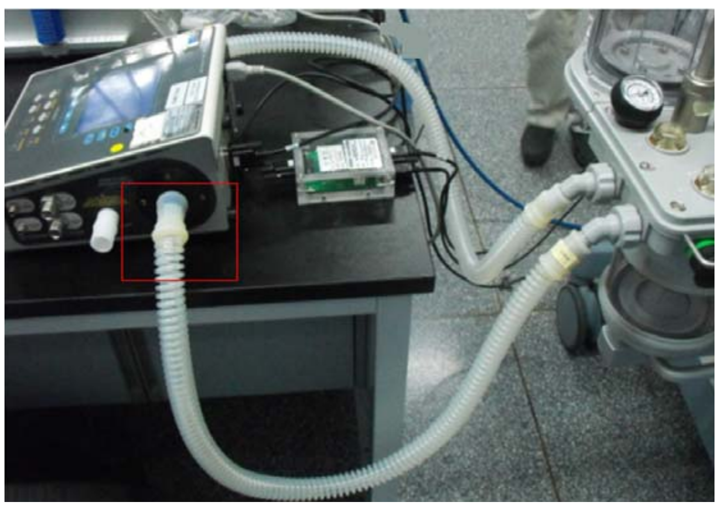


FIGURE 4-51 Pneumatic connection with the calibration device (VT Plus)

11. Press the Continue button to open the menu shown below.

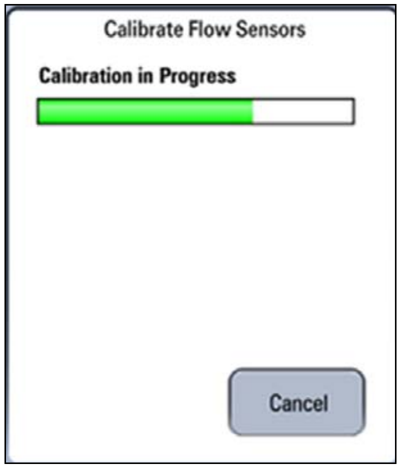


FIGURE 4-52

12. The screen shown below is displayed after the calibration is completed.

- The screen shown below is displayed if the flow sensor calibration has failed. When the calibration has failed, read the screen of the calibration device for further information on the cause of the failure. Select Try Again to do the calibration again. Select Done to exit the calibration screen.

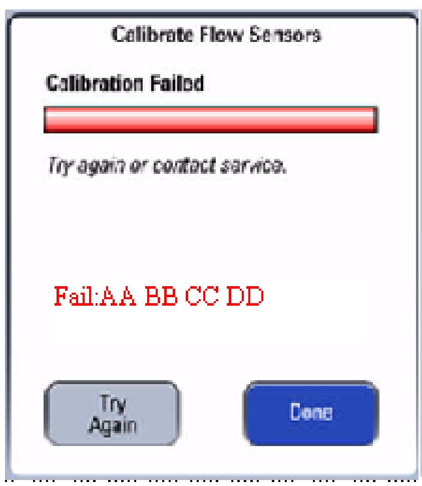


FIGURE 4-53

- The screen shown below is displayed after a successful flow sensor calibration. Select Done to exit the calibration screen.

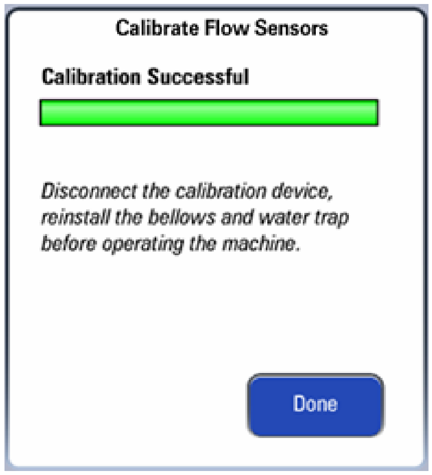


FIGURE 4-54

13. The screen shown below is displayed if the ongoing calibration is canceled. Select Try Again to do the calibration again. Select Done to exit the calibration screen.

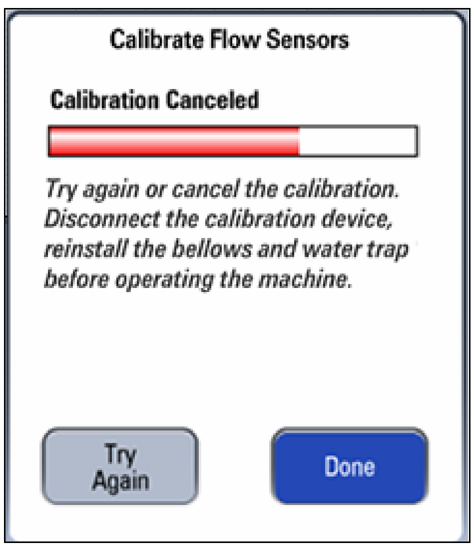


FIGURE 4-55

4.3.3.3 Manual Calibration

NOTE: BTPS (Body Temperature and Pressure, Saturated). For EPSON systems the mode can be set to ambient temperature and pressure or BTPS.

Follow these steps to calibrate the flow sensors.

1. Enter Standby.
2. Select Setup-> Service-> Calibration-> Flow Sensors to access the screen as shown.

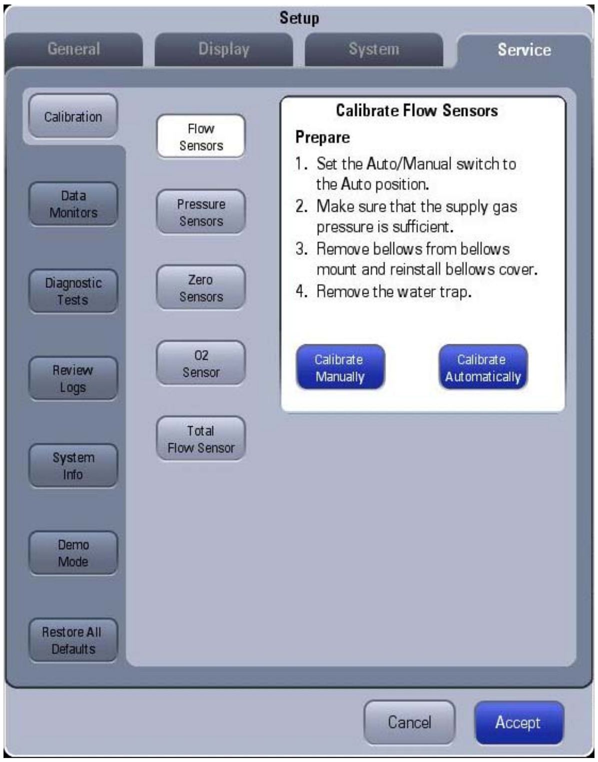


FIGURE 4-56

3. Select Calibrate Manually button to open the menu shown below.

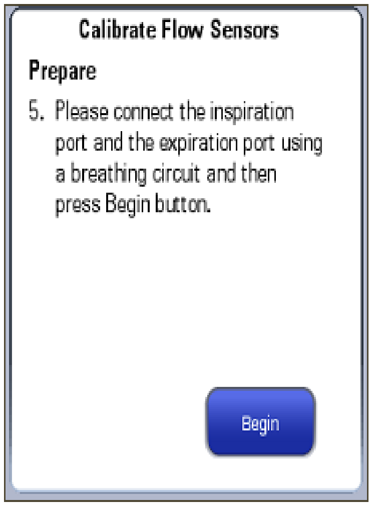


FIGURE 4-57

4. Connect the inspiration port and expiration port of the anesthesia machine following the on-screen instruction as shown below.

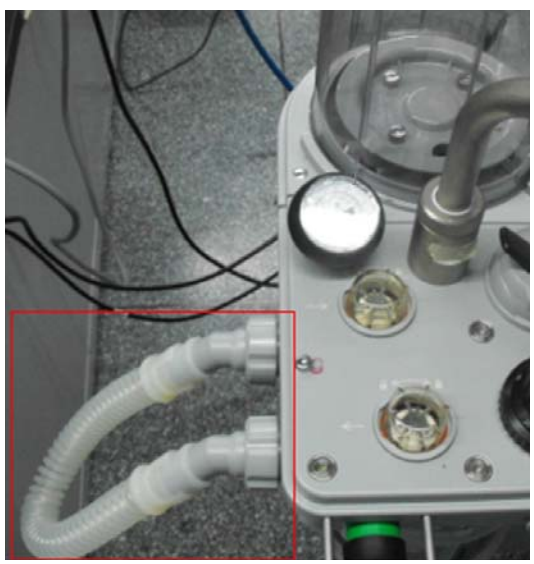


FIGURE 4-58

5. Press the Begin button to open the menu shown below.

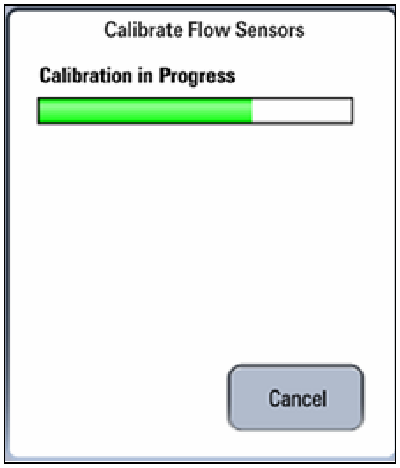


FIGURE 4-59

6. The menu shown below is displayed after the first step of manual calibration is completed.

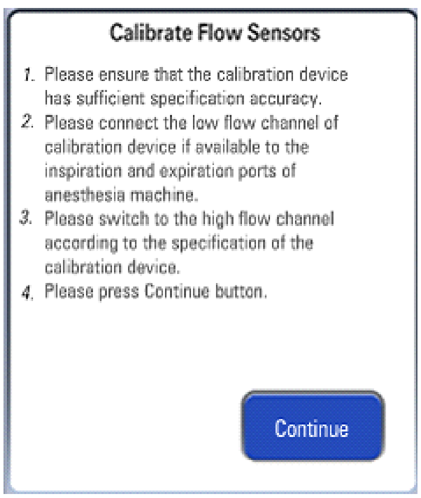


FIGURE 4-60

7. **Calibration Device Setup (TSI Certifier 4070, Cannot be Used for DSP Units)**:
a. Flow Setting: Press the to line select key until the top display reads LPM or SLPM. If the display reads SLPM, press the DISPLAY UNITS key until the top display reads LPM.
b. Gas Settings: Press the GAS SELECT key until the bottom left corner reads O2.

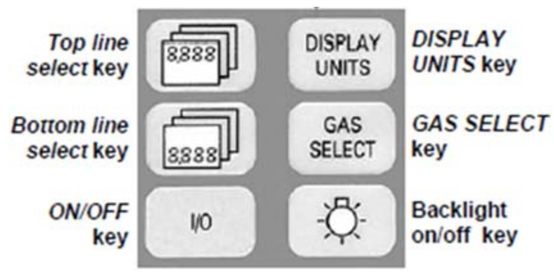


FIGURE 4-61

Calibration Device (CERTIFIER FA PLUS)

a. Touch on the following active areas of the Parameter Screen.

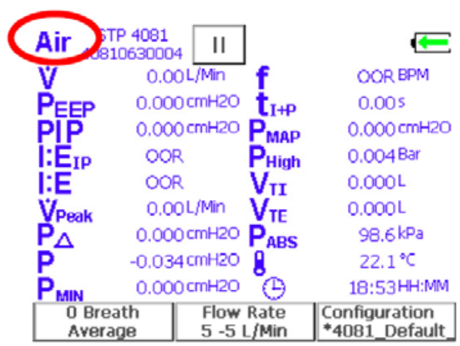


FIGURE 4-62

b. The following window will pop up.

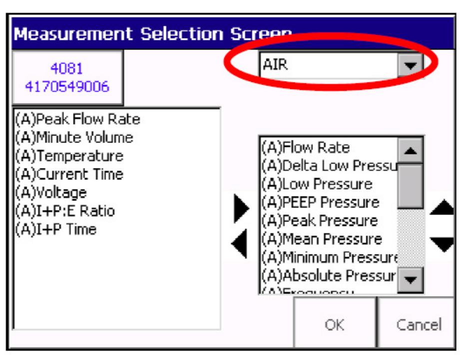


FIGURE 4-63

c. Select O2.

d. Select OK.

e. Touch on the following active areas of the Parameter Screen.

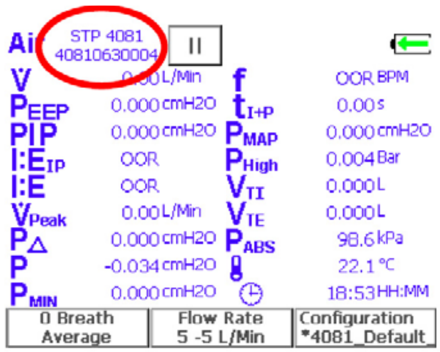


FIGURE 4-64

f. The following window will pop up.

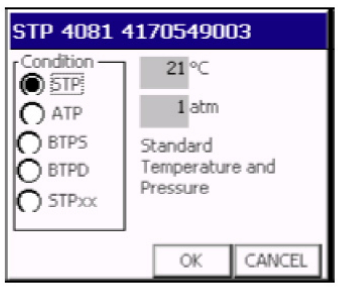


FIGURE 4-65

g. Select BTPS.

h. Select OK.

8. Connect the low flow channel (If available) of calibration device with the pneumatic circuit of anesthesia machine following the on-screen instructions.

FIGURE 4-66 Pneumatic connection with the calibration device (TSI Certifier 4070)

9. If applicable, determine when to switch to the high flow channel of calibration device.

NOTE: **If the flow meter has more than one channel, refer to the manufacturer's specification for when to change from one channel to the other.**

10. Select Continue to access the menu shown below. The system will calibrate the 32 calibration points one by one. When Waiting is displayed in the cell, wait for the system to control flow. When Input Cal Value is displayed in the cell, input the standard flow value displayed by the calibration device. During the calibration, you can select to re-calibrate any calibration point. After having inputted the standard flow values of all the 32 calibration points, select Accept to check and save the calibration data.

FIGURE 4-67

FIGURE 4-68 Manual Flow Sensor Calibration

11. Press the Accept button and the screen shown below is displayed.

- The screen shown below is displayed after a successful flow sensor calibration.

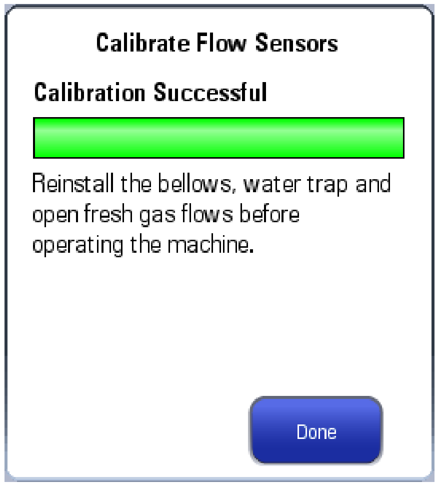


FIGURE 4-69

- The screen shown below is displayed if the flow sensor calibration has failed.

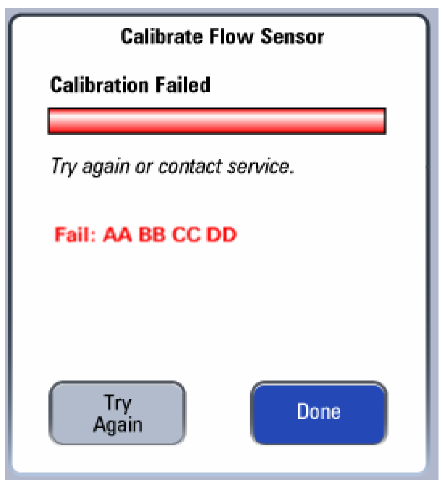


FIGURE 4-70

12. Select Cancel and the screen shown below is displayed.

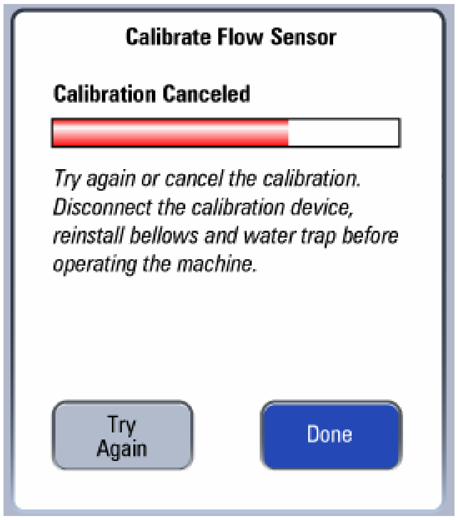


FIGURE 4-71

NOTE: **After flow calibration, check the accuracy of flow sensors by referring to Section 3.8.7 Check the Flow Sensor Accuracy.**

NOTE: **In case of calibration failure, first fix the problem and then perform flow calibration again.**

4.3.3.4 Commonly-encountered Problems and Recommended Actions

Failure description	Possible cause	Recommended action
After [Begin] is selected, no ventilation sound is heard. Very soon, the prompt message of [Calibration Failure! Please try again.] is displayed.	[Manual Vent.] is prompted. The Auto/Manual ventilation switch is set to the bag position.	Set the Auto/Manual ventilation switch to the mechanical ventilation position.
	[Drive Gas Pressure Low] is alarmed. The pressure indicated by the drive gas (O2) pressure gauge is lower than 200 kPa.	Replace or connect the gas supplies to make sure that drive gas pressure is within specifications.
	Zero point error occurs to the inspiratory/expiratory flow sensor.	Replace the ventilator control board.
After [Start] is selected, ventilation sound is heard. Very soon, the prompt message of [Calibration Failure! Please try again.] is displayed.	The sampling line of at least one out of the inspiratory flow sensor, expiratory flow sensor and ventilator flow sensor is not connected or is connected in the reverse order.	Re-connect the sensor sampling line.
	The maximum flow to open the inspiratory valve is less than 90 L/min.	Replace the expiratory valve assembly.
	1. The pneumatic circuit connection between the anesthesia machine calibration device and the ventilator control board has an error. 2. The communication connection between the anesthesia machine calibration device and the anesthesia machine has an error. 3. The settings of the anesthesia machine calibration device have an error.	1. Check the pneumatic circuit connection between the anesthesia machine calibration device and the ventilator control board. Re-connect the pneumatic circuit if necessary. 2. Check the communication connection between the anesthesia machine calibration device and the anesthesia machine. Or re-connect them to ensure normal communication. If the problem persists, replace the communication cable. 3. Check the settings of the anesthesia machine calibration device. Make settings again if necessary.
About 15 minutes after calibration is started, the prompt message of [Calibration Failure! Please try again.] is displayed.	Calibration data are not correct.	Replace the inspiratory and expiratory flow sensors and perform calibration again. If calibration still fails, replace the ventilator control board.
	When flow reaches 90 L/min, the counts value of the inspiratory or expiratory flow sensor is above3900, which is outside of the normal range.	1. Replace the flow sensor in the circuit. 2. Replace the ventilator control board.
[00 00 00 02] is displayed.	The drive gas pressure is too low.	1. Check the drive gas supply. 2. If there is no problem on the gas supply, check the gas supply pressure switch.
[00 00 00 04] is displayed.	The Auto/Manual switch is on Manual position.	1. Check if the operations are performed as directed. 2. If so, check the Auto/Manual switch.

Failure description	Possible cause	Recommended action
[00 00 00 08] is displayed.	Zero point error occurs to the inspiratory flow sensor. (For EPSON platform, zero point AD is greater than or equal to 2000, or is less than 0. For DSP platform, zero point AD is greater than or equal to 26457 or is less than 554)	1. Check if fresh gas is turned off. 2. Check if the inspiratory valve has closed the flow in the valve diagnostic tools, when valve closing DA is zero, AD of the ventilator sensor is basically unchanged when disconnecting and connecting the gas supply (the change is not more than 1% of the reading), indicating that the then valve is indeed fully closed. 3. Check the zero point. 4. Replace the board.
[00 00 00 10] is displayed.	Zero point error occurs to the expiratory flow sensor. (For EPSON platform, zero point AD is greater than or equal to 2000, or is less than 0. For DSP platform, zero point AD is greater than or equal to 26457 or is less than 554)	1. Check if fresh gas is turned off. 2. Check if the inspiratory valve has closed the flow in the valve diagnostic tools, when valve closing DA is zero, AD of the ventilator sensor is basically unchanged when disconnecting and connecting the gas supply (the change is not more than 1% of the reading), indicating that the then valve is indeed fully closed. 3. Check the zero point. 4. Replace the board.
[00 00 00 20] is displayed.	Zero point error occurs to the internal flow sensor. (For EPSON platform, zero point AD is greater than or equal to 2000, or is less than 0. For DSP platform, zero point AD is greater than or equal to 26457 or is less than 554)	1. Check the zero point. 2. Check if the inspiratory valve has closed the flow in the valve diagnostic tools, when valve closing DA is zero, AD of the ventilator sensor is basically unchanged when disconnecting and connecting the gas supply (the change is not more than 1% of the reading), indicating that the then valve is indeed fully closed. 3. Replace the board.

Failure description	Possible cause	Recommended action
[00 00 00 40] is displayed.	Measurement range error occurs to the inspiratory flow sensor.	1. Check if the sampling line is properly connected. 2. Diagnose by using the valve diagnotic tools: keep the pneumatic connection environment for calibration. Access the valve diagnostic tools. Occlude the expiration valve with 4000DA. Open the inspiration valve from small values to bigger values. Observe the measured value of the calibration device under different valve opening DA. If the inspiratory flow sensor sampling AD corresponding to the point of measured value of calibration device close to (less than 90) 90 L/min is greater than 3900 (EPSON platform) or 60000 (DSP platform), the measurement range of inspiratory flow sensor has an error. In this case, replace the inspiratory flow sensor. 3. Replace the board.
[00 00 00 80] is displayed.	Measurement range error occurs to the expiratory flow sensor.	1. Check if the sampling line is properly connected. 2. Diagnose by using the valve diagnotic tools: keep the pneumatic connection environment for calibration. Access the valve diagnostic tools. Occlude the expiration valve with 4000DA. Open the inspiration valve from small values to bigger values. Observe the measured value of the calibration device under different valve opening DA. If the inspiratory flow sensor sampling AD corresponding to the point of measured value of calibration device close to (less than 90) 90 L/min is greater than 3900 (EPSON platform) or 60000 (DSP platform), the measurement range of expiratory flow sensor has an error. In this case, replace the expiratory flow sensor. 3. Replace the board.

Failure description	Possible cause	Recommended action
[00 00 01 00] is displayed.	Measurement range error occurs to the internal flow sensor.	1. Check if the sampling line is properly connected. 2. Diagnose by using the valve diagnotic tools: keep the pneumatic connection environment for calibration. Access the valve diagnostic tools. Occlude the expiration valve with 4000DA. Open the inspiration valve from small values to bigger values. Observe the measured value of the calibration device under different valve opening DA. If the inspiratory flow sensor sampling AD corresponding to the point of measured value of calibration device close to (less than 45) 45 L/min is greater than 3900 (EPSON platform) or 60000 (DSP platform), the measurement range of ventilator flow sensor has an error. In this case, replace the ventilator flow sensor. 3. Replace the board.
[00 00 02 00] is displayed.	The calibration data of the inspiratory flow sensor is not unidirectional.	1. Check if the check valve is properly connected. 2. Check if the sampling line is properly connected. 3. Replace the inspiratory flow sensor. 4. Replace the board.
[00 00 04 00] is displayed.	The calibration data of the expiratory flow sensor is not unidirectional.	1. Check if the check valve is properly connected. 2. Check if the sampling line is properly connected. 3. Replace the expiratory flow sensor. 4. Replace the board.
[00 00 08 00] is displayed.	The calibration data of the internal flow sensor is not unidirectional.	1. Check if the sampling line is properly connected. 2. Replace the internal flow sensor. 3. Replace the board.
[00 00 10 00] is displayed.	Resolution error occurs to the inspiratory flow sensor.	1. Check the sampling line and air-tight connection. 2. Check the supply gas pressure. 3. Check the settings of the calibration device. 4. See section 5.4 (pg. 5-71) "Sensors and Valves Problems". 5. Replace the inspiratory flow sensor. 6. Replace the board.

Failure description	Possible cause	Recommended action
[00 00 20 00] is displayed.	Resolution error occurs to the expiratory flow sensor.	1. Check the sampling line and air-tight connection. 2. Check the supply gas pressure. 3. Check the settings of the calibration device. 4. See section 5.4 (pg. 5-71) "Sensors and Valves Problems". 5. Replace the expiratory flow sensor. 6. Replace the board.
[00 00 40 00] is displayed.	Resolution error occurs to the internal flow sensor.	1. Check if the sampling line is properly connected. 2. Replace the internal flow sensor. 3. Replace the board.
[00 00 80 00] is displayed.	The output flow of the valve is low.	1. Check if there is enough gas supply for the whole calibration process. 2. Check if the maximum output flow of the valve is more than 90 L/Min. If not, replace the inspiratory valve.
[00 01 00 00] is displayed.	The resolution of the valve is not enough.	1. Check if there is enough gas supply for the whole calibration process. 2. Check if the calibration device works well. 3. Replace the inspiratory valve.
[00 02 00 00] is displayed.	The change of flow is not unidirectional.	1. Check if the tubes are connected as directed. 2. Check if there is enough gas supply for the whole calibration process. 3. Check if the calibration device is working well.
[00 04 00 00] is displayed.	Communication with the calibration device is interrupted.	1. Check the connection between the calibration device and the communication cable. 2. Replace the calibration device and then perform calibration again.
[00 08 00 00] is displayed.	The system fails to write EEPROM.	1. Perform calibration again. 2. Replace the monitoring board.
[00 10 00 00] is displayed.	ACGO switch is on "ON" position.	1. Check if ACGO is positioned to "OFF". 2. Check the ACGO identification switch.

Failure description	Possible cause	Recommended action
[00 20 00 00] is displayed.	The maximum value cannot be found.	1. Diagnose by using the valve diagnostic tools: (1) open the inspiration valve with 4000DA. The flow measured by the calibration device can reach at least 90L/min. (2) close the inspiration valve. Increase the opening of inspiration valve with certain DA. When the flow measured by the calibration device is approximately 80L/min, based on this DA, increase valve opening by 10 DA. The flow increase does not exceed 5L/Min. It indicates that the point of maximum value is possible (not found by the software). Re-calibration is recommended. 2. Replace the inspiration valve.
[00 40 00 00] is displayed.	The minimum value cannot be found.	1. Diagnose by using the valve diagnostic tools: open the inspiration valve within the range of 0~2000DA. The AD value collected by the inspiratory flow sensor has the tendency of becoming bigger. Re-calibration is recommended. 2. Replace the inspiration valve.
[00 80 00 00] is displayed.	Only available for DSP platform. The time of finding DA, which cause flow is between 9L/min and 25L/min, is longer than 50 seconds.	1. Check if there is enough gas supply for the whole calibration process. 2. Check if the maximum output flow of the valve is between 9L/min and 25L/min. If not, replace the inspiratory valve.
[01 00 00 00] is displayed.	Only available for DSP platform. The zero point of calibration device is over range.	1.Check the calibration device.is working normally. 2.Check the inspiratory valve doesn't have leakage. If not, replace the inspiratory valve.
[02 00 00 00] is displayed.	Only available for DSP platform. Tube is disconnected.	Check the tube connection.
[04 00 00 00] is displayed.	Only available for DSP platform. When inspiratory valve close, the flow measured by inspiratory sensor is over 1L/min.	Check the inspiratory valve doesn't have leakage. If not, replace the inspiratory valve.
[FF FF FF FF] is displayed.	Communication error occurs.	1. Restart the machine. 2. Check the communication cable. 3. Check for communication error alarm messages. Replace the board.

4.3.4 Pressure Calibration (Service)

NOTE: **Pressure Calibration (Service) is necessary in case of replacing the ventilator control board, drive gas assembly or solenoid valve assembly.**

NOTE: **When a great deviation is detected between the measured value of the built-in pressure sensor and that of the standard pressure measurement device, you need to perform Pressure Calibration (Service).**

This calibration is intended for the airway pressure sensor in the breathing circuit, PEEP pressure sensor and the PEEP valve of the expiratory valve assembly. The standard pressure measurement device is used to calibrate the pressure sensors and the PEEP valve.

4.3.4.1 Calibration Procedures

NOTE: Before pressure calibration, make sure that the tubes are not leaky when connected.

NOTE: Do not move or press the tubes during calibration.

NOTE: You can select VT Plus for auto calibration. You can also select pressure calibration device which satisfies the accuracy requirement for manual calibration.

4.3.4.1.1 Auto Calibration

Follow these steps to calibrate pressure sensors and the PEEP valve.

1. Make sure that the anesthesia machine is in standby mode.
2. Select Setup-> Service-> Calibration-> Pressure Sensors to access the screen shown below.

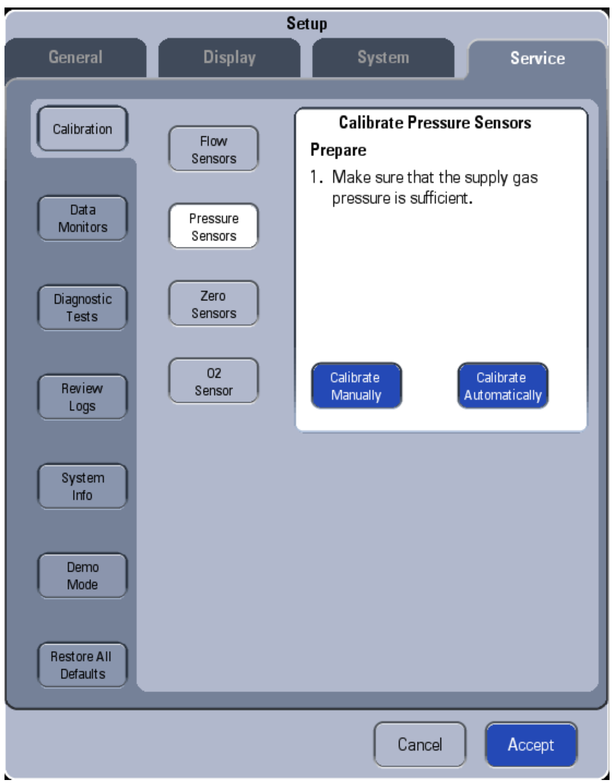


FIGURE 4-72

3. Select Calibrate Automatically button to open the menu shown below.

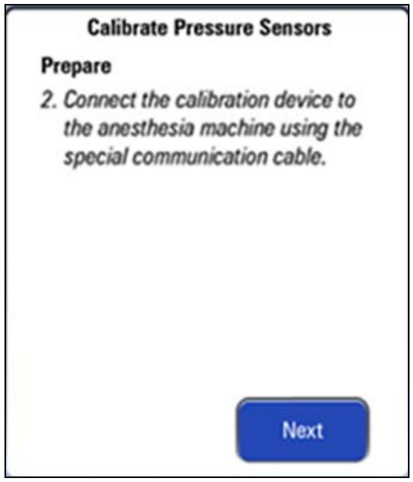


FIGURE 4-73

4. Connect the calibration device with the anesthesia machine using communication cable by referring to step 4. of "Auto Calibration" on page 4-17

5. Press the Next button to open the menu shown below.

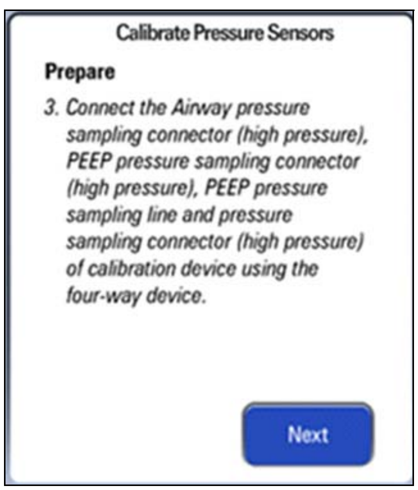
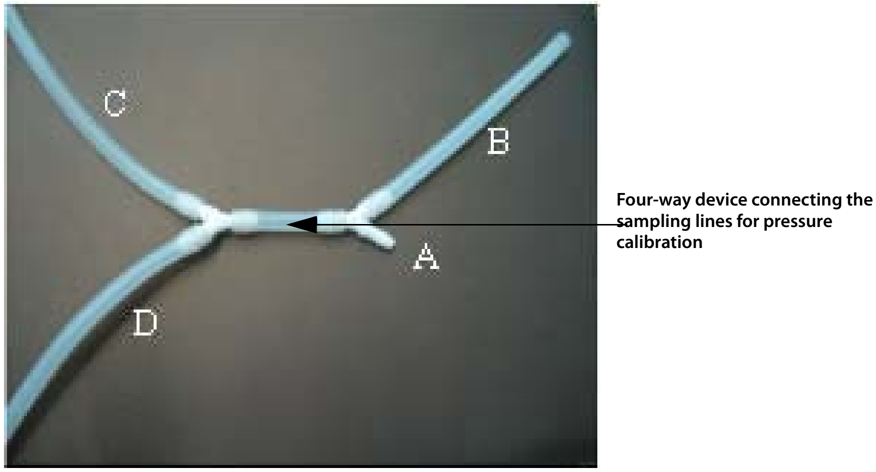


FIGURE 4-74

A four-way device is required to connect the sampling lines for pressure calibration. The following pictures show the four-way device, connectors on the calibration device and ventilator control board involved for pressure calibration.



a. Remove the two tubes marked as #72 and #9 from the pressure sensors (refer to the figure below).

b. Connect the four way tube to the pressure sensor P1 of monitor board, pressure sensor P2 of PEEP, the tube marked as #72, and the low pressure port of Fluke VT-Plus. The tube marked as #9 will remain unconnected for this calibration.

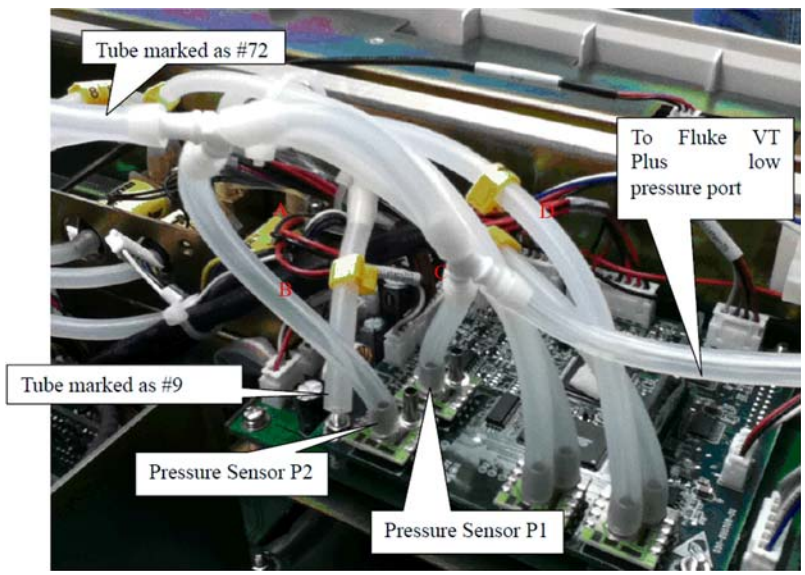


FIGURE 4-75

FIGURE 4-76 Pneumatic connections with the calibration device (VT-Plus)

6. Let the anesthesia machine calibration device be powered and manually zero the calibration device first.

7. Set up the calibration device.
Refer to step 5. of "Auto Calibration" on page 4-17

8. Press the Next button to open the menu shown below.

FIGURE 4-77

9. After selecting the desired auto calibration device, select Begin to access the calibration screen shown below. During the calibration, you can select Cancel to stop the calibration.

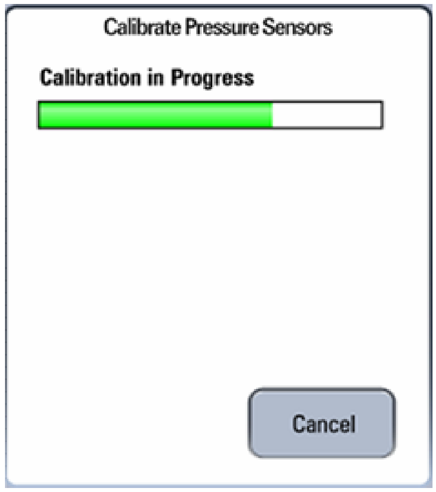


FIGURE 4-78

10. The screens shown below are displayed after the calibration is completed.

- The screen shown below is displayed if the pressure sensor calibration has failed. Select Try Again to do the calibration again.Select Done to exit the calibration screen.

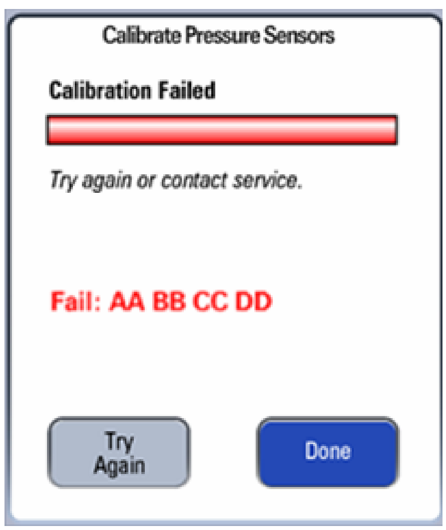


FIGURE 4-79

- The screen shown below is displayed after a successful pressure sensor calibration. Select Done to exit the calibration screen.

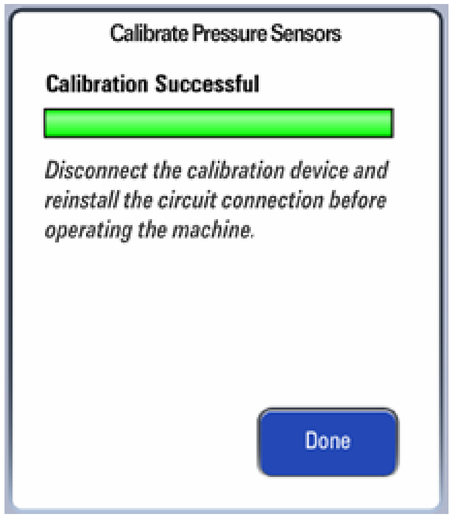


FIGURE 4-80

11. The screen shown below is displayed if the ongoing calibration is canceled. Select Try Again to do the calibration again. Select Done to exit the calibration screen.

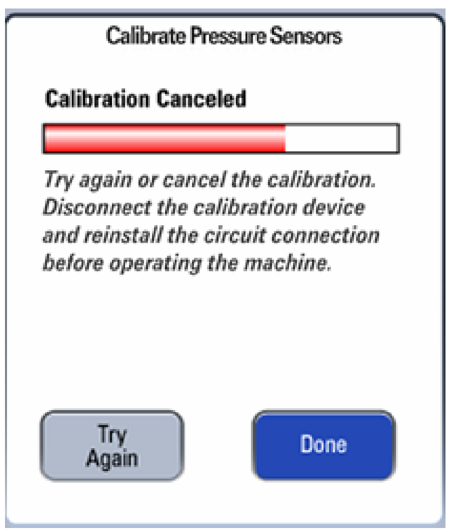


FIGURE 4-81

4.3.4.1.2 Manual Calibration

Follow these steps to calibrate pressure sensors and the PEEP valve.

1. Make sure that the anesthesia machine is in standby mode.
2. Select Setup-> Service-> Calibration-> Pressure Sensors to access the screen shown below.

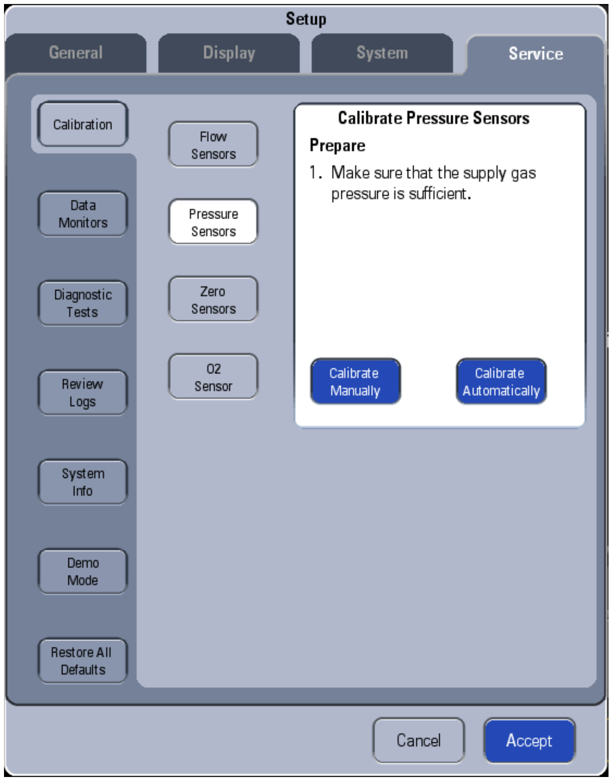


FIGURE 4-82

3. Select Calibrate Manually button to open the menu shown below.

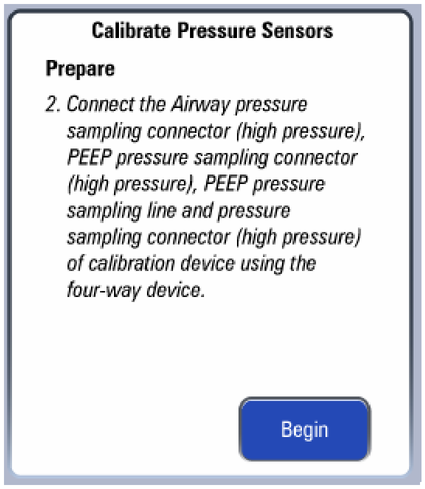
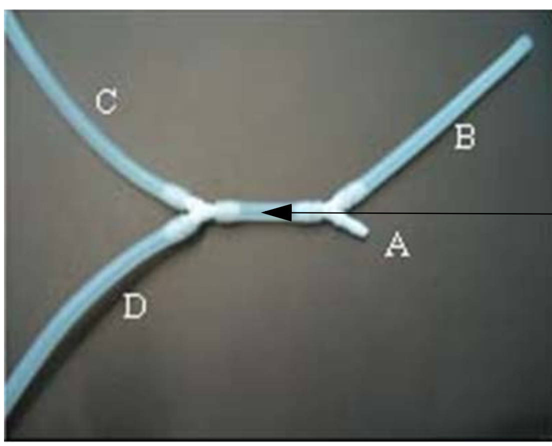


FIGURE 4-83

4. Perform pneumatic connections:

   1. A four-way device is required to connect the sampling lines for pressure calibration. The following pictures show the four-way device, connectors on the calibration device and ventilator control board involved for pressure calibration.



Four-way device connecting the sampling lines for pressure calibration

FIGURE 4-84

   2. Remove the two tubes marked as #72 and #9 from the pressure sensors (the figure below).

   3. Connect the four way tube to the pressure sensor P1 of monitor board, pressure sensor P2 of PEEP, the tube marked as #72, and the low pressure port of Fluke VT-Plus. The tube marked as #9 will remain unconnected for this calibration.

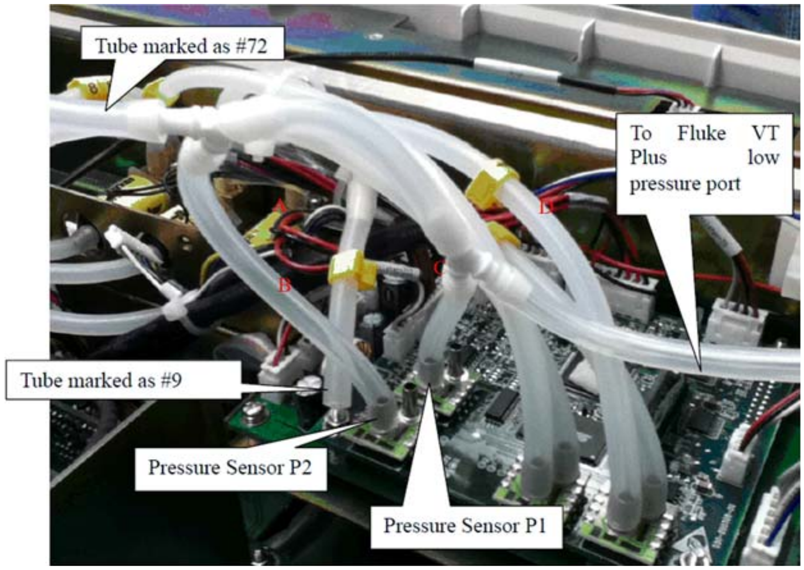


FIGURE 4-85

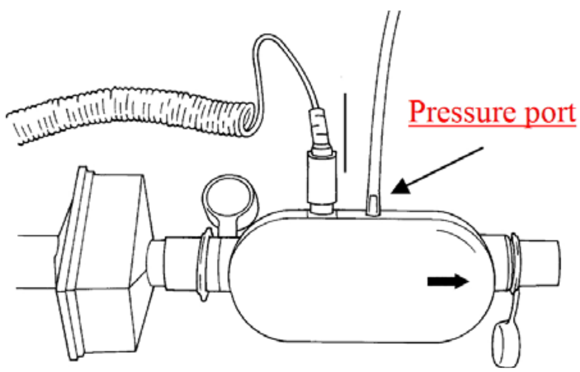


FIGURE 4-86 Calibration Device (TSI Certifier 4070)

FIGURE 4-87 CERTIFIER FA PLUS

5. Press the Begin button to open the menu shown below.

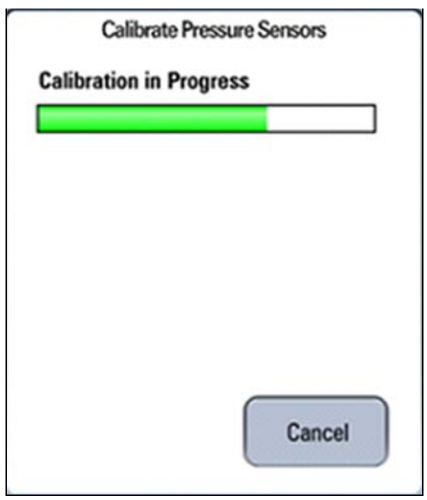


FIGURE 4-88

6. The menu shown below is displayed after the first step of manual calibration is completed.

FIGURE 4-89

7. For EPSON: Select Continue to access the menu shown below. The system will calibrate the 32 calibration points one by one. Of the 32 calibration points, points 1 to 16 correspond to the rising curve while points 17-32 correspond to the falling curves. During the calibration, you can select to re-calibrate any calibration point. When calibrating the point corresponding to falling curve, you cannot change the point corresponding to rising curve. When Waiting is displayed in the cell, wait for the system to control pressure. When Input Cal Value is displayed in the cell, input the standard pressure value displayed by the calibration device. After having inputted the standard pressure values of all the 32 calibration points, select Accept to check and save the calibration data.
For DSP: Select Continue to access the menu shown below. The system will calibrate the 16 calibration points one by one. When Input Cal Value is displayed in the cell, input the standard pressure value displayed by the calibration device. After having inputted the standard pressure values of all the 16 calibration points, select Accept to check and save the calibration data.

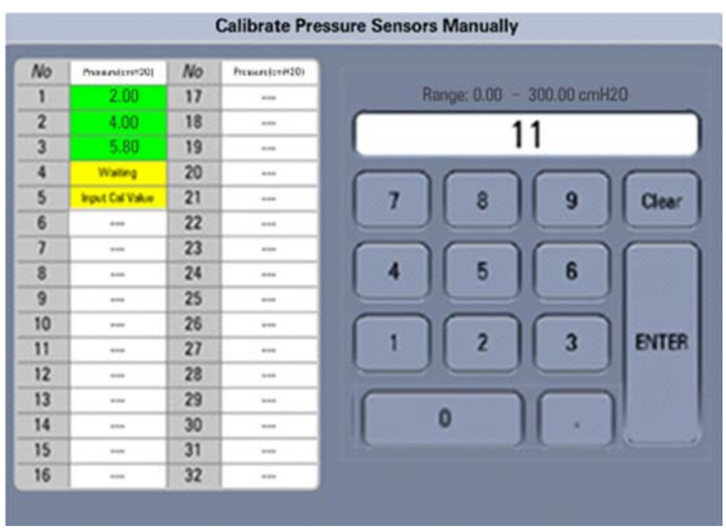


FIGURE 4-90 EPSON platform

FIGURE 4-91 DSP platform

8. Press the Accept button and the screen shown below is displayed.

- The screen shown below is displayed after a successful pressure sensor calibration.

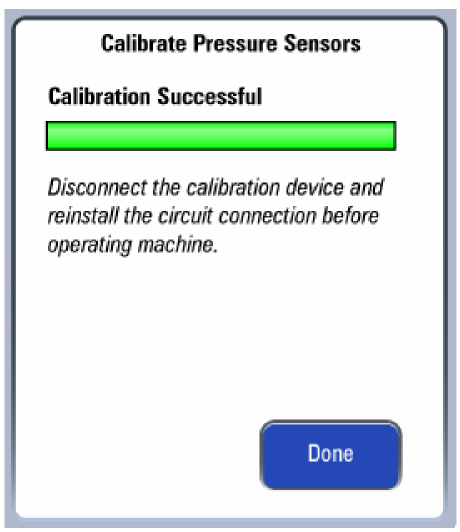


FIGURE 4-92

- The screen shown below is displayed if the pressure sensor calibration has failed.

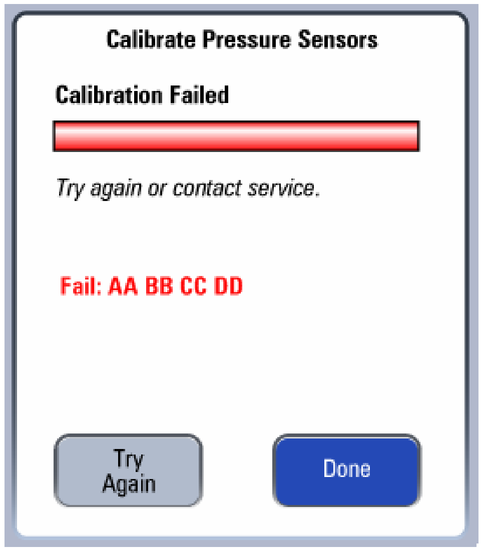


FIGURE 4-93

9. Select Cancel and the screen shown below is displayed.

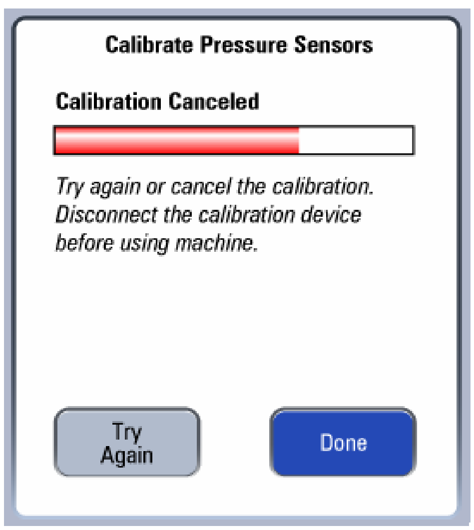


FIGURE 4-94

NOTE: **After pressure calibration, test the accuracy of pressure sensors by referring to 3.7.5 Check the Pressure Sensor Accuracy.**

NOTE: **In case of calibration failure, first fix the problem and then perform pressure calibration again.**

4.3.4.2 Commonly-encountered Problems and Recommended Actions

Failure description	Possible cause	Recommended action
After [Begin] is selected, no ventilation sound is heard. Very soon, the prompt message of [Calibration Failure! Please try again.] is displayed.	[Drive Gas Pressure Low] is alarmed. The pressure indicated by the drive gas (O2) pressure gauge is lower than 200 kPa.	Replace or connect the gas supplies to make sure that drive gas pressure is enough.
	Zero point error occurs to the airway pressure gauge or PEEP pressure sensor. Refer to "Check the Sensor Zero Point" on page 3-24.	Replace the ventilator control board.
After [Begin] is selected, ventilation sound is heard. Very soon, the prompt message of [Calibration Failure! Please try again.] is displayed.	The sampling line of at least one out of the airway pressure sensor and PEEP pressure sensor is not connected or is connected improperly. Refer to "Sensors and Valves Problems" on page 5-71.	Re-connect the sensor sampling line.
	The maximum pressure which the PEEP valve produces is less than 95 cmH2O. Refer to "Sensors and Valves Problems" on page 5-71.	Replace the expiratory valve assembly.
	1. The pneumatic circuit connection between the anesthesia machine calibration device and the ventilator control board has an error. 2. The communication connection between the anesthesia machine calibration device and the anesthesia machine has an error. 3. The settings of the anesthesia machine calibration device have an error.	1. Check the pneumatic circuit connection between the anesthesia machine calibration device and the ventilator control board. Re-connect the pneumatic circuit if necessary. 2. Check the communication connection between the anesthesia machine calibration device and the anesthesia machine. Or re-connect them to ensure normal communication. If the problem persists, replace the communication cable. 3. Check the settings of the anesthesia machine calibration device. Make settings again if necessary.
About 15 minutes after calibration is started, the prompt message of [Calibration Failure! Please try again.] is displayed.	Calibration data are not correct. Refer to "Check the Pressure Sensor Accuracy" on page 3-28.	Replace the ventilator control board.
[00 00 00 02] is displayed.	The drive gas pressure is too low.	1. Check the drive gas supply. 2. If there is no problem on the gas supply, check the gas supply pressure switch.
[00 00 00 04] is displayed.	The Auto/Manual switch is on Manual position.	1. Check if the operations are performed as directed. 2. If so, check the Auto/Manual switch.
[00 00 00 08] is displayed.	Zero point error occurs to the airway pressure sensor.	1. Check the zero point. 2. Replace the board.
[00 00 00 10] is displayed.	Zero point error occurs to the PEEP pressure sensor.	1. Check the zero point. 2. Replace the board.
[00 00 00 20] is displayed.	Measurement range error occurs to the airway pressure sensor.	1. Check the tube and air-tight connection. 2. Check the supply gas pressure. 3. Check the settings of the calibration device. 4. See section 5.4 (pg. 5-71) "Sensors and Valves Problems". 5. Replace the board.

Failure description	Possible cause	Recommended action
[00 00 00 40] is displayed.	Measurement range error occurs to the PEEP pressure sensor.	1. Check the tube and air-tight connection. 2. Check the supply gas pressure. 3. Check the settings of the calibration device. 4. See section 5.4 (pg. 5-71) "Sensors and Valves Problems". 5. Replace the board.
[00 00 00 80] is displayed.	The calibration data of the airway pressure sensor is not unidirectional.	1. Check the tube and air-tight connection. 2. Check the supply gas pressure. 3. See section 5.4 (pg. 5-71) "Sensors and Valves Problems". 4. Replace the board.
[00 00 01 00] is displayed.	The calibration data of the PEEP pressure sensor is not unidirectional.	1. Check the tube and air-tight connection. 2. Check the supply gas pressure. 3. See section 5.4 (pg. 5-71) "Sensors and Valves Problems". 4. Replace the board.
[00 00 02 00] is displayed.	Resolution error occurs to the airway pressure sensor. (The difference between the maximum AD and the minimum AD is less than or equal to 500AD (EPSON platform) or 30000AD (DSP platform). When the difference between one point and its previous pressure value is greater than or equal to 1 cmH2O, the resolution is less than 1cm H20 ~2AD (EPSON platform) or 20AD (DSP platform)).	1. Check the tube and air-tight connection. 2. Check the supply gas pressure. 3. Check the settings of the calibration device. 4. See section 5.4 (pg. 5-71) "Sensors and Valves Problems". 5. Replace the board.
[00 00 04 00] is displayed.	Resolution error occurs to the PEEP pressure sensor. (The difference between the maximum AD and the minimum AD is less than or equal to 500AD (EPSON platform) or 30000AD (DSP platform). When the difference between one point and its previous pressure value is greater than or equal to 1 cmH2O, the resolution is less than 1cm H20 ~2AD (EPSON platform) or 20AD (DSP platform)).	1. Check the tube and air-tight connection. 2. Check the supply gas pressure. 3. Check the settings of the calibration device. 4. See section 5.4 (pg. 5-71) "Sensors and Valves Problems". 5. Replace the board.
[00 00 08 00] is displayed.	The output pressure of the valve is low.	1. Check if there is enough gas supply for the whole calibration process. 2. Check if the maximum output pressure of the PEEP valve is more than 90 cmH2O. If not, replace the airway module.
[00 00 10 00] is displayed.	The change of flow is not unidirectional.	1. Check if the sampling line is properly connected. 2. Replace the board.
[00 00 20 00] is displayed.	Communication with the calibration device is interrupted.	1. Check the connection between the calibration device and communication cable. 2. Replace the calibration device and then perform calibration again.
[00 00 40 00] is displayed.	The system fails to write EEPROM.	1. Perform calibration again. 2. Replace the monitoring board.
[00 00 80 00] is displayed.	ACGO switch is on "ON" position.	1. Check if ACGO is positioned to "OFF". 2. Check the ACGO identification switch.

Failure description	Possible cause	Recommended action
[00 01 00 00] is displayed.	The resolution of the valve is not enough.	1. Check if there is enough gas supply for the whole calibration process. 2. Check if the calibration device works well. 3. Replace the PEEP valve.
[00 02 00 00] is displayed.	The maximum value cannot be found.	1. Diagnose by using the valve diagnostic tools: (1) open the PEEP valve with 4000DA. The pressure measured by the VT can reach at least 90cmH2O. (2) close the PEEP valve. Increase the opening of PEEP valve with certain DA. The AD value collected by the airway pressure sensor has the tendency of becoming bigger. Re-calibration is recommended if the above two conditions are satisfied. 2. Replace the PEEP valve.
[00 04 00 00] is displayed.	The minimum value cannot be found.	1. Diagnose by using the valve diagnostic tools: open the PEEP valve within the range of 0~2000DA. The AD value collected by the inspiratory pressure sensor has the tendency of becoming bigger. Re-calibration is recommended. 2. Replace the PEEP valve.
[00 08 00 00] is displayed.	Only available for the DSP platform. When PEEP valve is close, the calibration device value is over 3 cmH2O.	Check that the peep valve doesn't have leakage. If not, replace the inspiratory valve.
[00 10 00 00] is displayed.	Only available for the DSP platform.The sampling lines has leakage or disconnection.	Check the connection of sampling lines.
[FF FF FF FF] is displayed.	Communication error occurs.	1. Restart the machine. 2. Check the communication cable. 3. Check for communication error alarm messages. Replace the board.

4.3.5 Pressure and Flow Zeroing (Service)

During the operation of the anesthesia machine, pressure and flow are zeroed automatically at a specific interval. You can also zero pressure and flow manually in the factory maintenance menu. Manual zeroing can eliminate the measurement deviations caused by zero offset immediately. The anesthesia machine system provides the function of automatic flow and pressure zeroing at a specific interval. Zeroing is performed automatically at 5min, 15min, 30min, and 60min respectively after ventilation starts. After that, automatic zeoring is performed once every 120 minutes. During mechanical ventilation, before automatic zeroing, the three-way valve is opened and closed for flushing valve. During zeroing or three-way valve opening and closing, the waveform will be depressed.

4.3.5.1 Zeroing Procedures

Follow these steps to zero pressure and flow sensors.

1. Select Setup-> Service-> Calibration-> Zero Sensors to access the screen shown below.

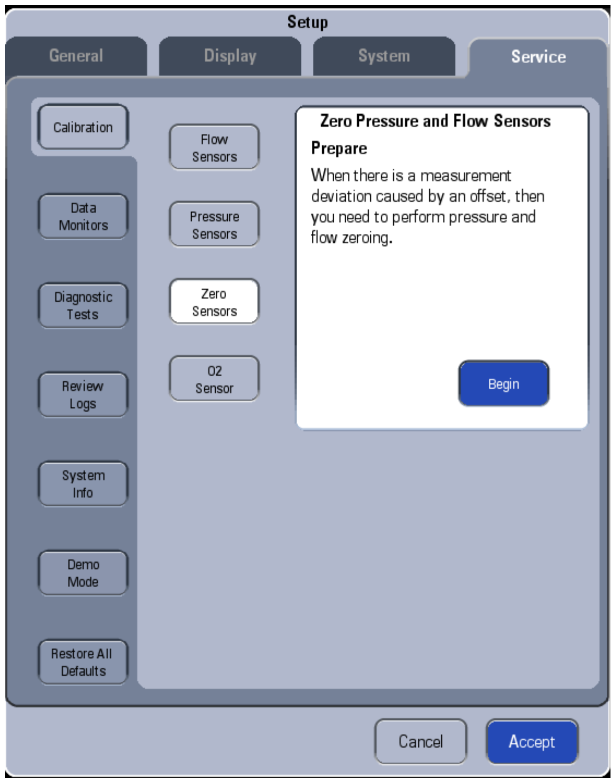


FIGURE 4-95

2. Select Begin to access the zeroing screen as show below. During the zeroing, you can select Cancel to cancel the zeroing.

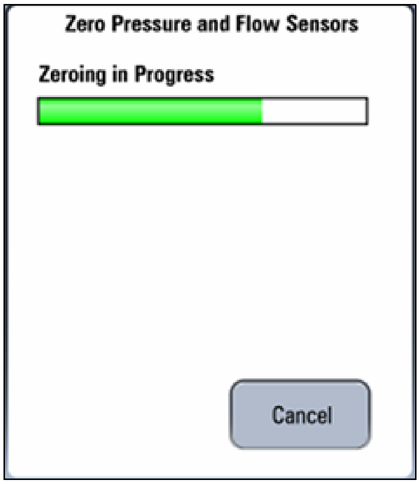


FIGURE 4-96

3. The screen shown below is displayed if the ongoing zeroing is canceled. Select Try Again to do the zeroing again.Select Done to exit the zeroing screen.

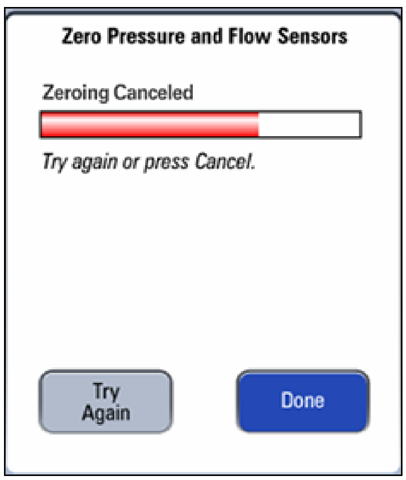


FIGURE 4-97

4. The screen shown below is displayed if the zeroing has failed. Select Try Again to do the zeroing again.Select Done to exit the zeroing screen.

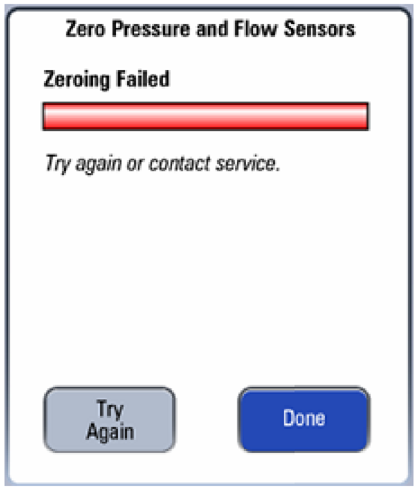


FIGURE 4-98

5. The screen shown below is displayed after a successful zeroing. Select Done to exit the zeroing screen.

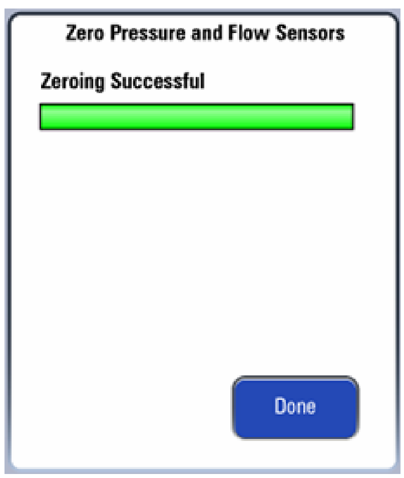


FIGURE 4-99

NOTE: **In case of zeroing failure, other faults may exist. You must isolate and eliminate the problem.**

4.3.5.2 Troubleshoot Pressure and Flow Zeroing Failure

In case of zeroing failure, troubleshoot as follows:

1. Set the anesthesia machine to manual ventilation or standby mode. Turn off fresh gas. Unplug the breathing tubes in the breathing system, causing the inspiration and expiration connectors to open to the air. Bleed the residual gas inside the bellows. Make sure that there is no flow or pressure entering the flow or pressure sensors inside the machine.
2. Check if the zero points of the sensors are normal by referring to 3.7.3 Check the Sensor Zero Point.
3. If a zero point error is detected, unplug the sensor sampling line to eliminate the effects caused by sampling line occlusion or three-way valve. If zero point is still out of the range, the ventilator control board is faulty. Replace the ventilator control board.
4. If zero points of the sensors are correct but zeroing is still failed, the solenoid valve assembly is faulty. Replace the solenoid valve assembly.

4.3.6 EFCS Zeroing (User)

After the gas supply is disconnected, zero offset may occur in the sensor of the EFCS if the pointer of the pressure gauge returns to zero but the EFCS still displays a non-zero flow value. You can zero the flowmeter manually to immediately eliminate measurement deviations caused by zero offset.

4.3.6.1 Zeroing Procedures

Perform the following steps to zero the EFCS.

1. Select **Setup** > **General**> **Zero Flow Meters** to enter the screen shown below. Select **Begin** to start zeroing.

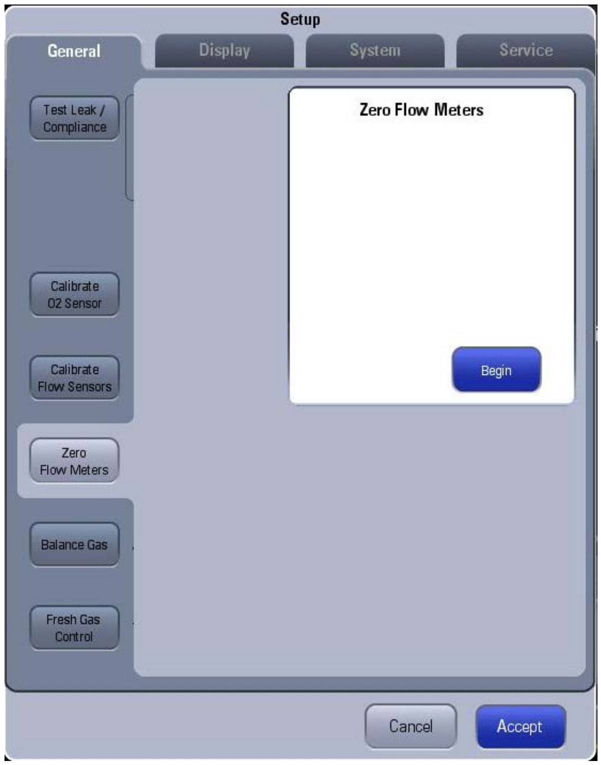


FIGURE 4-100

2. The zeroing screen shown below is displayed when Begin is selected. During the zeroing, you can select Cancel to cancel the zeroing.

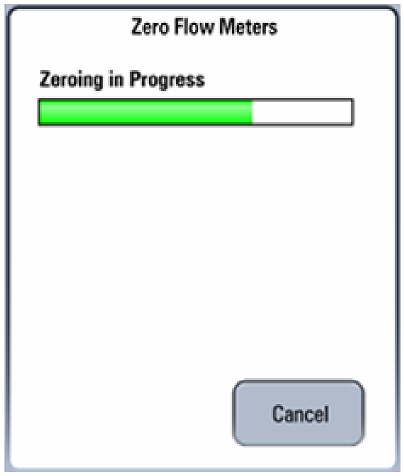


FIGURE 4-101

3. The screen shown below is displayed if the ongoing zeroing is canceled. Select Try Again to do the zeroing again.Select Done to exit the zeroing screen.

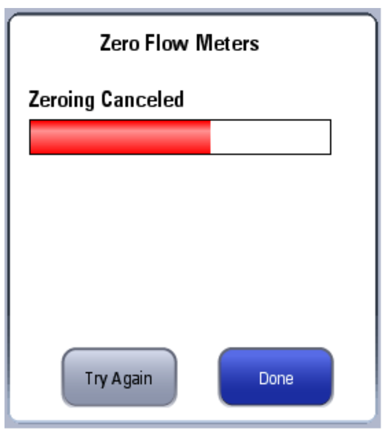


FIGURE 4-102

4. The screen shown below is displayed if the zeroing has failed. Select Try Again to do the zeroing again.Select Done to exit the zeroing screen.

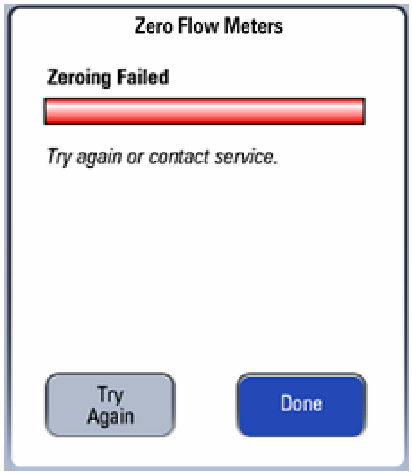


FIGURE 4-103

5. The screen shown below is displayed after a successful zeroing. Select Done to exit the zeroing screen.

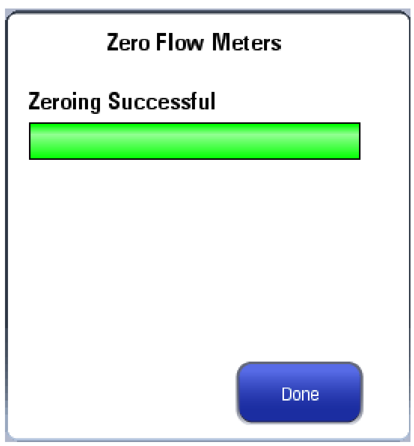


FIGURE 4-104

NOTE: **In case of zeroing failure, other faults may exist. You must isolate and eliminate the problem.**

4.3.6.2 Troubleshoot Electronic Flowmeter Zeroing Failure

In case of zeroing failure, troubleshoot as follows:

1. Disconnect the gas supplies. Bleed the gas inside the machine or adjust the flowmeter for the pointer of the pressure gauge to return to zero, and then perform zeroing again..
2. If the zeroing is successful, it is concluded that the previous zeroing failure is caused by the mechanical failure in the three-way valve or faults in the proportional valves. Replace the three-way valve assembly and proportional valve assemblies.
3. If the zeroing still fails, it is concluded that the cause is the fault in the Sensirion flow sensors or the EFCS board. Replace Sensirion flow sensor assemblies and EFCS board..

4.3.7 Total Flow Sensor Calibration (factory)

NOTE: Make sure that the N2O supply is connected and its pressure is within the normal range.

NOTE: Make sure that the machine is under EFCS state.

4.3.7.1 Calibration Procedure

Perform the following steps to calibrate the total flow sensor.

1. Enter the standby mode.
2. Select [Setup] > [Service] > [Calibration] > [Total Flow Sensor] to enter the screen shown below. Prepare by following the instructed on the screen.

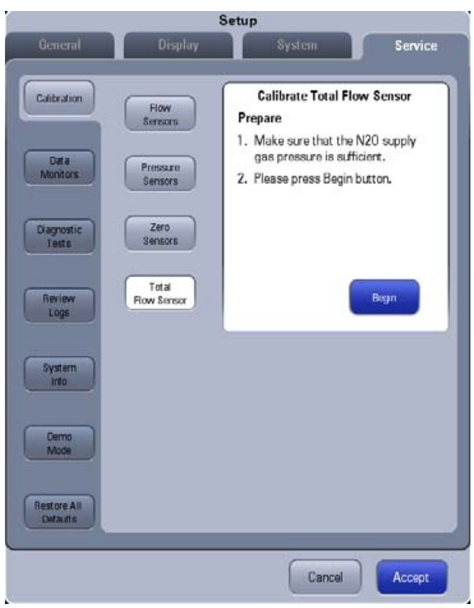


FIGURE 4-105

3. Select [Begin] to enter the screen shown below.

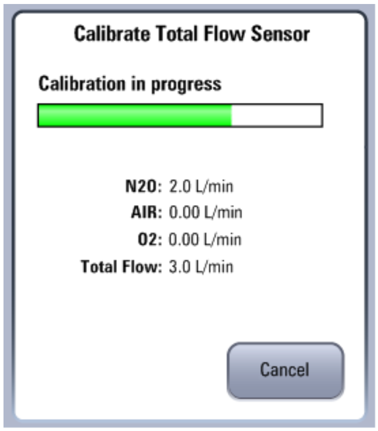


FIGURE 4-106

NOTE: **Realtime fresh gas flow is displayed on the [Calibrate Total Flow Sensor] screen. Normally, only N2O and total flow values are greater than 0, and N2O and total flow values ascend with the increase of calibration progress. Air and O2 values should be 0 or less than 0 all the time.**

4. The following screens are displayed after calibration is completed.

The screen shown below is displayed if total flow sensor calibration fails. Select [Try Again] to calibrate again or [Done] to exit calibration.

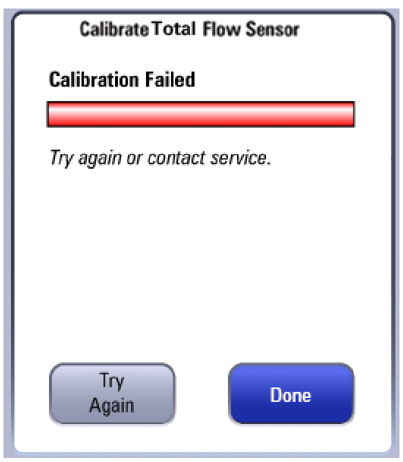


FIGURE 4-107

5. The screen shown below is displayed after successful total flow sensor calibration. Select [Done] to exit calibration.

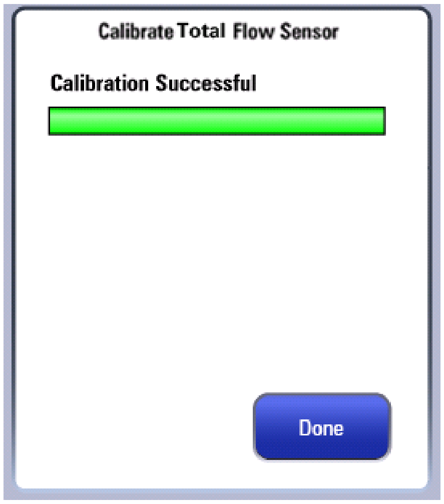


FIGURE 4-108

6. The screen shown below is displayed if the ongoing calibration is cancelled. Select [Try Again] to calibrate again or [Done] to exit calibration.

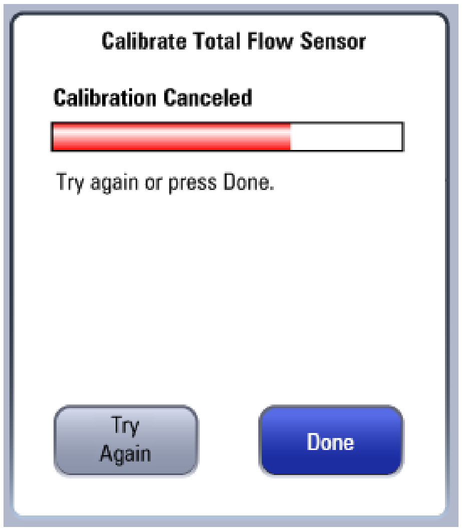


FIGURE 4-109

4.3.7.2 Common Failures and Recommended Actions

Failure Description	Possible Cause	Recommended Action
After Begin is selected, calibration failure is displayed very soon..	The machine is under BFCS state.	Set the machine to EFCS state.
	N2O supply pressure is low.	Replace or connect gas supply to make sure N2O pressure is within the specified range.
After Begin is selected, calibration fails about 1min later.	The calibration points are not in conformity with monotonicity.	Re-calibration is recommended.

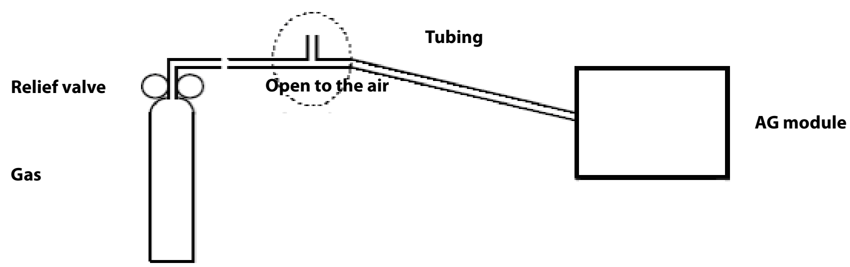
4.3.8 Calibrate the AG Module

Prepare the following before doing the calibration:

- Gas cylinder, with a certain standard gas or mixture gas. Gas concentration should meet the following requirements: AA≥1.5%, CO_2≥1.5%, N_2O≥40%, O_2≥40%, of which AA represents an anesthetic agent. a/c≤0.01 (a is the gas absolute concentration accuracy; c is the gas concentration).
- T-shape connector
- Tubing

Follow this procedure to perform a calibration:

1. Connect the test system as follows.



NOTE: When calibrating the internal AG module, open the back cover of the machine, disconnect the tubing as shown below and connect the standard gas to the gas inlet.

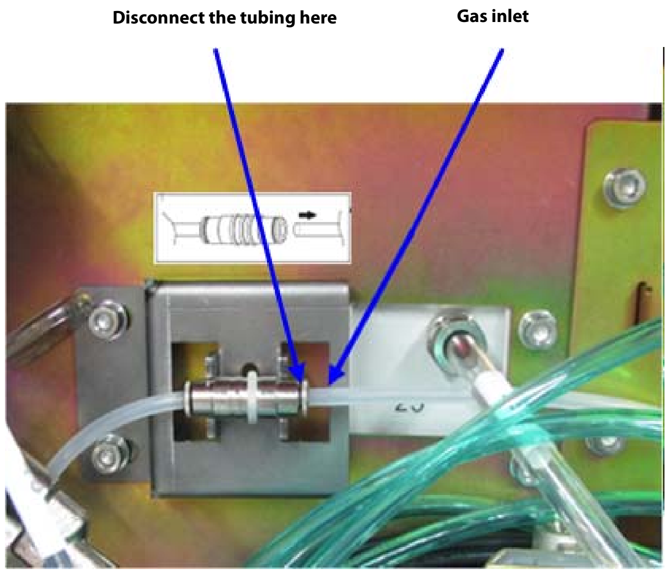


FIGURE 4-110

2. Ensure that the system is **Standby** mode. If not, select the **End Case** button in the Manual tab and follow the on-screen prompts to end the case and enter **Standby** mode.
3. Select **Setup** softkey> **System** tab (system password needed).
4. Select the **Calibration** button.
5. Select the **External AG Module** button or **Internal AG Module** button.
6. Wait for the AG module to be fully warmed up
7. Enter the actual concentration of the calibration gas.
8. Turn on the calibration gas canister and the system displays the real-time concentration of calibration gas.
9. Select the **Calibrate** button to start to calibrate the AG Module. The system will display the results of the calibration status when the process is completed.
10. After calibration, select **Done** to close the **Calibration** window.
11. Select the **Accept** button to close the **Setup** window.

NOTE: **The accuracy of both the internal and external AG module have to be checked.**

NOTE: **To avoid premature emptying of the the gas canister, always remove the regulator after the completion of the calibrations.**

4.3.9 Cylinder Yoke Regulator Calibration

Follow these steps to perform cylinder yoke regulator calibration (the following takes N2O cylinder yoke assembly as an example. The calibration steps of O2 and Air cylinder yoke regulators are same to those of N2O).

For O2 and Air, the pressure in the cylinder must be at least 1000 psi. For N2O, the pressure in the cylinder must be at least 500 psi.

For O2 and AIR, set the output pressure using the table below. For N2O, set the output pressure to 58 psi.

cylinder pressure (psi)	regulator pressure (psi)
1000	52.2
1250	50.6
1500	49.0
1750	47.4
2000	47.1
2250	46.8

1. Turn off the power supply and all gas supplies. Open the service door.

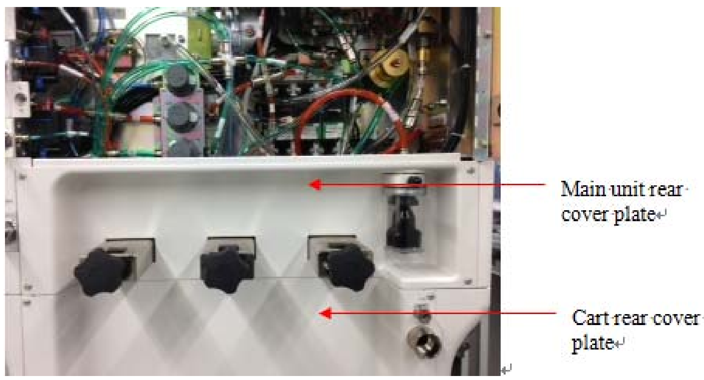


FIGURE 4-111

2. Open the main unit rear cover plate to remove the cart rear cover plate.

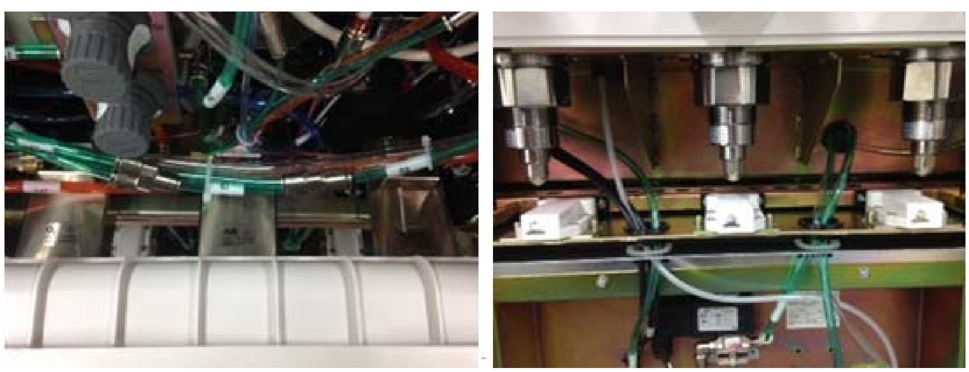


FIGURE 4-112

3. Unplug the tube connected to the unidirectional valve of the cylinder assembly and connect the tube to a Φ8 Y-piece. Connect another end to the unidirectional valve and the other end to the pressure monitoring device.

FIGURE 4-113

4. Start the system, turn on the cylinder gas supply (turn off the pipeline gas supply), and adjust the fresh gas flow to 1 L/min.

5. Remove the self-locking acorn nut at the head of the regulator. Install the cylinder.

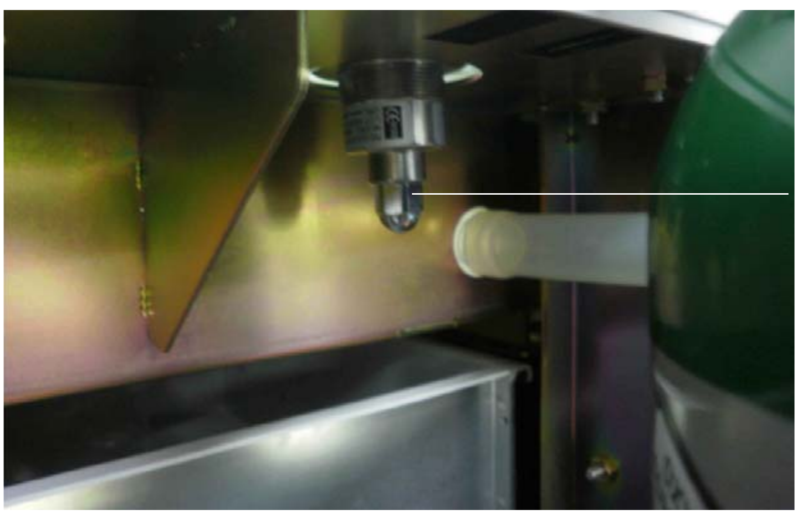


FIGURE 4-114

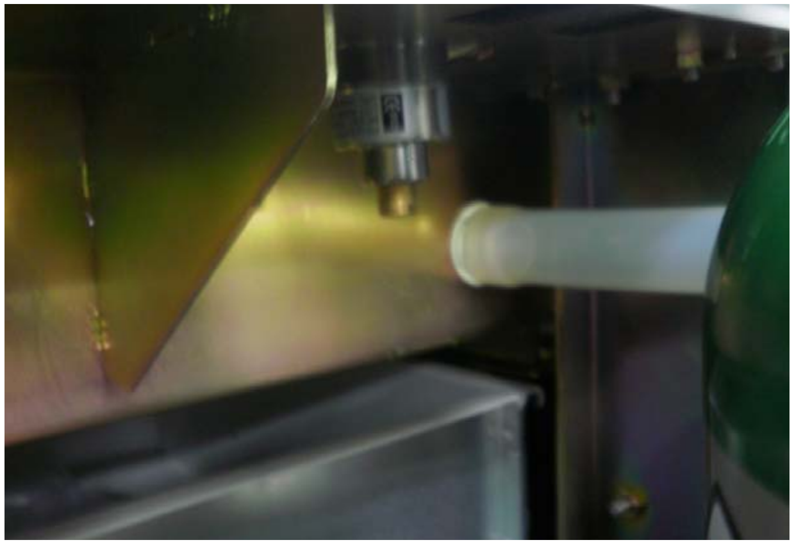


FIGURE 4-115

6. Rotate the regulating screw at the head slowly with a flathead screwdriver to adjust the output pressure range (rotate clockwise to increase the pressure and counterclockwise to reduce the pressure) until the adjusted pressure is within the range listed in the preceding table (±5%). After adjusting the pressure, reinstall and tighten the self-locking acorn nut.

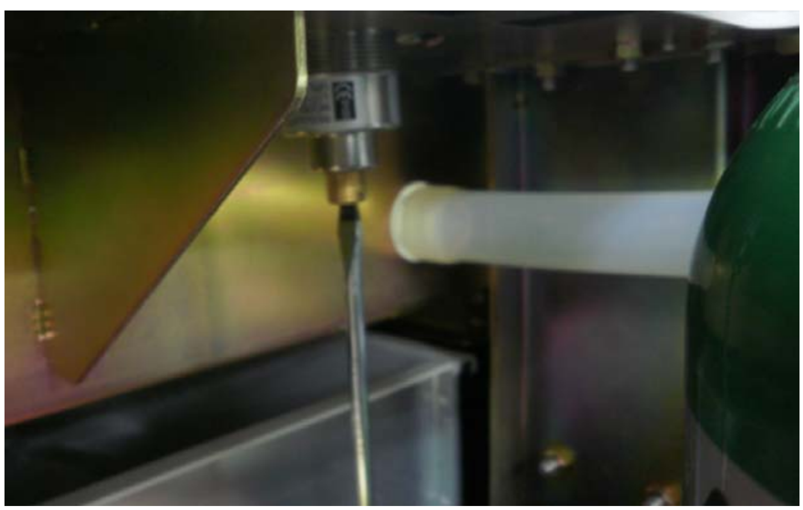


FIGURE 4-116

7. Turn off the gas supply and restore the equipment tube connections.

4.3.10 Adjust the back pressure valve

1. Connect Anesthesia machine calibration to the front end of the back pressure valve by 3140-08-00 Y piec e and 3106-10-00 adapter connector to monitor and measure the pressure of the front end of the back pressure valve. The connection diagram and connecting ports are shown as follows.

NOTE: Different pressure meters may require different adapters.

FIGURE 4-117

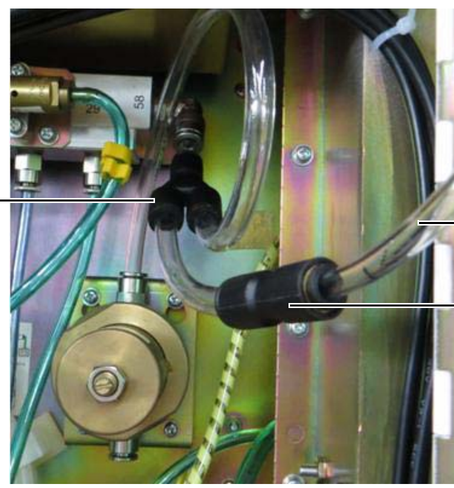


FIGURE 4-118

2. Disconnect the pipeline on the back end of the back pressure valve.
3. Connect to O2 source, and adjust O2 needle valve, while observing the flowmeter on the system interface of A7, to set the O2 flow rate to 5±0.1L/min.
4. Loose the nut of the back pressure valve.
5. Adjust the bolt of the back pressure valve, while observing the displaying pressure value of Anesthesia machine calibration device, to set the pressure value to 237 ± 10 cmH2O.
6. Lock the Nut, as shown in the following figure.

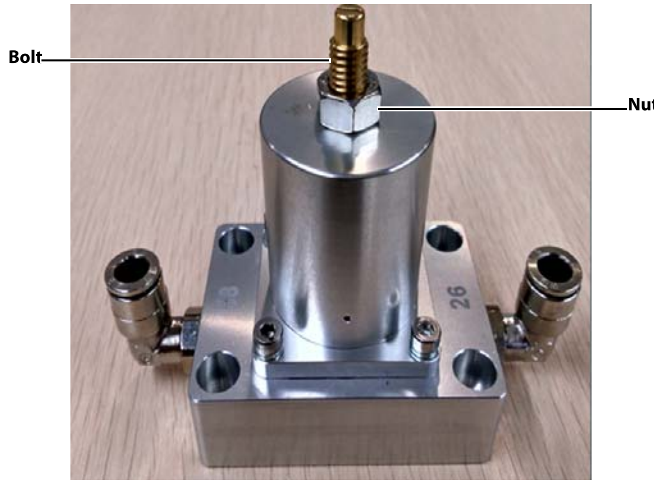


FIGURE 4-119

7. Take off 3140-08-00 Y piece and 3106-10-00 adapter connector, and reconnect the pipeline.

5.0 Repair and Troubleshooting

Troubleshooting Guidelines 5-2
Technical Alarms Check 5-3
Pneumatic Circuit System Problems 5-23
Sensors and Valves Problems 5-72
Hardware and Electrical Problems 5-81
Software Update and Software Configuration Activation 5-83

5.1 Troubleshooting Guidelines

5.1.1 Identify the problem

Due to the wide variety of potential symptoms, certain problems may be more subtle than others. Following the guidelines of the tests will help determine the problem, if one exists.

5.1.2 Avoid shorting component leads together

During repair procedures, it can be tempting to make a quick series of measurements. Always turn the power off before connecting and disconnecting the test leads and probes. The accidental shorting of leads can easily stress the components and cause a second failure (aside from the safety risk).

5.1.3 Use the proper equipment

During repair procedures, the following tools may be required:

- Metric Allen wrench es (2.5, 3, 4, 5, 8 mm)
- Phillips screwdriver (#1 and #2)
- Diagonal pliers
- Flathead screwdriver
- Metric M3 and M4 socket screwdriver
- Adjustable wrench
- Tweezers
- Krytox Lubricant (P/N:0510-00-0020)

It is imperative to use the designated equipment in order to ensure proper results of any and all test procedures.

5.1.4 Clean up the repair area

After any repair, clean off the repair area.

5.2 Technical Alarms Check

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:

- Startup alarm Messages
- CPU Board Runtime Alarm
- Power Board Runtime Alarm
- Runtime Alarms of Flow Sensor Board
- Ventilation Control Board Runtime Alarm
- AG module real-time alarm

Before troubleshooting the anesthesia machine, check for technical alarm message. If an alarm message is presented, eliminate the alarm first.

The following sections detail how to troubleshoot technical alarms related to the modules mentioned above.

For detailed information on possible causes and actions for other alarm and prompt messages, refer to the Operator's Manual.

5.2.1 Startup Alarm Messages

Message	Priority	Cause	Solution
Bundle Version Error Bundle Version: Time out	High	The software versions are not compatible.	1. Update to the compatible software version again.
Flowmeter Selftest Error 'Flowmeter Self Test: Time out	High	The CPU, RAM, address line, watchdog, Flash, O2/N2O/ air proportional valve self-test error, O2/N2O/air branch leakage, traffic zero point error, FPGA self-test error..	1. Restart the machine. 2. If the problem persists, replace the flow sensor board. 3. If the problem persists, replace the CPU board.
Aux Control Module Selftest Error Aux Control Module Self Test: Time out	High	1.CPU, Flash, WTD error 2.After power on, the CPU board can't communicate with the auxiliary control module.	1. Restart the machine. 2. Re-plug or replace the communication cable between the CPU Board and the auxiliary control module. 3. If the problem persists, replace the auxiliary control module. 4. If the problem persists, replace the CPU board.
Ventilator Selftest Error Ventilator Self Test: Time out	High	1.CPU, TIMER, RAM, WTD, EEPROM or AD error 2.After power on, the CPU board can't communicate with the ventilator control board.	1. Restart the machine. 2. Re-plug or replace the communication cable between the CPU Board and the ventilator control board. 3. If the problem persists, replace the ventilator control board. 4. If the problem persists, replace the CPU board.
Ventilator Voltage Error	High	5V or 12V voltage error	1. Restart the machine. 2. Measure the input voltage (voltage on the power cable) of the ventilator control module to see if it is within specifications. Check if the cable is defective. 3. If the input voltage is out of specification, replace the power board or cable. 4. If the problem persists, replace the ventilator control board.
PEEP Valve Failure	Med	1. PEEP valve voltage error. 2. PEEP valve pressure error.	1. Check if the pressure sensor on the PEEP circuit is within specifications. Perform pressure sensor calibration in the service menu or replace the sensor on the PEEP circuit when the pressure error. 2. Measure the voltage at the corresponding test point 3. Check the connection between power supply and expiratory valve assembly 4. Replace the Ventilator Control Board when necessary. 5. Replace the expiratory valve assembly. 6. Replace the power board when necessary
Insp Valve Failure	Med	1. Insp valve voltage error. 2. Insp valve flow error.	1. Check if the Inspiratory flow sensor is within specifications. Perform flow sensor calibration in Service menu or replace the flow sensor when flow error occurs. 2. Measure the voltage at the corresponding test point 3. Check the connection between power supply and expiratory valve assembly 4. Replace the Ventilator Control Board when necessary. 5. Replace the expiratory valve assembly. 6. Replace the power board when necessary
PEEP Safety Valve Failure	Med	PEEP safety valve voltage error.	1. Measure the voltage at the corresponding test point 2. Check the connection between power supply and expiratory valve assembly 3. Replace the Ventilator Control Board when necessary. 4. Replace the expiratory valve assembly. 5. Replace the power board when necessary

Message	Priority	Cause	Solution
Flow Sensor Failure	Low	Ventilator flow is out of range.	1. Check if the zero point of the flow sensor is within specifications. 2. Check if the measurement performed by the flow sensor is within specifications. 3. Replace the flow sensor and perform calibration. 4. Replace the ventilator control board and perform calibration.
Calibrate Flow Sensor and Insp Valve	Low	1.Cal. Table isn't found in EEPROM. 2.Checksum of Cal. Table don't match.	Perform service calibration. Refer to section "Flow Calibration (Service)" on page 4-17 .
Calibrate Pressure Sensor and PEEP Valve	Low	1.Cal. Table isn't found in EEPROM. 2.Checksum of Cal. Table don't match.	Perform service calibration. Refer to section 4.3.4 Pressure Calibration (Service).
Ventilator Initialization Error Ventilator Initialization: Time out	High	After power on, the CPU board can't send the parameter settings to ventilator board.	1. Restart the machine. 2. Re-plug or replace the communication cable between the CPU Board and ventilator control board. 3. If the problem persists, replace the ventilator control board. 4. If the problem persists, replace the CPU Board.
Drive Gas Pressure Low	High	Drive Gas Pressure Low	1. Check the status of actual gas supply to confirm if the alarm is in compliance with the actual status. 2. Short circuit the pressure switch and the alarm regarding outputted signals should disappear. Otherwise, it indicates that the pressure switch is defective. Replace the pressure switch. Otherwise, check the connection between the pressure switch and the ventilator control board and check the socket. 3. If the above two items are within specifications, replace the ventilator control board.
O2 Supply Failure	High	O2 Supply Failure	Use the same method to drive gas pressure low to check the O2 pressure switch.
Power Supply Voltage Error	High	3.3V, 5V, 12V voltage error	1. Measure the voltage at the corresponding test point. 2. If the problem persists, replace the power board.
RT Clock Needs Battery	High	There is no button cell available in the system, or the battery is empty.	1. Replace with a new button cell on the CPU board. 2. If the problem persists, replace the CPU board.
RT Clock Failure	High	RT chip malfunction.	1. Restart the machine. 2. If the problem persists, replace the CPU board.
Keyboard Self Test Error Keyboard Self Test: Time out	High	Keyboard malfunciton.	1. Check the cable connection between the keyboard and main control board. 2. Restart the machine and perform selftest. 3. If the problem persists, replace the keyboard.
External AG Self Test Error External AG: Time out	Low	External AG module selftest malfunction.	1. Re-plug the external AG module. Restart the machine and perform selftest. 2. Check the cable connection between the module rack and CPU board. 3. Check if the module rack works normally. 4. Replace the external AG module.

Message	Priority	Cause	Solution
Internal AG Selftest Error 02 Internal A: Time out	Low	The internal AG module malfunctions.	1. Restart the machine. 2. Re-plug the cable between the internal AG module and the CPU board. 3. Replace the internal AG module.
Flowmeter Selftest Error Flowmeter Selftest: Time out	High	See "EFCS Selftest Error Alarm Numbering Conventions" on page 5-6.	See "EFCS Selftest Error Alarm Numbering Conventions" on page 5-6.

5.2.1.1 EFCS Selftest Error Alarm Numbering Conventions

<table>
<tr><th>ID No</th><th>Cause</th><th>Solution</th></tr>
<tr><td>0x00000001</td><td>CPU selftest error.</td><td rowspan="5">1. Restart the machine.
2. If the problem still persists, it belongs to hardware failure. It may be 0632 EFCS VCM board PCBA failure. Replace with a new board and return the faulty board to R&D.</td></tr>
<tr><td>0x00000002</td><td>RAM selftest error.</td></tr>
<tr><td>0x00000004</td><td>Address line selftest error.</td></tr>
<tr><td>0x00000008</td><td>Watchdog selftest error</td></tr>
<tr><td>0x00000010</td><td>FLASH selftest error.</td></tr>
<tr><td>0x00000020</td><td>O2 Prop Valve selftest error.</td><td>1. Open the rear cover plate. Check if the proportional valve cable J7 in the EFCS module is properly inserted.
2. If cable connection is checked in good condition, give priority to replacing 0632 EFCS VCM board PCBA.
3. If the problem still persists after board replacement, replace the O2 Prop Valve and return the faulty board or proportional valve to R&D.</td></tr>
<tr><td>0x00000040</td><td>AIR Prop Valve selftest error.</td><td>1. Open the rear cover plate. Check if the proportional valve cable J7 in the EFCS module is properly inserted.
2. If cable connection is checked in good condition, give priority to replacing 0632 EFCS VCM board PCBA.
3. If the problem still persists after board replacement, replace the AIR Prop Valve and return the faulty board or proportional valve to R&D.</td></tr>
<tr><td>0x00000080</td><td>N2O Prop Valve selftest error.</td><td>1. Open the rear cover plate. Check if the proportional valve cable J7 in the EFCS module is properly inserted.
2. If cable connection is checked in good condition, give priority to replacing 0632 EFCS VCM board PCBA.
3. If the problem still persists after board replacement, replace the N2O Prop Valve and return the faulty board or proportional valve to R&D.</td></tr>
<tr><td>0x00000100</td><td>O2 flow leakage.</td><td>1 Select [Setup]?[Service]?[Data Monitors]?[Component]?[FCS].
2. Check the value of "O2 Limb Flow". Make sure that this value exceeds 0.07LPM. Then disconnect O2 supply (eject BFCS and open needle valve in O2 limb to exhaust the excess gas to prevent gas inside the pipeline from affecting the leak test result). After restarting the machine, if this alarm is still triggered, it is considered that Sensirion flow sensor in O2 limb is faulty. Replace this flow sensor.
3. If the fault disappears after O2 supply is disconnected, it can be considered that O2 Prop Valve cannot be closed. Consider to replace O2 Prop Valve and return the faulty flow sensor or proportional valve to R&D.</td></tr>
</table>

<table>
<tr><th>ID No</th><th>Cause</th><th>Solution</th></tr>
<tr><td>0x00000200</td><td>AIR flow leakage.</td><td>1 Select [Setup]?[Service]?[Data Monitors]?[Component]?[FCS].
2. Check the value of "AIR Limb Flow". Make sure that this value exceeds 0.07LPM. Then disconnect AIR supply (eject BFCS and open needle valve in AIR limb to exhaust the excess gas to prevent gas inside the pipeline from affecting the leak test result). After restarting the machine, if this alarm is still triggered, it is considered that Sensirion flow sensor in AIR limb is faulty. Replace this flow sensor.
3. If the fault disappears after AIR supply is disconnected, it can be considered that AIR Prop Valve cannot be closed. Consider to replace AIR Prop Valve and return the faulty flow sensor or proportional valve to R&D.</td></tr>
<tr><td>0x00000400</td><td>N2O flow leakage.</td><td>1 Select [Setup]?[Service]?[Data Monitors]?[Component]?[FCS].
2. Check the value of "N2O Limb Flow". Make sure that this value exceeds 0.07LPM. Then disconnect N2O supply (eject BFCS and open needle valve in N2O limb to exhaust the excess gas to prevent gas inside the pipeline from affecting the leak test result). After restarting the machine, if this alarm is still triggered, it is considered that Sensirion flow sensor in N2O limb is faulty. Replace this flow sensor.
3. If the fault disappears after N2O supply is disconnected, it can be considered that N2O Prop Valve cannot be closed. Consider to replace N2O Prop Valve and return the faulty flow sensor or proportional valve to R&D.</td></tr>
<tr><td>0x00000800</td><td>Startup zero reading error.</td><td rowspan="2">1. Restart the machine.
2. If the problem still persists, it belongs to hardware failure. It may be 0632 EFCS VCM board PCBA failure. Replace with a new board and return the faulty board to R&D.</td></tr>
<tr><td>0x00001000</td><td>FPGA configuration error.</td></tr>
</table>

5.2.2 CPU Board Runtime Alarm

Message	Priority	Cause	Solution
IP Address Conflict	Med	The IP address is same with other machine in the local network.	1. Set the IP address again. 2. If the problem persists, update the system software code or replace the CPU Board.
Fan Failure	Med	The speed of the fan is 20% off of the nominal value.	1. Check if the fan stops running or runs slowly (around 4000 rounds normally). 2. Plug in and out the fan power cable again. 3. If the problem persists, check if 12V for fan power supply on the power board is within specifications. If not, check the power board. 4. If the problem persists, replace the fan. 5. If the problem persists, replace the CPU board.
Fan Failure 02	Med	The speed of module rack fan is less than 3640 rounds/min.	1. Check if the fan stops running or runs slowly (around 4000 rounds per minute normally). 2. Plug in and out the fan power cable again. 3. If the problem persists, check if 12V for fan power supply is within specifications. If not, check the power board. 4. If the problem persists, replace the fan. 5. If the problem persists, replace the CPU board.

5.2.3 Power Board Runtime Alarm

Message	Priority	Cause	Solution
Power System Comm Stop	High	Lost communication with CPU board for 10 seconds.	1. Restart the machine. 2. Re-plug the communication cable. 3. Disconnect the battery from the AC mains. After the power board processor is powered off for 5 minutes, power it on again. 4. Replace with a new communication cable. 5. Check if the power board software is correct. Update the power board software again when necessary. 6. If the problem persists, replace the Power Board. 7. If the problem persists, replace the CPU Board.
Power Supply Voltage Error	High	3.3V, 5V, 12V voltage error	1. Measure the voltage at the corresponding test point. 2. Disconnect the battery from the AC mains. After the power board processor is powered off for 5 minutes, power it on again. Repeat Step 1 3. If the problem persists, replace the Power Board. 4. If the problem persists, contact the technical support.
Low Battery Voltage!	High	Battery voltage is less than 10.6V for 5 seconds.	1. Check the connection to the AC mains. Re-connect the AC mains immediately. 2. Check if the battery voltage is within specifications. 3. Check if the charging circuit is working correctly. If not, replace the Power Board.
System going DOWN, Battery depleted!	High	Battery voltage is less than 10.2V.	1. Restart the machine. 2. If the problem persists, connect to the normal mains supply. Make sure that the AC indicator is lit and charges the battery for 20 minutes. 3. If the problem persists, replace the battery. 4. If the problem persists, replace the power module.
Battery Undetected	Med	Battery Undetected	1. Check if the battery voltage is within specifications. 2. Check if the cable is connected correctly. 3. Replace the battery. 4. If the problem persists, replace the power board.

Message	Priority	Cause	Solution
Battery in Use	Low	AC power fail	1. Check the connection to the AC mains. 2. If the AC mains supply is connected correctly and the voltage is within specifications, check the connection between the AC mains and the power board. Check the AC mains inlet. 3. If the problem persists, replace the power board.
Power Board High Temp	High	The temperature of the power board is greater than 95 C for 10s continuously.C	1. Check the fan for the power module. 2. Stop using the machine for a period of time. If the problem persists after the machine is restarted, replace the power board.
Heating Module Failure	Low	1. Both resistance temps are greater than 106 C for 20 seconds. 2. One of resistance temp is greater than 110 C for 15 seconds.	1. Restart the machine. 2. If the problem persists, check if the heating temperature and voltage are within specifications. If not, replace the power board. 3. If the problem persists, update the SW of the CPU board and replace the CPU board if necessary.
Breathing Circuit Not Mounted	High	Breathing Circuit Not Mounted	1. Check that the circuit is installed in place. 2. Test the connection between the connection line and the connector. 3. Replace the power board.

5.2.4 Runtime Alarms of Flow Sensor Board

Message	Priority	Cause	Solution
Electronic Flow Control Error	Med	1. CPU DVCC, CPU DVDD, CPU AVDD or FPGA VPP , FPGA DVCC, FPGA 1.2V, FPGA 3.3V, AVCC, voltage error. 2. 3-way valve error. 3. The O2, N2O, or air flow sensor is faulty. 4. The O2/balance gas flow is not detected. Or the O2/balance gas temperature is too high. 5. FPGA error.	See "EFCS Failure Alarm Numbering Conventions" on page 5-12.
NO Fresh Gas	Med	Fresh gas is turned off in manual or mechanical ventilation mode.	1. Check whether gas is supplied normally. 2. Turn on the fresh gas and set it to a proper value.
O2 Branch Flow Not Achieved	Low	The O2 flow exceeds the preset value by 10% or 0.2 L/min. The greater value prevails.	1. Check whether gas is supplied normally. 2. Check whether the flow sensor complies with the specifications. 3. Replace the flow sensor when necessary.
Balance Gas Branch Flow Not Achieved	Low	The balance gas flow exceeds the preset value by 10% or 0.2 L/min. The greater value prevails.	1. Check whether gas is supplied normally. 2. Check whether the flow sensor complies with the specifications. 3. Replace the flow sensor when necessary.
Backup Flow Control Deployment Failure	High	The solenoid actuator malfunctions.	1. Restart the machine. 2. Replace components of the backup flow control system.
Backup Flow Control Retraction Failure	Med	The stepper motor malfunctions.	1. Restart the machine. 2. Replace components of the backup flow control system.
Air Supply Failure	Med	Air supply failure.	1. Check whether gas is supplied normally. 2. Short-circuit the pressure switch and the alarm should disappear. Otherwise, it indicates that the pressure switch is defective. Replace the pressure switch. If the pressure switch is not defective, check the connection between the pressure switch and the flow sensor board. 3. If the problem persists, replace the flow sensor board.
N2O Supply Failure	Med	N2O supply failure.	Use the same method as that of Air Supply Failure to check the N2O pressure switch.
Backup Flow Control Valves Open	Med	The BFCS needle valve is not fully turned off when EFCS is used.	1. Alarm mechanism: the needle valve contact switch detects signals and pass them to the EFCS VCM, which reads high/low level to judge the status of needle valve etc. 2. Check if the needle valve knobs of all limbs of the BFCS are already fully closed. If yes, it is considered that the position switch where the needle valve is located or the 0632 EFCS VCM board PCBA is faulty. Replace the position switch or board and return the position switch or board to R&D.
Backup Flow Control Enabled	Low	If the machine functions properly, the backup flow control system is enabled manually. If the flow sensor malfunctions, the backup flow control system is enabled automatically.	1. Retract BFCS manually on the main interface. 2. Access the service menu and retract BFCS. 3. Restart the machine. 4. Replace the flow sensor board.

Message	Priority	Cause	Solution
Flowmeter Comm Stop	Med	The CPU control board fails to communicate with the flow sensor board for 10 seconds.	1. Restart the machine. 2. Check the cable connection between the flow sensor board and the CPU board. 3. Replace the flow sensor board when necessary. 4. Replace the CPU board when necessary.
Keyboard Comm Stop	Med	The CPU board fails to communicate with the keyboard for 10 seconds.	1. Restart the machine. 2. Check the cable connection between the keyboard and the CPU board. 3. Replace the keyboard when necessary. 4. Replace the CPU board when necessary.
Backup Flow Control Error	Med	The BFCS ejection position sensor malfunctions. The BFCS retraction position sensor malfunctions. BFCS LED voltage input errors occur.	See “BFCS Failure Alarm Numbering Conventions” on page 5-14.

5.2.4.1 EFCS Failure Alarm Numbering Conventions

ID No	Cause	Solution
0x00000001	CPU AVDD Voltage Too Low	1. Restart the machine. 2. If the problem still persists, it belongs to hardware failure. It may be cable failure or board failure. Re-plug cables J1 and J3 of EFCS board. 3. If the problem still persists after cable re-plugging, replace with a new 0632 EFCS VCM board PCBA and return the faulty board to R&D.
0x00000002	CPU AVDD Voltage Too High	
0x00000004	CPU DVDD Voltage Too Low	
0x00000008	CPU DVDD Voltage Too High	
0x00000010	CPU DVCC Voltage Too Low	
0x00000020	CPU DVCC Voltage Too High	
0x00000040	FPGA VPP Voltage Too Low	
0x00000080	FPGA VPP Voltage Too High	
0x00000100	FPGA DVCC Voltage Too Low	
0x00000200	FPGA DVCC Voltage Too High	
0x00000400	FPGA3.3V Voltage Too Low	
0x00000800	FPGA3.3V Voltage Too High	
0x00001000	FPGA1.2V Voltage Too Low	
0x00002000	FPGA1.2V Voltage Too High	
0x00004000	AVCC Voltage Too Low	
0x00008000	AVCC Voltage Too High	
0x00010000	Three-way valve power-off voltage too low	1. Restart the machine. 2. If the problem still persists, check if cable J5 of EFCS board is normally connected. 3. Consider to replace the three-way valve if cable connection is normal. 4. If the problem still persists after replacement, replace with a new 0632 EFCS VCM board PCBA and return the faulty three-way valve or board to R&D.
0x00020000	Three-way valve power-off voltage too high	
0x00040000	Three-way valve power-on voltage too high	

ID No	Cause	Solution
0x00080000	Sensirion flow sensor in O2 limb is faulty, namely, 12C communication between FPGA and Sensirion flow sensor in O2 limb is not successful for continuous 1s.	1. Turn off the machine. Check if the flow sensor cable connection is normal. Restart the machine after making sure that cable connection is normal. 2. If the problem still persists, consider to replace 0632 flowmeter O2 flow sensor adapter board in O2 limb. 3. If this failure is still triggered after replacing the 0632 flowmeter O2 flow sensor adapter board, consider to replace the 0632 EFCS VCM board. Return the faulty 0632 flowmeter O2 flow sensor adapter board or 0632 EFCS VCM board to R&D. 4. If the flow sensor (051-002721-00) or EFCS control board is replaced, upgrade the software bundle version to 02.12.00 and later.
0x00100000	Sensirion flow sensor in AIR limb is faulty, namely, 12C communication between FPGA and Sensirion flow sensor in AIR limb is not successful for continuous 1s.	1. Turn off the machine. Check if the flow sensor cable connection is normal. Restart the machine after making sure that cable connection is normal. 2. If the problem still persists, consider to replace 0632 flowmeter AIR flow sensor adapter board in AIR limb. 3. If this failure is still triggered after replacing the 0632 flowmeter AIR flow sensor adapter board, consider to replace the 0632 EFCS VCM board. Return the faulty 0632 flowmeter AIR flow sensor adapter board or 0632 EFCS VCM board to R&D. 4. If the flow sensor (051-002721-00) or EFCS control board is replaced, upgrade the software bundle version to 02.12.00 and later.
0x00200000	Sensirion flow sensor in N2O limb is faulty, namely, 12C communication between FPGA and Sensirion flow sensor in N2O limb is not successful for continuous 1s.	1. Turn off the machine. Check if the flow sensor cable connection is normal. Restart the machine after making sure that cable connection is normal. 2. If the problem still persists, consider to replace 0632 flowmeter N2O flow sensor adapter board in N2O limb. 3. If this failure is still triggered after replacing the 0632 flowmeter N2O flow sensor adapter board, consider to replace the 0632 EFCS VCM board. Return the faulty 0632 flowmeter N2O flow sensor adapter board or 0632 EFCS VCM board to R&D. 4. If the flow sensor (051-002721-00) or EFCS control board is replaced, upgrade the software bundle version to 02.12.00 and later.
0x00400000	O2 Branch Flow Not Achieved exceeds 0.4LPM	1. Select [Setup]-> [Service]->[Review Logs]->[Alarms]. Observe if there is "FPGA FAIL" item available (ID:1000 0000) triggering "Electronic Flow Control Error" alarm. 2. If this item is available, it indicates that there is problem with the communication between FPGA and CPU. Or FPGA stops running, restart the machine. If the problem still persists after restarting the machine, replace 0632 EFCS VCM board PCBA. 3. If there is no "FPGA FAIL" item available, the part of flow sensor in O2 limb may have problem. In this case, turn off the machine and check flow sensor cable connection. If cable connection is in good condition and the problem still persists after restarting the machine, it can be considered that the flow sensor is fault. Replace the flow sensor. 4. Return the faulty board or flow sensor to R&D.
0x00800000	Balance Gas AIR Branch Flow Not Achieved exceeds 0.4LPM	1. Select [Setup]->[Service]->[Review Logs]->[Alarms]. Observe if there is "FPGA FAIL" item available (ID:1000 0000) triggering "Electronic Flow Control Error" alarm. 2. If this item is available, it indicates that there is problem with the communication between FPGA and CPU. Or FPGA stops running, restart the machine. If the problem still persists after restarting the machine, replace 0632 EFCS VCM board PCBA. 3. If there is no "FPGA FAIL" item available, the part of flow sensor in AIR limb may have problem. In this case, turn off the machine and check flow sensor cable connection. If cable connection is in good condition and the problem still persists after restarting the machine, it can be considered that the flow sensor is fault. Replace the flow sensor. 4. Return the faulty board or flow sensor to R&D.

ID No	Cause	Solution
0x01000000	Balance Gas N2O Branch Flow Not Achieved exceeds 0.4LPM	1. Select [Setup]->[Service]->[Review Logs]->[Alarms]. Observe if there is "FPGA FAIL" item available (ID:1000 0000) triggering "Electronic Flow Control Error" alarm. 2. If this item is available, it indicates that there is problem with the communication between FPGA and CPU. Or FPGA stops running, restart the machine. If the problem still persists after restarting the machine, replace 0632 EFCS VCM board PCBA. 3. If there is no "FPGA FAIL" item available, the part of flow sensor in N2O limb may have problem. In this case, turn off the machine and check flow sensor cable connection. If cable connection is in good condition and the problem still persists after restarting the machine, it can be considered that the flow sensor is fault. Replace the flow sensor. 4. Return the faulty board or flow sensor to R&D.
0x02000000	O2 temperature limit	1. Make sure that the temperature of O2 supply gas does not exceed 50°C. If excess temperature does not occur to the gas supply, it is probably Sensirion flow sensor failure in O2 limb. 2. Turn off the machine. Restart the machine after making sure that cable connection is normal. If the problem still persists, consider replacing the O2 flow sensor.
0x0400000	Balance gas AIR temperature limit	1. Make sure that the temperature of AIR supply gas does not exceed 50°C (the possibility is very small). If excess temperature does not occur to the gas supply, it is probably Sensirion flow sensor failure in AIR limb. 2. Turn off the machine. Restart the machine after making sure that cable connection is normal. If the problem still persists, consider replacing the AIR flow sensor.
0x0800000	Balance gas N2O temperature limit	1. Make sure that the temperature of N2O supply gas does not exceed 50°C (the possibility is very small). If excess temperature does not occur to the gas supply, it is probably Sensirion flow sensor failure in N2O limb. 2. Turn off the machine. Restart the machine after making sure that cable connection is normal. If the problem still persists, consider replacing the N2O flow sensor.
0x1000000	FPGA FAIL	Restart the machine. If the problem still persists, it belongs to hardware failure. It may be board failure. Replace with a new EFCS board.
0x2000000	Flow sensor single selftest error	1. Alarm mechanism: open a certain flow. Compare the measured values of O2 and N2O flow sensors in the respective limb with those of O2 flow sensor in the total limb. This alarm is triggered only when the measured values of flow sensor in the limb is not consistent with those of O2 flow sensor in the total limb. It is not a problem with proportional valve or EFCS board. 2. Restart the machine. Conduct flow sensor single selftest again. If the problem still persists, check if the cable connection between the flow sensor in each limb and that in the total limb, and tube connection between the flow sensor in the total limb and the EFCS module are normal. 3. If the problem still persists with normal cable connection and tube connection, replace the flow sensor in O2 or N2O limb according to the prompt message of selftest result and return the faulty flow sensor to R&D.

5.2.4.2 BFCS Failure Alarm Numbering Conventions

ID No	Cause	Solution
0x00000001	LED Power Voltage Too Low	1. Restart the machine. If the problem still persists, it belongs to hardware failure. It may be cable failure or 0632 EFCS VCM board PCBA failure. 2. If the problem still persists after re-plugging the cable, replace with a new board and return the faulty board to R&D.
0x00000002	LED Power Voltage Too High	

ID No	Cause	Solution
0x00000004	Position switch where BFCS ejects is faulty.	1. Restart the machine. If the problem still persists, it belongs to hardware failure. It may be cable failure or position switch failure where BFCS ejects. 2. If the problem still persists after re-plugging the cable, replace with a new position switch and return the faulty part to R&D.
0x00000008	Position switch where BFCS retracts is faulty.	
0x00000010	BFCS Three-way valve failure	1. Alarm mechanism: run BFCS auto selftest. Switch three-way valve to BFCS limb. The measured flow by total flow sensor is less than 0.2/min. 2. Restart the machine. Conduct BFCS system selftest again. If the problem still persists, set several O2 flows of around 1LPM under EFCS. Select [Setup]?[Service]?[Data Monitors]?[Component]?[FCS]. Check if total limb flow is obviously smaller than O2 limb flow (by more than 0.2LPM). If yes, re-plug the flow sensor and then confirm if the measured values are consistent. 3. If total limb flow is still obviously smaller than O2 limb flow, replace the O2 flow sensor in the total limb to make the measured values consistent. Then conduct BFCS system selftest again. If the problem still persists, consider replacing the three-way valve and return the faulty flow sensor or three-way valve to R&D.

5.2.5 Ventilator Control Board Runtime Alarm

Message	Priority	Cause	Solution
Aux Control Module Comm Stop	High	Lost communication with CPU board for 10 seconds.	1. Restart the machine. 2. Re-plug or replace the communication cable between the CPU Board and the ventilator control board. 3. If the problem persists, replace the auxiliary control module. 4. If the problem persists, replace the CPU Board.
Ventilator Voltage Error	High	5V or 12V voltage error	1. Restart the machine. 2. Measure the input voltage (voltage on the power cable) of the ventilator control module to see if it is within specifications. Check if the cable is defective. 3. If the input voltage is out of specification, replace the power board or cable. 4. If the problem persists, replace the ventilator control board.
PEEP Valve Failure	Med	1. PEEP valve voltage error. 2. PEEP valve pressure error.	1. Check if the pressure of pressure sensor on the PEEP circuit is within specifications. Perform pressure sensor calibration in the service menu or replace the sensor on the PEEP circuit when the pressure error. 2. Measure the voltage at the corresponding test point 3. Check the connection between power supply and expiratory valve assembly 4. Replace the ventilator control board when necessary. 5. Replace the expiratory valve assembly. 6. Replace the power board when necessary
Insp Valve Failure	Med	1. Insp valve voltage error. 2. Insp valve flow error.	1. Check if the inspiratory flow sensor is within specifications. Perform flow sensor calibration in the service menu or replace the flow sensor when the flow error. 2. Measure the voltage at the corresponding test point. 3. Check the connection between power supply and expiratory valve assembly. 4. Replace the ventilator control board when necessary. 5. Replace the expiratory valve assembly. 6. Replace the power board when necessary.
PEEP Safety Valve Failure	Med	PEEP safety valve voltage error.	1. Measure the voltage at the corresponding test point. 2. Check the connection between power supply and expiratory valve assembly. 3. Replace the ventilator control board when necessary. 4. Replace the expiratory valve assembly. 5. Replace the power board when necessary.
Flow Sensor Failure	Low	1.Insp flow is out of range. 2.Exp flow is out of range. 3.Internal Flow sensor is disconnected	1. Check if the zero point of the flow sensor is within specifications. 2. Check if the measurement performed by the flow sensor is within specifications. 3. Replace the flow sensor and perform calibration. 4. Check cable connection between the ventilator inside sensors. Plug in and out the cables again. Replace the sensor when necessary. 5. Replace the ventilator control board and perform calibration.
Check Flow Sensors	High	1.Insp reverse flow 2.Exp reverse flow	1. Check the check valve. 2. Check if the sampling lines of the sensor are connected in correct order. 3. Test the measurement status of the sensor in the valves test tool.

Message	Priority	Cause	Solution
Pinsp Not Achieved	Low	In pressure mode, Pinsp is less than 2/3 of its setting value (setting value is greater than 9cmH2O) or less than setting value-3cmH2O (setting value is less than 9cmH20) for 6 cycles continuously.	1. Check for breathing circuit leakage. 2. Check the measurement accuracy of the pressure sensor. 3. Perform calibration in case of measurement failure. 4. Replace the ventilator control board and perform calibration.
Vt Not Achieved	Low	TVi is less than TV setting value for 6 cycles continuously for over 20% or 50ml, whichever is greater.	1. Check for breathing circuit leak. 2. Check the measurement accuracy of the pressure sensor. 3. Perform calibration in case of measurement failure.
Patient Circuit Leak	Med	1. Pressure less than 2cmH20 for 30s continuously during mechanical ventilation. 2. Patient not connected.	1. Check the breathing circuit connections and flow sensor connections. 2. Check the tidal volume measurement accuracy of the sensor. 3. Check for breathing system leakage.
CO2 A bsorber Canister Not Locked	High	CO2 Ca nister Not Mounted	1. Re-mount the CO2 absorber canister. 2. Check the cable connected between the CO2 absorber canister and the ventilator control board. Replace the cable if necessary. 3. If the problem persists, replace the ventilator control board. 4. If the problem persists, replace the switch on the CO2 abso rber canister.
Ventilator Comm Stop	High	Lost communication with CPU board for 10 seconds.	1. Restart the machine. 2. Re-plug or replace the communication cable between the CPU board and the ventilator control board. 3. If the problem persists, replace the ventilator control board. 4. If the problem persists, replace the CPU board.
Drive Gas Pressure Low	High	Drive Gas Pressure Low	1. Check the status of actual gas supply to confirm if the alarm is in compliance with the actual status. 2. Short circuit the pressure switch and the alarm regarding outputted signals should disappear. Otherwise, it indicates that the pressure switch is defective. Replace the pressure switch. Otherwise, check the connection between the pressure switch and the ventilator control board and check the socket. 3. If the above two items are within specifications, replace the ventilator control board.
O2 Supply Failure	High	O2 Supply Failure	Use the same method to drive gas pressure low to check the O2 pressure switch. If this message occurs when using tanks as the gas supply source, check that the O2 regulator is within specifications and calibrate it as required.
3-way Valve Failure	Low	Error of Solenoid valve electrical signal control status	1. Check the Solenoid valve connection line. 2. Replace the Solenoid valve assembly. 3. Replace the ventilator control board.
Auto Ventilation Disabled	Low	System self test failure. Manual Only.	1. Restart the machine. 2. If the problem persists, check the relevant module based on the system selftest result. 3. If the problem persists, replace the relevant module based on the system selftest result.
Auto Ventilation Disabled - Leak Test Failed	Low	Automatic circuit leak test failure	1. Check if the circuit and tubes are correctly installed (if the sampling port is occluded and if the drain valve is occluded) 2. Do leak test again.

Message	Priority	Cause	Solution
Auto Ventilation is Non-Functional	High	Manual Only. But the Auto/Manual switch is in Auto position.	1. Place the Auto/Manual switch in Manual position.
ACGO Failure	Med	The status of the ACGO switch is incorrect.	1. Check whether the drive gas pressure is within the normal range. If not, ensure that the drive gas pressure is within the normal range. Then turn on or off the ACGO switch. 2. If the problem persists, replace the ACGO switch. 3. If the problem persists, replace the CPU board. 4. If the problem persists, replace the VCM
Electronic ACGO Undetected	Low	No electronic ACGO is detected.	1. Check whether an electronic ACGO module is configured for the machine. 2. If so, check the connections between the ACGO module and the CPU board, and between the ACGO module and the VCM. 3. Replace the electronic ACGO module when necessary. 4. Replace the CPU board or VCM when necessary.

5.2.6 Real-time Alarms of External AG Module

Message	Priority	Cause	Solution
AG Hardware Error	Med	AG hardware error.	Replace the AG module.
O2 Sensor Error	Med	O2 sensor error.	Replace the AG module.
External AG Self Test Error	Low	AG self-test failure.	Replace the AG module.
AG Hardware Malfunction module	High	The AG module was installed improperly or malfunctioned.	Replace the AG.
AG Init Error	High	AG initialization error.	Replace the AG module.
AG No Watertrap	Low	The AG module watertrap was disconnected from the anesthesia machine.	1. Check the AG module watertrap. 2. Replace the AG module watertrap. 3. Replace the AG module.
AG Watertrap Type Wrong	Low	When the patient type was infant, the watertrap type was adult.	Replace with a neonatal watertrap.
AG Change Watertrap	Med	The AG watertrap was required to be changed.	1. Check the AG module watertrap. 2. Replace the AG module watertrap. 3. Replace the AG module.
AG Comm Stop	High	AG module malfunction or communication failure.	1. Replace the AG module communication cable. 2. Replace the AG module.
AG Airway Occluded	High	The actual pump rate of the AG module was less than 20ml/min for more than one second.	1. Check the AG module sampling. 2. Replace the AG module watertrap. 3. Replace the AG module.
AG Data Limit Error	Med	AG module malfunction.	Replace the AG module.
AG Zero Failed	Low	AG module zeroing failure.	1. Re-zero the AG module. 2. Replace the AG module.
AG Cal. Failed	High	AG module calibration failure.	1. Re-calibrate the AG module. 2. Replace the AG module.
O2 Accuracy Unspecified	Low	The measured value exceeded the module accuracy range.	1. Re-calibrate the AG module. 2. Replace the AG module.
N2O Accuracy Unspecified	Low	The measured value exceeded the module accuracy range.	1. Re-calibrate the AG module. 2. Replace the AG module.
CO2 Accuracy Unspecified	Low	The measured value exceeded the module accuracy range.	1. Re-calibrate the AG module. 2. Replace the AG module.
Enf Accuracy Unspecified	Low	The measured value exceeded the module accuracy range.	1. Re-calibrate the AG module. 2. Replace the AG module.

Iso Accuracy Unspecified	Low	The measured value exceeded the module accuracy range.	1. Re-calibrate the AG module. 2. Replace the AG module.
Sev Accuracy Unspecified	Low	The measured value exceeded the module accuracy range.	1. Re-calibrate the AG module. 2. Replace the AG module.
Hal Accuracy Unspecified	Low	The measured value exceeded the module accuracy range.	1. Re-calibrate the AG module. 2. Replace the AG module.
Des Accuracy Unspecified	Low	The measured value exceeded the module accuracy range.	1. Re-calibrate the AG module. 2. Replace the AG module.
Mixed Agent	Low	The AG module supported monitoring and calculation of two kinds of halogenated anesthetic agents, and the measured MAC was less than 3.	Use only one halogenated anesthetic agent.
Mixed Agent	Med	The AG module supported monitoring and calculation of two kinds of halogenated anesthetic agents, and the measured MAC was less than 3. And the monitored value of one agent was invalid.	Use only one halogenated anesthetic agent.
Mixed Agent and MAC≥3	Med	The AG module supported monitoring and calculation of two kinds of halogenated anesthetic agents, and the measured MAC was greater than or equal to 3.	Use only one halogenated anesthetic agent.
External AG Module Disconnected	High	FDA version had external AG module in standard configuration, but the external AG module was not connected.	Load the external AG module.
Incompatible AG Software Version	High	AG module software version was lower than 1.7.3.	1.Replace with AG module of high version software. 2.Return to the factory to update the low-version AG module of low version.
EtCO2 Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
FiCO2 Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.

EtO2 Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
FiO2 Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
EtN2O Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
FiN2O Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
EtHAL Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
FiHAL Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
EtENF Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
FiENF Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
EtISO Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
FiISO Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
EtSEV Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
FiSEV Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.

EtDES Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
FiDES Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.
Rate Overrange	Low	The monitored value exceeded the module measurement range.	1. Reduce the concentration of the monitored gas to the normal range. 2. Re-calibrate the AG module. 3. Replace the AG module.

5.2.7 Runtime Alarms of Internal AG Module

Message	Priority	Cause	Solution
Internal AG Error 01	Low	The AG hardware malfunctions.	Replace the AG module.
Internal AG Error 02	Low	An error occurs during AG module self-test..	Replace the AG module.
Internal AG Error 03	Low	The AG module is not properly installed or malfunctions.	Replace the AG module.
Internal AG Error 04	Low	An error occurs during AG initialization.	Replace the AG module.
Internal AG Error 05	Low	The AG module malfunctions or the communication fails.	1. Replace the communication cable of the AG module. 2. Replace the AG module.
Internal AG Error 07	Low	Zeroing for the AG module fails.	1. Zero the AG module again. 2. Replace the AG module.
Internal AG Error 08	Low	Calibration for the AG module fails.	1. Calibrate the AG module again. 2. Replace the AG module.
Internal AG Error 09	Low	The substitutional device of the watertrap of the internal AG module loosens.	1. Check the substitutional device of the watertrap of the internal AG module. 2. Replace the substitutional device of the watertrap of the internal AG module. 3. Replace the AG module.
Internal AG Error 10	Low	The pump rate of the AG module is below 20 ml/min for more than 1 second.	1. Check the sampling of the AG module. 2. Replace the substitutional device of the watertrap of the internal AG module. 3. Replace the AG module.
Internal AG Error 11	Low	The substitutional device of the watertrap needs to be replaced.	1. Check the substitutional device of the watertrap of the internal AG module. 2. Replace the substitutional device of the watertrap of the internal AG module. 3. Replace the AG module.
Internal AG Error 12	Low	The measured AG module parameter values exceed the normal range	1. Calibrate the AG module again. 2. Replace the AG module.

5.3 Pneumatic Circuit System Problems

The pneumatic circuit system is mainly composed of anesthetic gas delivery system, anesthetic agent delivery device (vaporizer), anesthetic ventilator, breathing system and anesthetic gas scavenging system. This chapter details possible failures regarding the pneumatic circuit system and how to troubleshoot them.

5.3.1 Tools for on-site Maintenance

The tools required for troubleshooting are listed below.

Name	Quantity	P/N
Negative pressure ball	1	040-000814-00*
Injector (100m)	1	040-000040-00*
Circuit adapter test fixture	1	115-002452-00*
Flow sensor pressure sampling pipeline test fixture	1	115-002456-00*
Vaporizer manifold test fixture	1	115-002453-00*
1 MPa (10 bar / 145 psi) Test pressure gauge	1	0611-30-67602*
T-shaped Allen wrench (4*100)	1	M90-100111---*
3106-04-06adapter connector	1	M6Q-030068---*
3106-06-08adapter connector	1	M6Q-030051---*
3106-10-00adapter connector	2	082-000021-00*
3106-06-00adapter connector	1	M6Q-030059---*
Breathing tube adapter connector	1	115-002454-00*
3126-04-00 tube plug	2	082-000023-00*
3126-06-00 tube plug	3	M6Q-120001---*
3126-08-00 tube plug	4	M6Q-120002---*
3126-10-00 tube plug	3	082-000022-00*
Y piece	2	M90-100030---*
Breathing tube Y piece	1	M6Q-030028---*
3140-08-00 Y piece	1	M6Q-030025---*
PU tube (4X200)	1	M6G-020046---*
PU tube (6X100)	1	M6G-020026---*
PU tube (6X200)	1	
PU tube (6X300)	1	
PU tube (8X200)	2	M6G-020014---*
Breathing tube	4	M6G-020017---*
Ø6 silicone tube	3	A21-000007---*
A7 Service Manual	\	046-001140-00
Test Lung, Adult	\	0138-00-0012
Tank Wrench	\	0367-00-0080
Y-Fitting 15 mm connection	\	0103-00-0508
Respiration Tube, 0.6 meter silicone, 15mm	2	0004-00-0076
Breathing Bag 2.3 L silicone	\	0992-00-0139
Regulator Calibration Hose	\	0453-00-1216

Name	Quantity	P/N
A7 troubleshooting kit	\	115-009450-00
Vaporizer Instruction Manual	\	\
Safety Analyzer Dempsey 430 or equivalent	\	\
Digital Volt Meter 3 1/2 digit	\	\
Agent (and NO2) Analyzer ±0.3 V/V%+5% of reading	\	\
Digital Pressure Meter BC Biomedical DPM-2301751 NMC Digital Pressure Meter or equivalent	\	\
Central supplied O2,NO2,AIR Minimum of 35 psi, DISS connections.	\	\
Cylinder gases O2,NO2,AIR Full PISS yoke connections	\	\
Hand tools, Allen wrench set Metric	\	\
Gas Flow Analyzer with 2% accuracy	\	\
A Series Calibration Set (required if using Fluke VT Plus Gas Flow Analyzer)	\	801-0631-00121-00
Ethernet Crossover Cable	\	0012-00-1392-06
USB flash drive	\	0992-00-0297-04
Regulator	\	0119-00-0235**
AG Calibration gas	\	0075-00-0048-01**

* = is part of the 115-009450-00 A7 troubleshooting kit.
** = for units with a AG gas module only

The following pictures show the tools listed above.

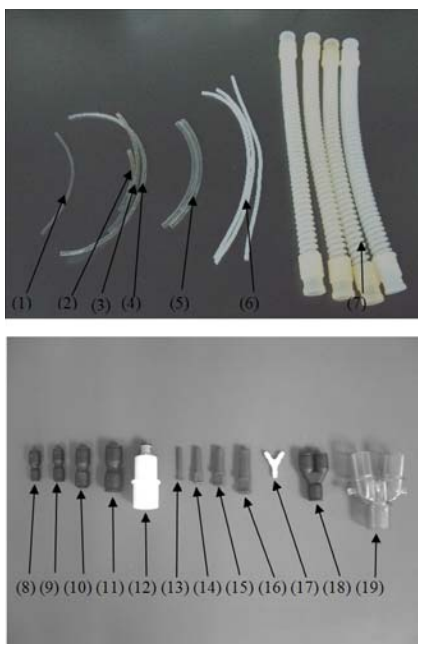


FIGURE 5-1 (1) PU tube (4X200), (2) PU tube (6X100), (3) PU tube (6X200), (4) PU tube (6X300), (5) PU tube (8X200), (6) Ø6 silicone tube, (7) Breathing tube, (8) 3106-04-06 adapter connector, (9) 3106-06-00 adapter connector, (10) 3106-06-08 adapter connector, (11) 3106-10-00 adapter connector, (12) Breathing tube adapter connector, (13) 3126-04-00 tube plug, (14) 3126-06-00 tube plug, (15) 3126-08-00 tube plug, (16) 3126-10-00 tube plug, (17) Y piece, (18) 3140-08-00 Y piece, (19) Breathing tube Y piece

Negative pressure ball:

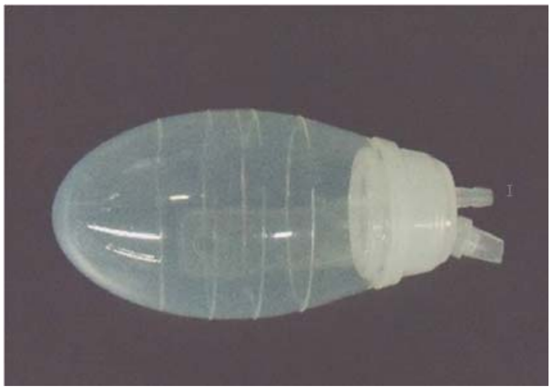


FIGURE 5-2

Circuit adapter test fixture:

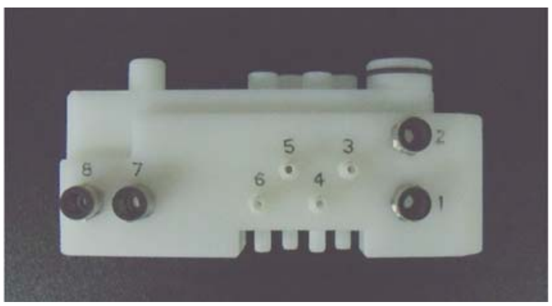


FIGURE 5-3

Flow sensor pressure sampling pipeline test fixture:

FIGURE 5-4

Vaporizer manifold test fixture:

FIGURE 5-5

Anesthesia machine calibration device (fluke VT plus):

FIGURE 5-6

Anesthesia machine calibration device (TSI Certifier 4070):

FIGURE 5-7

Anesthesia machine calibration device (Certifier FA Plus):

FIGURE 5-8

1 MPa (10bar / 145 psi) test pressure gauge:

FIGURE 5-9

5.3.1.1 Precautions for Use of Circuit Adapter Test Fixture

There are four connectors for pressure sampling lines and four Ø6 quick plug-in connectors with number marked on the circuit adapter test fixture, as shown below.

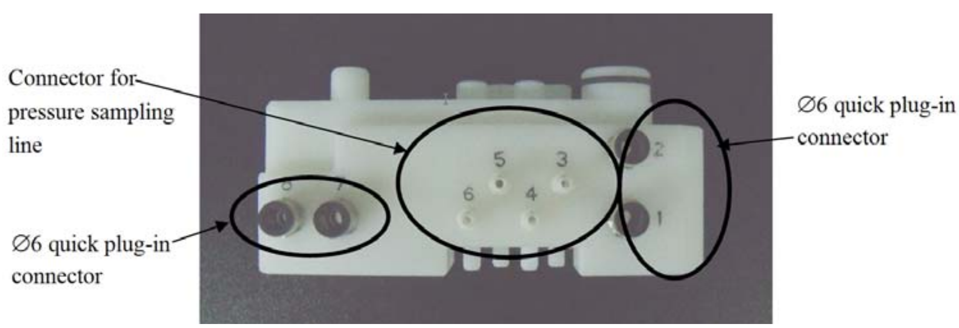


FIGURE 5-10

The connectors for pressure sampling lines can be connected with Ø6 silicone tubes and the Ø6 quick plug-in connectors with PU tube (6X100), PU tube (6X200) and PU tube (6X300), as shown below.

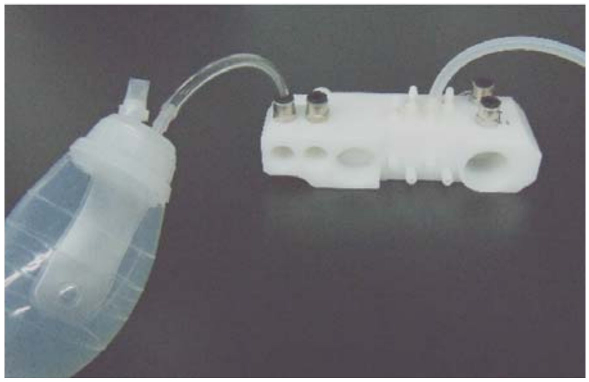


FIGURE 5-11

The circuit adapter test fixture can be mounted either onto the circuit adapter or onto the removed breathing system. The following pictures show the test fixture mounted in position.

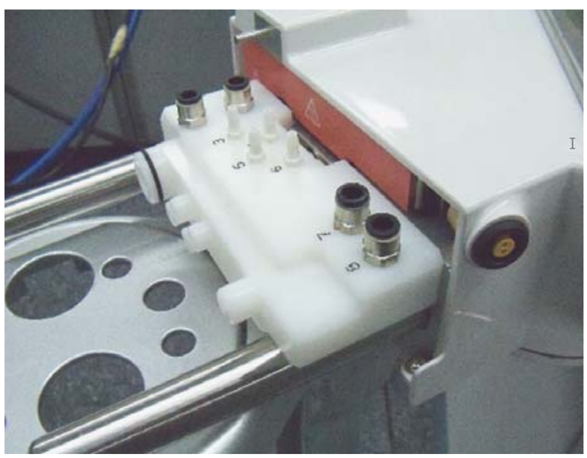


FIGURE 5-12

FIGURE 5-13

If it is hard to install and remove the test fixture, apply a layer of KRYTOX lubricant to the seals (as shown below).

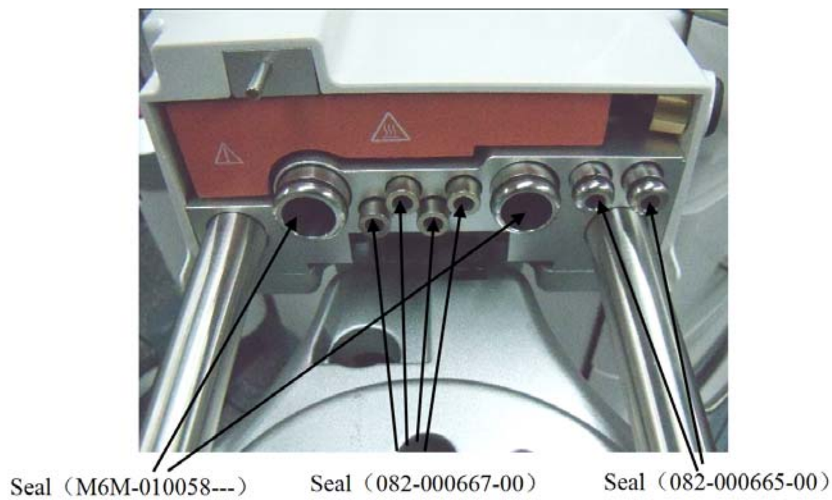


FIGURE 5-14

5.3.1.2 Precautions for Use of Flow Sensor Pressure Sampling Pipeline Test Fixture

There are two connectors for pressure sampling lines on the flow sensor pressure sampling pipeline test fixture, as shown below.

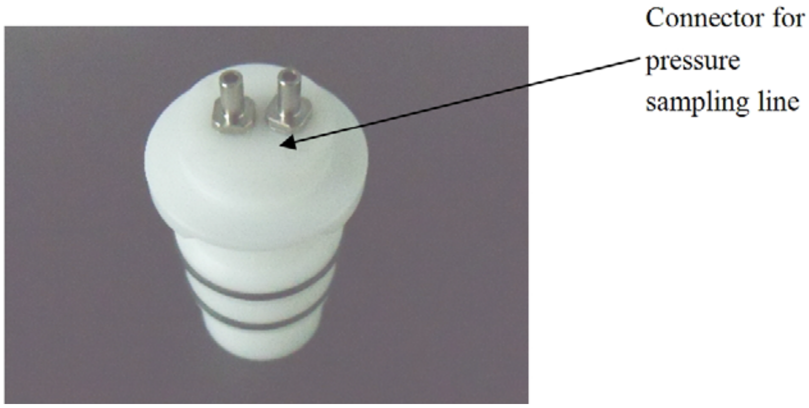


FIGURE 5-15

The connector for pressure sampling line can be connected with Ø6 silicone tubes. When using the flow sensor pressure sampling pipeline test fixture, remove the expiratory or inspiratory flow sensor from the breathing system first. Then mount the flow sensor pressure sampling pipeline test fixture onto the position where the expiratory or inspiratory flow sensor was originally mounted and tighten the Inspiration/Expiration Connector Coupling, as shown below. Perform test after connecting the Ø6 silicone tube to the connector for pressure sampling line.

FIGURE 5-16

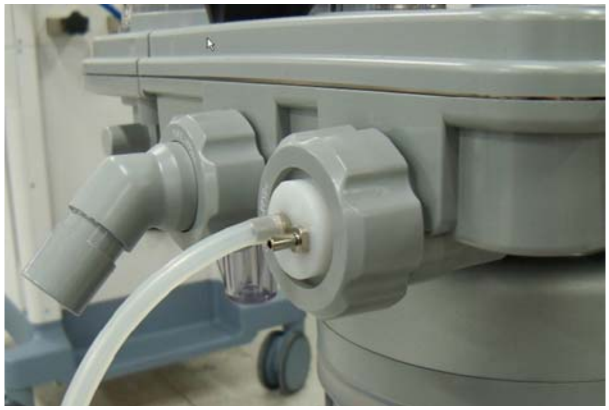


FIGURE 5-17

5.3.1.3 Precautions for Use of Vaporizer Manifold Test Fixture

When using the vaporizer manifold test fixture, remove the o-ring seal on the vaporizer manifold assembly. Then slide the test fixture onto the connector, as shown below.

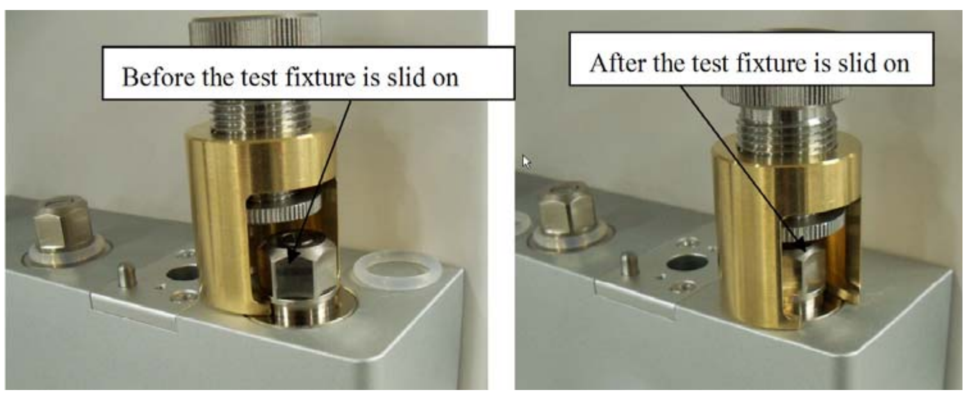


FIGURE 5-18

Turn the knob clockwise until the bottom surface of the pressure head is in contact with the top surface of the connector, as shown below.

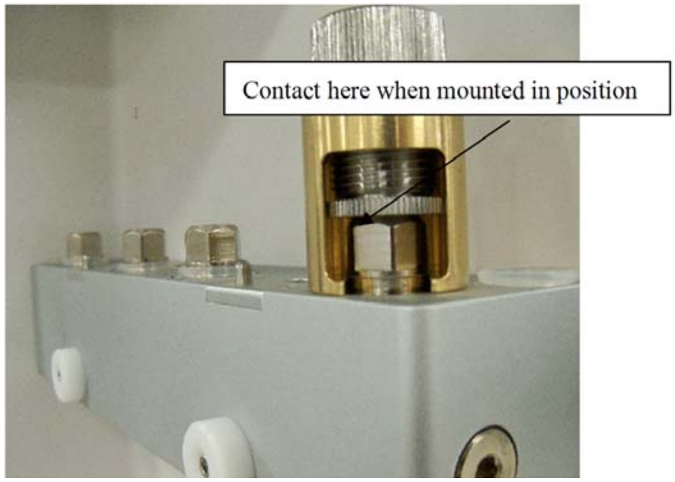


FIGURE 5-19

5.3.1.4 Precautions for Use of Negative Pressure Ball

Besides one sealing cover, the negative pressure ball also has two one-way valves at its front end, as shown below. The built-in one is connected with the gas inlet of the ball which permits the gas come in only, and the exterior one only permits the gas come out. If the front sealing cover is removed or loosened, the sealing performance of the negative pressure ball will compromise. In this case, you need to tighten the sealing cover.

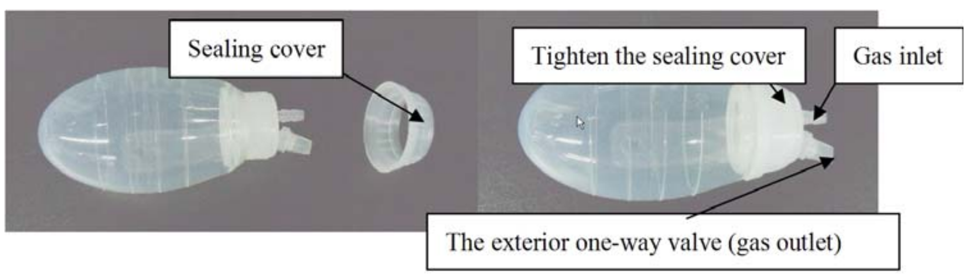


FIGURE 5-20

When the negative pressure ball is connected with the tested component, the ball permits the gas in only, but meanwhile it's free to release air when it's pressed.

FIGURE 5-21

Before using the negative pressure ball, make sure that it is not leaky. Check if the front sealing cover is tightened. Then flatten the negative pressure ball to remove the gas inside. Install the gas outlet plug properly. Block the front gas inlet with your finger then release the ball. Ball should not visibly inflate for at least 30 seconds. If it does, replace the ball.

5.3.2 Gas Supplies and Drive Gas

The following table lists gas supplies and drive gas related failures.

Failure description	Possible cause	Recommended action
Leak	The gas supply tube is damaged or the seal at the connection is damaged.	Replace the gas supply tube or the seal at the connection.
	The quick plug-in connector leaks.	Replace the quick plug-in connector or PU tube (when the PU tube is not damaged, if the tube is long enough, cut off a small segment of the tube where the quick plug-in connector is met, and then insert the tube into position).
	The pipeline gas supply inlet assembly leaks.	Check if the check valve of the pipeline gas supplies inlet assembly leaks in the reverse direction. Replace it if necessary. Check and replace the damaged seal of the pipeline gas supplies inlet assembly. If the problem persists, replace the pipeline gas supplies inlet assembly.
	The drive gas pipeline leaks.	Check and repair the expiratory valve assembly as per the procedures described in "Leak Test of Low-pressure Pneumatic Circuit System" on page 5-58,
Pipeline pressure gauge shows inaccurate readings or no readings.	The pipeline pressure gauge is damaged.	Replace the pipeline pressure gauge.

Failure description	Possible cause	Recommended action
The readings on the pipeline pressure gauge fluctuate greatly.	The filter of pipeline gas supply inlet assembly or the PU tube of the pipeline pressure gauge is occluded or the pressure gauge is damaged.	1. After confirming that the pipeline gas pressure is stable, check the PU tube of the pipeline pressure gauge and filter of the pipeline gas supply inlet assembly. If the tube or the filer is occluded, replace it. 2. If the problem persists, replace the pipeline pressure gauge.
No "O2 Supply Failure" alarm occurs when the O2 pressure is low or this alarm occurs when the O2 supply pressure is within specifications.	The gas pressure switch of the O2 supply inlet assembly is ineffective.	Adjust the pressure switch of the O2 supply inlet assembly to cause O2 supply pressure to approach 0.2 MPa as much as possible within the range of 0.15 to 0.25 MPa when this alarm occurs. If the adjustment fails, replace the pressure switch (refer to "Adjust the Pressure Switch" on page 5-41.).
No "Drive Gas Pressure Low" alarm occurs when the drive gas pressure is low or this alarm occurs when the drive gas pressure is within specifications.	The pressure switch on the integrated pneumatic circuit of the expiratory valve assembly or the PEEP safety valve is ineffective. Or, the filter on the integrated pneumatic circuit of the expiratory valve assembly is occluded.	Adjust the pressure switch on the integrated pneumatic circuit of the expiratory valve assembly to cause drive gas pressure to approach 0.14 MPa as much as possible within the range of 0.05 to 0.2 MPa when this alarm occurs. If the adjustment fails, replace the pressure switch. If the problem persists after the pressure switch is replaced, replace the integrated pneumatic circuit of the expiratory valve assembly (refer to "Adjust the Pressure Switch" on page 5-41)

5.3.2.1 Test the Pipeline Pressure Gauge and Correct the Regulator

Use the following tools to test the pipeline pressure gauge and regulator of the pipeline gas supply inlet assembly:

- 1 MPa (10bar / 145 psi) test pressure gauge (before the test, make sure that the 1 MPa (10bar / 145 psi) test pressure gauge is in good condition) (quantity: 1)
- 3106-04-06 adapter connector (quantity: 3)
- PU tube (4X200) (quantity: 1)
- PU tube (6X200) (quantity: 1)

Test procedures:

I O2 supply inlet assembly:

1. Turn off the pipeline gas supply and bleed the residual pressure through O2 flushing.
2. Disconnect tube 57. The end of the tube which connects the auxiliary O2 supply is not pulled out but the end to Y piece is pulled out.Connect 1MPa test pressure gauge to the above Y piece through "3106-04-06 adapter connector".

FIGURE 5-22

3. Turn on O2 pipeline supply and record the reading on the O2 pipeline pressure gauge. Observe the test pressure gauge. If the reading on the test pressure gauge is not within the range of 0.15 to 0.25 MPa (namely 22.7 to 36.3 psi), adjust the regulator of the O2 supply inlet assembly to cause the reading on the test pressure gauge to reach 0.2 MPa (namely, 39 pai). For operations of the regulator, refer to “Adjust the Regulator of the Pipeline Gas Supply Inlet Assembly” on page 5-41.
4. Turn off the pipeline gas supply and bleed the residual pressure through O2 flushing.
5. Reconnect tube 57.
6. Disconnect tube 39 which connects the O2 supply inlet assembly to the O2 pipeline pressure gauge. Remove the end of tube to the O2 supply inlet assembly.
7. Connect 1MPa test pressure gauge to the outlet of O2 supply inlet assembly through “3106-04-06 adapter connector”.

FIGURE 5-23

8. Turn on the pipeline gas supply and record the reading on the test pressure gauge. If the difference between this reading and the reading on the O2 pipeline pressure gauge is more than 0.1 MPa (14.5 psi), it indicates that the O2 pipeline pressure gauge is damaged. Handle this problem as described in the troubleshooting table.

9. Reconnect tube 39.

NOTE: **For numbers of all PU tubes, refer to sections and 1.2.2 Pneumatic Connections.**

II N2O supply inlet assembly:

1. Turn off the pipeline gas supply. Open the needle valve to bleed the residual pressure and close the needle valve. Disconnect tube 119. The end of the tube which connects the EFCS module is pulled out but the other end is not pulled out.

2. Connect 1MPa test pressure gauge, the pulled-out end of tube 119, and EFCS module N2O inlet through "3106-04-06 adapter connector" and Y piece (17).

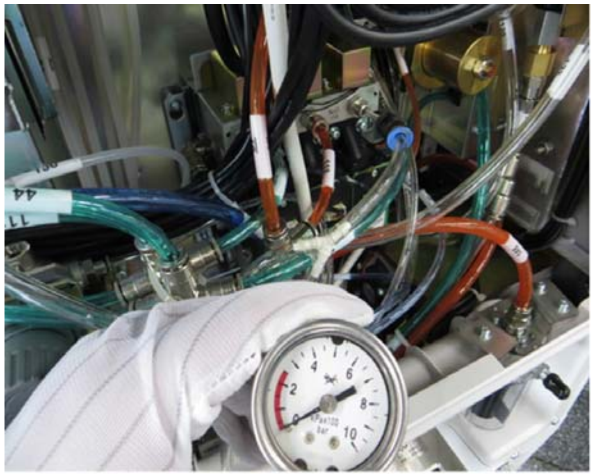


FIGURE 5-24

3. Turn on N2O pipeline supply. Adjust the regulator of the N2O supply inlet assembly to the same value as measured/set for the O2 supply inlet assembly (see step 4 of O2 supply inlet assembly) Record the reading on the N2O pipeline pressure gauge.
4. Turn off N2O pipeline supply and bleed the residual pressure by opening the N2O flow regulator.
5. Reconnect tube 119.
6. Pull out No.40 PU tube which connects the N2O supply inlet assembly to the N2O pipeline pressure gauge. Remove the tube end which connects N2O supply inlet assembly.
7. Connect 1MPa test pressure gauge to the outlet of N2O supply inlet assembly through "3106-04-06 adapter connector".

FIGURE 5-25

8. Turn on the N2O pipeline supply and record the reading on the test pressure gauge. If the difference between this reading and the reading on the N2O pipeline pressure gauge is more than 0.1 MPa (14.5 psi), it indicates that the N2O pipeline pressure gauge is damaged. Handle this problem as described in the troubleshooting table.
9. Reconnect tubing to pressure gauge. Reconnect tube 40.

III AIR supply inlet assembly:

1. Turn off the pipeline gas supply. Disconnect tube 67. The end of the tube which connects auxiliary gas supply is not pulled out but the other end which connects the Y piece is pulled out.
2. Connect 1MPa test pressure gauge to the above Y piece through "3106-04-06 adapter connector".

FIGURE 5-26

3. Turn on AIR pipeline supply. If the reading on the test pressure gauge is not within the range of 0.2±0.05 MPa (29 ± 7 psi), adjust the regulator to cause the reading on the test pressure gauge to reach 0.2 MPa (29 psi). Record the reading on the AIR pipeline pressure gauge.
4. Turn off AIR pipeline supply and bleed the residual pressure by opening the AIR flow regulator.
5. Reconnect PU tube No.50 into the "Y" fitting. Reconnect tube 67.
6. Pull out No.41 PU tube which connects the AIR supply inlet assembly to the AIR pipeline pressure gauge. Remove the tube end which connects AIR supply inlet assembly.
7. Connect 1MPa test pressure gauge to the outlet of AIR supply inlet assembly through "3106-04-06 adapter connector".

FIGURE 5-27

8. Turn on the AIR pipeline supply and record the reading on the test pressure gauge. If the difference between this reading and the reading on the AIR pipeline pressure gauge is more than 0.1 MPa (14.5 psi), it indicates that the AIR pipeline pressure gauge is damaged. Handle this problem as described in the troubleshooting table.
9. Reconnect PU tube No.41 to the pressure gauge.

5.3.2.2 Test the Pressure Switch

Use the following tools to verify the pressure switches of the O2 supply inlet assembly and the expiratory valve assembly are within specifications:

- 1 MPa (14.5 psi) test pressure gauge (quantity:1)
- 3106-04-06 adapter connector (quantity:1)
- 3106-06-08 adapter connector (quantity:1)
- 3140-08-00 Y piece (quantity:1)
- PU tube (8X200) (quantity:2)
- PU tube (6X200) (quantity:1)
- PU tube (4X200) (quantity:1)

Test procedures:

1. Turn off the pipeline gas supply and bleed the residual pressure by pushing the O2 flush button.
2. Disconnect tube 47. The end of the tube which connects pressure regulator assembly is pulled out but the other end is not pulled out.
3. Connect one PU tube (8X200) to the O2 inlet of pressure regulator assembly and connect the other end of the PU tube and also the pulled-out end of tube 47 to the two connectors of "3140-08-00 Y piece" respectively.
4. Connect the test pressure gauge to the third connector of "3140-08-00 Y piece" through "3106-06-08 adapter connector" and "3106-04-06 adapter connector".

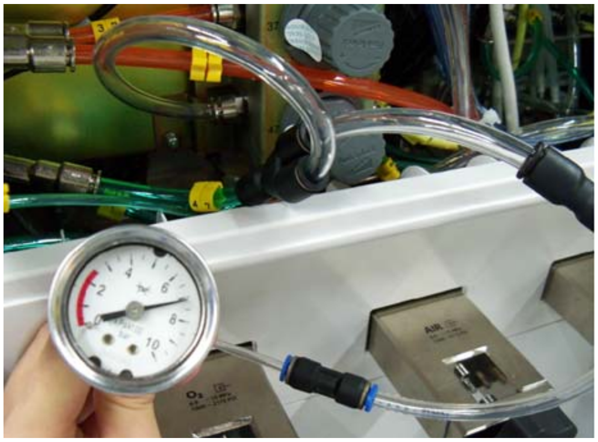


FIGURE 5-28

5. Turn on the O2 pipeline supply.
6. Turn on the machine to enter Standby.
7. Turn off all flow regulators.
8. Turn off the pipeline gas supply (if the reading on the test pressure gauge begins to fall dramatically and continuously after the gas supply is turned off, it indicates that there are one or more leaks in the O2 supply inlet assembly, expiratory valve assembly, O2 flush button assembly, system switch assembly, and/or the O2 flow regulator. Perform the subsequent operations after the leaks are serviced. Failures can be located by using the methods described in "Anesthetic Gas Delivery System" on page 5-42. and "Breathing System" on page 5-54.Breathing System except O2 supply inlet assembly related failures).
9. Manually adjust the O2 flow regulator until O2 flow is approximately 1 L/min, causing the reading on the test pressure gauge to fall gradually to 0.25 MPa (36 psi).
10. Turn off O2 flow to cause the reading on the test pressure gauge not to fall. If the "O2 Supply Failure" alarm occurs 10 seconds later, it indicates that the pressure switch of the O2 supply inlet assembly is defective. Troubleshoot this problem as described in the relevant failure table.
11. Adjust the O2 flow regulator until O2 flow is approximately 0.5 L/min, causing the reading on the test pressure gauge to fall gradually to 0.2 MPa (29 psi).
12. Turn off O2 flow to cause the reading on the test pressure gauge not to fall. If the "Drive Gas Pressure Low" alarm occurs 10 seconds later, it indicates that the pressure switch on the integrated pneumatic circuit of the expiratory valve assembly is defective. Troubleshoot this problem as described in the relevant failure table.
13. Adjust the O2 flow regulator until O2 flow is approximately 0.3 L/min, causing the reading on the test pressure gauge to fall gradually to 0.15 MPa (21.7 psi).
14. Turn off O2 flow to cause the reading on the test pressure gauge not to fall. If the "O2 Supply Failure" alarm does not occur 10 seconds later, it indicates that the pressure switch of the O2 supply inlet assembly is defective. Troubleshoot this problem as described in the relevant failure table.
15. Adjust the O2 flow regulator until O2 flow is approximately 0.3 L/min, causing the reading on the test pressure gauge to fall gradually to 0.05 MPa (7 psi).
16. Turn off O2 flow to cause the reading on the test pressure gauge not to fall. If the "Drive Gas Pressure Low" alarm does not occur 10 seconds later, it indicates that the pressure switch on the integrated pneumatic circuit of the expiratory valve assembly is defective. Troubleshoot this problem as described in the relevant failure table.

5.3.2.3 Adjust the Pressure Switch

Adjust the O2 supply pressure switch and drive gas pressure switch as described below.

Use a flathead screwdriver to adjust the O2 supply pressure switch as shown below. Turn for small degrees each time such as 30 degrees. Note that turning the pressure switch clockwise will decrease its alarm limits and counterclockwise increase its alarm limits. Test the assembly after each pressure adjustment is made. Repeat until the pressure switch is properly adjusted and is within specification (nominal 220 kPa +/- 10 kPa).

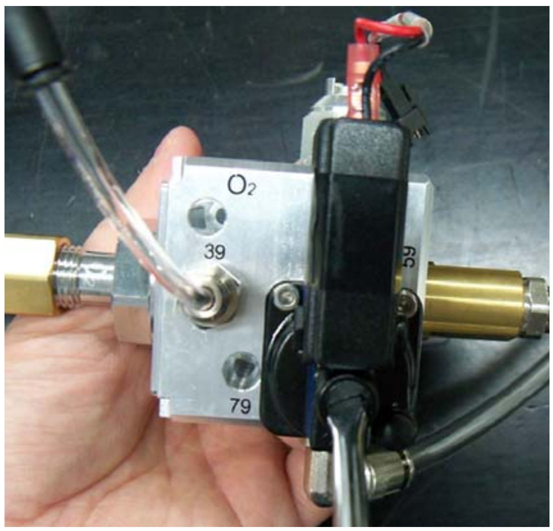


FIGURE 5-29

5.3.2.4 Adjust the Regulator of the Pipeline Gas Supply Inlet Assembly

Pull up the knob cover of the regulator. Turn the cover clockwise to increase pressure or counterclockwise to decrease pressure, as shown below. Bleed the inside pressure of the pipeline gas supply inlet assembly after each pressure adjustment is made, using the Regulator Calibration hose (PN 0453-00-1216). Then, turn on the pipeline gas supply again. Observe the adjusted pressure through the test pressure gauge. Adjust to 200kPa.

FIGURE 5-30

5.3.3 Anesthetic Gas Delivery System

The following table lists anaesthetic gas delivery system related failures.

Failure description	Possible cause	Recommended action
Leak	The O2 flush button assembly leaks.	Replace the seal on the O2 flush button assembly or replace the O2 flush button assembly.
	The system switch assembly leaks.	Replace the seal on the system switch assembly or replace the systems switch assembly.
	The vaporizer is installed improperly, which results in leak.	Re-install the vaporizer.
	The seal between the vaporizer manifold assembly and the vaporizer is damaged.	Clean or replace the seal. The seal should be replaced at least once per year as required.
	The seal between the vaporizer manifold inside and the connection or the rubber plain washer between the vaporizer manifold inside and the spring is damaged or dirty.	Clean the sealing part or replace the damaged seal and rubber plain washer.
	The vaporizer manifold assembly is damaged.	Replace the vaporizer manifold assembly.
	The total flowmeter leaks.	Replace the total flowmeter.
	The flow regulator leaks.	Replace the flow regulator.
	The pressure relief valve at the breathing connection leaks.	Check and replace the defective pressure relief valve.
	The CGO assembly leaks.	Replace the CGO assembly.
	The fresh gas connections of the circuit adapter assembly leak.	Check the seals and tubes at the fresh gas connections. Replace the defective parts and re-install the parts.

Failure description	Possible cause	Recommended action
The gas supplies cannot be turned off after the machine is turned off.	The seal inside the system switch assembly is damaged.	Replace the system switch.
The machine cannot be powered on after turned on.	The contact switch is ineffective.	Replace the contact switch of the system switch assembly.
The flowmeter float indicates inaccurate value or remains unmoved.	The total float rotameter is damaged.	Replace the total float rotameter.
The knob of the flow regulator gets loose.	The flow regulator is damaged.	Replace the flow regulator.

5.3.3.1 Leak Test of the O2 Flush Button Assembly

Perform a leak test of the O2 flush button assembly by using the following tools:

- Negative pressure ball (quantity:1)
- 3106-06-00 adapter connector (quantity:1)
- PU tube (6X100) (quantity:1)

Test procedures:

1. Turn off the pipeline gas supplies and bleed the residual pressure through O2 flushing.
2. Remove the work surface. Pull out No.52 PU tube which connects the O2 flush button assembly to the ACGO assembly. Disconnect at the ACGO end.
3. Connect the inlet of the negative pressure ball to PU No.52 through 3106-06-00 adapter connector and then flatten the negative pressure ball to remove the gas inside.
4. Release the negative pressure ball as shown below. If the negative pressure ball is fully expanded within 30 seconds, it indicates that the O2 flush button assembly is damaged.

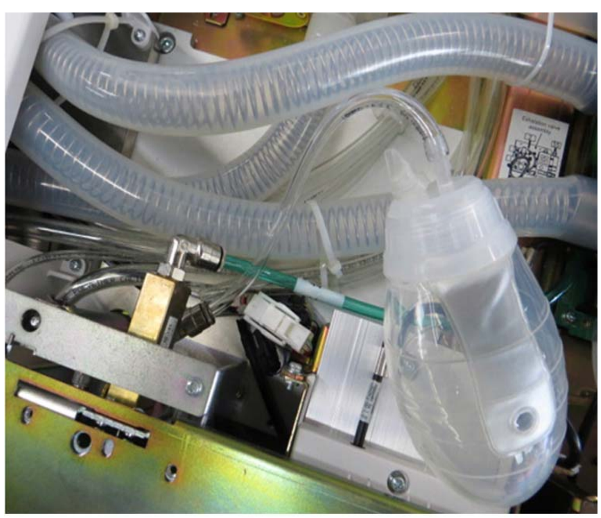


FIGURE 5-31

5.3.3.2 Leak Test of the Flowmeter Related Assembly

Perform a leak test of the flowmeter related assembly (from flow regulator to total flowmeter) by using the following tools:

- Negative pressure ball (quantity:1)
- 3106-06-00 adapter connector (quantity:1)
- 3106-06-08 adapter connector (quantity:1)
- 3126-06-00 tube plug (quantity:3)
- 3126-08-00 tube plug (quantity:1)
- PU tube (6X100) (quantity:1)

Test procedures:

1. Turn off the pipeline gas supplies and turn on the system switch. Bleed the residual pressure by opening the flow regulators.
2. Turn off the system switch. Turn on the flow regulators and turn them counterclockwise for more than half a circle.
3. Pull out No.25 PU tube which connects the total flowmeter to the vaporizer manifold assembly. Disconnect at the vaporizer manifold end.
4. Pull out No.137, 49 and 51 PU tubes which connect with the flow regulator. Disconnect at flow regulator end.
5. Occlude the pulled-out tube end on the flow regulator by using three 3126-06-00 tube plugs.

FIGURE 5-32

6. Connect the other end of the negative pressure ball to the pulled-out end of No.25 PU tube through 3106-06-08 adapter connector, as shown below, and then flatten the negative pressure ball to remove the gas inside.

FIGURE 5-33

7. Release the negative pressure ball. If the negative pressure ball is fully expanded within 30 seconds, it indicates that the total flowmeter assembly is damaged. In this case, pull out the tube plug at the inlet of needle valve and perform the following operations.
8. Pull out No.26 PU tube which connects the back pressure regulator to the total flowmeter. Disconnect at the total flowmeter end.
9. Occlude the pulled-out tube end on the total flowmeter by using 3126-08-00 tube plug.

FIGURE 5-34

10. Compress the negative pressure ball still connected to tube 25 to bleed the air inside.

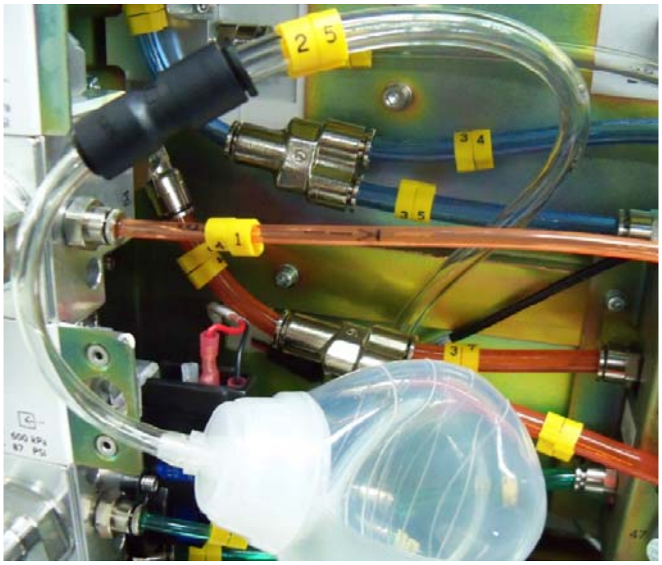


FIGURE 5-35

11. Release the negative pressure ball. If the negative pressure ball is fully expanded within 30 seconds, it indicates that the total flowmeter leaks.

12. Re-connect tube 25. Disconnect tube 58 and pull out its end connecting the back pressure valve. Disconnect tube 26 and pull out its end connecting the total flowmeter.

13. Occlude the pulled-out tube end on the back pressure regulator by using one 3126-08-00 tube plug and connect the negative pressure ball to the pulled-out end of No.26 PU tube through 3106-06-08 adapter connector.

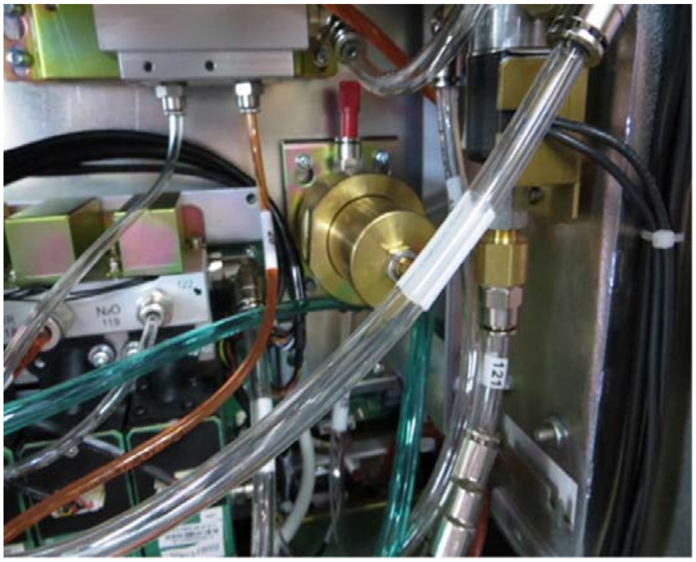


FIGURE 5-36

14. Compress the negative pressure ball to bleed the air inside.

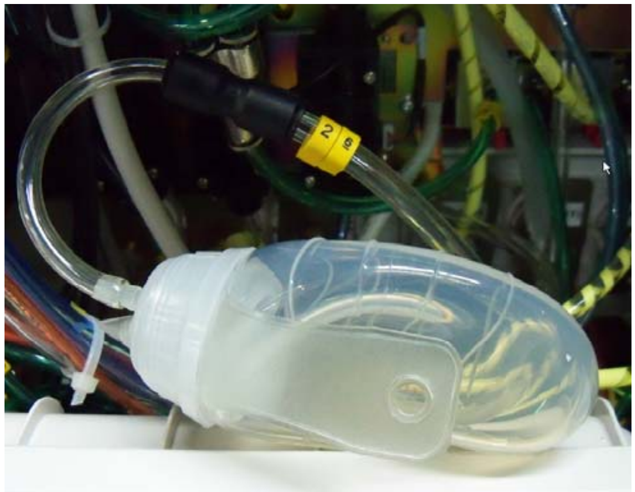


FIGURE 5-37

15. Release the negative pressure ball. If the negative pressure ball is fully expanded within 30 seconds, it indicates that the back pressure regulator leaks.

16. Pull out No.27, 28 and 29 PU tubes which connect the flow sensor to the gas mixer. Disconnect at the gas mixer end.

17. Occlude the pulled-out tube end on the gas mixer by using three 3126-06-00 tube plugs.

18. Disconnect tube 122 and plug out its end connecting the back pressure valve. Connect the negative pressure ball to the pulled-out end of tube 122 through "3106-06-08 adapter connector".

19. Flatten the negative pressure ball to remove the gas inside.

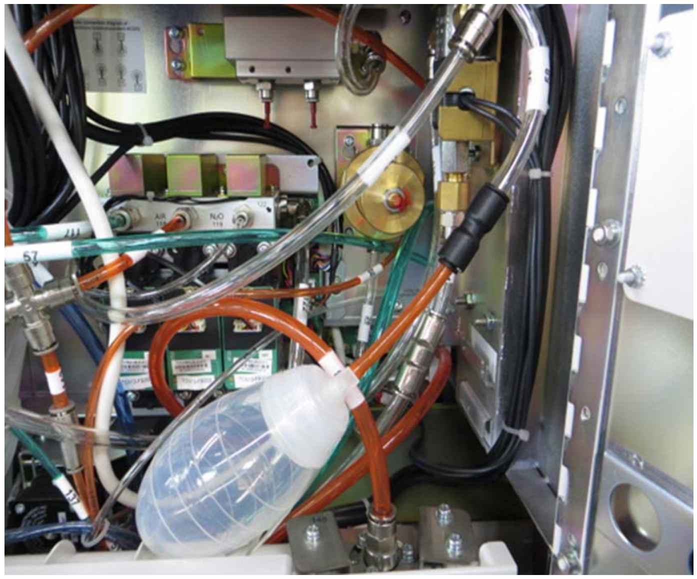
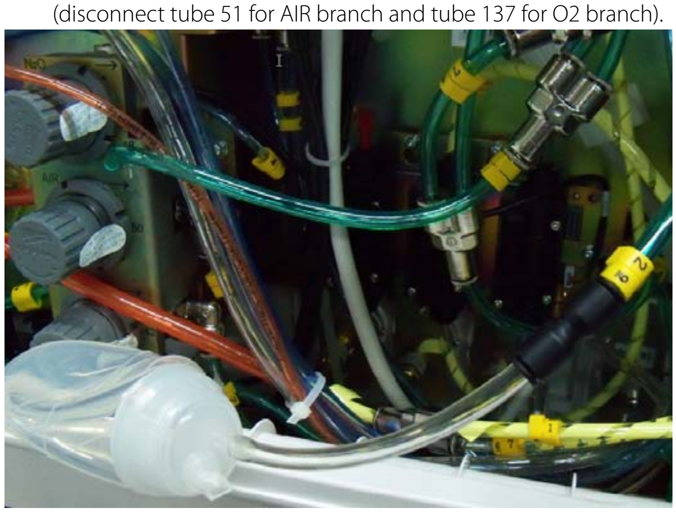


FIGURE 5-38

20. Release the negative pressure ball. If the negative pressure ball is fully expanded within 30 seconds, it indicates that the gas mixer leaks.

21. For N2O branch, disconnect tube 49 and pull out its end connecting the needle valve (disconnect tube 51 for AIR branch and tube 137 for O2 branch).



22. Occlude the pulled-out tube end on the needle valve by using 3126-06-00 tube plug.

23. For N2O branch, disconnect tube 27, pull out its end connecting the needle valve, and connect the gas inlet of the negative pressure ball to the gas outlet of the needle valve through "3106-06-00 adapter connector" and PU tube (6X200) (disconnect tube 28 for AIR branch and tube 73 for O2 branch). Compress the negative pressure ball to bleed the gas inside.

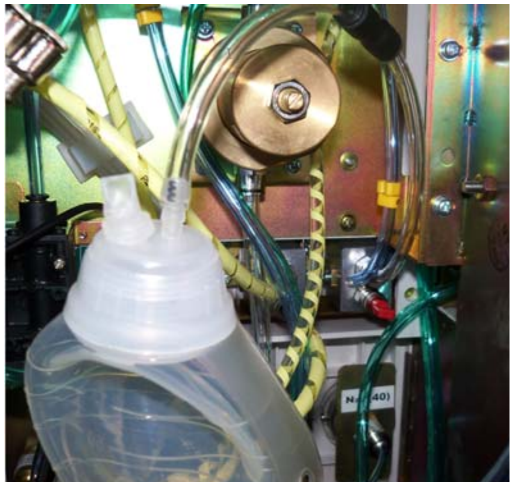


FIGURE 5-39

FIGURE 5-40

FIGURE 5-41

24. Release the negative pressure ball. If the negative pressure ball is fully expanded within 30 seconds, it indicates that the needle valve leaks.

5.3.3.3 Leak Test of the System Switch Assembly

Perform a leak test of the system switch assembly by using the following tools:

- Negative pressure ball (quantity:1)
- 3106-06-00 adapter connector (quantity:1)
- 3106-06-08 adapter connector (quantity:1)
- 3126-08-00 tube plug (quantity:1)
- PU tube (6X100) (quantity:1)

Test procedures:

1. Turn off the pipeline gas supplies and turn on the system switch. Bleed the residual pressure by opening the flow regulators.

2. Pull out No.45 which connects the system switch assembly to the flow regulator. Disconnect at the flow regulator end and connect the pulled-out tube end to the negative ball through one 3106-06-00 adapter connector.

3. Pull out No.43 which connects the system switch assembly to the Y piece. Disconnect at the Y piece end and occlude the pulled-out tube end through one 3106-06-08 adapter connector and one 3126-08-00 tube plug.

4. Flatten the negative pressure ball to remove the gas inside.

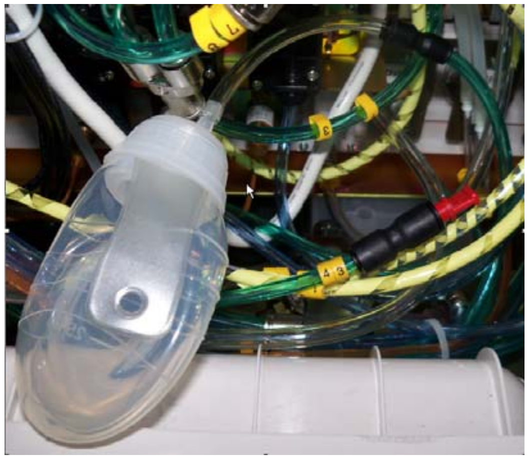


FIGURE 5-42

5. Release the negative pressure ball. If the negative pressure ball is fully expanded within 30 seconds, it indicates that tube connected with the system switch assembly is damaged.
6. Turn off the system switch.
7. Pull out the 3126-08-00 tube plug which was used to occlude tube No.43 before.
8. Flatten the negative pressure ball to remove the gas inside.

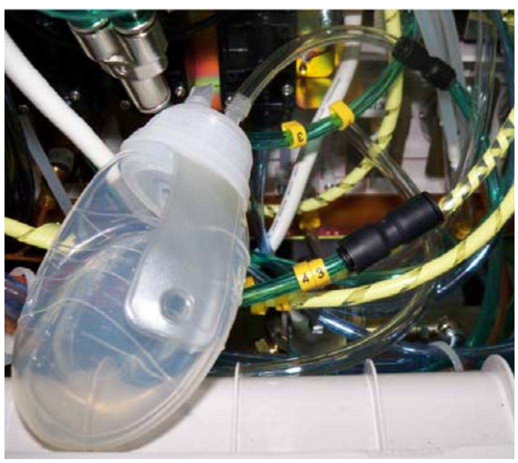


FIGURE 5-43

9. Release the negative pressure ball. If the negative pressure ball is fully expanded within 30 seconds during one of the two tests, it indicates that the system switch assembly is damaged.

5.3.3.4 Leak Test of the Vaporizer Manifold Assembly

Perform a leak test of the vaporizer manifold assembly by using the following tools:

- Negative pressure ball (quantity:1)
- 3106-06-08 adapter connector (quantity:1)
- 3126-06-00 tube plug (quantity:1)
- PU tube (6X100) (quantity:1)
- PU tube (8X200) (quantity:1)
- Vaporizer manifold test fixture (quantity:1)

Test procedures:

1. Turn off the system switch.
2. Remove the vaporizer.

FIGURE 5-44

3. Pull out No.25 PU tube which connects the total flowmeter to the vaporizer manifold assembly. Disconnect at the vaporizer manifold end and occlude it with 3126-08-00 tube plug
4. Pull out No.53 PU tube which connects the vaporizer manifold assembly to the CGO assembly. The end of the tube which connects the vaporizer manifold assembly is pulled out, and connected with the negative ball through one 3106-06-08 adapter connector
5. Flatten the negative pressure ball to remove the gas inside.

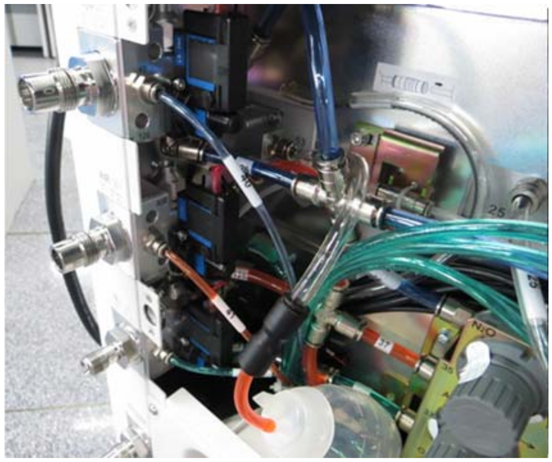


FIGURE 5-45

6. Release the negative pressure ball. If the negative pressure ball is fully expanded within 30s, it indicates that the rubber plain washers or its upper surface contacted mechanical surface are damaged. Handle this problem as described in the troubleshooting table. If not, continue the following tests.
7. Remove the seal ring, and mount the vaporizer manifold test fixture onto the connector of the vaporizer manifold assembly (remove the seal between the connector and the vaporizer when mounting the test fixture)

FIGURE 5-46

8. Repeat step 5 and step 6 every time when the vaporizer manifold test fixture is transferred to the next position. Once the negative pressure ball is fully expanded within 30s, it indicates that the rubber plain washers or its lower surface contacted mechanical surface are damaged. Handle this problem as described in the troubleshooting table. If the four tests are all past, then continue the following tests.
9. Put the seal ring back, mount the vaporizer and turn it on.

FIGURE 5-47

10. Repeat step 5 and step 6 every time when the vaporizer manifold test fixture is transferred to the next position. Once the negative pressure ball is fully expanded within 30s, it indicates that the seal rings are damaged. If the two tests are both past, then the vaporizer manifold assembly and the four seal rings are OK.

5.3.4 Breathing System

The following table lists breathing system related failures.

Failure description	Possible cause	Recommended action
Leak	The CO2 absorber canister is not installed properly.	Re-install the CO2 absorber canister. Remove the sodalime at the sealing connection. Ensure the correct installation of sadalime canister.
	The sealing piece for the absorbent canister assembly is damaged, including the two sealing cushions (049-000142-00 and 049-000145-00), which are in direct contact with the absorbent canister and the two sealing rings (082-001504-00) on the bypass upper cover which are in contact with the circuit bottom housing.	Replace the sealing component of the CO2 absorber canister assembly. It is required to replace the seal once a year.
	The seal for the bag arm is damaged.	Replace the seal for the bag arm. It is required to replace the seal once a year.
	The water collection cup gets loose.	Check and tighten the water collection cup.
	The seal for the water collection cup assembly is damaged.	Replace the seal for the water collection cup assembly. It is required to replace the seal once a year.
	The seal for the circuit adapter assembly is damaged.	Replace the seal, which is required to be replaced once a year.
	The bellows housing or bellows is not installed properly.	Re-install the bellows housing or bellows. Ensure their correct installation.

Failure description	Possible cause	Recommended action
	The bellows sealing cushion falls off or is damaged.	Replace the bellows sealing cushion, which is required to be replaced once a year.
	The valve cover of the breathing valve assembly is not installed properly.	Re-install the valve cover and ensure its correct installation.
	The seal for the valve cover of the breathing valve assembly is damaged.	Replace the seal.
	The breathing tube connecting the patient is damaged.	Replace the breathing tube.
	The bellows is damaged.	Replace the bellows, which is required to be replaced once a year.
	The sealing connection of other parts of the breathing system is damaged.	Repair or replace the sealing connection as per the procedures described in "Adjust the Regulator of the Pipeline Gas Supply Inlet Assembly" on page 5-41
	The condensate valve of the canister assembly is not installed properly or the seal inside is damaged.	Re-install the condensate valve or replace the damaged seal inside.
O2 concentration measurement fails or has great deviations.	The AG Module is not calibrated.	Calibrate the AG Module as per section 4.3.8 (pg. 4-78) "Calibrate the AG Module" .
	The AG Module is damaged.	Replace the AG Module.
The airway pressure gauge shows inaccurate reading or its pointer cannot move.	The airway pressure gauge is damaged.	Replace the airway pressure gauge.
The flow wave is displayed irregularly.	The flow sensor assembly is not installed properly.	Re-install the flow sensor assembly.
	There is water built up inside the flow sensor assembly.	Remove the flow sensor assembly and clear its inside water build-up.
	The membrane of the flow sensor assembly is distorted, dirty or its inside resistance changes. Zero drift occurs to the pressure sensor of the fresh flow sensor board.	Enter the service mode and calibrate the flow sensor as per the procedures described in "If measurement deviations are not corrected after multiple flow sensor calibrations, the user is recommended to replace the flow sensor and then perform calibration. If the problem persists, factory maintenance is necessary." on page 4-17.
	The flow sensor is damaged.	Replace the flow sensor assembly.
	The pressure sensor on the fresh flow sensor board is defective.	Replace the fresh flow sensor board.
	The flow sensor pressure sampling pipeline leaks.	Repair the flow sensor pressure sampling pipeline after checking as per the procedures described in "Leak Test of Flow Sensor Pressure Sampling Pipeline" on page 5-56.

5.3.4.1 Leak Test of Flow Sensor Pressure Sampling Pipeline

If the flow waveform is displayed irregularly, the flow sensor pressure sampling pipeline may be leaky. Perform the leak test by using the following tools:

- Anesthesia machine calibration device (quantity:1)
- Flow sensor pressure sampling pipeline test fixture (quantity:1)
- Circuit adapter test fixture (quantity:1)
- Injector (quantity:1)
- Ø6 silicone tube (quantity:3)
- Y piece (quantity:1)

Test procedures:

A. Leak test of the flow sensor pressure sampling pipeline (the four sampling pipelines of the expiratory and inspiratory flow sensors are all tested)

1. Turn off the system switch.
2. Install the breathing system properly.
3. Remove the flow sensor assembly.
4. Mount the flow sensor pressure sampling pipeline test fixture onto the position where the flow sensor assembly was originally mounted. Tighten the breathing connector rotary cap.
5. Connect the Ø6 silicone tubes to the pressure sensor connector (positive pressure end) on the anesthesia machine calibration device), injector (before mounting, pull out the push rod of the injector) connector and the connector for the flow sensor pressure sampling pipeline test fixture by using a Y piece, as shown below.

FIGURE 5-48

6. Push in the push rod of the injector to let the pressure reading on the anesthesia machine calibration device rise to 70 to 90 cmH2O and then stop pushing. Keep the relative position between the push rod and the injector unchanged. If the pressure reading on the anesthesia machine calibration device does not fall more than 5cmH2O within 15 s, this test is passed.

B. Leak test of the flow sensor pressure sampling pipeline inside the main unit (perform this test if test "A" fails)

1. Mount the circuit adapter test fixture onto the circuit adapter assembly.
2. Connect the Ø6 silicone tubes to the pressure sensor connector (positive pressure end) on the anesthesia machine calibration device), injector (before mounting, pull out the push rod of the injector) connector and the connector (one connector out of No.3 through 6 connectors on the test fixture) for the circuit adapter test fixture by using a Y piece, as shown below.

FIGURE 5-49

3. Push in the push rod of the injector to let the pressure reading on the anesthesia machine calibration device rise to 70 to 90 cmH2O and then stop pushing. Keep the relative position between the push rod and the injector unchanged. If the pressure reading on the anesthesia machine calibration device does not fall more than 5cmH2O within 15s, this test is passed.

If test "A" is failed and "B" passed, it indicates that the flow sensor pressure sampling pipeline on the breathing system is damaged. In this case, replace the breathing system. If both tests "A" and "B" are failed, check the sampling lines and connectors inside the main unit, seals and solenoid valve of the circuit adapter assembly until test "B" is passed. Then perform test "A". If test "A" is still failed, it indicates the flow sensor pressure sampling pipeline on the breathing system is damaged. In this case, replace the breathing system.

5.3.4.2 Leak Test of Low-pressure Pneumatic Circuit System

After making sure that the flow sensor pressure sampling pipeline is not leaky, perform leak tests of the low-pressure pneumatic circuit system as shown in the following figures.

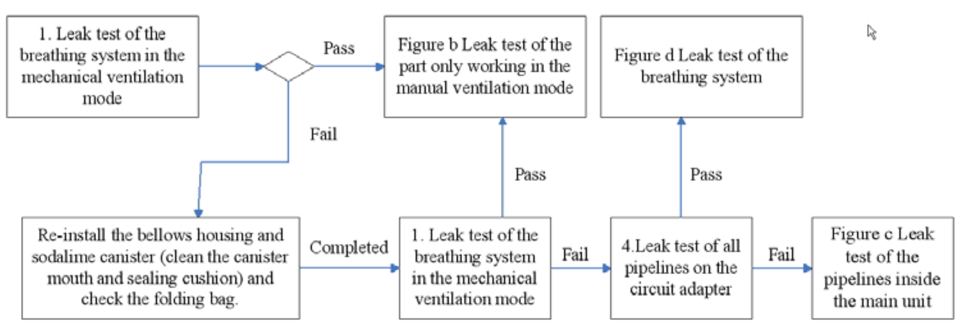


FIGURE 5-50 System Leak Test

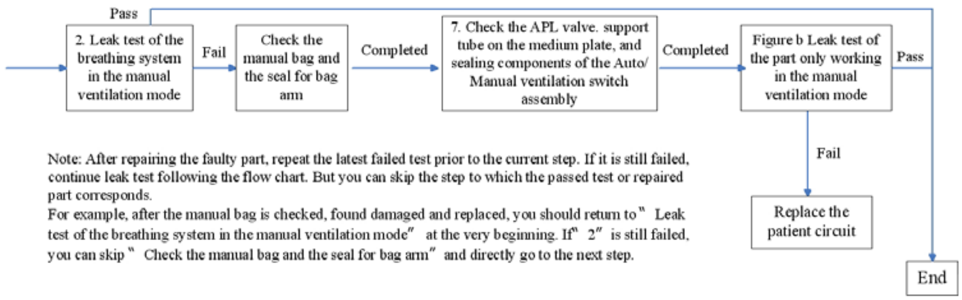


FIGURE 5-51 Leak test of the part only working in the manual ventilation mode

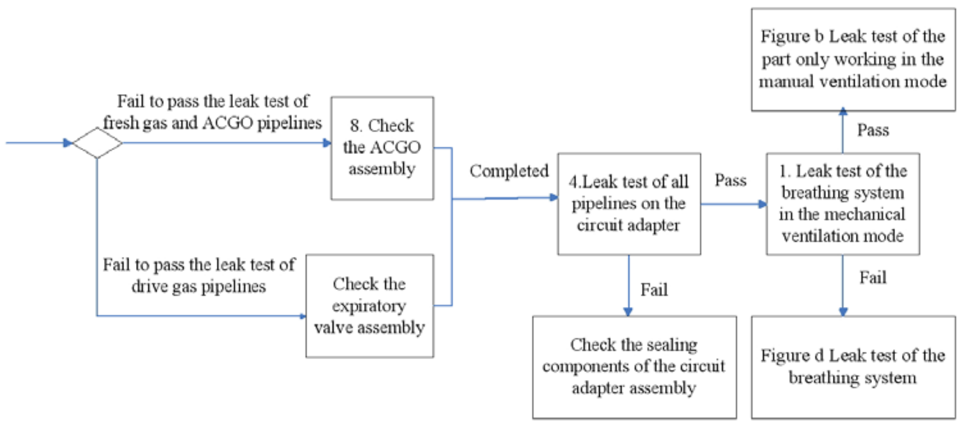


FIGURE 5-52 Leak test of the pipelines inside the main unit

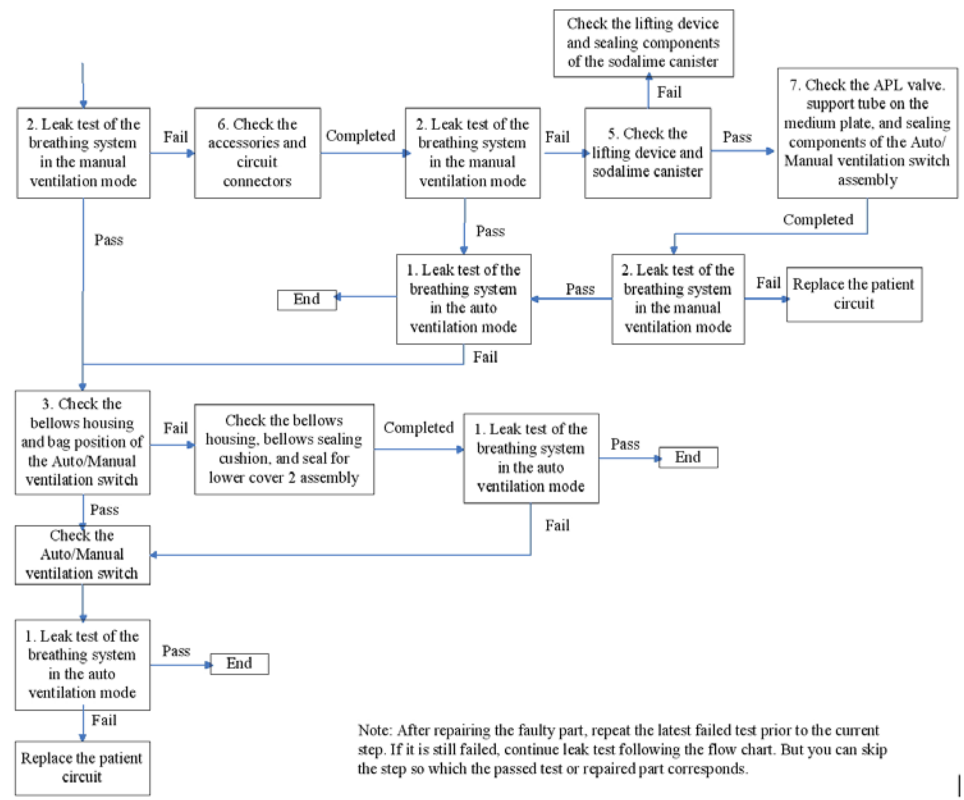


FIGURE 5-53 Leak test of the breathing system

1. Leak test of the breathing system in the mechanical ventilation mode Perform the test as described in"Breathing System Leak Test in Mechanical Ventilation Mode" on page 2-25.
2. Leak test of the breathing system in the manual ventilation mode

Tools required:

- Breathing tube (quantity: 3)
- Breathing tube Y piece (quantity: 1)

Test procedures:

1. Let the system enter Standby.
2. Mount the breathing system properly.
3. Set the Auto/Manual ventilation switch to the Manual position.
4. Set the pressure of the APL valve to maximum.
5. Occlude the inspiratory and expiratory ports and bag arm port by using three breathing tubes and one breathing tube Y piece as shown below.

FIGURE 5-54

6. Turn on the O2 flow regulator and adjust O2 flow to 0.2L/min,
7. Push the O2 flush button to let the reading on the Paw pressure gauge rise to 30cmH2O.
8. Stop O2 flushing. If the reading on the Paw pressure gauge falls under 30cmH2O, this test is failed.
9. If the reading on the Paw pressure gauge rises rapidly, to prevent defective APL valve from damaging the Paw pressure gauge, note to turn off the O2 flow regulator timely to prevent the over range of the Paw pressure gauge (The test which involves O2 flow regulator turned off due to this reason is considered to be passed).

3. Check the bellows housing and the Manual position of the Auto/Manual ventilation switch

Tools required:

- Anesthesia machine calibration device (quantity: 1)
- Circuit adapter test fixture (quantity: 1)
- Injector (quantity: 1)
- Ø6 silicone tube (quantity: 2)
- PU tube (6X300) (quantity: 1)
- Y piece (quantity: 1)

Test procedures:

1. Remove the bellows.
2. Mount the bellows housing properly.
3. Set the Auto/Manual ventilation switch to the Manual position
4. Remove the breathing system.
5. Mount the circuit adapter test fixture onto the breathing system.
6. Connect the Ø6 silicone tubes and PU tube (6X300) to the injector connector, pressure sensor (of the anesthesia machine calibration device) connector (positive pressure end), and No.2 connector to which drive gas corresponds on the circuit adapter test fixture by using a Y piece, as shown below.

FIGURE 5-55

7. Push in the push rod of the injector to let the pressure reading on the anesthesia machine calibration device rise to 30 to 35 cmH2O and then stop pushing. Keep the relative position between the push rod and the injector unchanged. If the pressure reading on the anesthesia machine calibration device falls more than 10cmH2O within 30s, this test is failed. It indicates that the bellows housing or the Manual position of the Auto/Manual ventilation switch is leaky. (Removing the bag arm indicated in the picture has no impact upon the test because the drive gas does not pass through the bag arm.)

4. Leak test of all pipelines on the circuit adapter

Tools required:

- Negative pressure ball (quantity: 1)
- Circuit adapter test fixture (quantity: 1)
- PU tube (6X100) (quantity: 1)

Test procedures:

1. Turn off the system switch.
2. Turn off the flow regulators.
3. Remove the breathing system.
4. Mount the circuit adapter test fixture onto the circuit adapter.
5. Flatten the negative pressure ball to remove the gas inside. Then re-install the plug to seal the ball. Connect the other end of the negative pressure ball to the No.7 connector (on the circuit adapter test fixture) fresh gas pipeline of the circuit adapter test fixture, as shown below.

FIGURE 5-56

6. Release the negative pressure ball. If the negative pressure ball is fully expanded within 30 seconds, it indicates that the test of fresh gas pipeline has failed. Locate the leak inside the main unit as per the method described in “Anesthetic Gas Delivery System” on page 5-42..
7. Turn on the system switch and let the systems enter Standby.
8. Select [Setup] >[Service] > [Diagnostic Tests] > [Valves] to set the A/D value of the PEEP valve to make PEEP exceed 50 cmH2O. Set the A/D value of the inspiratory valve to “0” to produce 0 L/min of flow. Set PEEP safety valve to ON, as shown below.

FIGURE 5-57

9. Flatten the negative pressure ball to remove the gas inside. Then re-install the plug to seal the ball. Connect the other end of the negative pressure ball to No.1 connector to which drive gas pipeline of the circuit adapter test fixture corresponds, as shown below.

10. Release the negative pressure ball. If the negative pressure ball is fully expanded within 30 seconds, it indicates that the test of the drive gas pipeline has failed. Check the expiratory valve assembly and the drive gas related pipeline inside the main unit.

5. Check the absorb canister assembly

Tools required:

- VT PLUS (quantity: 1)
- Lucer adapter connector (quantity: 1)
- Injector (quantity: 1)
- Ø6 silicone tube (quantity: 2)
- PU tube (6X300) (quantity: 1)
- Breathing tube (quantity: 3)
- Y piece (quantity: 1)
- Breathing tube Y piece (quantity: 1)
- Breathing tube adapter connector (quantity: 1)
- T-shaped Allen wrench (quantity: 1)

Test procedures:

1. Turn off the system switch.
2. Disassemble the pre-pak assembly and remove the patient circuit.
3. Mount the pre-pak assembly.
4. Remove the seals on the two connectors of the absorb canister assembly. Connect the two connectors of the lifting device by using two breathing tubes and one breathing tube Y piece. The other end of the breathing tube Y piece is connected to the breathing tube adapter connector through another breathing tube. Connect the injector connector, pressure sensor (of the anesthesia machine calibration device) connector (positive pressure end), and the breathing tube adapter connector to a Y piece, as shown below.
5. Push in the push rod of the injector to cause the pressure reading on the anesthesia machine calibration device rise to 30 to 35 cmH2O and then stop pushing. Keep the relative position between the push rod and the injector unchanged. If the pressure reading on the anesthesia machine calibration device falls more than 10cmH2O within 30 seconds, it indicates that absorb canister assembly are leaky. The test is failed. This step is required when the absorbent canister assembly is in bypass on or bypass off status.

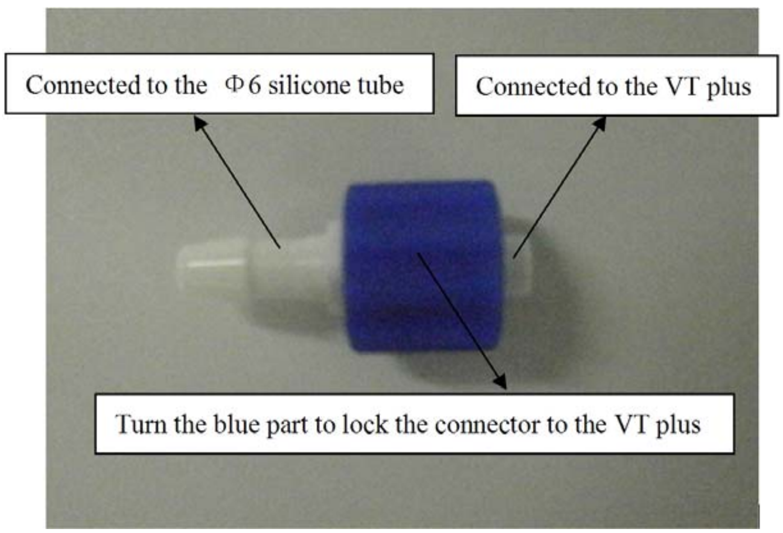


FIGURE 5-58 Lucer adapter connector

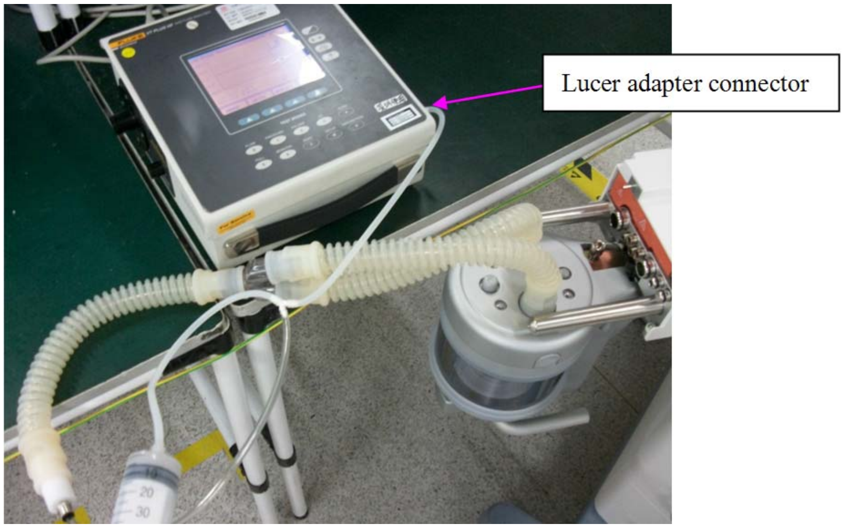


FIGURE 5-59 Bypass Off

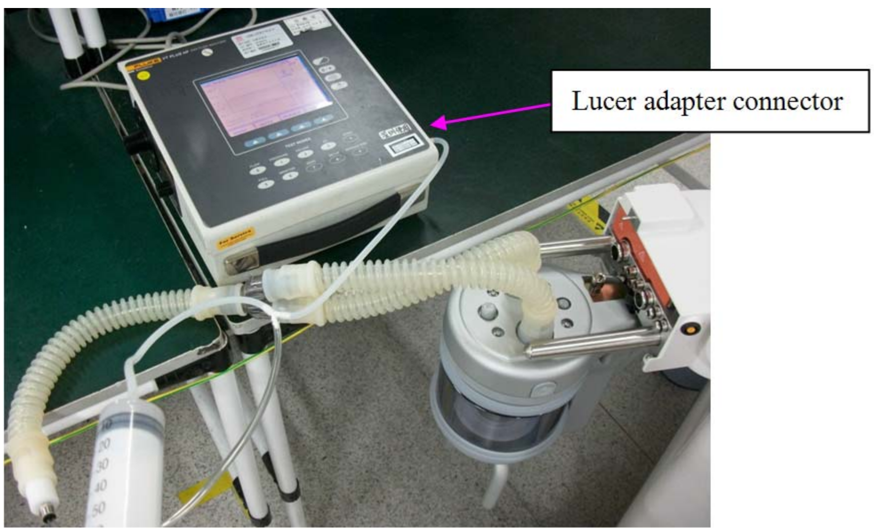


FIGURE 5-60 Bypass On

6. Check the seals on the two connections of the lifting device. It they are damaged, replace the seal and then re-mount the lifting device onto the breathing system.

6. Check the accessories and circuit inspiratory and expiratory parts

Test procedures:

1. Turn off the system switch.
2. Check the manual bag and replace if damaged.
3. Check the breathing tube and replace if damaged.
4. Remove the Paw pressure gauge. Check the seal and replace if found damaged.
5. Remove the water collection cup. Check the seal and replace if found damaged.
6. Remove the O2 sensor (if there is no O2 sensor, remove the plug where the O2 sensor should be installed). Check the seal and replace if damaged.
7. Remove the check valve dome. Check the seal and replace if damaged.
8. Remove the bag arm. Check the seal and replace if damaged.
9. Remove the prepak assembly as shown below. Check the seal and replace if damaged.

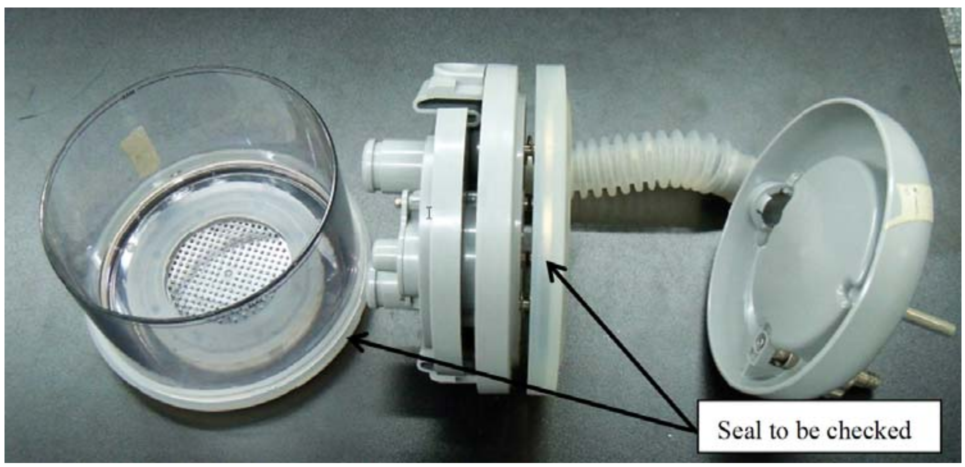


FIGURE 5-61

7. Check the APL valve, support tube on the median plate, and sealing components of the Auto/Manual ventilation switch assembly

The test requires a T-shaped Allen wrench.

Test procedures:

1. Turn off the system switch.
2. Remove the APL valve. Check all seals and replace the defective ones.
3. Remove the support tube on the median plate. Check the seals and replace the defective ones.
4. Remove the Auto/Manual ventilation switch. Check the seals and replace the defective ones.

8. Check the ACGO assembly

Tools required:

1. Negative pressure ball (quantity: 1)
2. 3126-06-00 tube plug (quantity: 1)
3. 3126-08-00 tube plug (quantity: 1)
4. 3126-10-00 tube plug (quantity: 1)
5. 106-10-10 adapter connector (quantity: 1)

Test procedures:

1. Turn off the system switch.
2. Pull out No.22 PU tube which connects the ACGO assembly to the circuit adapter assembly. The end of the tube which connect the ACGO assembly is pulled out but the other end is not, as shown below.
3. Occlude the pulled-out tube end by using one 3106-10-00 adapter connector and one 3126-10-00 tube plug.

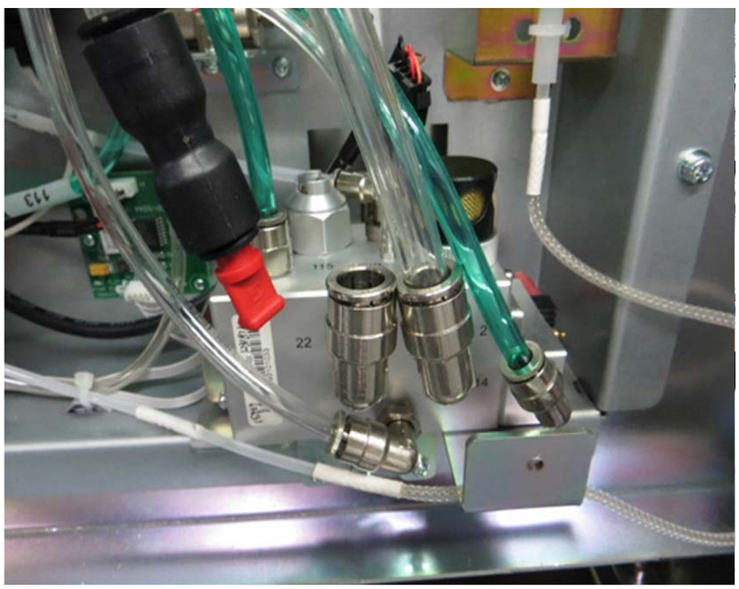


FIGURE 5-62

4. Repeat steps 3 through 7 in "4 Leak test of all pipelines on the circuit adapter". If the test is failed, it indicates that the connectors of the circuit adapter or seals are damaged. If there is no leak, insert the pulled-out tubes into the ACGO assembly.
5. Pull out No.52 and 53 PU tubes which connect the O2 flush button assembly and the vaporizer manifold assembly to the ACGO assembly. Disconnect at ACGO assy. end.
6. Occlude the pulled-out tube ends by using 3126-06-00 and 3126-08-00 tube plugs, as shown below.

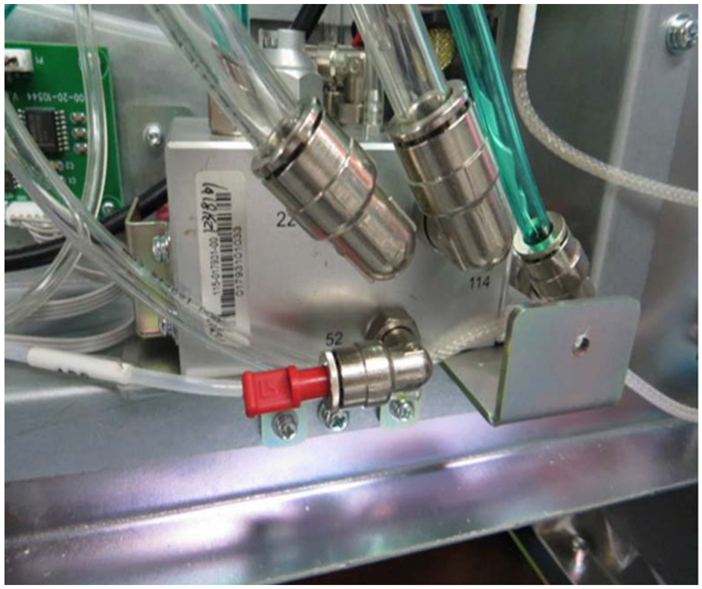


FIGURE 5-63

7. Repeat steps 3 through 7 in "4 Leak test of all pipelines on the circuit adapter". If the test fails, it indicates the CGO assembly is damaged. Check the seals in the CGO assembly and replace any damaged seals.

5.3.5 Tidal Volume

The following table lists tidal volume inaccuracy related failures.

Failure description	Possible cause	Recommended action
Inaccurate tidal volume	The flow sensor is not installed properly.	Re-install the flow sensor.
	The setting of fresh gas flow is inappropriate.	Adjust the fresh gas flow.
	There are significant leaks in the breathing system and the fresh gas flow is too low.	Repair the leaking points after checking as per the procedures described in "Anesthetic Gas Delivery System" on page 5-42. and "Breathing System" on page 5-54.
	* There is water build-up inside the flow sensor.	Remove the flow sensor and clear its inside water build-up.
	*The membrane of the flow sensor assembly is distorted, dirty or its inside resistance changes. Zero drift occurs to the pressure sensor on the ventilator control board.	Enter the service mode and calibrate the flow sensor as described in "If measurement deviations are not corrected after multiple flow sensor calibrations, the user is recommended to replace the flow sensor and then perform calibration. If the problem persists, factory maintenance is necessary." on page 4-17..
	*The flow sensor pressure sampling pipeline is leaky.	Repair the leaking points after checking as per the procedures described in "Leak Test of Flow Sensor Pressure Sampling Pipeline" on page 5-56..

Failure description	Possible cause	Recommended action
	*The flow sensor is damaged.	Replace the flow sensor.
	*The pressure sensor on the ventilator control board is defective.	Replace the ventilator control board.
	The inlet gas flow regulator on the integrated pneumatic circuit of the expiratory valve assembly is defective.	Replace the integrated pneumatic circuit of the expiratory valve assembly or replace the expiratory valve assembly.
	The current Plimit is set too low, which causes expiration to start in advance.	Set Plimit to a higher value to cause Paw not to exceed the limit.
	The displayed TVe and TVi are not the same.	In the valves test tool, compare the measurement error made by three sensors and judge whether to perform calibration as per 4.3.2 Flow Calibration (Service).

In the above table, possible causes marked "*" are related to inaccurate measured values by flow sensors. Do the following to detect if tidal volume inaccuracy results from "*" marked causes.

1. Turn off the flow regulators.
2. Make sure that the patient is disconnected from the system and that the Auto/Manual ventilation switch is set to the mechanical ventilation position.
3. Remove the bellows and then install the bellows housing properly.
4. Remove the water collection cup.
5. Connect the inspiration and expiration connectors together by using a breathing tube, as shown below.

FIGURE 5-64

6. Turn on gas supplies and enter Standby.
7. Select [Setup] > [Service] > [Diagnostic Tests] > [Valves] to set the A/D value of the PEEP valve to make PEEP exceed 40 cmH2O. Set PEEP safety valve to ON, as shown below.

FIGURE 5-65

Set the A/D value of the inspiratory valve to cause the flow of inspiratory valve to reach a certain value. In this case, the flows measured by the ventilator flow sensor, inspiratory flow sensor, and expiratory flow sensor should be the same. Test multiple points by setting the A/D value of the inspiratory valve. For each point, the flows measured by the three sensors should be the same. If not, the measured value by the flow sensor is inaccurate. Troubleshoot the possible causes marked "*" in the above table.

5.4 Sensors and Valves Problems

To use Diagnostic Tests to troubleshoot the sensors or valves related failures, you must be familiar with the one-to-one correspondence between the menu options on the Diagnostic Tests screen and the actual pneumatic circuit and hardware components.

5.4.1 Correspondence with Pneumatic Circuit Components

The following figure shows the one-to-one correspondence between the sensors & valves on the valves-test tool screen and the actual components in the pneumatic circuit diagram.

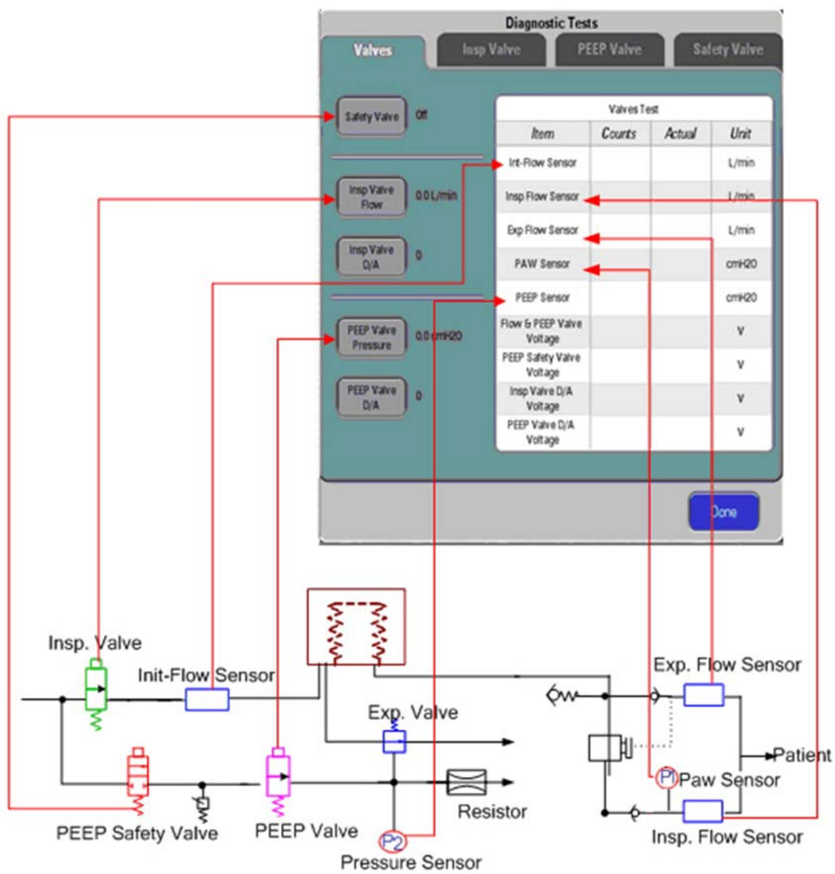


FIGURE 5-66

5.4.2 Correspondence with Hardware Components

The following figure shows how the sampling lines of the sensors are actually connected on the ventilator control board.

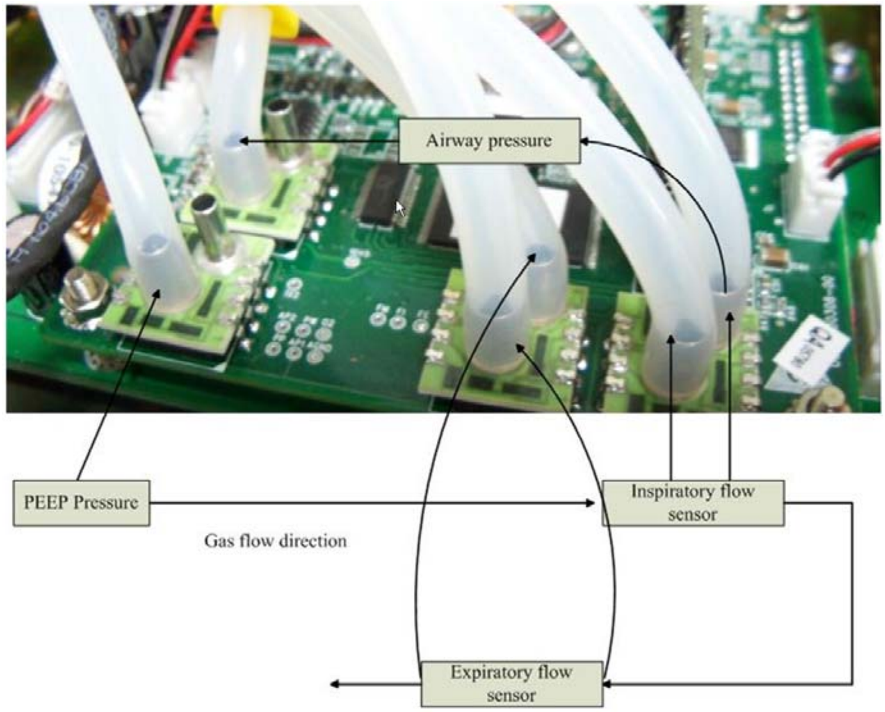


FIGURE 5-67 EPSON Platform

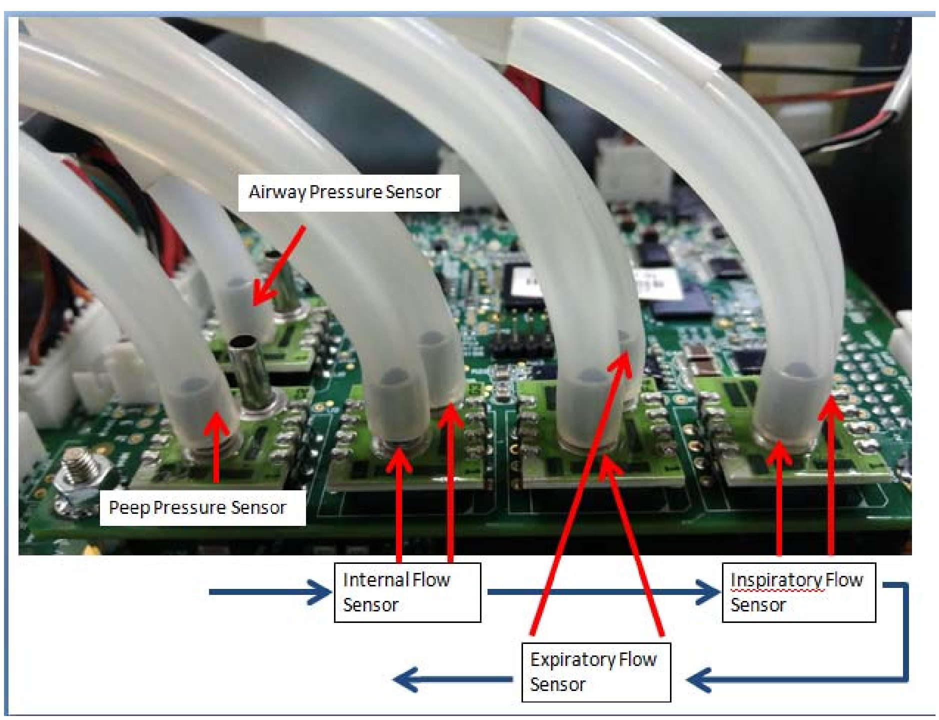


FIGURE 5-68 DSP Platform

5.4.3 Preparations before Using Diagnostic Tests

Make the following preparations before using the valves-test tool to locate the valves or sensors related failures:

1. Connect the pneumatic circuit according to the type of sensor or valve to be checked.

   Before using the Diagnostic Tests Menu: connect the tubes of the anesthesia machine following the constant-flow connection method to check the flow sensors and inspiratory valve. For details, refer to "Flow Calibration (Service)" on page 4-17.
2. Make sure that the supply gas pressure is within specifications.
3. When the system is in Standby, select the [Setup] shortcut key > [Service] > [Diagnostic Tests] to access the [Diagnostic Tests] menu.

5.4.4 Zero Points of Flow & Pressure Sensors Problems

By using the [Diagnostic Tests], you can easily detect if the zero points of all the pressure and flow sensors are within specifications.

To diagnose the zero points of the sensors:

1. Disconnect all gas supplies and make sure that the actual values of the sensors are "0".
2. Check the A/D counts of the sensors in the valve-test tool menu, which are the zero points of the sensors.
3. If the zero point of one sensor is outside of specifications, it indicates that the ventilator control board is defective. You need to replace the board.

You can also detect the zero points of the sensors by referring to 3.7.3 Check the Sensor Zero Point.

NOTE: For the normal range of sensors' zero points, refer to "Check the Sensor Zero Point" on page 3-25.

5.4.5 Connections and Measurement of the Flow Sensors Problems

The flow sensor has two sampling lines. Connection errors include:

- The two sampling lines are connected backward.
- One sampling line is not connected.
- Both sampling lines are not connected.

By using the Diagnostic Tests tool, you can detect if the sampling lines are connected correctly.

To diagnose the sampling line connection of the flow sensor:

1. Connect the tubes of the anesthesia machine following the constant-flow connection method. Refer to “Preparations before Using Diagnostic Tests” on page 5-74.
2. Make sure that gas supplies are within specifications. In the [Diagnostic Tests], PEEP safety valve to ON and the D/A value of the PEEP valve to more than “1500”, making sure that the PEEP valve closes at above 30 cmH2O.
3. Increase the D/A value of the inspiratory valve gradually and the A/D value of the flow sensor should also increase. With the gradual increase of gas supplied,
    - If the A/D value of one sensor decreases gradually, it is possible that the two sampling lines of the sensor are connected backward.
    - If the A/D value of one sensor stays unchanged, it is possible that the two sampling lines of the sensor are broken or not connected.
    - If the A/D value of one sensor nears saturation (above “4000”) quickly, it is possible that the sampling line at the low pressure end (gas outlet end) of the sensor is not connected.
4. If sampling line connection errors are detected, re-connect all sampling lines and verify proper connection of lines.

To diagnose the measurement error of the flow sensors:

1. After confirming that both the zero points of the sensors and the sampling line connections of the sensors are correct, check the flow sensor accuracy:
    - With the gradual increase of actual flow, the measured value of the flow sensor should also increase. Otherwise, the calibration data have errors. You need to calibrate the flow sensor again.
    - Compared with the measured value of the standard flow measurement device (anesthesia machine calibration device), the measured value of the flow sensor should be accurate. Otherwise, the calibration data have errors. You need to calibrate the flow sensor again.

For details, refer to “Check the Flow Sensor Accuracy” on page 3-27..

5.4.6 Connections and Measurement of the Pressure Sensors Problems

The pressure sensor has one sampling line. Connection errors include:

- The sampling line is not connected.
- The sampling line is connected incorrectly.

By using the Diagnostic Tests tool, you can detect if the sampling lines are connected correctly.

To diagnose the sampling line connection of the pressure sensor: ....

- During normal ventilation, if a sampling line connection error occurs, it is easily detected through the Paw waveform and technical alarms. If with the increase of actual pressure, pressure waveform data decreases and the alarm of “Paw Too Low” or “Patient Circuit Leak” occurs simultaneously, it is possible that the sampling line of the airway pressure sensor is connected incorrectly.
- You can enter the [Diagnostic Tests] menu to set the PEEP safety valve to ON. Gradually increase the D/A value of the PEEP valve and observe if the A/D value of the PEEP pressure sensor also increases gradually. If not, it further indicates that the PEEP pressure sensor may be connected incorrectly.

To diagnose the sampling line connection of the pressure sensor in case of pressure calibration failure:

1. Connect the tubes of the anesthesia machine just like described in "Preparations before Using Diagnostic Tests" on page 5-74.
2. Make sure to mount the water collection cup again
3. Make sure that gas supplies are within specifications. In the [Diagnostic Tests] menu, set the PEEP safety valve to ON. Set the Insp. Valve at 5 L/min.
4. Increase the D/A value of the PEEP valve gradually and the A/D value of the pressure sensor should also increase due to the gradual increase of actual pressure,
    - If the A/D value of one sensor decreases gradually, it is possible that the sampling line of the sensor is connected incorrectly.
    - If the A/D value of one sensor remains unchanged, it is possible that the sampling line of the sensor is not connected.
    - The pressure of the airway pressure gauge should increase. If not, it is possible that the airway pressure gauge is defective.
5. If sampling line connection errors are detected, re-connect the sampling lines and verify proper connection of all lines.

To diagnose the measurement error of the flow sensors:

1. With the gradual increase of actual pressure, the measured value of the pressure sensor should also increase. Otherwise, the calibration data have errors. You need to calibrate the pressure sensor again.
2. Compared with the measured value of the standard pressure measurement device (anesthesia machine calibration device), the measured value of the pressure sensor should be accurate. Otherwise, the calibration data have errors. You need to calibrate the pressure sensor again.

For details, refer to "Check the Flow Sensor Accuracy" on page 3-27.

5.4.7 Opening State of the Inspiratory Valve Problems

By using [Diagnostic Tests], you can detect if the opening state of the inspiratory valve is correct.

1. The methods for tube connections and settings of the anesthesia machine are the same as those for sampling line connections of the flow sensors. For details, refer to "Preparations before Using Diagnostic Tests" on page 5-74.
2. In the [Diagnostic Tests] menu, gradually increase the D/A value of the inspiratory valve. If the measured values of the ventilator flow sensor, inspiratory flow sensor, and expiratory flow sensor change very little and low gas flow is felt at the connector of water collection cup, it indicates that the inspiratory valve or the D/A on the Ventilator Control Board is defective.
3. Normally, when the D/A value of the inspiratory valve is set to "2500", the flow measured by the standard flow measurement device can reach 90 L/min.
4. If when the D/A value of the inspiratory valve is set to more than "4000", the flow measured by the standard flow measurement device fails to reach 90 L/min, flow calibration will fail. In this case, you need to replace the expiratory valve assembly or the ventilator control board.
5. To locate if the DA on the Ventilator Control Board is defective, you can use a multimeter to measure the output of DA on the Ventilator Control Board corresponding to the inspiratory valve. If voltage also increases with the increase of D/A value, and voltage nears 6V when D/A value is set to more than "4000", it indicates that the DA on the Ventilator Control Board corresponding to the inspiratory valve may be correct.
6. After the expiratory valve assembly or the Ventilator Control Board is replaced, you can use the similar method to check if the problem is fixed.

5.4.8 Opening States of the PEEP Safety Valve Problems

When the PEEP safety valve is permanently OFF and the gas supplies are within specifications, the [Drive Gas Pressure Low] is alarmed.

By using Diagnostic Tests, you can detect if the opening states of the PEEP safety valve and PEEP valve are correct.

To diagnose the opening state of the PEEP safety valve:

1. Make sure that gas supplies are within specifications.
2. In the [Diagnostic Tests] menu, when the PEEP safety valve is switched on, a subtle click is heard.
3. Adjust the D/A value of the PEEP valve to cause the pressure measured by the PEEP pressure sensor to exceed 0 cmH2O.
4. Switch off the PEEP safety valve. The pressure measured by the PEEP pressure sensor should drop to 0 cmH2O immediately. Switch on the PEEP safety valve again. The measured value of the PEEP pressure sensor rapidly restores almost the same value to that before PEEP safety valve is switched off. During this period, gas flow and also change of gas flow when the PEEP safety valve is switched on or off can be felt at the PEEP outlet, which helps to judge if the PEEP safety valve can be switched on or off correctly.
5. If an error is detected, it is possible that the PEEP safety valve or the safety valve drive voltage on the ventilator control board is defective. You can use a multimeter to measure the drive signals on the ventilator control board corresponding to the PEEP safety valve (measurement can be performed at the corresponding socket). When the PEEP safety valve is turned on, the drive voltage should near 6V. When the PEEP safety valve is turned off, the drive voltage should near 0V. If these two conditions are met simultaneously, the ventilator control board is normal.
6. If the PEEP safety valve is defective, replace the expiratory valve assembly. After replacement, you can use the similar method to check if the problem is fixed.

5.4.9 Opening State of the PEEP Valve Problems

When the PEEP valve is defective, pressure related alarms occur in mechanical ventilation modes.

By using Diagnostic Tests, you can detect if the opening states of the PEEP valve is correct.

To diagnose the opening state of the PEEP valve:

1. Make sure that gas supplies are within specifications. In the [Diagnostic Tests] menu, set the PEEP safety valve to ON.
2. With the increase of D/A value of the PEEP valve, the measured value of the PEEP pressure sensor (or the anesthesia machine calibration device) should also rise. Note that there is a non-response area for the PEEP valve when the D/A value is relatively small. When the D/A value is less than this range, the PEEP valve cannot be opened and the output is "0" continuously. When the D/A value is greater than this range, the pressure output will increase with the increase of D/A value. This phenomenon also exists for the inspiratory valve.
3. For subsequent diagnosis rules, refer to "Opening State of the Inspiratory Valve Problems" on page 5-77.

5.4.10 Basal Flow Adjustment of O2 Needle Valve

1. Disconnect the #137 tube from the O2 needle valve on the anesthesia machine and connect the tube to the inlet of the test needle valve assembly. Connect the outlet of the test needle valve with the flow analyzer as show below(FIGURE 5-69).

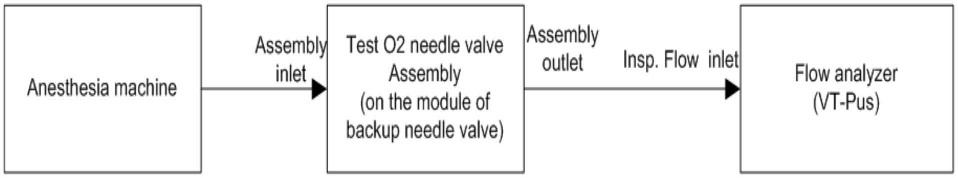


FIGURE 5-69

2. Remove the two M3X3 set screws on the needle valve spacing turntable. Adjust the O2 needle valve assembly so that the flow of flow analyzer is 1.1±0.1L/min (try to be close to 1.1L/min as much as possible to make sure the requirement is satisfied repeatedly).
3. Operate as follows with the flow kept unchanged:
   a. Rotate the turntable to let the bulge touch the spacer pin (located on the trigger switch mounting block and trigger rod), see FIGURE 5-70.

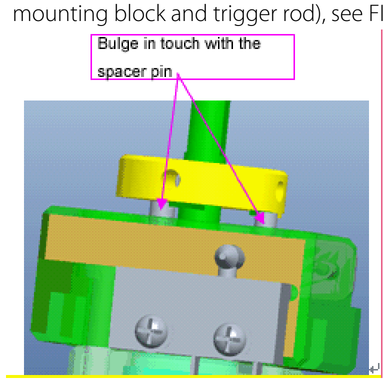


FIGURE 5-70

   b. Plug the assembling limited block (0632-J07) for needle valve in the middle. Fix the needle valve spacing turntable with two M3X3 set screws (dispensing thread sealant 243), see FIGURE 5-71. The screws are located inside the two threaded holes vertical to each other, The tightening torque is 4 to 5kgf.cm.

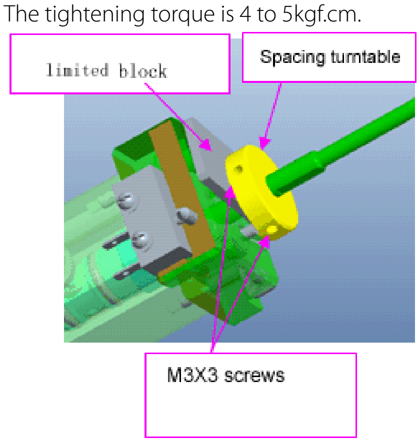


FIGURE 5-71

NOTE: Do not rotate the turntable when tightening the screws, so that the bulge of the needle valve spacing turntable is in touch with the spacer pin all the time.

NOTE: Do not close flow before fixing the needle valve spacing turntable. Fix the needle valve spacing turntable when the flow remains open. After the needle valve spacing turntable is fixed, make sure (fully close flow after increasing flow) the flow satisfies the requirement immediately repeatedly.

4. After fixing the needle valve spacing turntable, open the needle valve via valve knob to set the flow to 5L/min. Then rotate the needle valve to decrease flow until the needle valve is fully closed. Confirm that the flow of flow analyzer is 1.1±0.1L/min. Repeat for three times and make sure the flow satisfies the requirement.

5.5 Hardware and Electrical Problems

Failure description	Possible cause	Recommended action
When switch ON, AC and battery indicator lamps are not lit, the machine can not ventilate and the screen is not lit.	AC power supply is not connected and the batty capacity is insufficient.	Check and make sure that the AC power supply is connected properly.
	The breaker of AC input is tripped and the battery capacity is insufficient.	Reset the breaker. If the breaker is still tripped when powered on after reset, it indicates the machine inside is short-circuited.
	The fuse of power board is burned and the battery capacity is insufficient.	Replace the fuse. If the fuse is replaced, the machine still can not be started up. It indicates there exists internal shorting in the machine.
The auxiliary AC electrical outlet has no voltage output.	The breaker of auxiliary outlet is tripped.	If there is still no voltage output after the breaker is reset, it indicates the auxiliary A/C electrical outlet is shorted.
Anesthesia machine can not be started.	The system switch is damaged.	Replace the system switch.
	The cable connected to system switch falls off.	Check and make sure that the cable is connected properly.
	The power board hardware circuit failure results in no power output of 15.2V, 3.3V, 5V, and 12V.	Replace the power board.
	The power board software code error results in no power output of 15.2V, 3.3V, 5V, and 12V.	Update the software.
The screen of anesthesia machine can not be lit.	The cable connected to the inverter falls off.	Check and make sure that the cable is connected properly.
	Screen Backlight Board is damaged.	Replace the Screen Backlight Board.
	The power board hardware failure causes improper output.	Replace the power board.
	The power board software failure causes improper output.	Update the power board software.
The screen of anesthesia machine can be lit, but without any content.	The screen power supply fuse is burned out, which results in no 3.3V output.	Replace the fuse.
	The main control board failure results in no display output.	Replace the main control board.
The screen of anesthesia machine can be lit and shows content, but the screen flashes.	The failure of power board causes power fluctuations	Replace the power board.
	The time sequence of main control board LVDS is abnormal.	Update the software of main control board. If the screen persists flashing, replace the main control board.
The heater is ineffective.	The heater driver and control circuit of power board are damaged.	Replace the power board.
	The heater is damaged.	Replace the heater.
	The internal sensor of heater is ineffective.	
	The cable connected to heater falls off.	Check and make sure that the cable is connected properly.

Failure description	Possible cause	Recommended action
The touch panel is ineffective.	The touch panel is damaged.	Replace the touch screen.
	The controller of touch panel is damaged.	
	The cable connected to touch panel falls off.	Check and make sure that the cable is connected properly.
During the operation of the anesthesia machine, ventilation stops all of a sudden but the display and buttons work normally.	The ventilator control board or valve is damaged.	Select [Setup] > [Service] > [Diagnostic Tests] > [Valves] Test the status of each valve and reference power supply in the valves-test tool window. If valve malfunction or reference power supply error is detected, replace the valve or ventilator control board.
Exiting Standby fails.	The ventilator control board hardware self-test is failed.	Replace the ventilator control board.
Alarm messages are displayed on the screen but without alarm sound.	The speaker is damaged.	Replace the speaker.
	The speaker cable is disconnected	Check and make sure that the cable is properly connected.
Network connection is failed.	The cables connected to the network connection board get loose.	Properly insert the cables.
	The network cable is too long.	Shorten the network cable. Recommended cable length is approximately 1.5 m.
	The network cable is used incorrectly.	The network cable has two linear orderings that should be differentiated.
No gas is outputted through the valve in mechanical ventilation mode.	The Auto/Manual ventilation switch is defective.	Check the screen to see if the anesthesia machine is in mechanical ventilation mode and if there is an alarm triggered.
	The valve cannot be opened.	1. Set tidal volume to maximum. 2. Switch between standby and mechanical statuses or between manual and mechanical statuses repeatedly. 3. Replace the pneumatic circuit block.
Communication between CPU board and infrared communication board fails.	The cables between CPU board and infrared communication board get loose.	Properly insert the cables.
	The communication board or CPU board is damaged.	Replace the communication board or CPU board.

5.6 Software Update and Software Configuration Activation

NOTE: Software upgrade may by required when replacing the CPU Board (P/N: 115-040636-00 (EPSON) or 115-052903-00 (DSP)), the Ventilator Control Board (P/N: 801-0631-00027-00 (EPSON) or 115-058771-00 (DSP)), the Power Board (P/N: 115-018145-00) or the EFCS Control Board (P/N: 115-018150-00).

1. Connect the Ethernet port of the PC to the Ethernet port of the A7 using the Ethernet Crossover Cable.
2. Before running Mindray Patient Monitor System Update Tool, verify that the IP address of the PC is set to 192.168.23.1., and the Subnet mask is set to 255.255.255.0. To check and set the IP address on the PC follow these instructions.
   a. On the PC click Start, Settings and then Network Connections.
   b. Right click Local Area Connection and then left click Properties.
   c. Scroll down to Internet Protocol (TCP/IP), click on it and then click Properties.
   d. Click the radio button for "Use the following IP address:" Set the IP address and Subnet mask and then click OK.

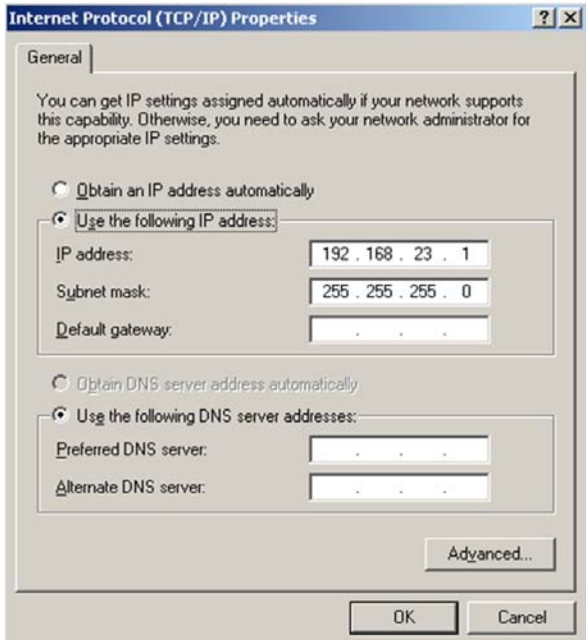


FIGURE 5-72

3. Make sure that the Mindray Patient Monitor System Update Tool has been installed to the PC. If it has not been installed then follow these steps:

a. Run the SystemUpdateToolForService.exe file .

b. When prompted to setup a language select "English" and then select "OK".

c. When the Welcome dialog window is displayed select "Next".

d. When the Customer Information dialog window is displayed enter the following:

- User Name: Manufacturing
- Company Name: Mindray
- Serial Number: 366-267-2667
- Select "Next".

e. When the Administrator password dialog window is displayed enter "datascope" as the password and confirm it, then select "Next".

f. When the Destination Location dialog window is displayed select "Next" to accept the default Destination Folders.

g. When the Select Program Folders dialog window is displayed select "Next" to accept the default Program Folder.

h. When the Install Shield Wizard dialog window is displayed select "Finish" to complete the installation.

4. Upgrade Software:

a. From the Desktop, run the Mindray Anesthesia Machine and Ventilator Software Upgrade Tool Icon. When the "Select Product Series" dialog is displayed select A Series followed by OK. Once the System Update Tool starts perform the following to update the software:

b. Select "Select Package" from the top tool bar.

c. When the Select Package dialog is displayed select ">>>"

d. When the Open dialog is displayed select down arrow "▼" for Look in.

e. If changing the CPU Board (P/N: 115-040636-00 (EPSON) or 115-052903-00 (DSP)), the Ventilator Control Board (P/N: 801-0631-00027-00 (EPSON) or 115-058771-00 (DSP)) or EFCS Control Board (P/N: 115-018150-00), select the System VXX.XX.XX XXXX-XX-XX.mpkg

f. If changing the Power Board (P/N: 115-018145-00), select the POWER VX.X.pkg

File Name	Creating Time	Module	Checksum	Version	Note
BIOS-V01.11.00.00.pkg	2014-09-01 11:09	BIOS	9D EF 29 32	01.11.00.00	\
A7 system software V03.06.00.mpkg	2014-09-28 17:12	\	\	\	\
		Host Program	B0 81 71 46	03.06.00	\
		Language file	\	3.7	\
		Common config	\	\	\
		Bundle Verison	\	02.06.00	\
		Icons resource file	\	\	\
		FPGA display drive	2B 71 7C A2	1.4	\
		FPGA sound drive	EA 0C 3B 2D	1.3	\
		Module software	B2 CC F0 41	01.00/ 01.01	Key board
		Module software	01 A1 CF F5	01.14.00	VCM
		Module software	CF A3 04 4D	1.1	VPM
EFCS-V01.05.00.pkg	2014-09-28 16:53	Module software	F9 F7 6E A6	01.05.00	EFCS
FPGA-EFCS V3.0.pkg	2013-02-25 11:28	Module software	F3 E8 A2 7D	3.0	FPGA EFCS
Power V1.7.pkg	2013-08-22 09:57:55	Module software	D6 1D 6E D5	1.7	POWER

NOTE: **This only an example of a Software version / Checksum table. Check for Technical bulletins to find the correct table for the software version you are installing.**

g. Select "Open".

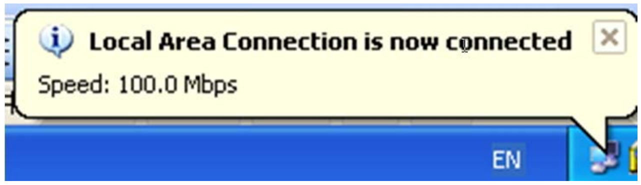
h. A dialog box will appear. Verify that for each file the Creating Time, Module, Checksum, Version and Note are correct from the table above. If they are correct then click OK.

i. Turn on the A7 unit on, wait at least ten seconds before proceeding to the next step.

j. Click "Start (Single)" on the Mind ray Anesthesia Machine and Ventilator Software Upgrade Tool.

k. Turn off and then turn on the A7 unit within one second of each other.

l. You will see that the Windows XP network icon indicate that it is connected.



m. While updating the software the A7 will show text which explains the progress of the software update.

n. Once the Download is complete the Mind ray Anesthesia Machine will display "succeeded". And Ventilator Software Upgrade Tool will display "update system successfully".

NOTE: **It is normal for the power board software that it will fail at the first time and it will be successful at the second time in upgrade process.**

o. Once the last file is upgraded turn off the A7 unit and then restart A7 unit.

p. Check the software version on the A7 by clicking Setup then Service, enter the service password followed by Enter, then go to System Info and then SW Versions. Verify that the software version on the A7 match the following table.

Software version V02.06.00

Module	Software Version	Date*
Bundle Version	02.06.00	\
Host Software	03.06.00	9/28/2014
BIOS	01.11.00.00	4/3/2013
FPGA Display	1.4	\
FPGA Sound	1.3	\
Ventilator Protect Module	V1.1	11/26/2010
Ventilator Control Module	V01.14.00	8/20/2013
Power System	V1.7	7/15/2013
EFCS Software	V01.05.00	9/28/2014
FPGA EFCS	3.0	\
Key Board Software	01.00/01.01	12/18/2012
Language	3.7	\

* The Date format may differ depending on the unit setup

Perform software upgrade as following order:

1. Upgrade the BIOS.
2. Upgrade the A7 system software.
3. Upgrade the power system software.
4. Upgrade the EFCS software.
5. Upgrade the FPGA EFCS.

NOTE: **This only an example of a Software version table. Check for Technical bulletins to find the correct table for the software version you are installing.**

After A7 DSP software is updated (Software Bundle Version 03.01.00 and later), check that the standard ventilation modes VCV, SIMV-VC, PCV, PCV-VG, SIMV-PC, CPAP/PS, and Manual are present. Make sure in manual mode the following buttons appear: Alarms, ACGO, Monitor (if AG module is installed), and CO2 Alarms (if AG module is installed). Verify that the options that were activated with the license keys are present.

After A7 EPSON software is updated (Software Bundle Version earlier than 03.01.00), verify that the ventilation modes are VCV, SIMV-VC, PCV (with VG), SIMV-PC, PS and Manual. Make sure in manual mode the following buttons appear: Alarms, Bypass, ACGO, Monitor, and CO2 Alarms. Make sure that the Spirometry tab is present. Make sure that the optimizer is displayed or can be enabled in the System menu.

The clear package file will completely clear the contents of the CPU board and will set the system to factory defaults. This file is only used when a CPU board needs to be programmed from DSP to EPSON or from EPSON to DSP. If necessary, clear package as following order:

1. Upgraded the clear package file "Clear BIOS File For Upgrades.pkg".
2. Upgrade the BIOS.
3. Upgrade the A7 system software.
4. Upgrade the power system software.
5. Upgrade the EFCS software.
6. Upgrade the FPGA EFCS.

Activate the software licenses (only for DSP systems):

1. Load the license key to the USB.
2. Insert the USB into the machine.
3. Enter Setup-> Service menu and click "license" button to open the submenu. The license menu is below:

4. After click "Install" button, the function will be activated.
5. Please contact Mindray Technical Support if Software Licenses are required for optional features.

5.7 Factory Setup

Perform the following procedure to enter the factory setup menu.

1. Ensure the anesthesia system is in Standby mode.
2. Select Setup softkey > Service tab > enter factory password.

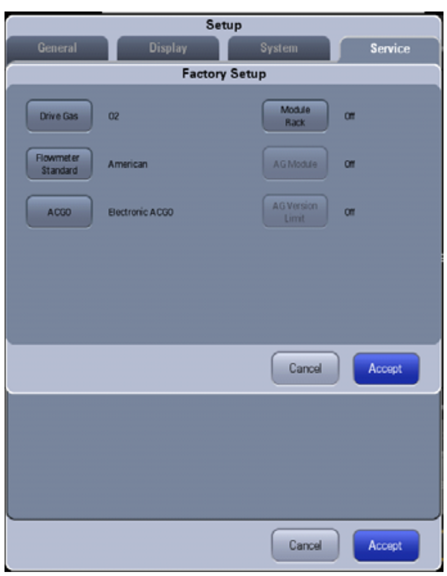


FIGURE 5-73

FACTORY SETUP	CHOICES	DEFAULT
Drive Gas	**O2, AIR**	**O2**
Flowmeter Standard	**American, Canadian**	**American**
ACGO	**Off, ACGO with 3-way Valve, Electronic ACGO**	**Electronic ACGO**
Module Rack	**On, Off**	**On**
AG module	**On, Off**	**On**
AG Version Limit	**On, Off**	**On**

TABLE 5-1 Factory Setup Menu Settings

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6.0 Repair and Disassembly

Prepare for Disassembly 6-2

Disassemble the Assemblies 6-3

Disassemble the Breathing System 6-77

6.1 Prepare for Disassembly

6.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Metric Allen wrenches (1.5, 2, 2.5, 3, 4, 5, 6, 8, 10mm)
- Phillips screwdriver (#1 and #2)
- Diagonal pliers
- Flathead screwdriver
- Metric M3 and M4 socket screwdriver
- Adjustable wrench
- Tweezers
- Krytox Lubricant (P/N: 0510-00-0020)

6.1.2 Preparations

Before disassembly:

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine as described below.
- Disconnect all pipeline and cylinder gas supplies.
- Prepare the tools required for disassembly.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

CAUTION: The internal parts may be contaminated. Wear special gloves during disassembly and inspection.

6.1.3 Bleed Gas Pressure

Make sure to bleed down the gas pressure inside the anesthesia machine before disassembling pneumatic fittings to avoid personal injury or equipment damage. To bleed gas pressure:

1. Close other cylinder valves and disconnect pipeline gas supplies. Do not disconnect the O2 pipeline. If O2 pipeline is not available, connect O2 cylinder and open the O2 cylinder valve.
2. Set the system switch to ON.
3. Turn on all the flow controls (except O2).
4. Make sure that N2O and AIR pipeline pressure gauges read zero.
5. Disconnect the O2 pipeline supply (or close the O2 cylinder valve). Push the O2 flush button to bleed O2 from the system.
6. Set the system switch to OFF.

6.2 Disassemble the Assemblies

6.2.1 Disassemble the Internal Assemblies of the Machine Upper Half

6.2.1.1 Open the Service Door

Turn the two screws on the service door counter-clockwise one half turn to open the door.

FIGURE 6-1

6.2.1.2 Remove the Gas Supply Inlet Assembly

1. Open the service door.
2. Disconnect the tubes from the N2O, AIR and O2 supply inlet assemblies.
3. Open the protection cover of the pressure switch from the N2O and AIR supply inlet assemblies and disconnect the cables from the pins of the pressure switch. Disconnect the plug for butt joint from O2 supply inlet assemby.
4. Unscrew the two screws to remove the assembly.

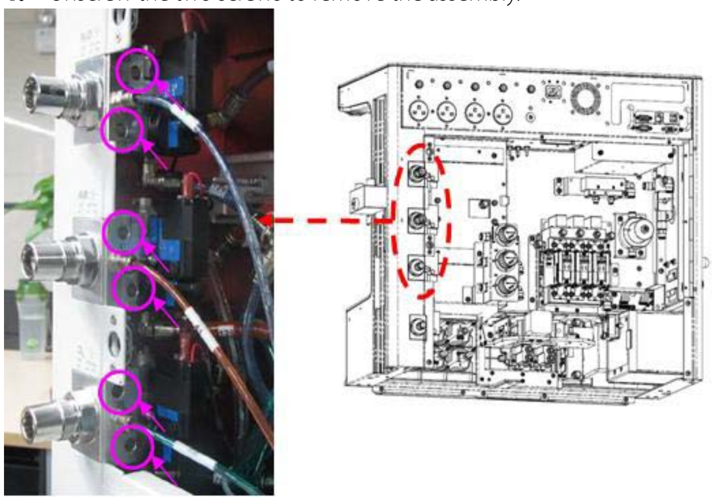


FIGURE 6-2

6.2.1.3 Remove the Pressure Regulator Assembly

1. Open the service door.
2. Unplug the tubes from the pressure regulator assembly.
3. Unscrew the three screws on the pressure regulator assembly and remove it.

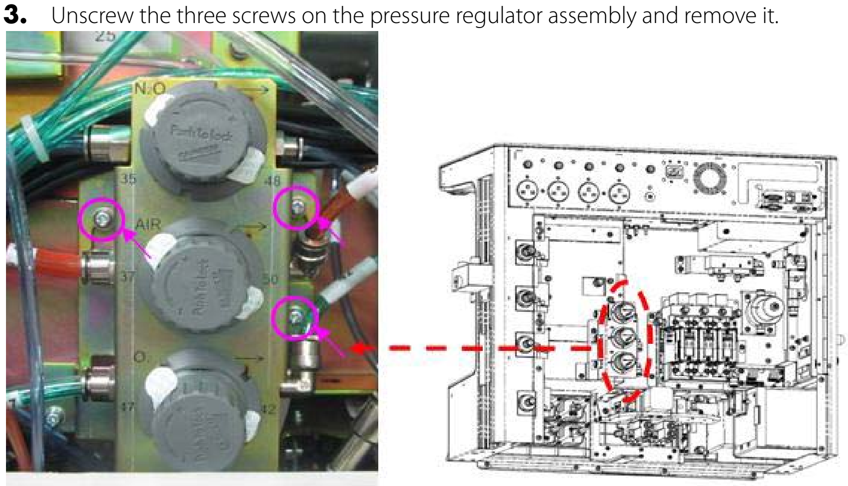


FIGURE 6-3

6.2.1.4 Remove the Electronic Flow Control System Assembly

1. Open the service door.
2. Unplug the related cables and tubes from the EFCS module.
3. .Unscrew the three screws and remove the EFCS module.

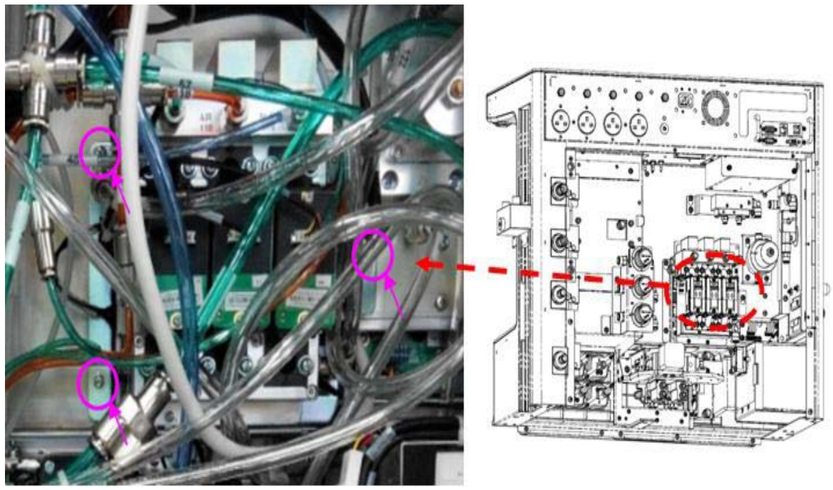


FIGURE 6-4

6.2.1.5 Remove the Proportional Valve

1. Remove the EFCS module.
2. Disconnect the plug of the proportional valve from the flowmeter monitoring board.
3. Unscrew the two screws and remove the battery valve isolation metal sheet.

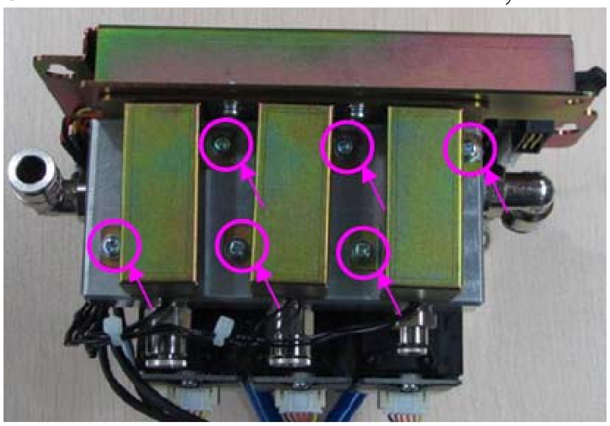


FIGURE 6-5

4. Unscrew the two screws and remove the proportional valve.

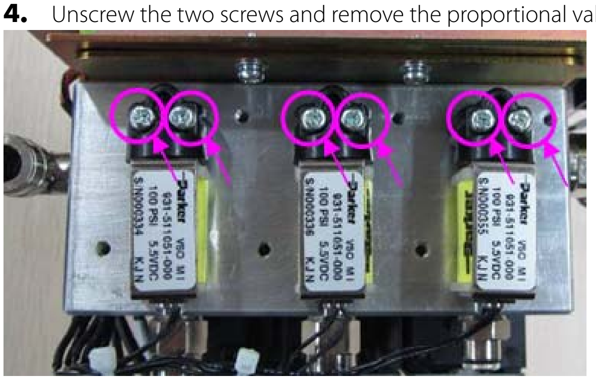


FIGURE 6-6

6.2.1.6 Remove the Electronic Flowmeter

1. Remove the EFCS module.
2. Disconnect the cables from the electronic flowmeter.
3. Unscrew the four screws to remove the O2, N2O and AIR electronic flowmeters. Take care not to drop the sealing rings below the electronic flowmeters.

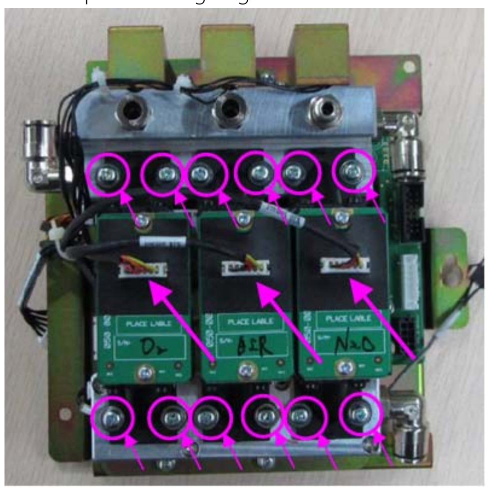


FIGURE 6-7

6.2.1.7 Remove the Total Electronic Flowmeter

1. Remove the EFCS module.
2. Disconnect the cables from the flowmeter monitoring board.
3. Unscrew the four screws to remove the upper assembly.

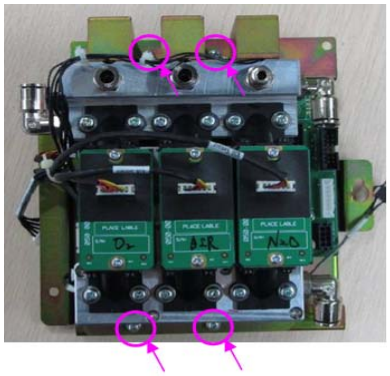


FIGURE 6-8

4. Disconnect the cables from the electronic flowmeter.
5. Unscrew the four screws to remove the O2, N2O and AIR electronic flowmeters. Remove the sealing rings below the electronic flowmeters.

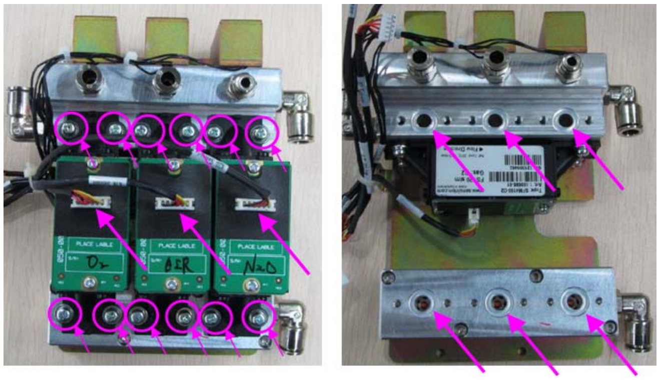


FIGURE 6-9

6. Unscrew the four screws to remove the flowmeter outlet assembly.

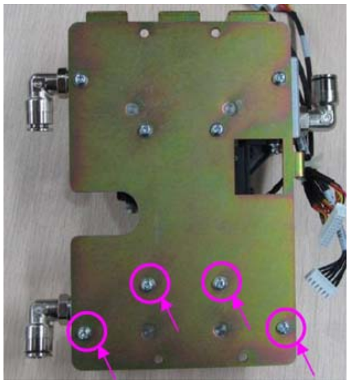


FIGURE 6-10

7. Disconnect the cables and unscrew the four screws to remove the total electronic flowmeter.

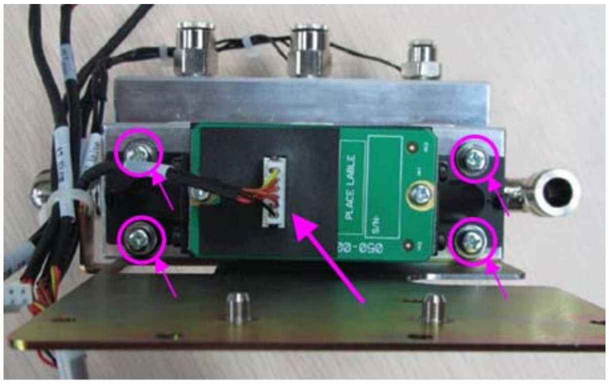


FIGURE 6-11

6.2.1.8 Remove the Flowmeter Monitoring Board

1. Remove the EFCS module.
2. Disconnect the cables from the flowmeter monitoring board.
3. Unscrew the four screws to remove the upper assembly.

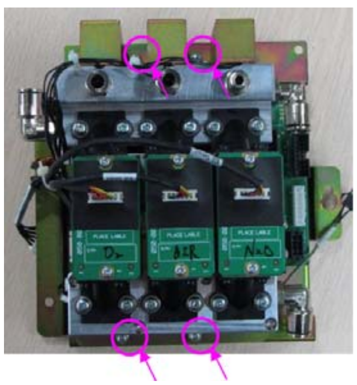


FIGURE 6-12

4. Unscrew the four screws to remove the flowmeter monitoring board.

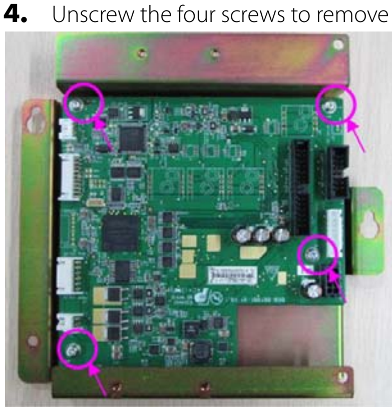


FIGURE 6-13

6.2.1.9 Remove the Gas Mixer Assembly

1. Open the service door.
2. Unplug the tubes from the gas mixer assembly.
3. Unscrew the four screws on the gas mixer assembly to remove the assembly.

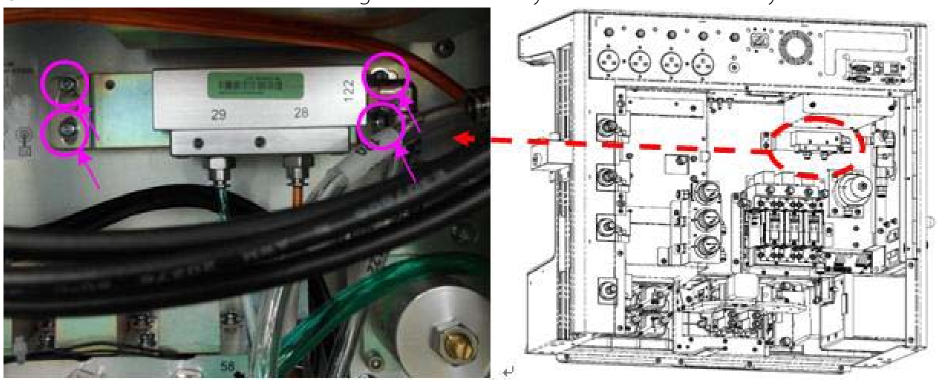


FIGURE 6-14

6.2.1.10 Remove the Back Pressure Valve Assembly

1. Open the service door.
2. Unplug the tubes from back pressure valve assembly.
3. Unscrew the four screws on the back pressure valve assembly to remove the assembly.

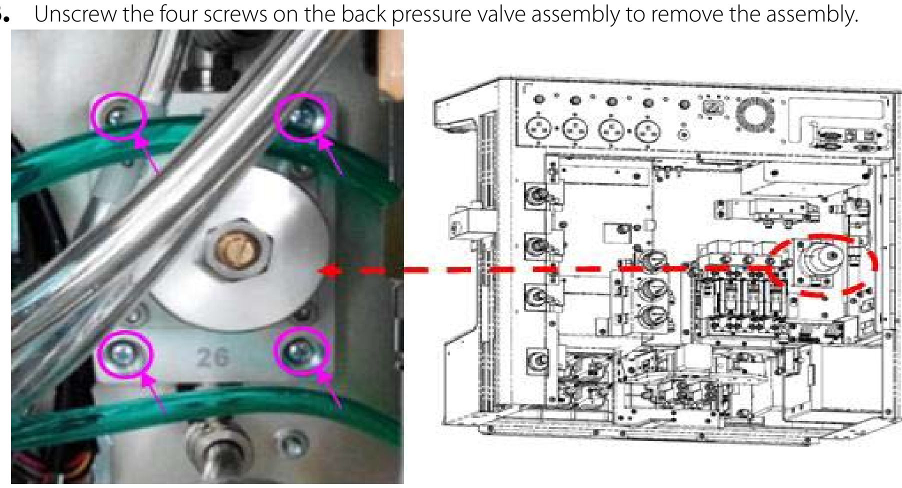


FIGURE 6-15

6.2.1.11 Replace the Lithium-ion Battery

1. Open the service door.
2. Unscrew the two screws on the battery box cover, and then you can take out the lithium-ion battery.
3. Place the new lithium-ion battery into the battery box in the original direction to complete battery replacement.

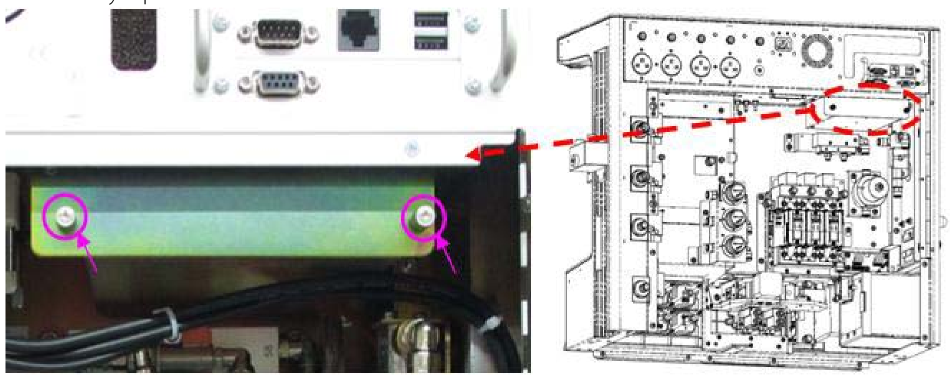


FIGURE 6-16

6.2.1.12 Remove the Vaporizer Manifold

1. Open the service door.
2. Unplug the tubes from the vaporizer manifold.
3. Unscrew the four screws and remove the vaporizer manifold.

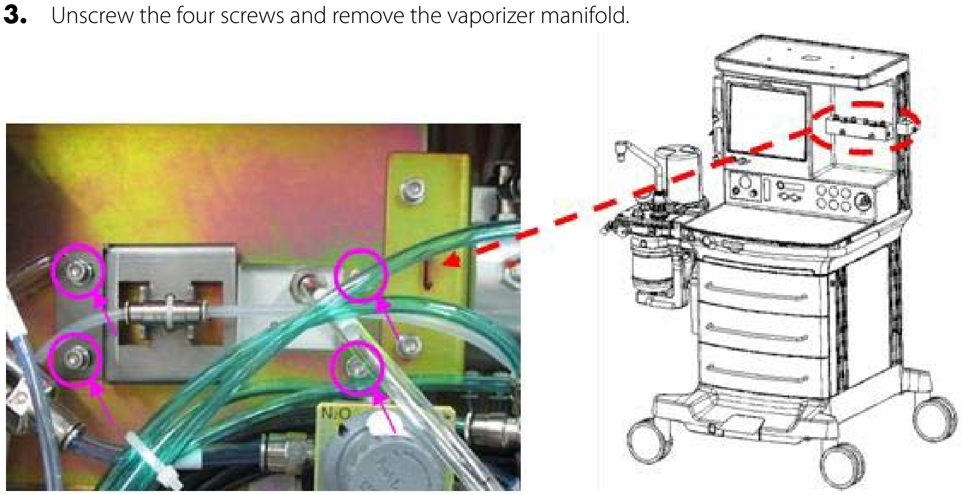


FIGURE 6-17

6.2.1.13 Remove the Three-way Valve Assembly

1. Open the service door.
2. Unplug the tubes from the three-way valve assembly, and disconnect the cables.

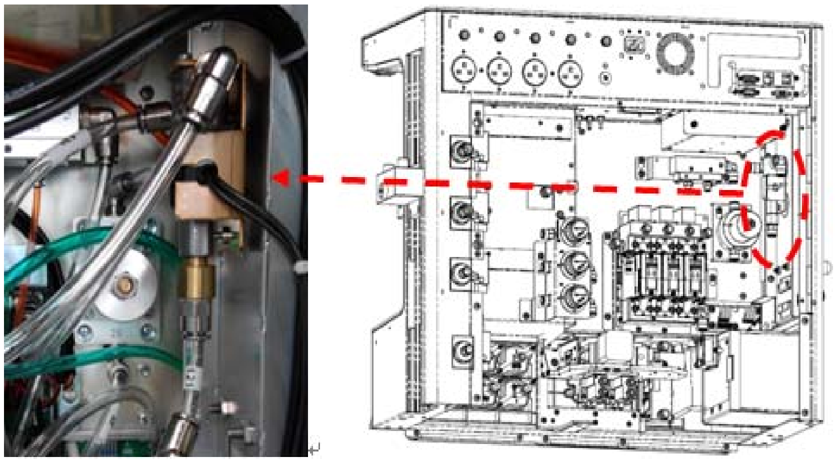


FIGURE 6-18

3. Unscrew the four screws from the slide on the left side of the main unit to remove the slide.

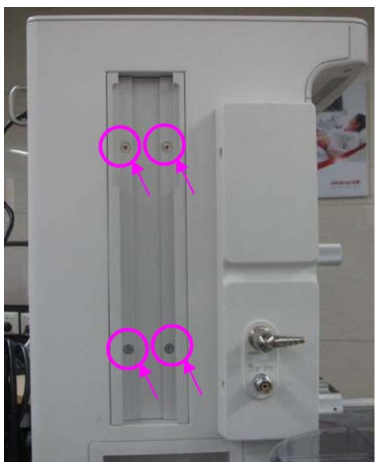


FIGURE 6-19

4. Unscrew the two screws to remove the three-way valve assembly.

FIGURE 6-20

5. The removed three-way valve assembly is as shown below..

FIGURE 6-21

6.2.2 Disassemble Hardware Box

6.2.2.1 Remove the Top Plate of the Hardware Box

1. Unscrew the three screws from the top plate of the hardware box.

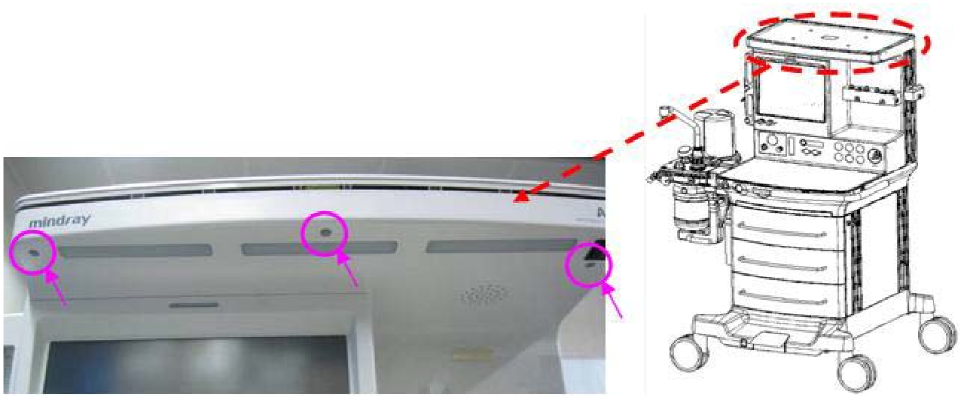


FIGURE 6-22

2. Lift off the top plate to remove it.

FIGURE 6-23

6.2.2.2 Remove the Cell Battery from the CPU Board

1. Remove the top plate assembly.
2. Remove the cell battery from the CPU board.

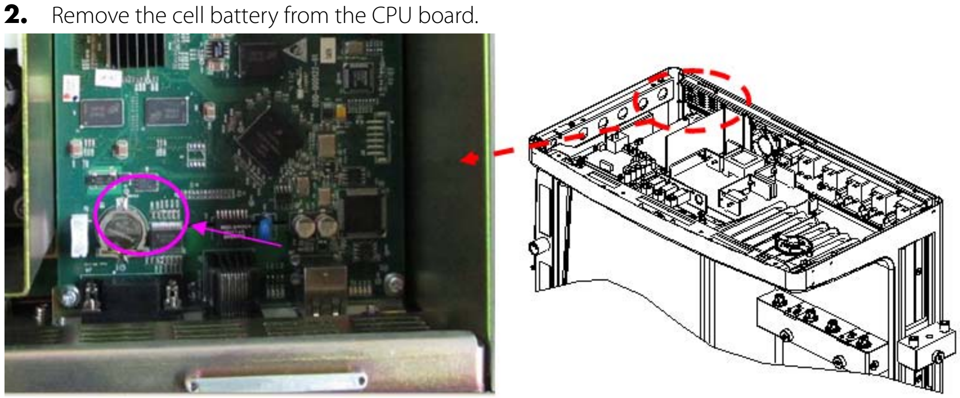
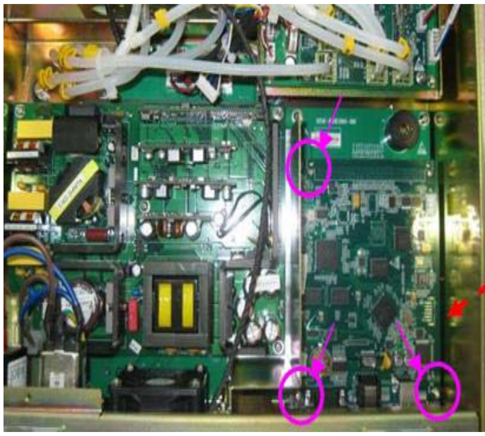


FIGURE 6-24

6.2.2.3 Remove the CPU Board

NOTE: When replacing the CPU Board, software reinstallation may be required.

1. Remove the top plate assembly.
2. Unscrew the three screws fastening the main control board to remove the board.



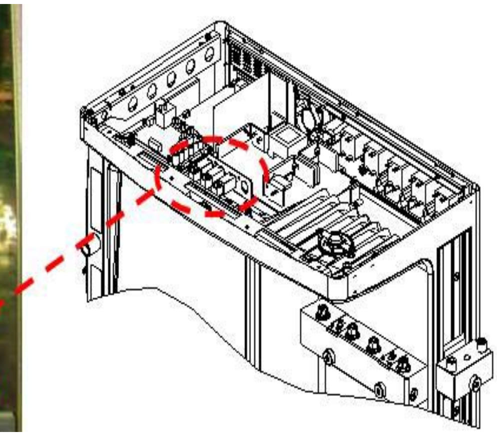


FIGURE 6-25

6.2.2.4 Remove the Ventilator Control Board

NOTE: When replacing the Ventilator Control Board, software reinstallation may be required.

1. Remove the top plate assembly.
2. Unplug the related cables and tubes from the ventilator control board.

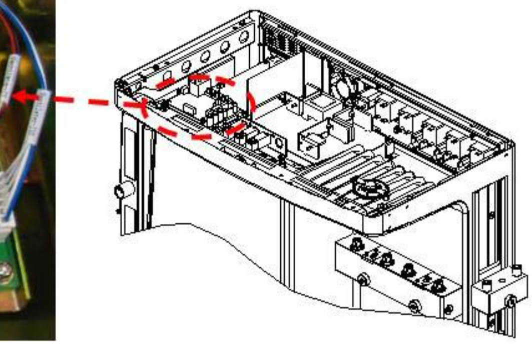


FIGURE 6-26

3. Unscrew the four screws fastening the ventilator control board to remove it.

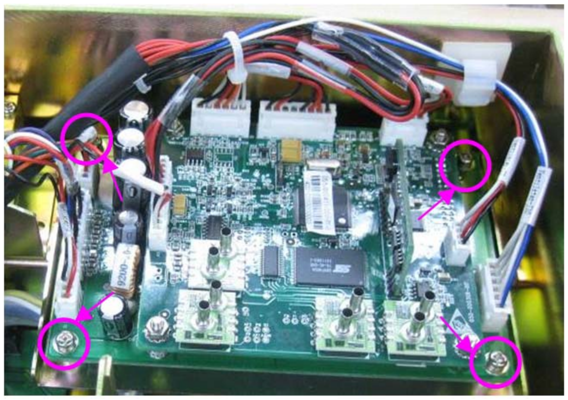


FIGURE 6-27

- The ventilator control board for the EPSON platform.

FIGURE 6-28

- The ventilator control board for the DSP platform.

FIGURE 6-29

Refer to “Connections Between Pneumatic Circuit, Breathing System and Ventilator Control Board” on page 1-11.

6.2.2.5 Remove the Power Board

1. Disassemble the top panel assembly.
2. Unscrew the two screws fastening the high-pressure protection cover to remove the protection cover.

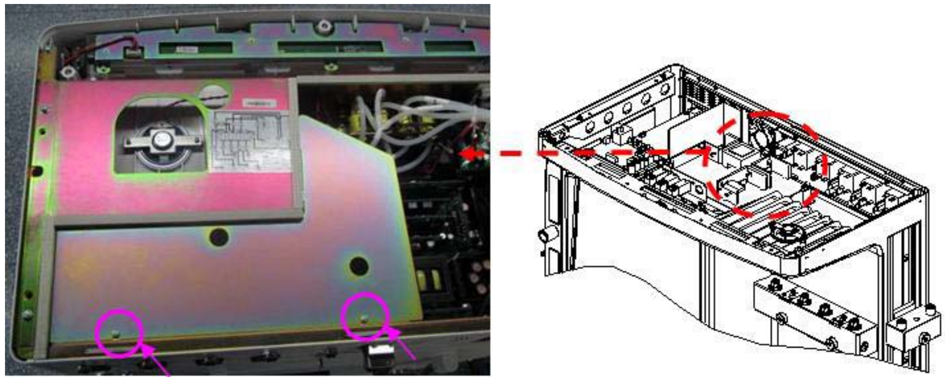


FIGURE 6-30

3. Unplug the filter cable plug. Unscrew the screw on the power board support sheet, three screws and one nut fastening the power board to remove the power board.

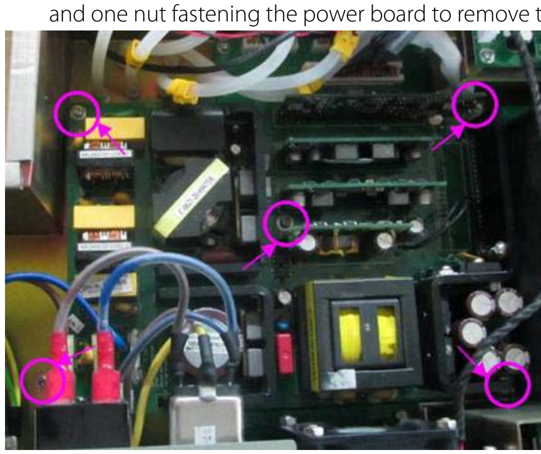


FIGURE 6-31

4. Unscrew the screw on the power board support sheet to remove the support sheet.

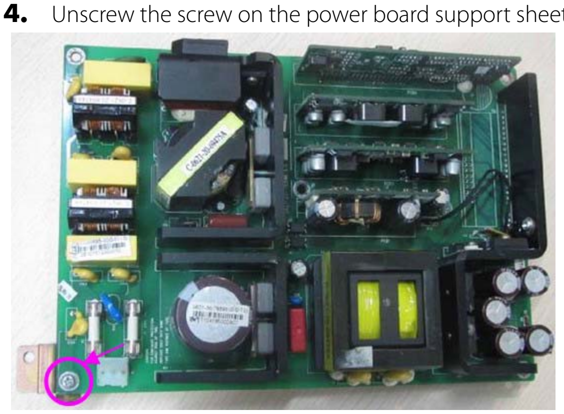


FIGURE 6-32

6.2.2.6 Remove the Motherboard

1. Open the service door.

2. Disconnect the three cables from the motherboard.

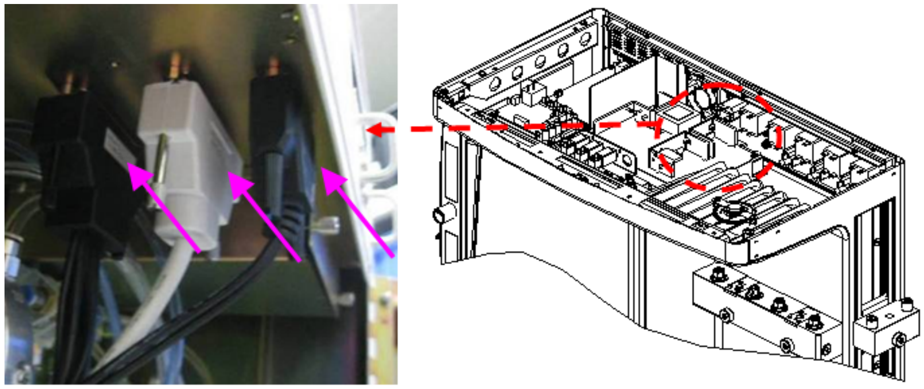


FIGURE 6-33

3. Remove the top plate assembly.

4. Unscrew the three screws on the CPU board output bracket and remove the CPU board and the metal sheet.

FIGURE 6-34

5. Remove the power board.

6. Unscrew the three screws to and remove the wind shield.

FIGURE 6-35

7. Remove the power board insulation overlay.

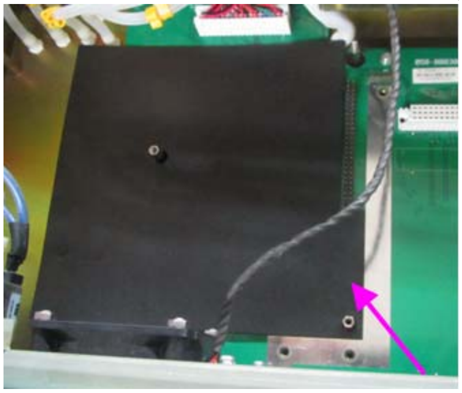


FIGURE 6-36

8. Disconnect the cables from the motherboard.

9. Unscrew the two screws on the motherboard output bracket and the 12 screws fastening the motherboard to remove the motherboard.

FIGURE 6-37

6.2.2.7 Remove the Solenoid Valve Assembly

1. Remove the top plate assembly.
2. Unplug the related tubes and cables from the solenoid valve assembly.

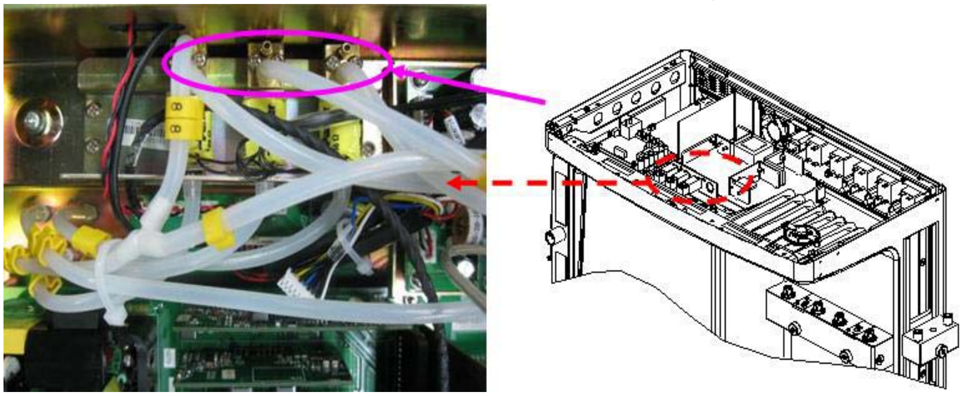


FIGURE 6-38

3. Unscrew the three screws on the solenoid valve to remove the solenoid valve assembly.

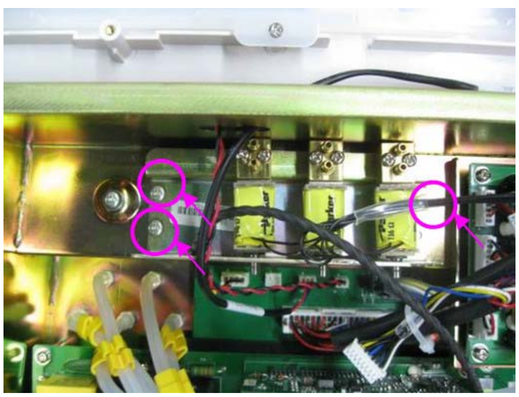


FIGURE 6-39

Refer to "Connections Between Pneumatic Circuit, Breathing System and Ventilator Control Board" on page 1-11..

6.2.2.8 Remove the Speaker

1. Remove the top plate assembly.
2. Unplug the speaker cables from the backplane.
3. Unscrew the two screws to remove the speaker.

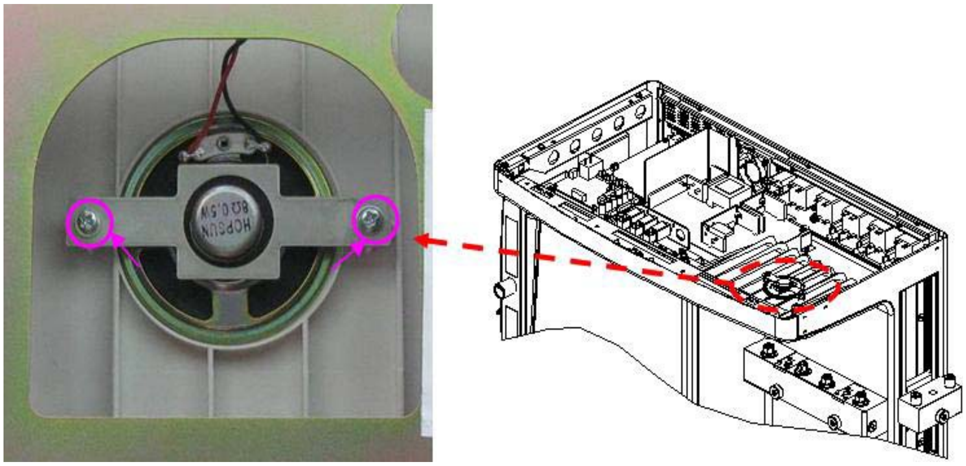


FIGURE 6-40

6.2.2.9 Remove the Rocker Switch

1. Remove the top plate assembly.
2. Unplug the plug of the rocker switch and remove the rocker switch.

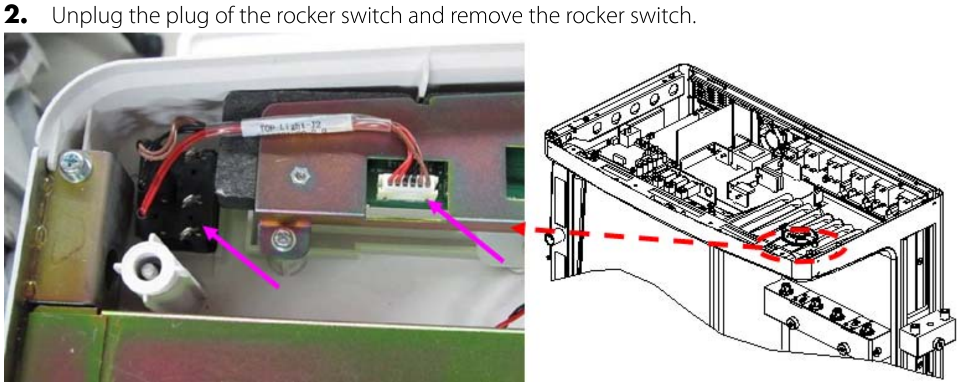


FIGURE 6-41

6.2.2.10 Remove the Top Light Board

1. Remove the top plate assembly.
2. Unplug the cables from the top light board.
3. Unscrew the five screws to remove this assembly.

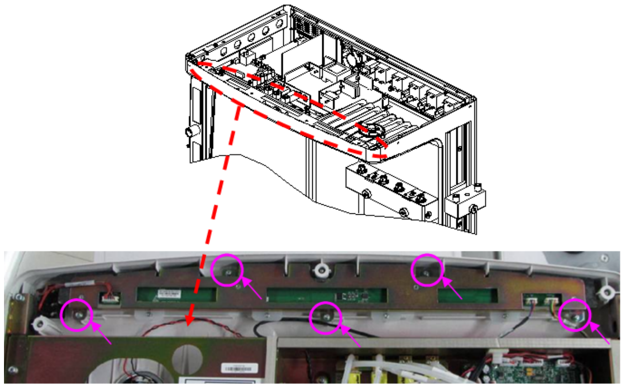


FIGURE 6-42

4. Unscrew the four screws to remove the top light board.

FIGURE 6-43

6.2.2.11 Disassemble the Rear Panel Assembly

1. Remove the top plate assembly.
2. Open the service door.Remove the cables and tubes from the hardware box assembly.

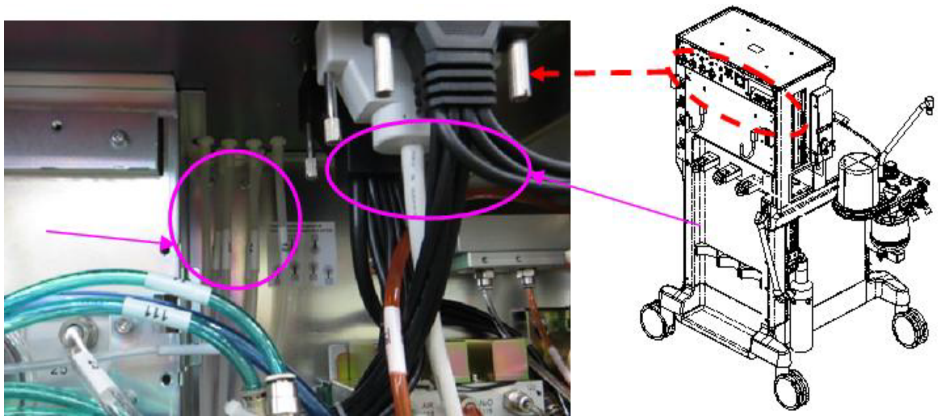


FIGURE 6-44

3. Unscrew the three screws fastening the power plug protection hook to remove the power cord and protection hook.

FIGURE 6-45

4. Unscrew the two screws fastening the high-pressure protection cover to remove the protection cover.

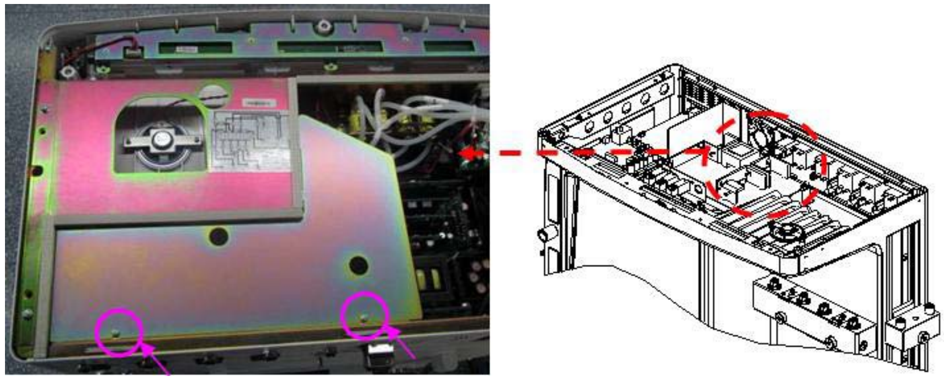


FIGURE 6-46

5. Unscrew the seven screws on the hardware box and lift off the hardware box to remove it.

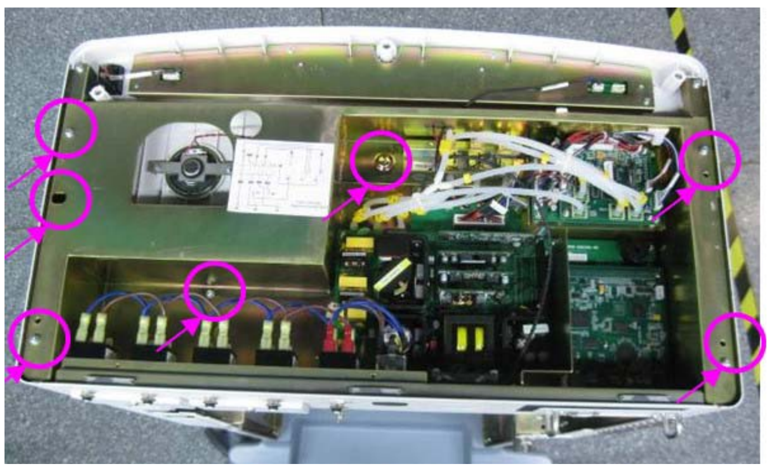


FIGURE 6-47

6. Remove related cables on the rear panel assembly from other assemblies

7. Unscrew the elevn screws on the rear panel of hardware box to remove the rear panel assembly.

FIGURE 6-48

Remove the Fan

1. Remove the rear panel of hardware box.
2. Unscrew the four screws on the fan to remove the fan.

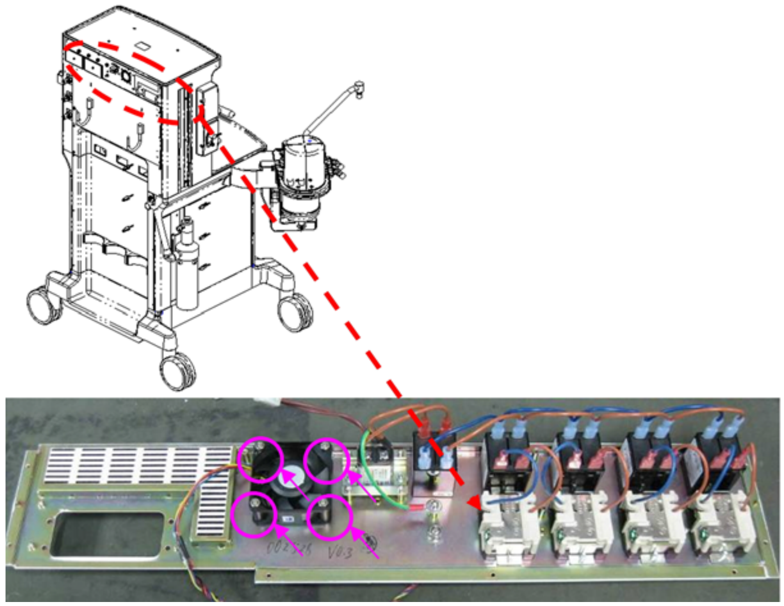


FIGURE 6-49

Remove the Filter

1. Remove the rear panel assembly of hardware box.
2. Unscrew the five screws on the filter to remove the filter.

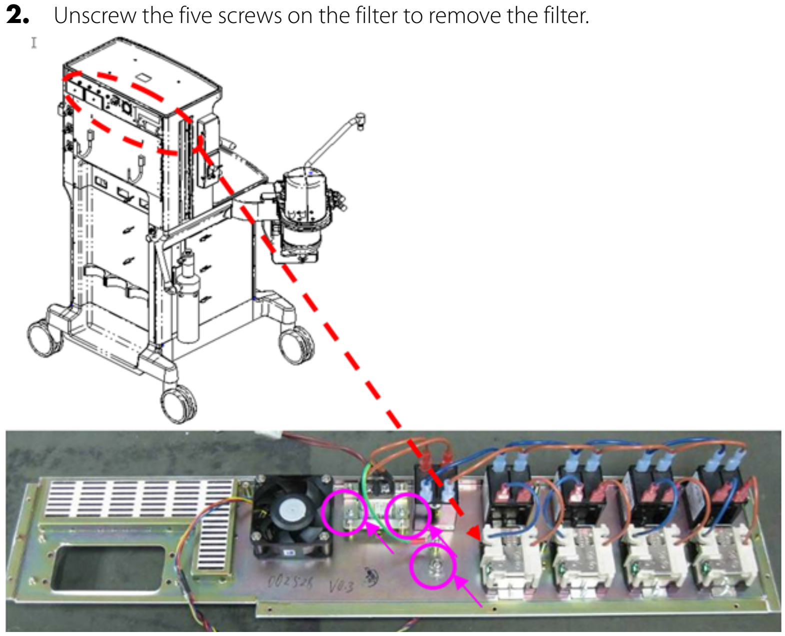


FIGURE 6-50

Remove the Auxiliary Outlet Assembly

1. Remove the rear panel assembly of the hardware box.

2. Unscrew one nut and disconnect the cable from the breaker.

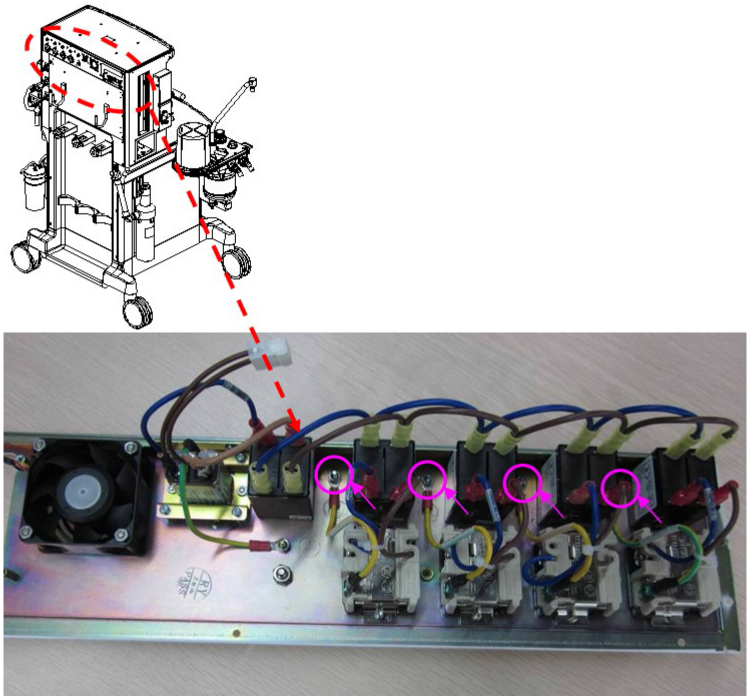


FIGURE 6-51

3. Unscrew the two screws on each auxiliary outlet to remove the auxiliary outlets. The A5 has four (4) auxiliary outlets, as shown in the photograph below. The A3 has three (3) auxiliary outlets (not shown).

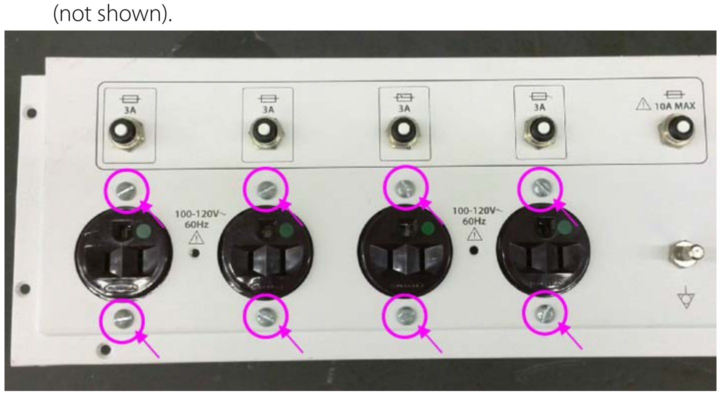


FIGURE 6-52

Remove the Breaker Assembly

1. Remove the rear panel assembly of the hardware box.
2. Unscrew the breaker screws to remove each breaker.

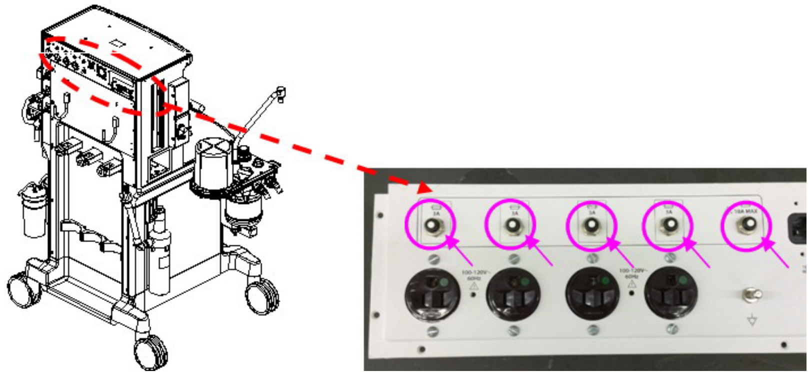


FIGURE 6-53

6.2.3 Disassemble the Work Surface

6.2.3.1 Remove the Drawer Assembly

1. Pull out the drawer until the black locking piece on the rail can be seen.
2. Lift up the locking piece on the right rail of drawer, and press down on the locking piece on the left rail at the same time.

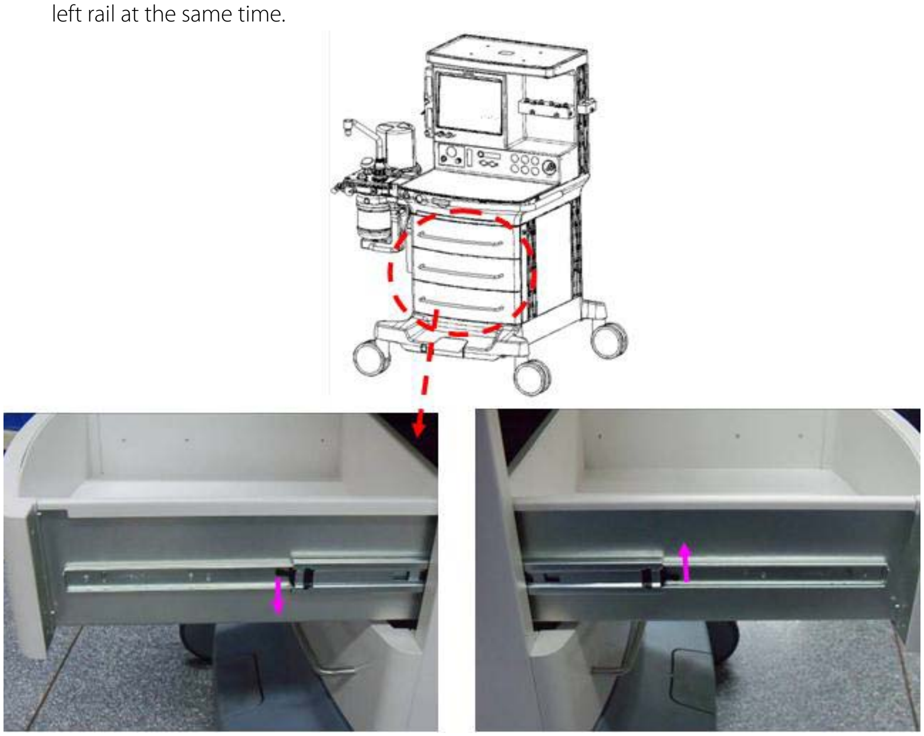


FIGURE 6-54

3. Take out the drawer.

6.2.3.2 Remove the Work Surface Cover Plate

1. Remove the first drawer.
2. Pull out the auxiliary work surface.
3. Unscrew the five screws on the work surface cover plate.

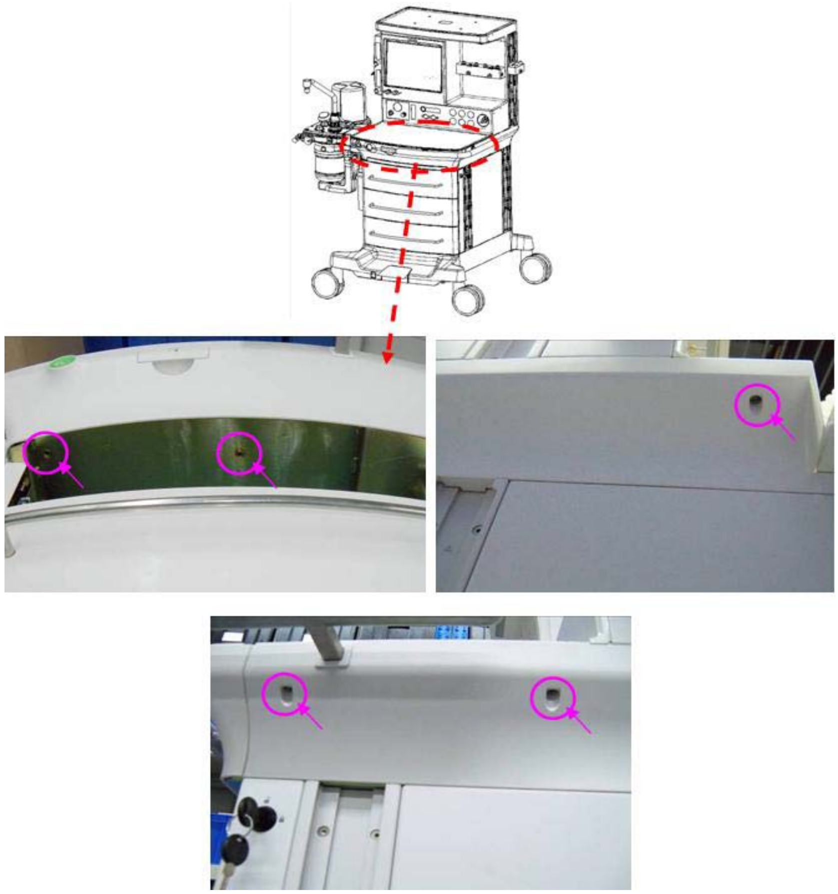


FIGURE 6-55

4. .Lift off the cover plate from the work surface. When the cover plate is removed, the internal structure of the work surface is shown as below:

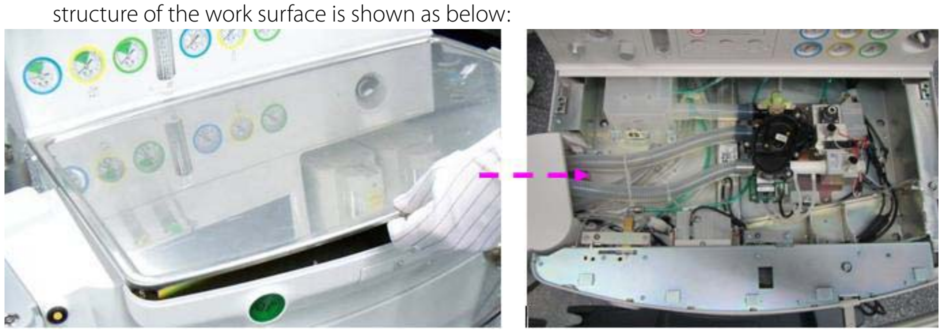


FIGURE 6-56

6.2.3.3 Remove the Metal Cover Plate

1. Remove the work surface cover plate.
2. Unscrew the eight screws on the metal cover plate to remove the cover plate.

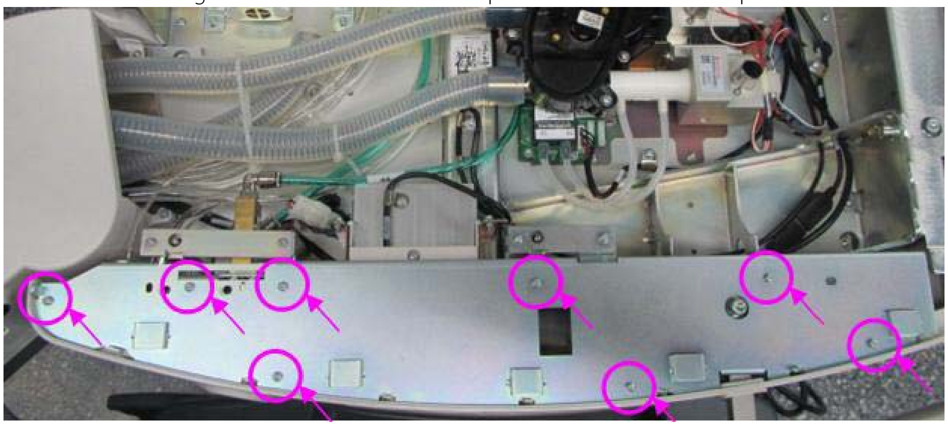


FIGURE 6-57

6.2.3.4 Remove the Rear Cover Plate Assembly

1. Open the service doorand refer to "Open the Service Door" on page 6-3.
2. Unplug the AGSS transfer tube connecting to the exhaust tube and refer to "Remove the AGSS Assembly" on page 6-62.

FIGURE 6-58

3. "Remove the AGSS Assembly" on page 6-62.

4. Unscrew the six screws on the lower rear panel assembly to remove it.

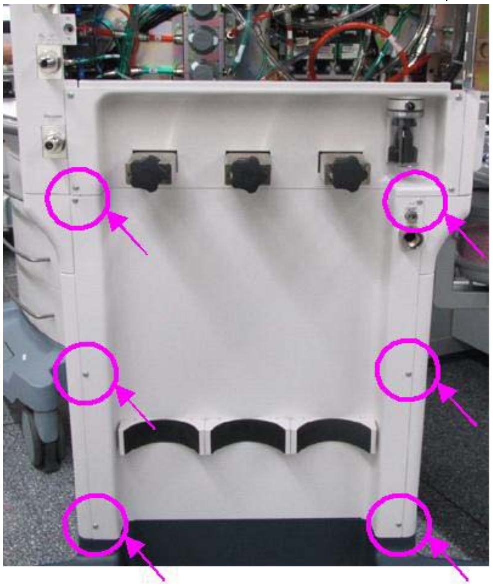


FIGURE 6-59

5. Remove the pentagonal knob on the cylinder yoke assembly

FIGURE 6-60

6. Unplug the tube connected to the overfill protection cup.Unscrew the four screws on the upper rear panel (yoke cover) to remove it.

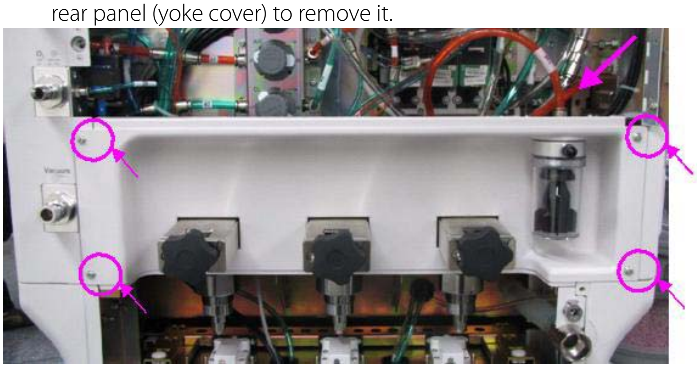


FIGURE 6-61

6.2.3.5 Remove the Drive Gas Assembly

1. Remove the work surface cover plate.
2. Unplug the tubes from the drive gas assembly.

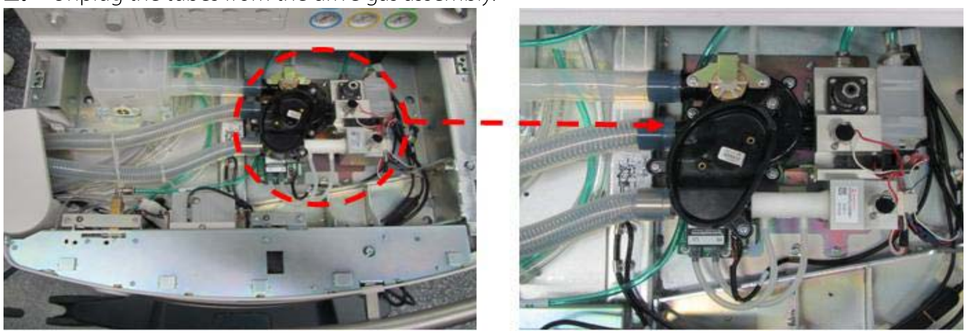


FIGURE 6-62

3. Unscrew the four screws on the drive gas assembly to remove the assembly.

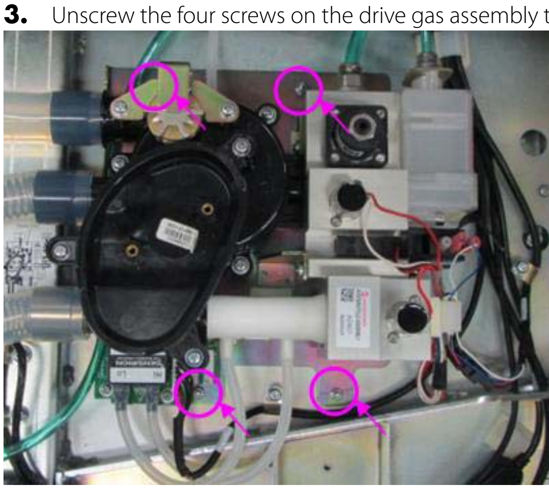


FIGURE 6-63

- The drive gas assembly for the EPSON platform (distinguish EPSON platform and DSP platform according to the codes (A0901) on the proportional valve).

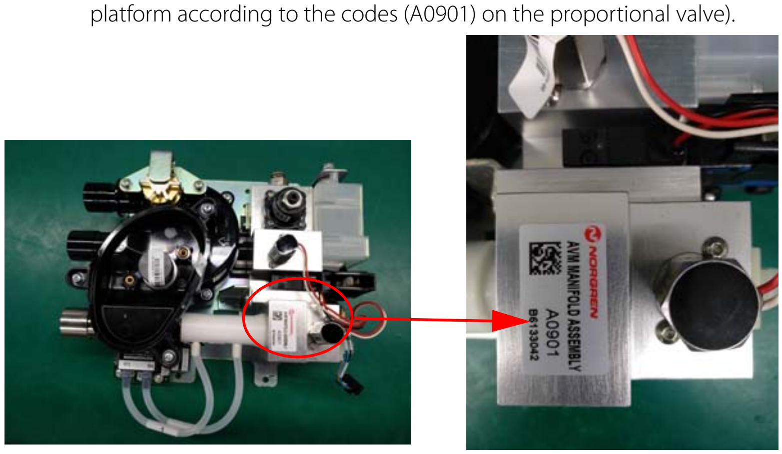


FIGURE 6-64

- The drive gas assembly for the DSP platform (distinguish EPSON platform and DSP platform according to the codes (A1636-M01) on the proportional valve).

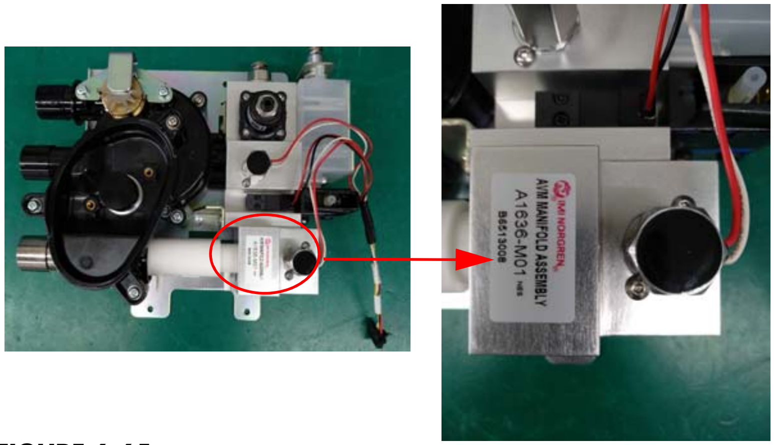


FIGURE 6-65

6.2.3.6 Remove the O2 Flush Assembly

1. Remove the work surface cover plate and refer to “Remove the Work Surface Cover Plate” on page 6-28..
2. Remove the metal cover plate and refer to “Remove the Metal Cover Plate” on page 6-29..
3. Unplug the tubes from the O2 flush assembly.

4. Unscrew the two screws on the bracket and remove it.

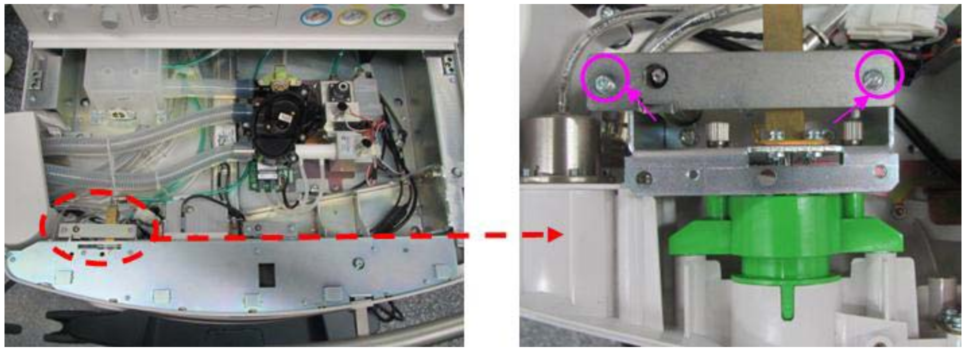


FIGURE 6-66

5. Remove the metal post on the right side of the O2 flush assembly.
6. Unscrew the five screws around the O2 flush assembly to remove it.

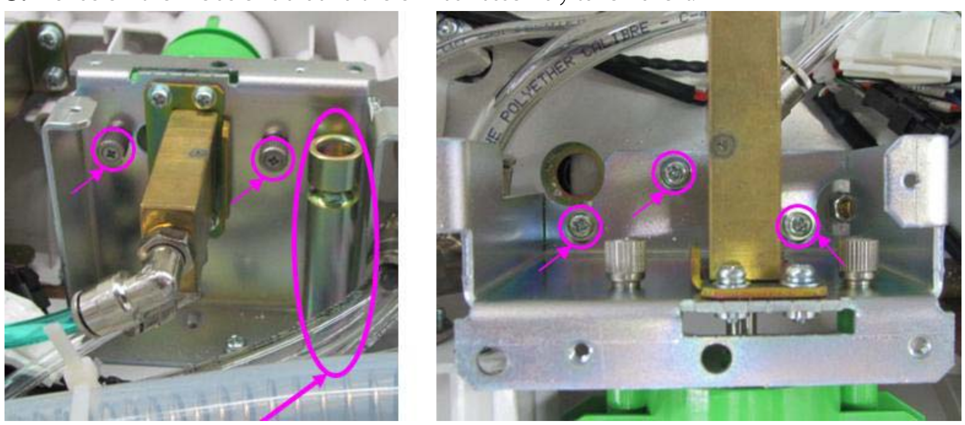


FIGURE 6-67

7. Unscrew the four screws around the O2 flush assembly to remove the assembly from the manifold.

FIGURE 6-68

8. Unscrew the two screws around the O2 flush button to remove the button from the machine. If neccessory, clean the O2 flush button with a soft, lint-free cloth. The recommended cleaning

agents are water and green soap tincture. Ensure thar the O2 flush button is completely dry before reinstall it.

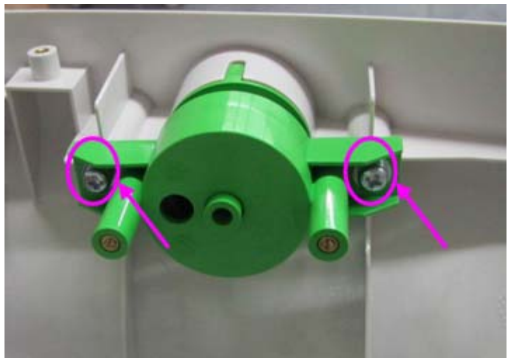


FIGURE 6-69

6.2.3.7 Remove the Touch Panel

1. Remove the work surface cover plate and refer to "Remove the Work Surface Cover Plate" on page 6-28..
2. Remove the metal cover plate and refer to "Remove the Metal Cover Plate" on page 6-29..
3. Unplug the touch panel data cable.
4. Unscrewthe six screws on the touch panel to remove the panel.

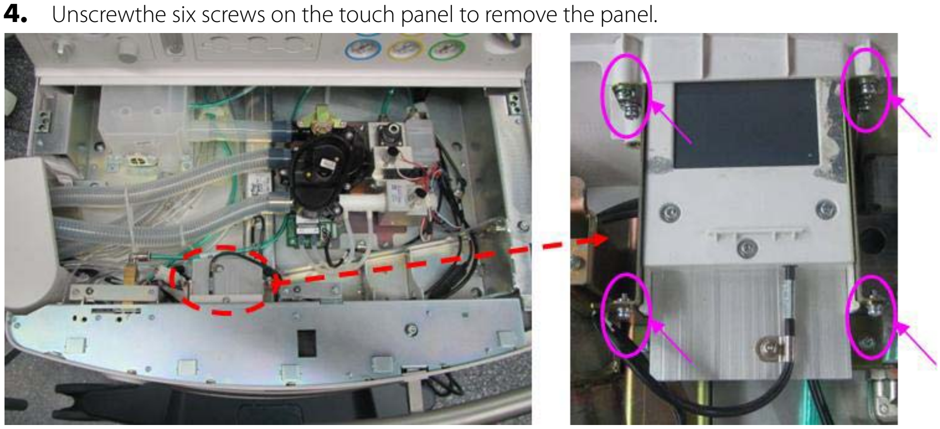


FIGURE 6-70

6.2.3.8 Remove the separate ACGO outlet

1. Remove the work surface cover plate and refer to "Remove the Work Surface Cover Plate" on page 6-28...
2. Remove the metal cover plate and refer to "Remove the Metal Cover Plate" on page 6-29.
3. Remove the Rotating Block of Breathing Circle and refer to "Remove the Rotating Block of Breathing Circle" on page 6-61.
4. Unplug the tubes from the separate ACGO outlet.
5. Unscrew the four screws on the separate ACGO outlet and romove,and pull out the outlet to remove the cover sheet.

FIGURE 6-71

6.2.3.9 Remove the Cylinder Bracket Assembly

1. Open the service door and refer to"Open the Service Door" on page 6-3..
2. Remove the rear panel and refer to "Remove the Rear Cover Plate Assembly" on page 6-29..
3. Remove the module rack cabinet assembly and refer to "Remove the Module Rack Assembly" on page 6-48.
4. Remove the module rack bracket assembly and refer to "Remove the Module Rack Fan" on page 6-49.
5. Unplug the tubes from the cylinder bracket assembly.
6. Remove the copper pipe from cylinder bracket assembly.
7. Unscrew the four screws on the cylinder bracket to remove the assembly.

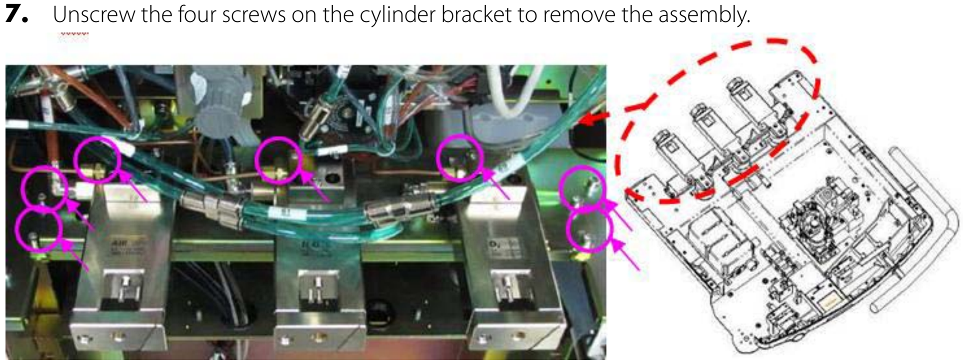


FIGURE 6-72

8. Unscrew the four screws on the cylinder bracket to remove O2, N2O and AIR cylinder bracket assemblies.

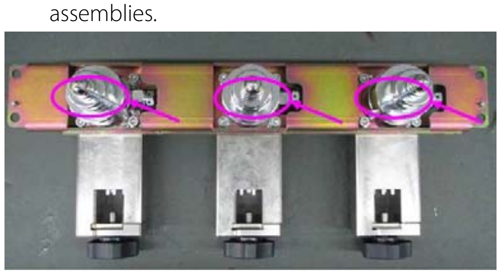


FIGURE 6-73

9. The removed cylinder bracket assembly is shown below

FIGURE 6-74

6.2.3.10 Remove the Spring Tube

1. Remove the work surface cover plate and refer to “Remove the Work Surface Cover Plate” on page 6-28.
2. Remove the rotating block of breathing circle and refer to “Remove the Rotating Block of Breathing Circle” on page 6-61.
3. Cut the cable ties on the spring tubes, then disconnect the spring tubes from the connectors. Remove the spring tubes.

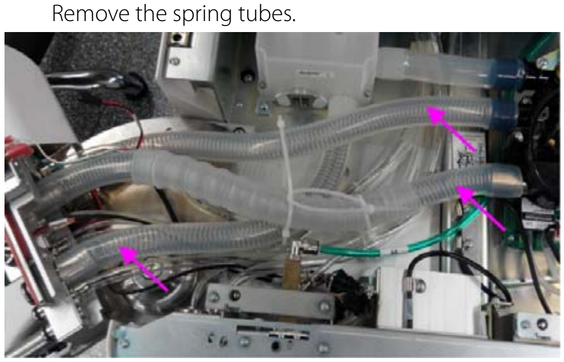


FIGURE 6-75

4. Re-install the spring tubes. Tie the spring tubes as follows:

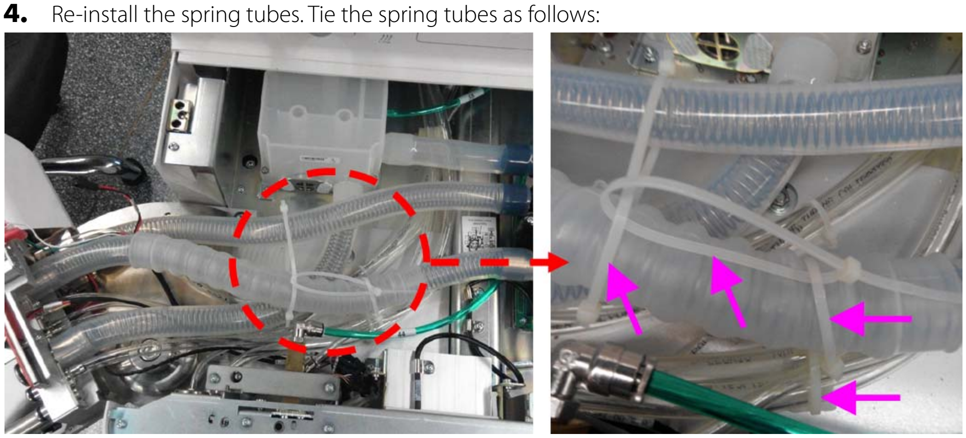


FIGURE 6-76

6.2.4 Disassemble the Auxiliary Work Surface

6.2.4.1 Remove the Auxiliary Work Surface Cover Plate

1. Remove the three drawers and refer to “Remove the Drawer Assembly” on page 6-27.
2. Unscrew the 16 screws and pull out the upper part of the auxiliary work surface assembly horizontally.

FIGURE 6-77

3. Unscrew the 12 screws to remove the auxiliary work surface cover plate.

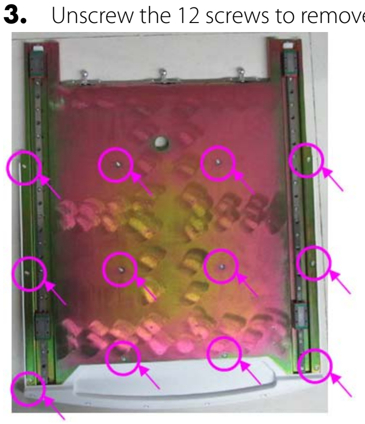


FIGURE 6-78

6.2.4.2 Remove the Slide of the Auxiliary Work Surface

1. Remove the auxiliary work surface cover plate and refer to “Remove the Auxiliary Work Surface Cover Plate” on page 6-37.
2. Unscrew the 7 screws of each slide to remove the slide.

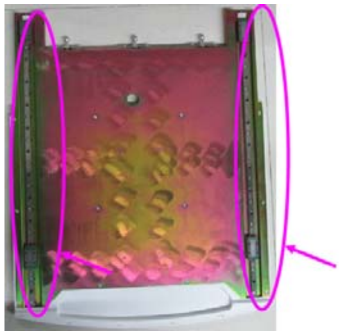


FIGURE 6-79

6.2.4.3 Remove the Non-magnetic Touch Latch

1. Unscrew the 6 screws to remove the rear cover plate of the cart.

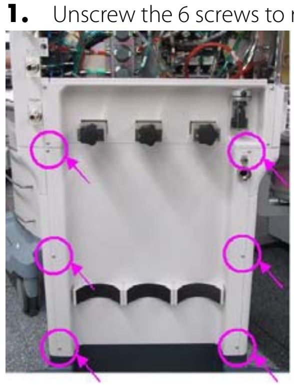


FIGURE 6-80

2. Unscrew the four screws to remove the non-magnetic touch latch.

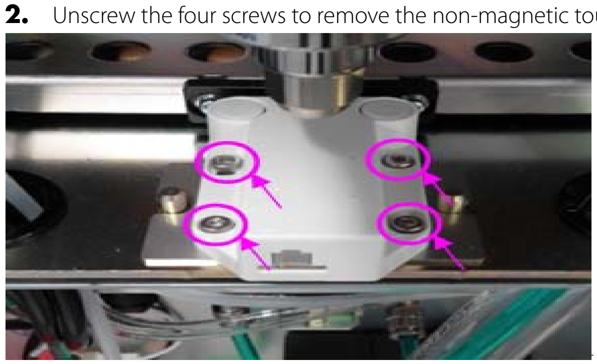


FIGURE 6-81

6.2.5 Disassemble the Display

1. Open the service door and refer to "Open the Service Door" on page 6-3..
2. Remove the related cables and tubes from hardware box and unscrew the four mounting screws to remove the display.

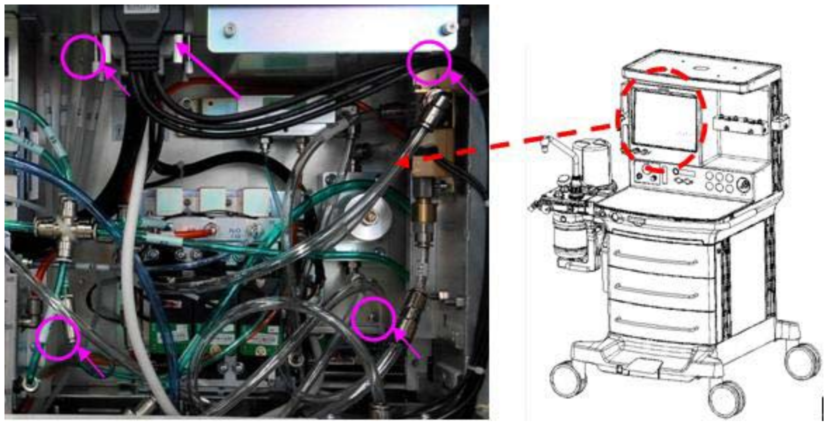


FIGURE 6-82

6.2.5.1 Remove the Alarm Lamp Board

1. Remove the display assembly.
2. Unplug the related cables from the alarm lamp board.
3. Unscrew the two mounting screws on the alarm lamp board to remove the board.

FIGURE 6-83

6.2.5.2 Remove the Display Adaptation Board

1. Remove display assembly and refer to "Disassemble the Auxiliary Work Surface" on page 6-37..
2. Unscrew the five screws on the cover plate of the display mount.

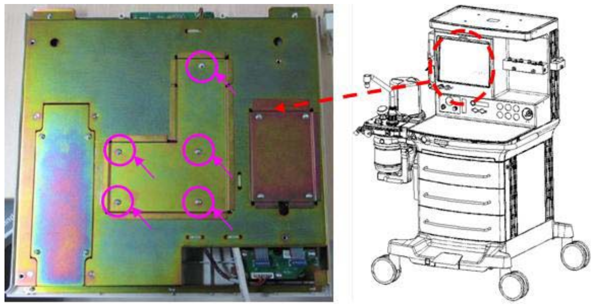


FIGURE 6-84

3. Unplug the related cables from the display interface board.
4. Unscrew the four screws on the display interface board and remove the board.

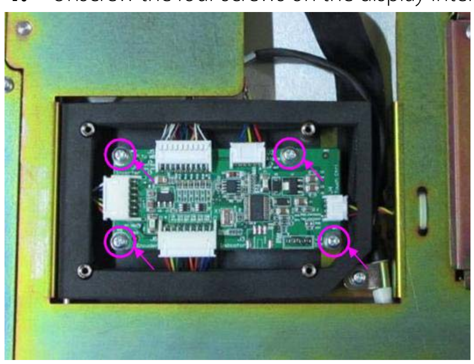


FIGURE 6-85

6.2.5.3 Remove the Touch Screen Control Board

1. Remove display assembly.
2. Unscrew the four screws and the cover plate of the touch screen control board.

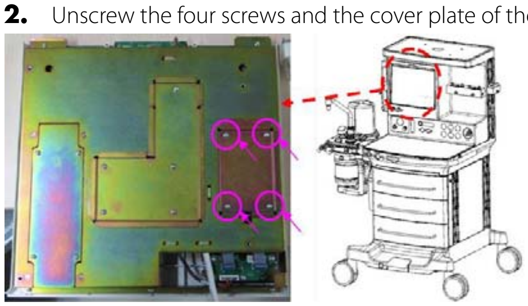


FIGURE 6-86

3. Unplug the related cables from the touch screen control board.

4. Unscrew the two screws on the touch screen control board to remove the board.

FIGURE 6-87

6.2.5.4 Remove the Backlight Inverter Board

1. Remove display assembly.
2. Unscrew the four screws and the cover plate of the backlight inverter board.

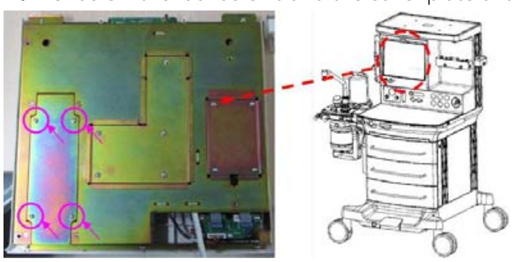


FIGURE 6-88

3. Unplug the related cables from the backlight inverter board.
4. Unscrew the two screws on the backlight inverter board to remove the board.

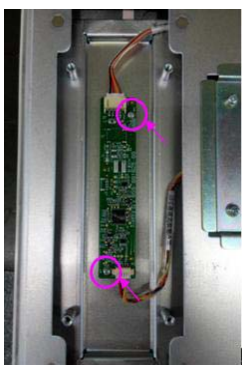


FIGURE 6-89

6.2.5.5 Remove the Encoder Board

1. Remove the display assembly and refer to “Remove the Display” on page 6-46.
2. Unplug the related cables from the encoder board.

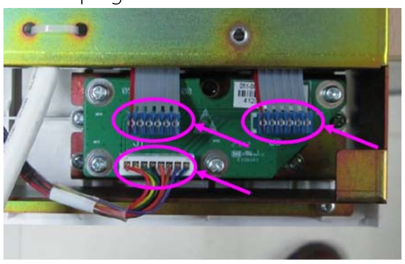


FIGURE 6-90

3. Unscrew the four screws on the encoder board to remove the encoder board.

FIGURE 6-91

6.2.5.6 Remove the Encoder Assembly

1. Remove the display assembly and refer to "Remove the Display" on page 6-46.
2. Unscrew the two screws on the encoder knob protection bar to remove the protection bar.

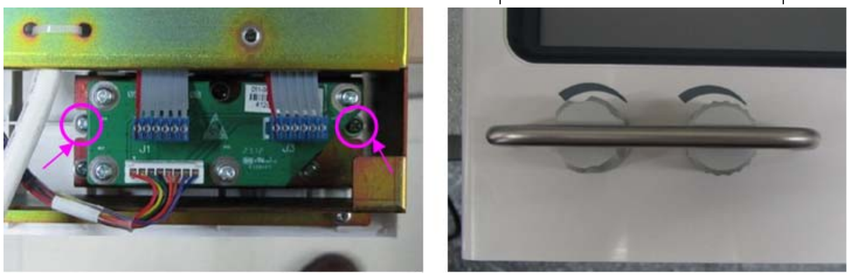


FIGURE 6-92

3. Unplug the encoder knob assembly.

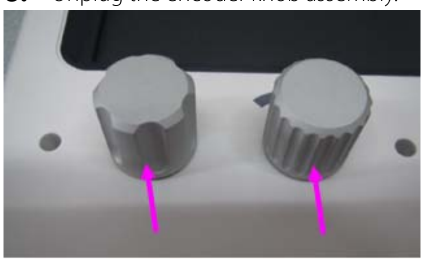


FIGURE 6-93

4. Unscrew the three screws to remove the encoder assembly.

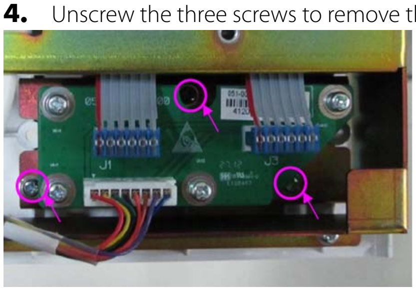


FIGURE 6-94

5. Unplug the related cables from the encoder board and unscrew the four screws to remove the encoder board.

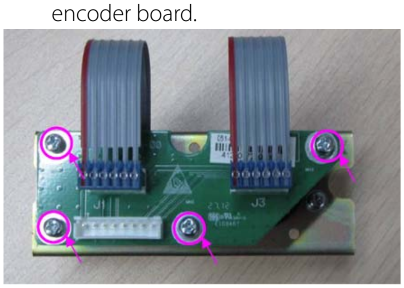


FIGURE 6-95

6. Unscrew the two set screws.

FIGURE 6-96

7. Unscew the two encoder fixation stud and remove the encoder.

FIGURE 6-97

6.2.5.7 Remove the Touch Screen

1. Remove the display assembly.

2. Unscrew the four screws on the cover plate of the touchscreen control board to remove the cover plate..

FIGURE 6-98

3. Unplug the related cables from the touchscreen control board.

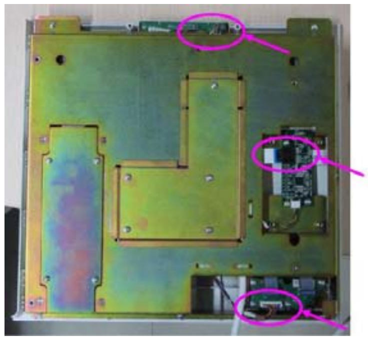


FIGURE 6-99

4. Unscrew the 11 screws around the display backplane and then remove the display backplane.

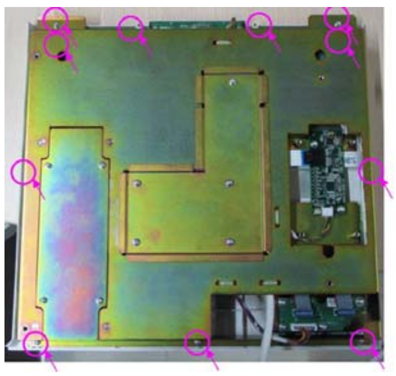


FIGURE 6-100

5. Slightly lift the touch screen off the display front cover to remove the touch screen.

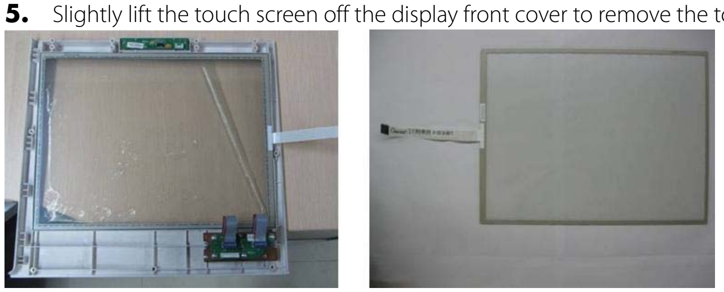


FIGURE 6-101

6.2.5.8 Remove the Display

1. Remove the display touch screen and refer to the step 1, 2, 3, 4 in "Remove the Touch Screen" on page 6-44.
2. Unscrew the 9 screws on the display adaptation board cover plate and on the backlight board cover plate.

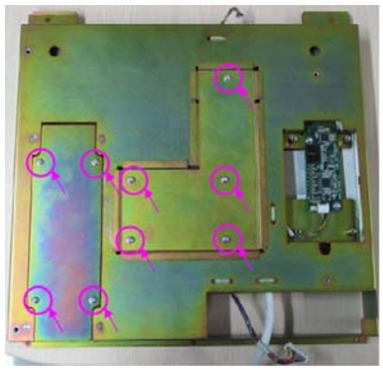


FIGURE 6-102

3. Unplug the related cables from the display.

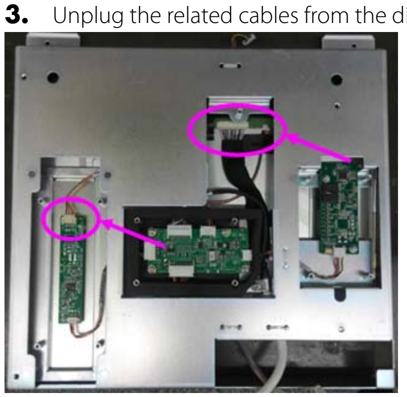


FIGURE 6-103

4. Unscrew the four screws and remove the display.

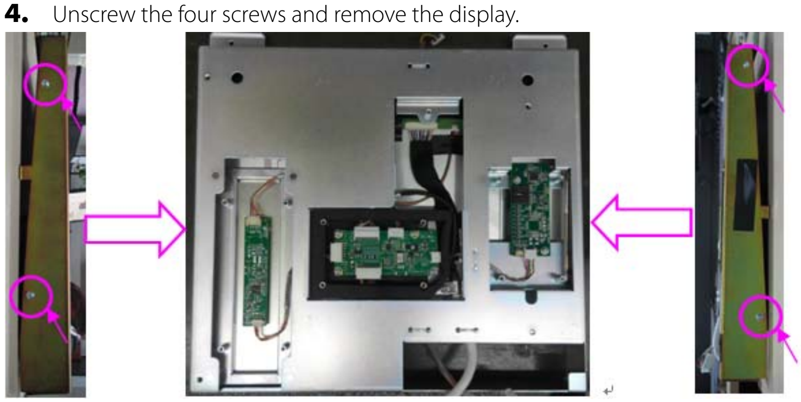


FIGURE 6-104

6.2.5.9 Remove the Display Replacement Package

1. Remove the touchscreen.
2. After the above mentioned assemblies are removed from the display assembly, the remaining part is the display replacement package.

FIGURE 6-105

6.2.6 Remove the Module Rack Assembly

1. Open the service door and refer to "Open the Service Door" on page 6-3.
1. Disassemble the rear panel and refer to "Remove the Rear Cover Plate Assembly" on page 6-29.
2. Unplug the cable plug connecting the module rack assembly.

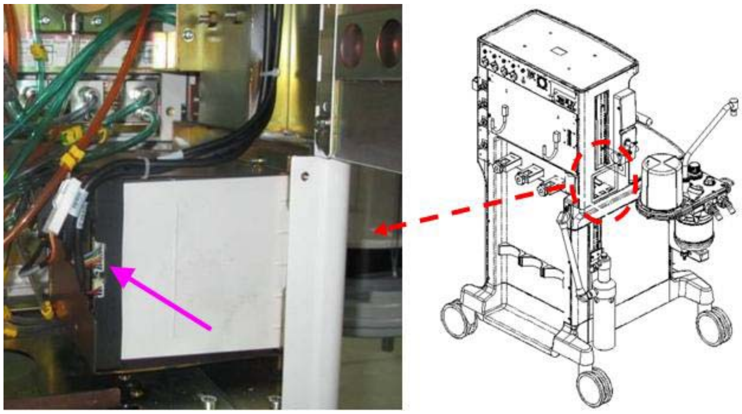


FIGURE 6-106

3. Unscrew the four screws to remove the module rack assembly.

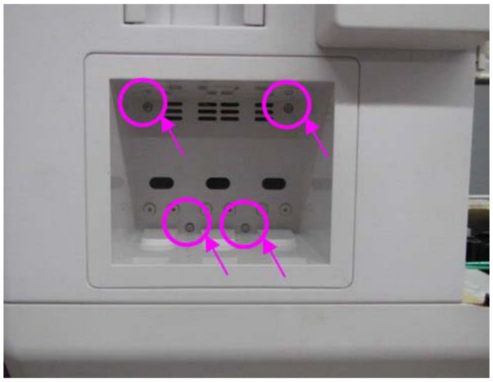


FIGURE 6-107

4. Unscrew the five screws to remove the infrared communication board.

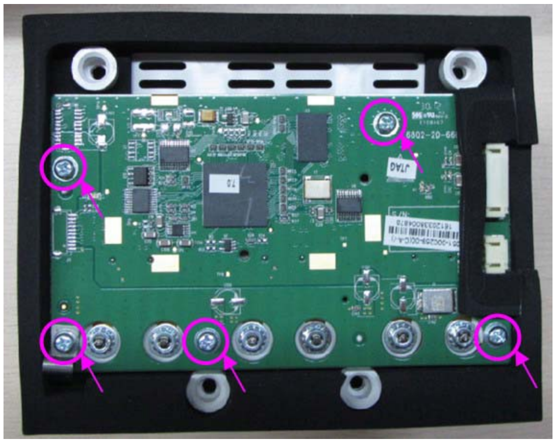


FIGURE 6-108

6.2.7 Remove the Module Rack Fan

1. Remove the module rack assembly.
2. Unplug the cable plug for module rack fan.
3. Unscrew the four screws to remove the module rack bracket assembly.

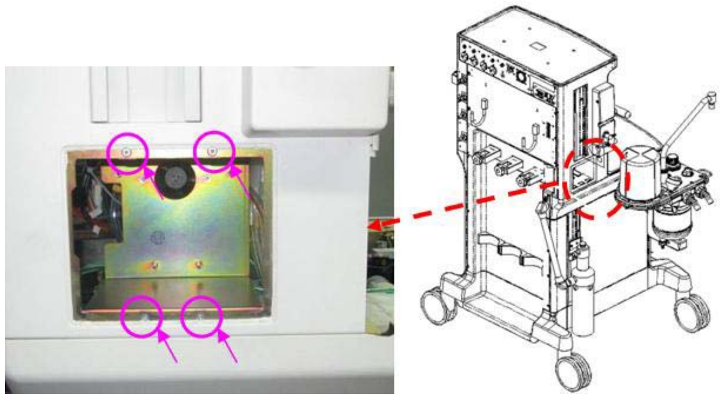


FIGURE 6-109

4. Unscrew the two screws to remove the fan and bracket.

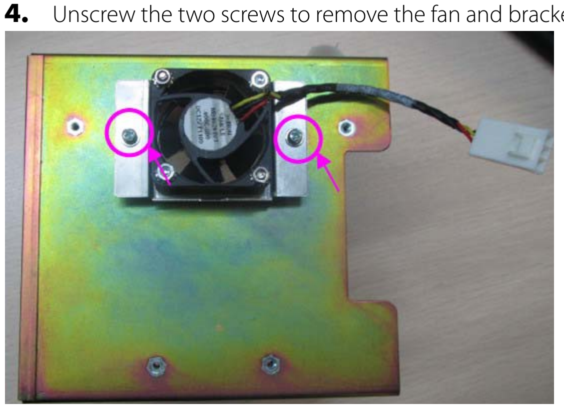


FIGURE 6-110

5. Unscrew the four screws to remove the module rack fan.

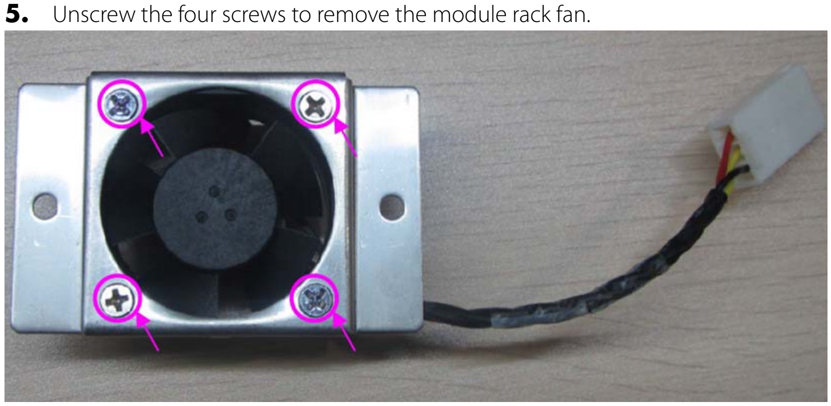


FIGURE 6-111

6.2.8 Remove the Panel of Pressure Gauges

1. Open the service door and refer to "Open the Service Door" on page 6-3.
2. Disassemble the rear panel and refer to "Remove the Rear Cover Plate Assembly" on page 6-29.
3. Remove the module rack cabinet assembly and refer to "Remove the Module Rack Assembly" on page 6-48.
4. Disconnect the cables from the system switch, indicator board, and auxiliary needle valve extension mechanism.
5. Unplug the related tubes from the gas supply pressure gauge and system switch assembly of the instrument panel and unplug one end of the tubes from the total flowmeter assembly and needle valve module.
6. Remove the three copper pipes on the high-pressure pressure gauges from cylinder bracket assembly.

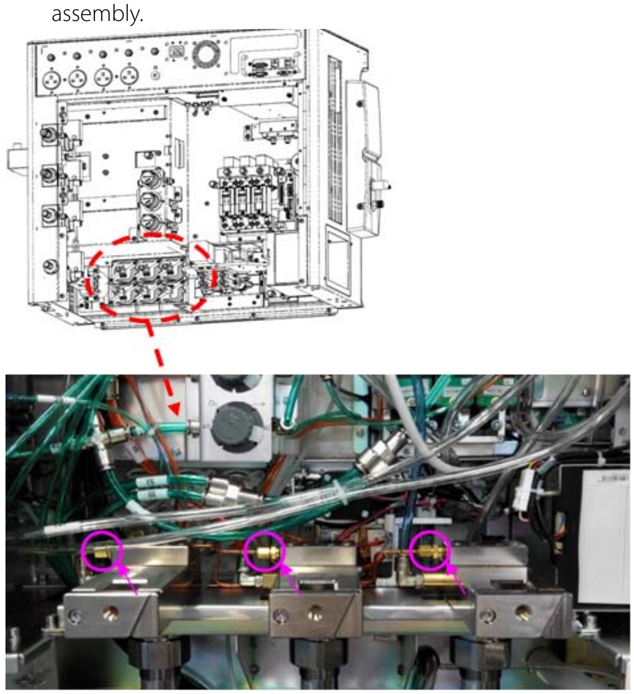


FIGURE 6-112

7. To remove the work surface cover plate assembly, refer to "Remove the Work Surface Cover Plate" on page 6-28.
8. Unscrew one screw from the back of the machine to remove the BFCS support bar.

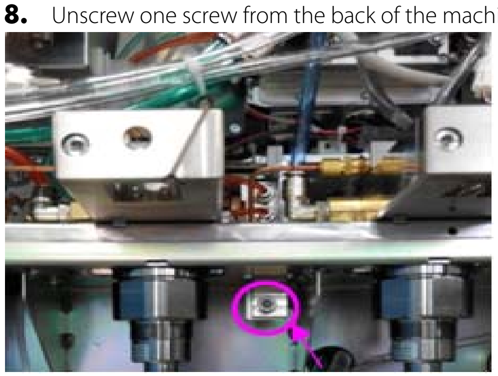


FIGURE 6-113

9. Unscrew the three screws from the back of the machine and fully loosen the captive screw.

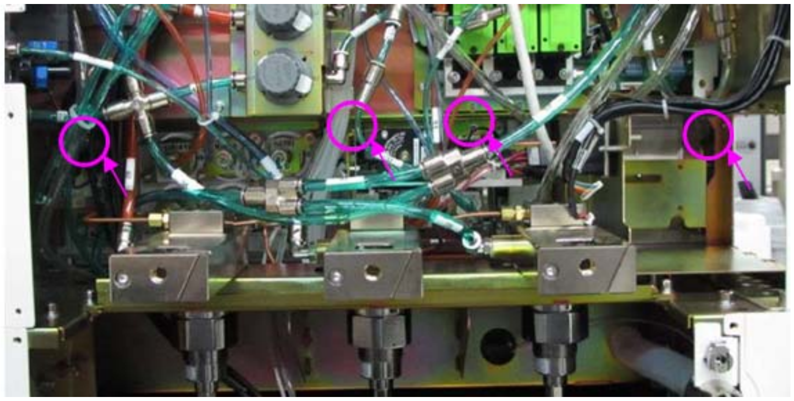


FIGURE 6-114

10. Unscrew the four screws on the gauge panel to remove the panel. When taking out the gauge panel, note that high pressure test tube shall avoid the internal tubes and cables of the machine.

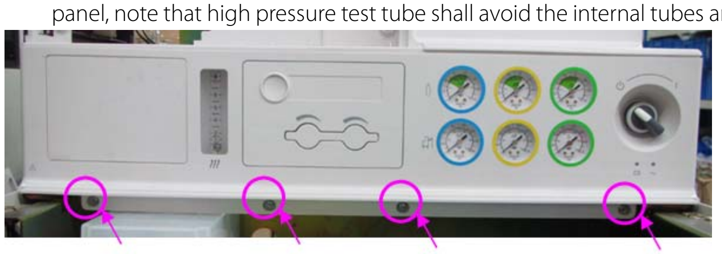


FIGURE 6-115

6.2.8.1 Remove the Pressure Gauges

1. Remove the pressure gauge panel.
2. Unscrew the two screws from the pressure gauge and remove gas supply pressure gauge and high-pressure gauge..

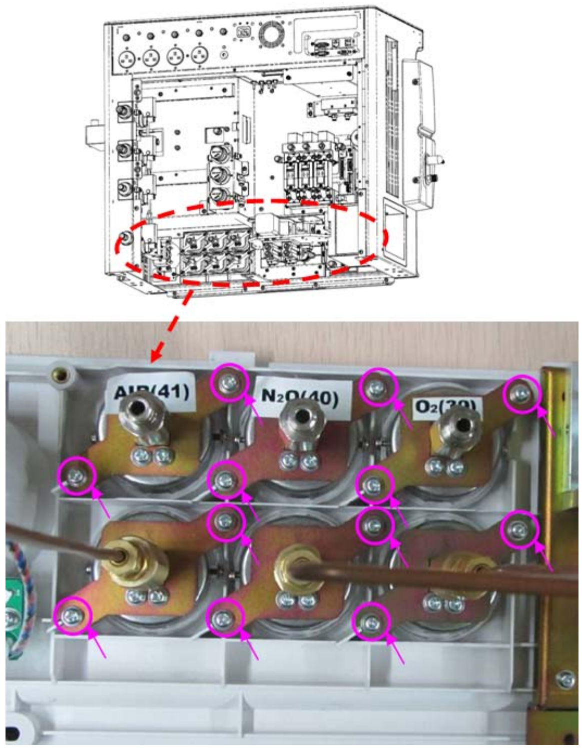


FIGURE 6-116

3. If replacing the pressure gauge cover is necessary, take out the white gasket inside the gauge cover. Then remove the gauge cover from the gauge panel. Before replacement, clear the residual adhesive strip on the gauge panel.

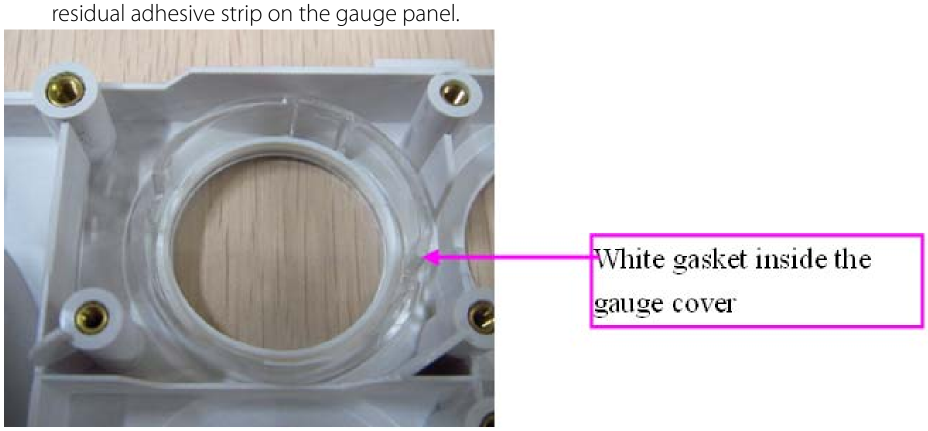


FIGURE 6-117

6.2.8.2 Remove the Total Flowmeter

1. Remove the panel of the pressure gauge and refer to "Remove the Panel of Pressure Gauges" on page 6-50..
2. Unscrew the four screws on the total flowmeter and to remove it.

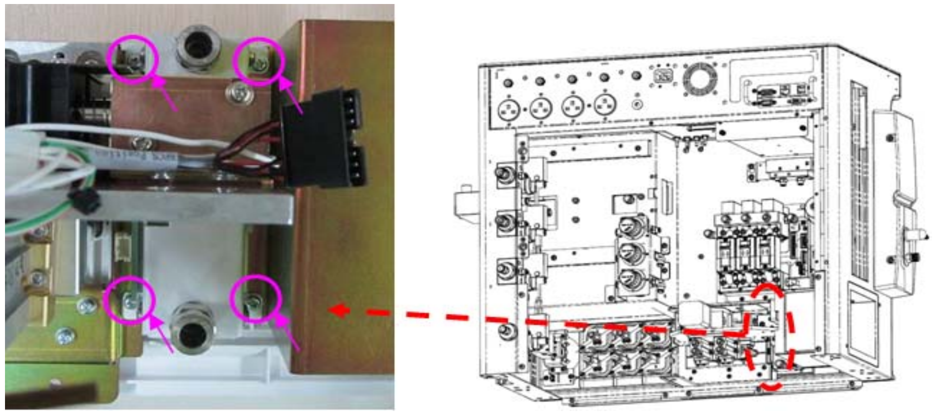


FIGURE 6-118

6.2.8.3 Remove the System Switch

1. Remove the panel of the pressure gauge and refer to "Remove the Panel of Pressure Gauges" on page 6-50..
2. Unscrew the four screws on the system switch to remove the switch.

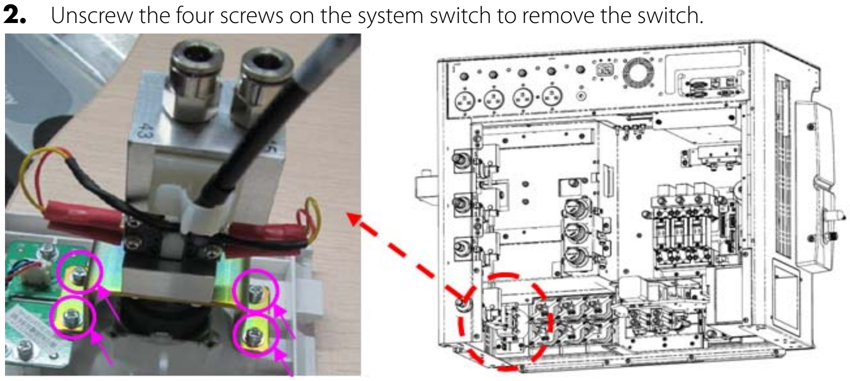


FIGURE 6-119

6.2.8.4 Remove the Indicator Light Board

1. Remove the panel of the pressure gauge and refer to"Remove the Panel of Pressure Gauges" on page 6-50. .
2. Unscrew the two screws on the indicator light board to remove the board.

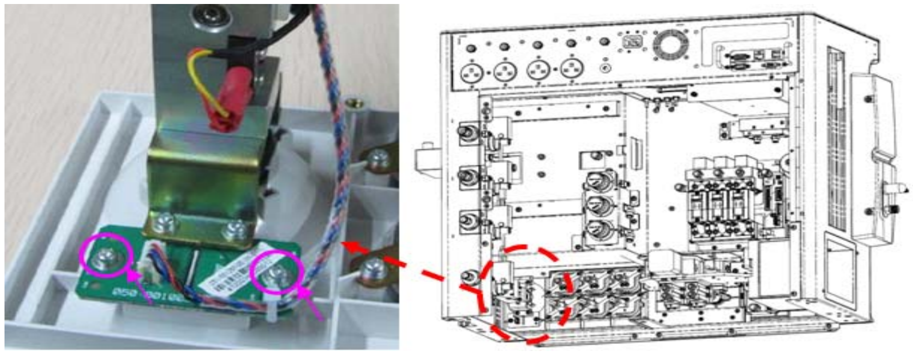


FIGURE 6-120

6.2.8.5 Remove the Needle Valve Assembly

1. Remove the panel of the pressure gauge and refer to 6.2.8.
2. Disconnect the tubes and cables from the needle valve assembly.
3. Unscrew the three screws to remove the needle valve assembly.

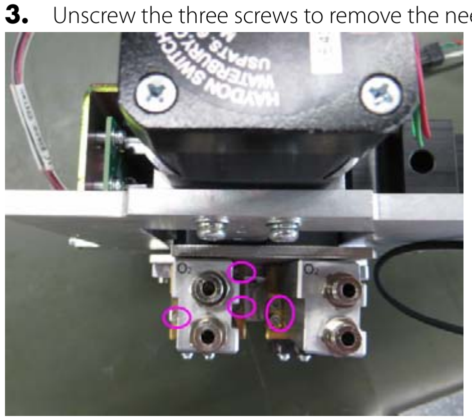


FIGURE 6-121

4. Unscrew the two screws on the contact switch to remove the contact switch.

6.2.8.6 Remove the Electromagnet

1. Remove the panel of the pressure gauge and refer to 6.2.8.
2. Disconnect the cable from the stepper motor.
3. Unscrew the three screws to remove the electromagnet assembly.

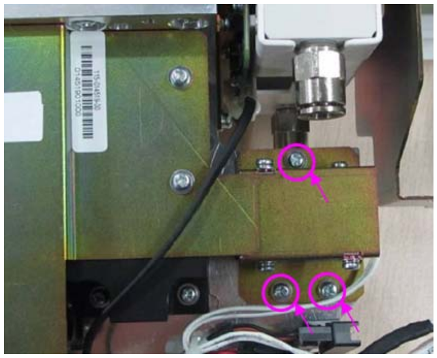


FIGURE 6-122

6.2.8.7 Remove the Motor Position Check Board

1. Remove the panel of the pressure gauge and refer to 6.2.8.
2. Disconnect the cable from the motor position check board.
3. Unscrew the four screws to remove the protective shield.

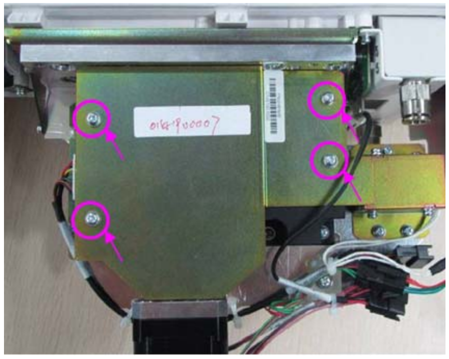


FIGURE 6-123

4. Unscrew the two screws to remove the motor position check board and metal sheet.

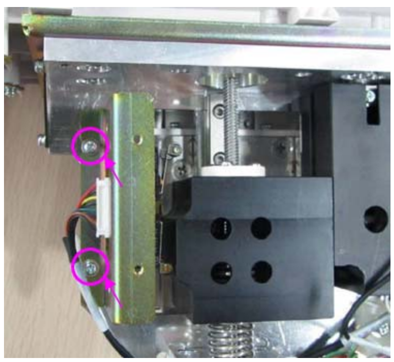


FIGURE 6-124

5. Unscrew the three screws to remove the motor position check board.

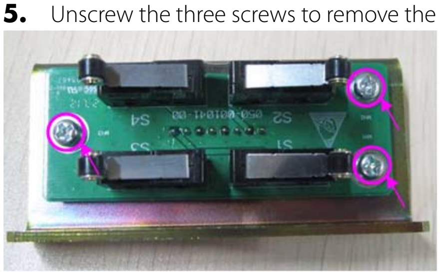


FIGURE 6-125

6.2.8.8 Remove the Needle Valve Extension Mechanism

1. Remove the panel of the pressure gauge and refer to 6.2.8.
2. Unscrew the four screws to remove the needle valve extension mechanism and the needle valve module.

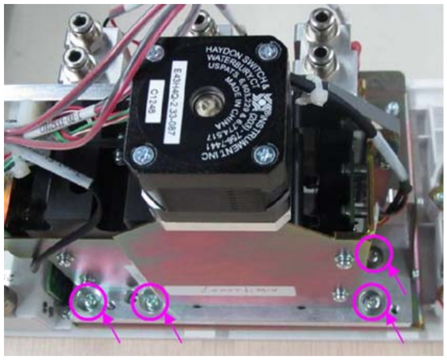


FIGURE 6-126

3. Unscrew the 4 screws to remove the needle valve extension mechanism.

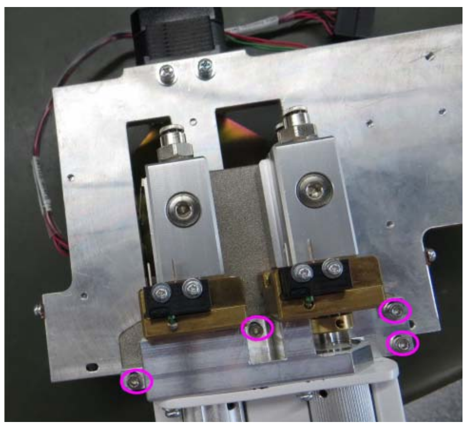


FIGURE 6-127

6.2.9 Disassemble the Vacuum Suction Related Assembly

6.2.9.1 Remove the Overfill Protection Cup Assembly

1. Open the service door and refer to 6.2.1.1.
2. Unplug the tube connected to the overfill protection cup and unscrew the three screws fixing the cup to remove this assembly.

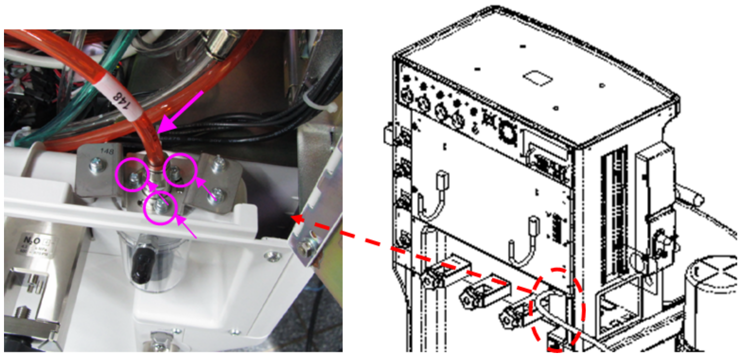


FIGURE 6-128

6.2.9.2 Remove the pipeline vacuum inlet assembly

1. Open the service door and refer to 6.2.1.1.
2. Remove the rear cover plate assembly and refer to 6.2.3.4.
3. Unplug the tube connected to the pipeline vacuum inlet assembly.
4. Unscrew the two screws fixing the pipeline vacuum inlet assembly to remove the assembly.

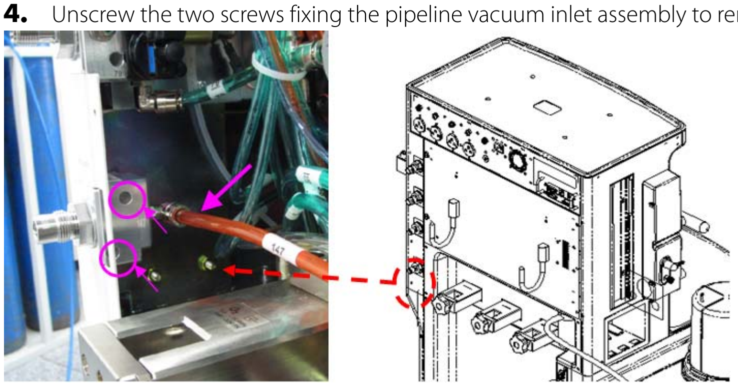


FIGURE 6-129

6.2.9.3 Remove the Vacuum Control Panel Assembly

1. Remove the module rack cabinet assembly and refer to 6.2.6.
2. Unplug the tube or plug connected to the vacuum control panel assembly and unscrew the four screws as shown below.

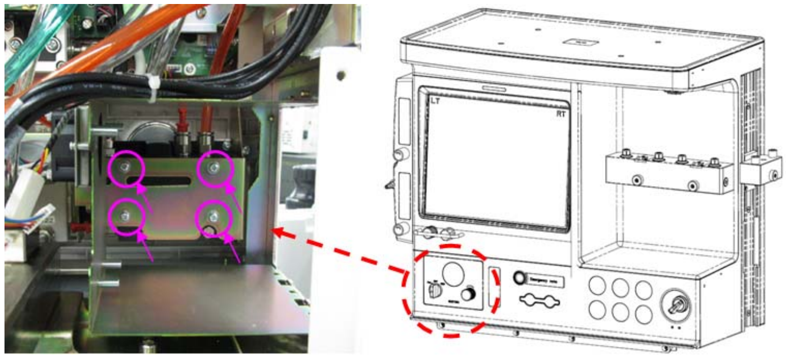


FIGURE 6-130

3. Take out the vacuum control panel assembly from the front of the machine.

FIGURE 6-131

4. Unscrew the four screws to remove the vacuum control main body assembly FRU.

FIGURE 6-132

5. Unscrew the two screws to remove the negative pressure gauge assembly FRU.

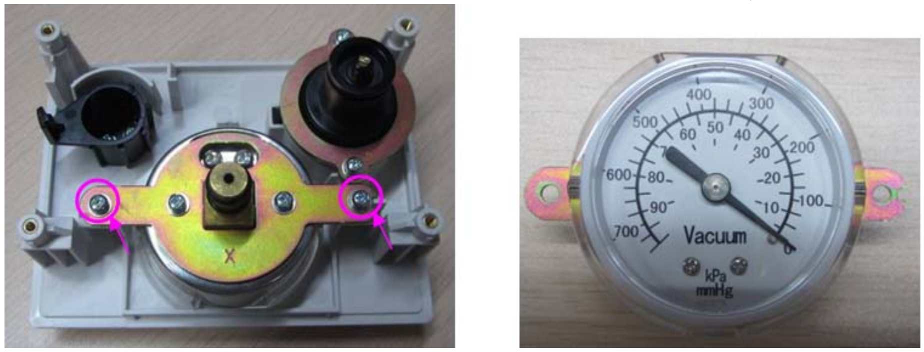


FIGURE 6-133

6. Unscrew the two screws and then rotate the needle valve knob to remove the negative pressure needle valve assembly FRU.

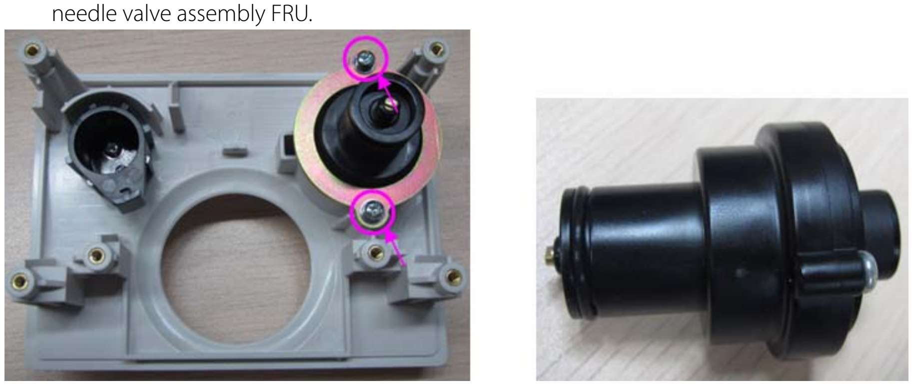


FIGURE 6-134

7. Unscrew the two screws to remove the selector switch and dialing switch. The remaining part is needle valve knob and panel RFU.

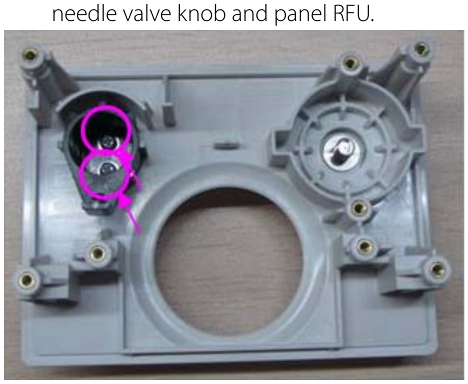


FIGURE 6-135

6.2.10 Remove the Auxiliary Gas Outlet Assembly

1. Open the service door and refer to “Open the Service Door” on page 6-3..
2. Unplug the related tubes from auxiliary gas outlet assembly.

3. Unscrew the two screws on the auxiliary gas outlet assembly to remove the assembly.

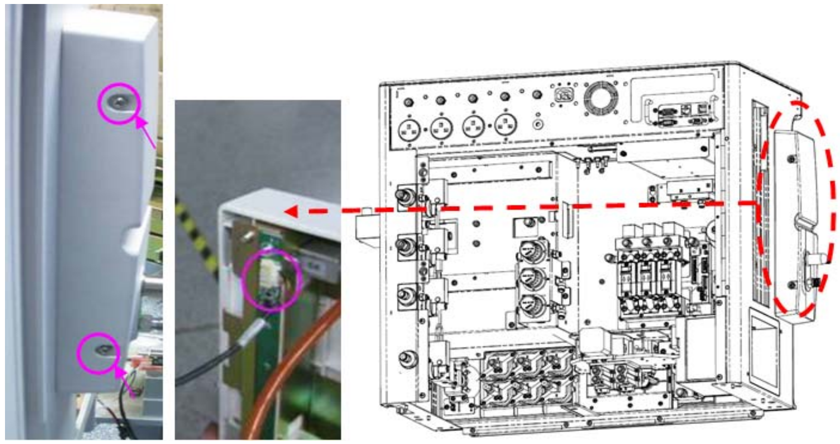


FIGURE 6-136

4. Unscrew the three screws to remove the backlight board PCBA of auxiliary gas supply flowmeter
.

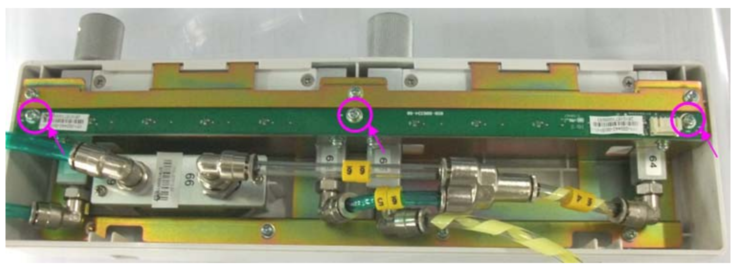


FIGURE 6-137

6.2.11 Remove the Rotating Block of Breathing Circle

1. Remove the work surface cover plate and refer to "Remove the Work Surface Cover Plate" on page 6-28.
2. Unplug the breathing system assembly from the rotating block.
3. Unscrew the four screws and remove the rotating block of breathing circle.

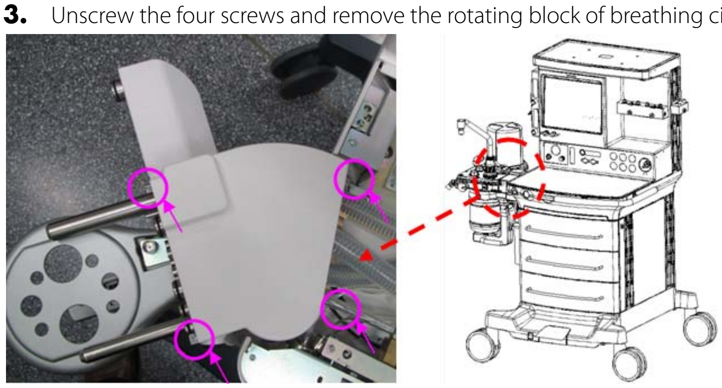


FIGURE 6-138

6.2.12 Remove the AGSS Assembly

1. Unplug the transfer tubes from AGSS assembly.
2. Loosen the AGSS rail locking knob on the AGSS assembly. Lift the AGSS assembly along the side to remove the assembly.

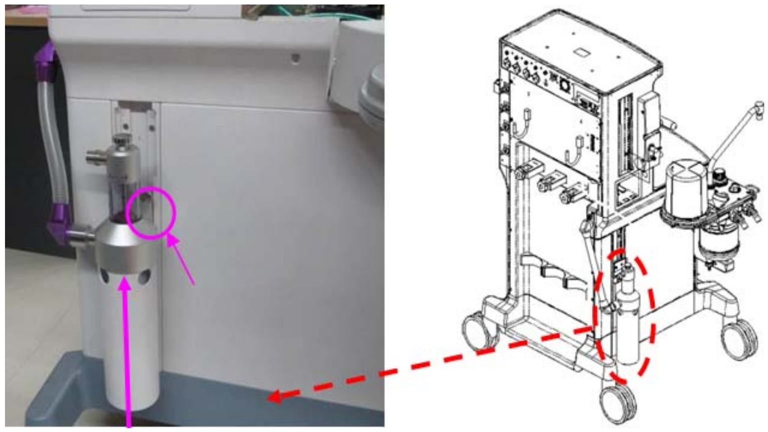


FIGURE 6-139

6.2.13 Remove the Electronically Controlled ACGO Drive Valve

1. Unscrew the 6 screws to remove the back cover plate of the cart.

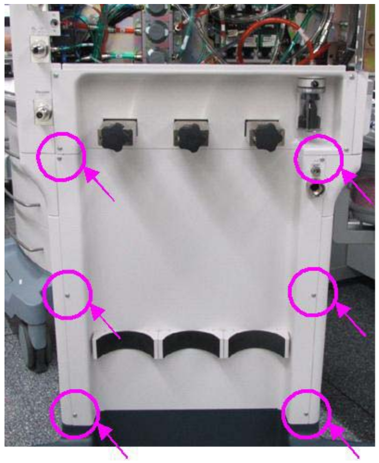


FIGURE 6-140

2. Unplug the related tubes and cables from the ACGO drive valve.
3. Unscrew the two screws to remove the ACGO drive valve.

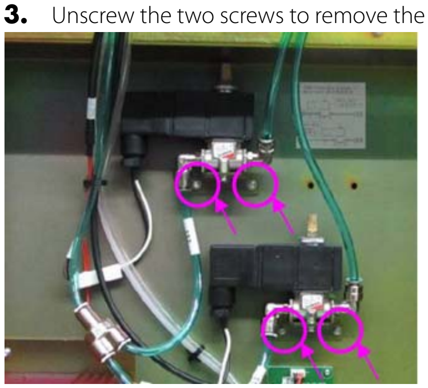


FIGURE 6-141

6.2.14 Remove the Built-in Anesthesia Module

1. Unscrew the 6 screws to remove the back cover plate of the cart.

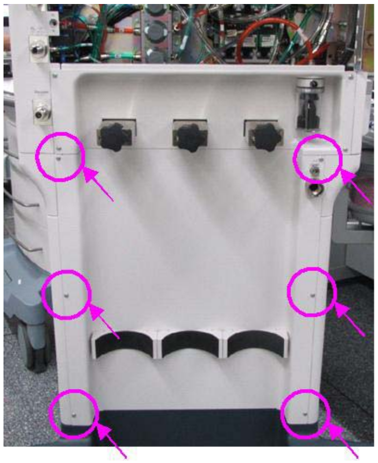


FIGURE 6-142

2. Unplug the related tubes and cables from the anesthesia module.
3. Unscrew the four screws to remove the anesthesia module and the metal sheet bracket as well.

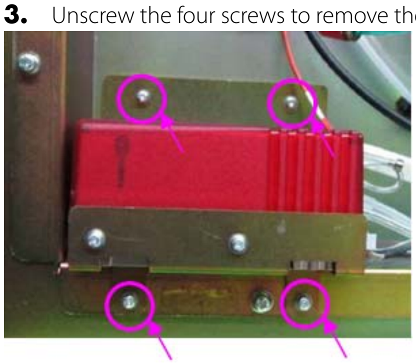


FIGURE 6-143

4. Unscrew the four screws to remove the anesthesia module.

FIGURE 6-144

5. Unscrew the three screws to remove the anesthesia module adaptation board.

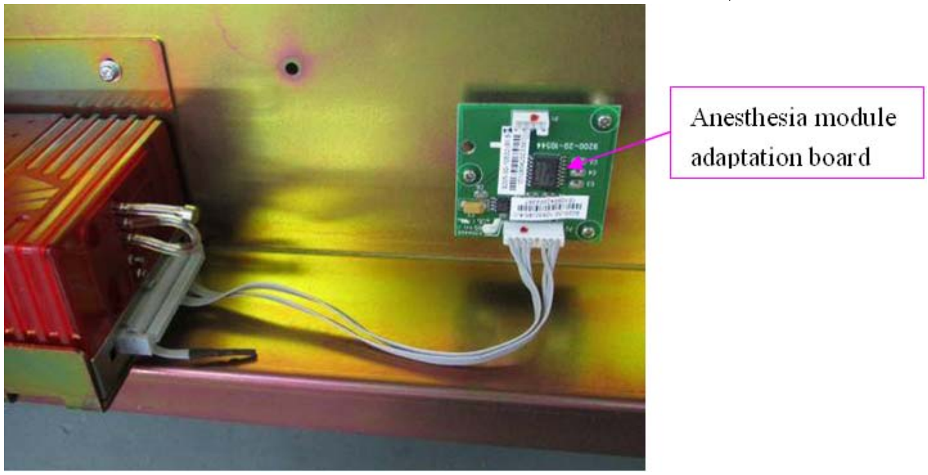


FIGURE 6-145

After removing the built-in anesthesia module communication cable, unscrew the three screws to remove the anesthesia module adaptation board.

6.2.15 Remove the ACGO Assembly (electronically controlled)

1. Unscrew the 6 screws to remove the back cover plate of the cart.

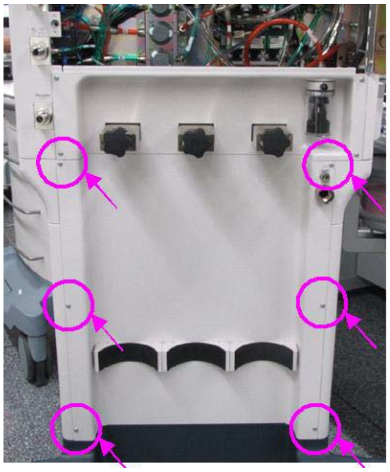


FIGURE 6-146

2. Unplug the tubes and cables from the ACGO assembly (electronically controlled).
3. Unscrew the four screws to remove the ACGO assembly (electronically controlled)l.

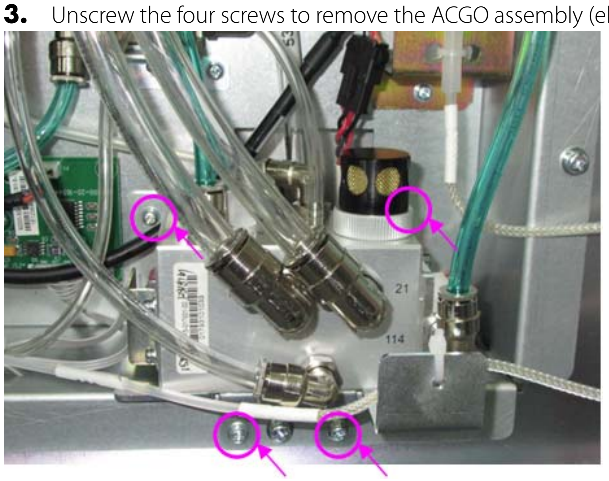


FIGURE 6-147

6.2.16 Remove Anesthesia Module Inlet Pipeline Assembly

1. Open the service door and refer to"Open the Service Door" on page 6-3.
2. Remove the rear panel and refer to"Remove the Rear Cover Plate Assembly" on page 6-29..
3. Unplug the tubes from the anesthesia module and two-way connector.

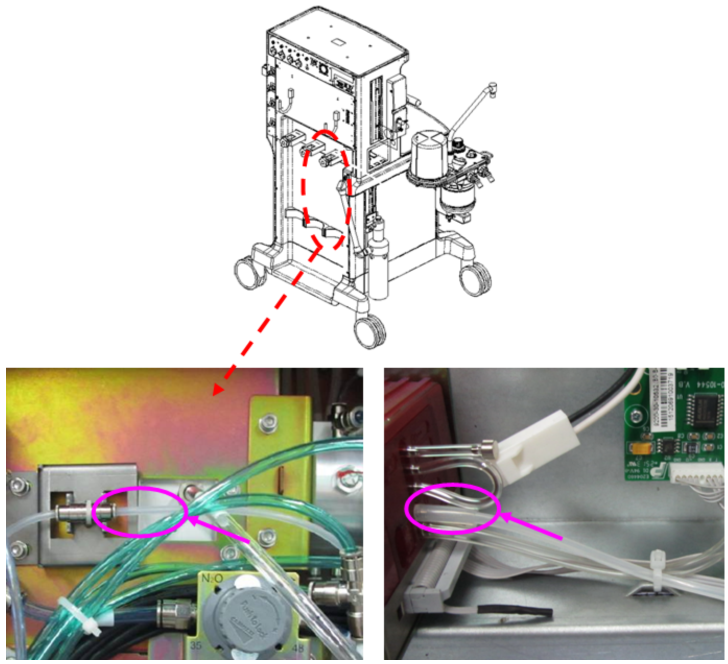


FIGURE 6-148

4. Unscrew the two screws to remove the anesthesia module inlet pipeline assembly.

FIGURE 6-149

Cut the cable tie used to fix the filter and disconnect the tube from the filter to remove the filter.

6.2.17 Disassemble the Base Assembly

Distinguish the new base assembly and the old base assembly: The difference between the new base assembly and the new base assembly is the installation of casters. There are four screws (M8X16 hexagon socket screws) fastening one caster of the old base assembly.

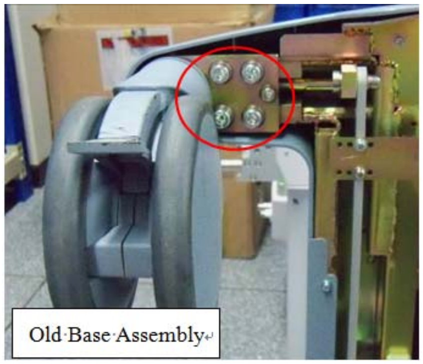


FIGURE 6-150 The Old Base Assembly

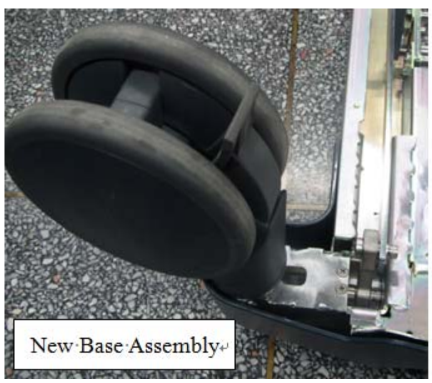


FIGURE 6-151 The New Base Assembly

6.2.17.1 Remove the Caster Assembly (Old Base Assembly)

1. Remove the breathing system and tilt the A7 backward.

FIGURE 6-152

2. Unscrew the four screws and remove the caster assembly.

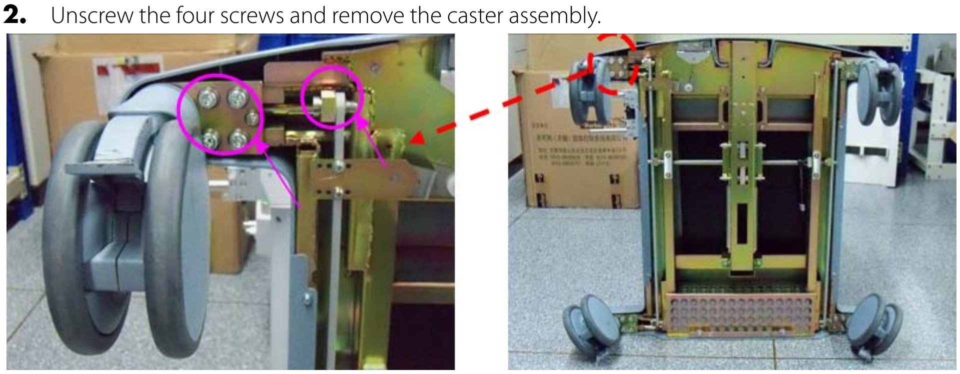


FIGURE 6-153

3. When you maintain the old base assembly with the caster (P/N: 034-000285-00), remove the parts below and install them on the new caster.
4. Unscrew the one screw and remove the transmission axis of the caster.

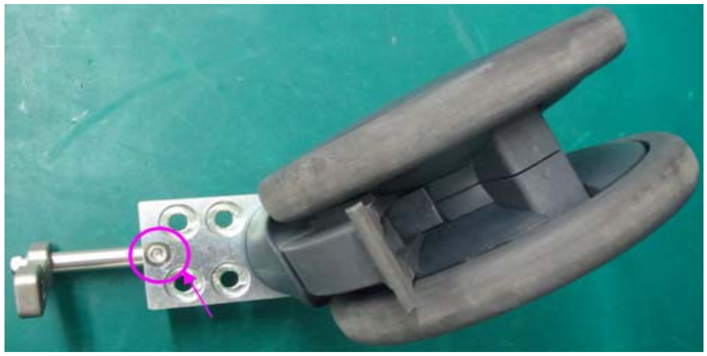


FIGURE 6-154

5. Unscrew the two screws and remove the installation block of the caster.

FIGURE 6-155

6.2.17.2 Remove the Caster Assembly (New Base Assembly)

1. Remove the drawer assembly. See section 6.2.3.1 (pg. 6-27) "Remove the Drawer Assembly".
2. Remove the lower rear panel assembly. See the step 3 in the section 6.2.3.4 (pg. 6-29) "Remove the Rear Cover Plate Assembly".
3. Unscrew the ten screws on the left and right side panel fastening the cart and remove the upper part.

FIGURE 6-156

4. Unscrew the four screws fastening the cover of the base assembly and remove the cover.

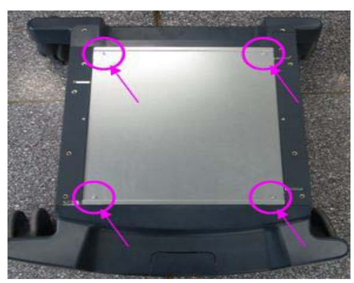


FIGURE 6-157

5. Unscrew the two screws on the left and right trim panel fasting the base assembly.

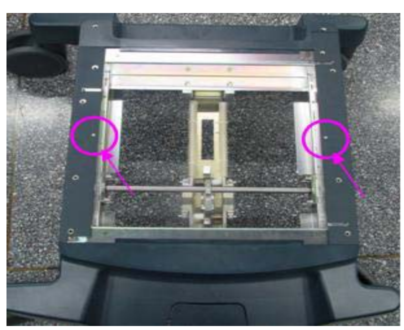


FIGURE 6-158

6. Turn over the base assembly. Unscrew the four screws on the left and right trim panel fastening the base assembly and remove the left and right trim panel.

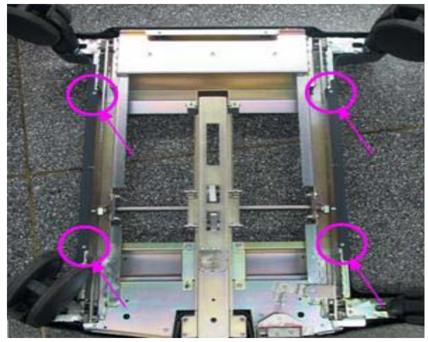
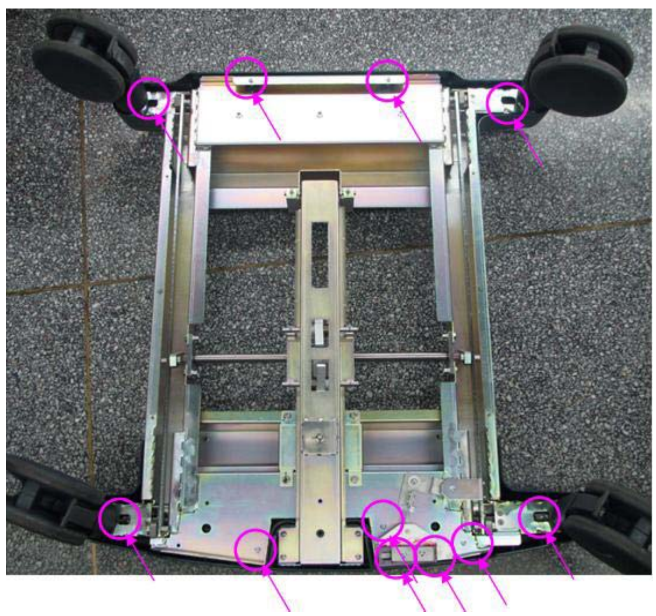


FIGURE 6-159

7. According to the situation of the caster replacement, unscrew the screws fastening the front cover and the rear cover of the base assembly and remove the front cover and the rear cover.



8. Unscrew the two screws fastening the connecting rod.

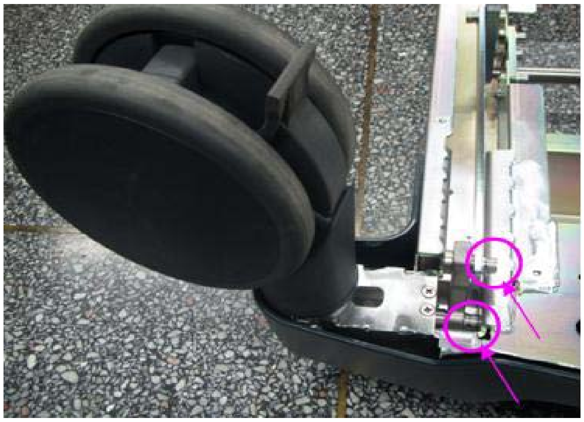


FIGURE 6-160

9. Unscrew the two screws fastening the installation block of the caster, and remove the installation block and transmission axis of the caster.

FIGURE 6-161

10. Unscrew the two screws fastening the caster and remove the caster.

FIGURE 6-162

6.2.17.3 Remove the Brake Indicator Drive Plate I and II

1. Tilt A7 backward.
2. Unscrew the two screws on the brake indicator drive plate I to remove the plate.

FIGURE 6-163

3. Unscrew the one screw on the brake indicator drive plate II to remove the plate.

FIGURE 6-164

6.2.17.4 Remove the Brake Assembly

1. Tilt A7 backward.
2. Unscrew the six screws on the brake assembly to remove the assembly.

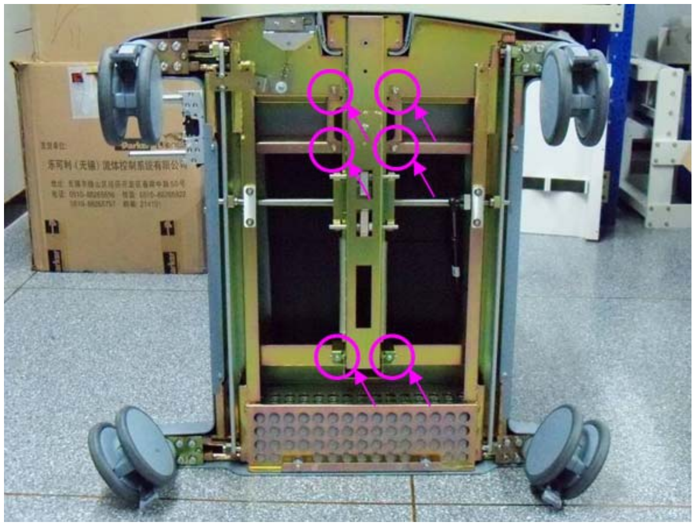


FIGURE 6-165

6.2.17.5 Remove the Brake Main Axis

1. Tilt A7 backward.
2. Remove brake assembly.
3. For the old base assembly, unscrew the six screws and remove the brake main axis.

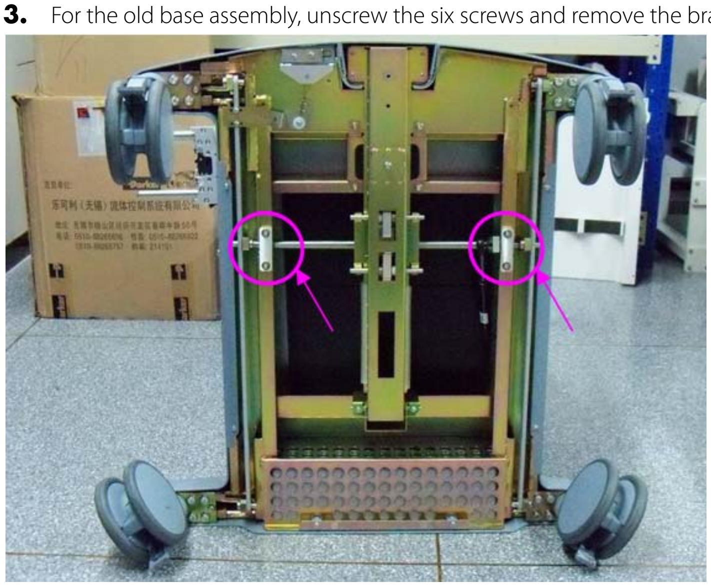
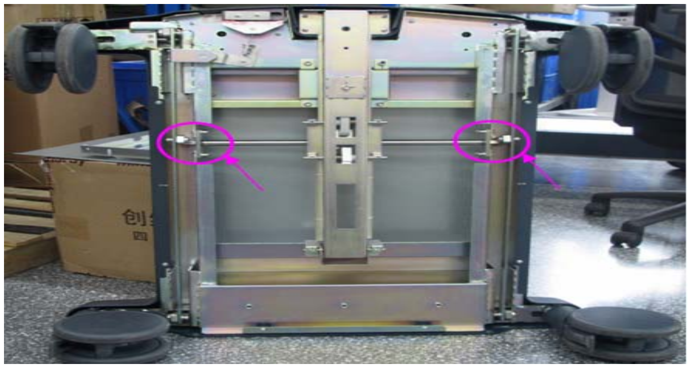


FIGURE 6-166

4. For the new base assembly, unscrew the ten screws and remove the brake main axis.



6.2.17.6 Remove the Principal Axis of Brake

1. Tilt A7 backward.
2. Remove the brake indicator drive plate II.
3. Unscrew the six screws on the brake rod to remove the rod.

6.3 Disassemble the Breathing System

6.3.1 Remove the Breathing Tubes

NOTE: When disassembling the breathing tube, hold the tube connectors at both ends of the tube to prevent damage to the tube.

1. Remove the filter from the Y piece.

FIGURE 6-167

2. Disconnect the breathing tubes from the inspiration/expiration connectors on the circuit.

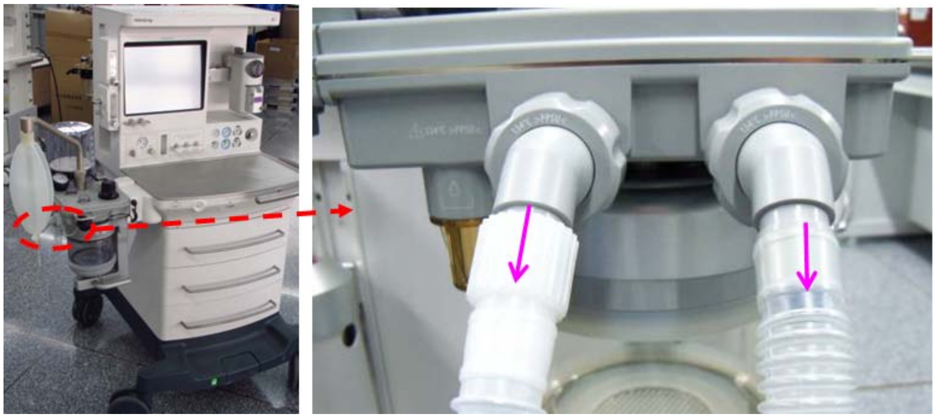


FIGURE 6-168

6.3.2 Remove the Flow Sensor

1. Turn the locking nuts counterclockwise.

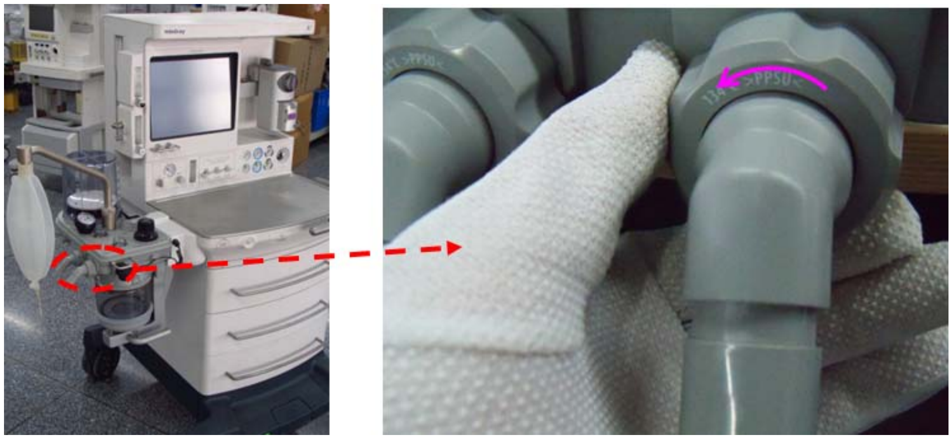


FIGURE 6-169

2. Pull out the inspiration and expiration connectors together with their locking nuts. And then pull out the flow sensors horizontally.

FIGURE 6-170

3. The following pictures show the appearance of inspiratory and expiratory flow sensor assemblies.

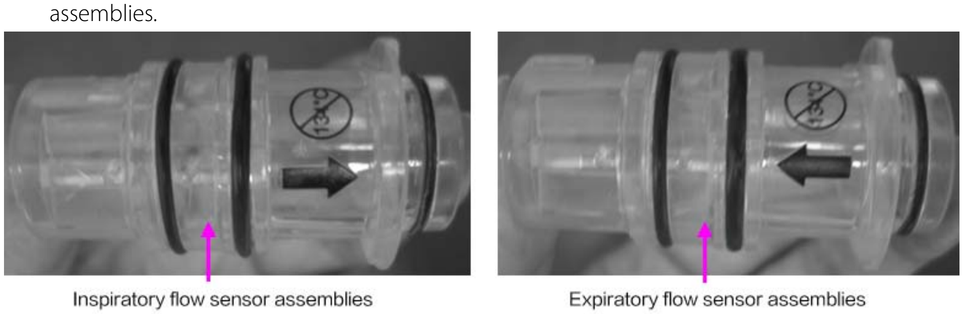


FIGURE 6-171

6.3.3 Remove the Manual Bag

Remove the manual bag from the connector on the breathing system as shown below.

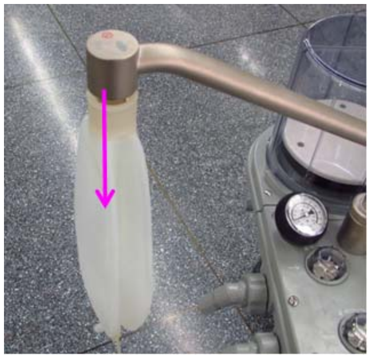


FIGURE 6-172

6.3.4 Remove the Absorbent Canister

1. Hold and turn the rotary handle clockwise for 45 degrees.

FIGURE 6-173

2. Pull out the absorbent canister horizontally.

FIGURE 6-174

WARNING: **Sodalime is a caustic substance and is a strong irritant to eyes, skin and respiratory system. Affected areas should be flushed with water. If irritation continues after flushing with water, seek medical assistance immediately.**

If it is necessary to replace or re-install the Pre-pak absorber sealing cushion (049-000143-00), set the internal groove of the Pre-pak absorber sealing cushion in the side flange of the Pre-pak absorber, as shown below..

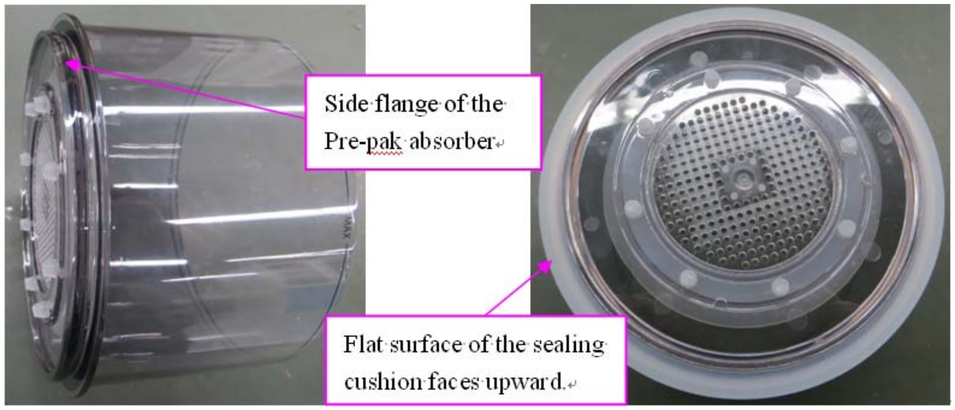


FIGURE 6-175

Make sure that the sealing cushion is correctly installed. The comparison between correct installation and incorrect installation is shown below..

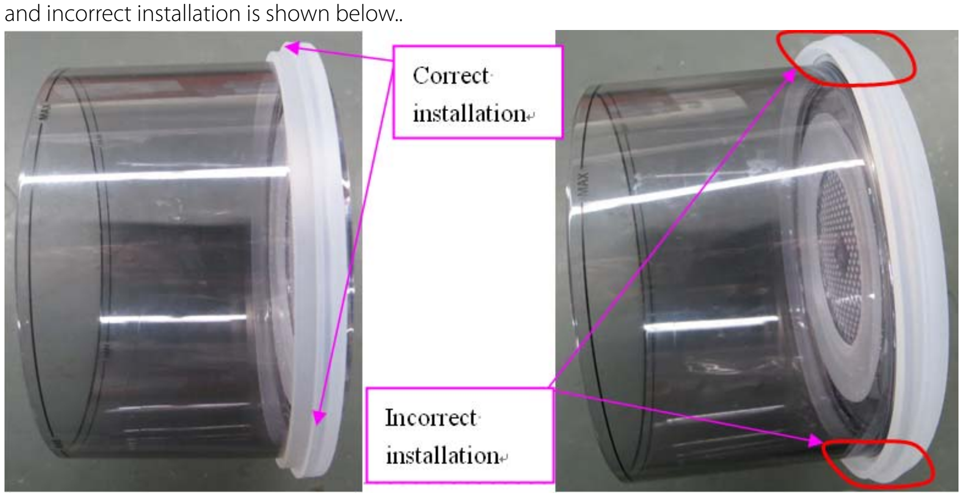


FIGURE 6-176

6.3.5 Remove the CO2 Bypass Assembly

1. Remove the absorbent canister as per section 6.3.5.
2. Press inward the fasteners on both sides and the CO2 bypass assembly will drop down for removal.

FIGURE 6-177

If it is necessary to replace or re-install the bypass trigger plate sealing cushion (049-000142-00), pay attention to the matching between the interior convex rib of the bypass trigger plate sealing cushion and the groove of the bypass trigger plate when assembling the bypass trigger plate sealing cushion onto the bypass trigger plate, as shown below.

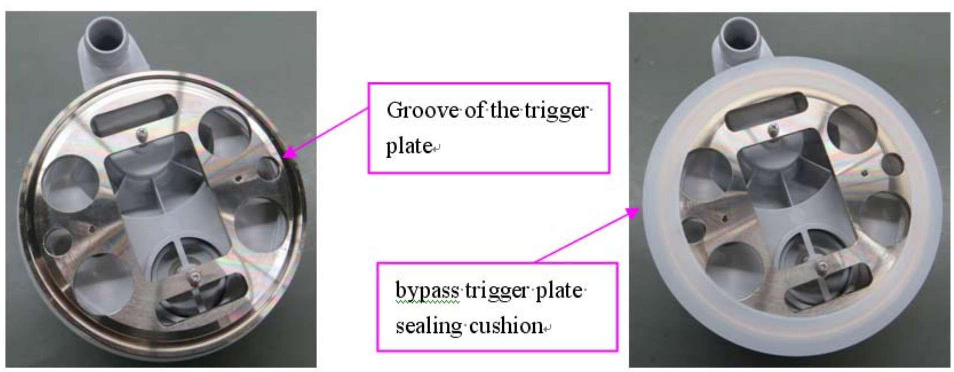


FIGURE 6-178

Make sure that the sealing cushion is correctly installed. The comparison between correct installation and incorrect installation is shown below.

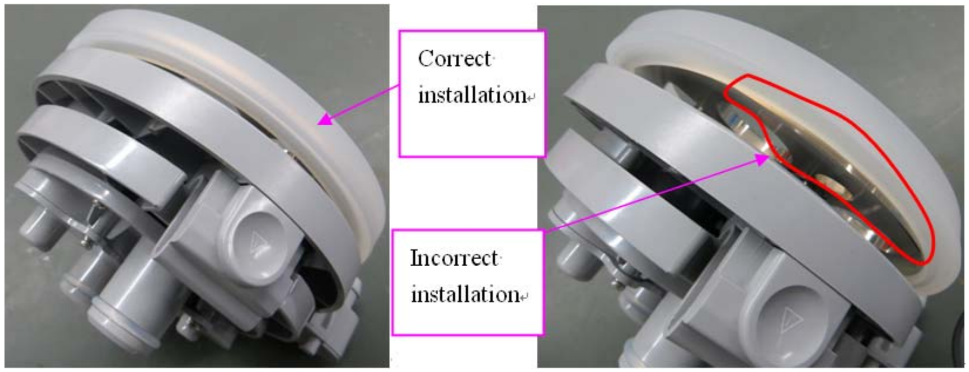


FIGURE 6-179

6.3.6 Remove the Prepak Handle

1. Refer to 6.3.4 and 6.3.5 to remove the absorber canister assembly and CO2 bypass assembly.
2. Unscrew the screw to remove the handle and the cam.

FIGURE 6-180

6.3.7 Remove the Contact Switch of the L-shaped Handle

1. Refer to “Remove the Absorbent Canister” on page 6-80. and “Remove the CO2 Bypass Assembly” on page 6-82. to remove the absorber canister assembly and CO2 bypass assembly.
2. Unscrew the two screws to remove the handle and the cam.

FIGURE 6-181

3. Unplug the cable and, unscrew the two screws to remove the contact switch.

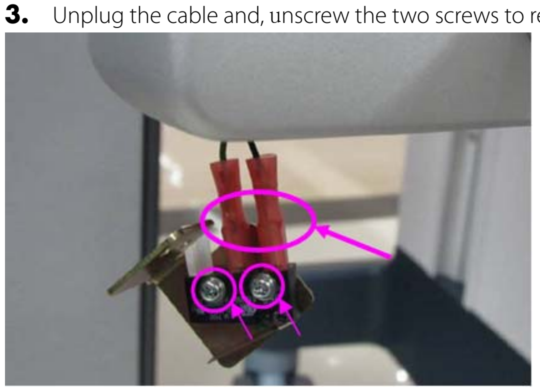


FIGURE 6-182

6.3.8 Remove the Patient Circle Assembly

1. Remove the CO2 Bypass assembly as per section “Remove the CO2 Bypass Assembly” on page 6-82..
2. Pull the patient circle assembly away from the rotating block assembly.

FIGURE 6-183

6.3.9 Remove the Bellows Assembly

1. Turn the bellows dome counterclockwise and lift off to remove.

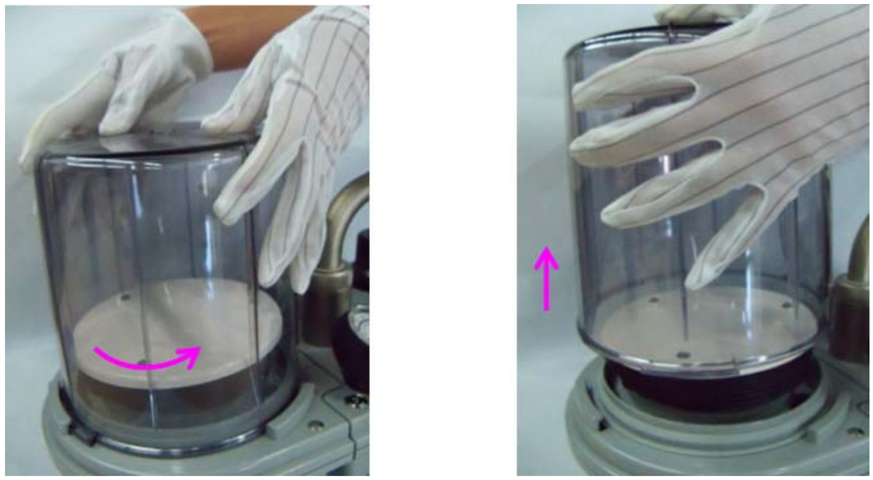


FIGURE 6-184

2. Remove the bellows from the bellows base.

FIGURE 6-185

6.3.10 Remove the Pop-off Valve Assembly

1. Remove the bellows assembly as per section 6.3.9.
2. Unscrew the four locking screws as shown in the picture. Hold and pull up the Pop-Off valve cover to remove it.


FIGURE 6-186

3. Take out the rubber and metal Pop-Off valve.

FIGURE 6-187

6.3.11 Disassemble the Expiratory/Inspiratory Check Valve Assemblies

1. Turn the check valve cover counterclockwise to remove it.

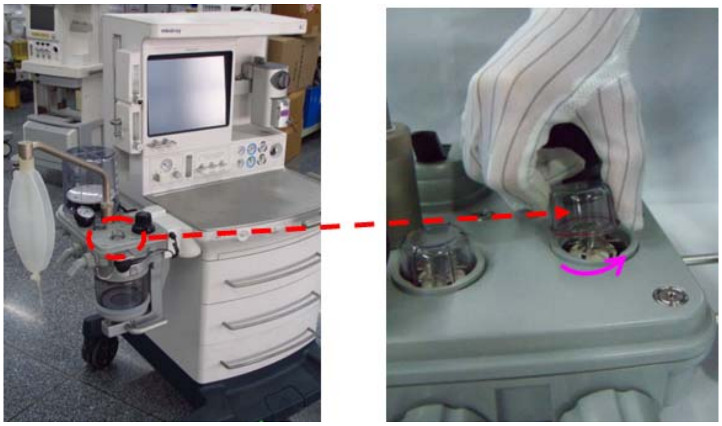


FIGURE 6-188

2. Pull out the check valve as shown in the following picture.

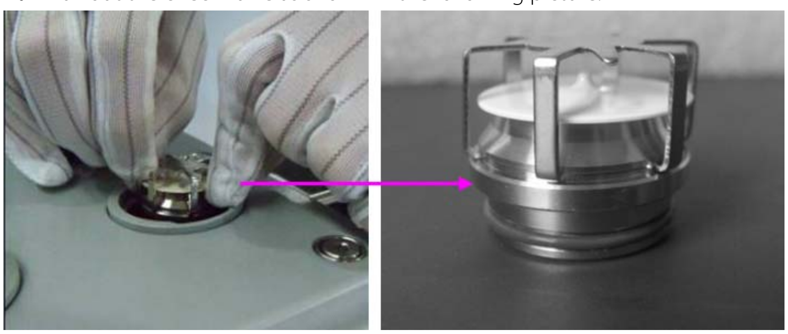


FIGURE 6-189

6.3.12 Remove the Water Collection Cup

1. Hold the water collection cup and turn it counterclockwise to remove it.

FIGURE 6-190

2. Remove the water collection cup.

FIGURE 6-191

6.3.13 Remove the Airway Pressure Gauge

Lift the airway pressure gauge straight up to remove it.

FIGURE 6-192

6.3.14 Remove the Bag Arm

1. Unscrew the locking nut counterclockwise and lift straight up to remove bag arm.

FIGURE 6-193

2. Remove the bag arm from the bag arm mount.

FIGURE 6-194

6.3.15 Remove the Back Upper Cover and Back Lower Cover Assemblies

1. Remove the O2 sensor, breathing tubes, manual bag, patient circuit assembly, bellows assembly, water collection cup, airway pressure gauge and bag arm as per sections 6.3.1,6.3.1, 6.3.3, , 6.3.9, 6.3.12, 6.3.13, 6.3.14.

2. Unscrew the six screws as shown in the following picture.

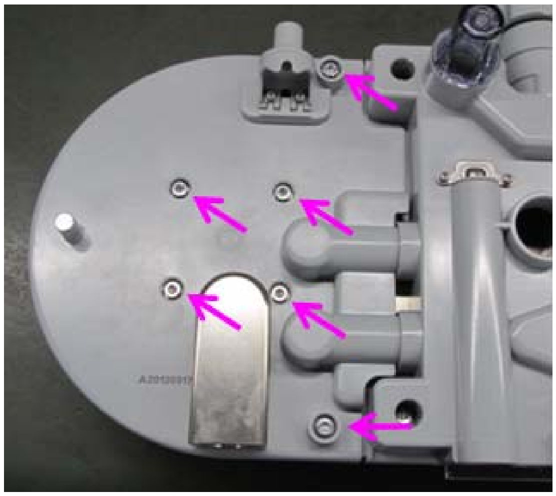


FIGURE 6-195

3. Unscrew the knurled thumb nut as shown in the following picture.

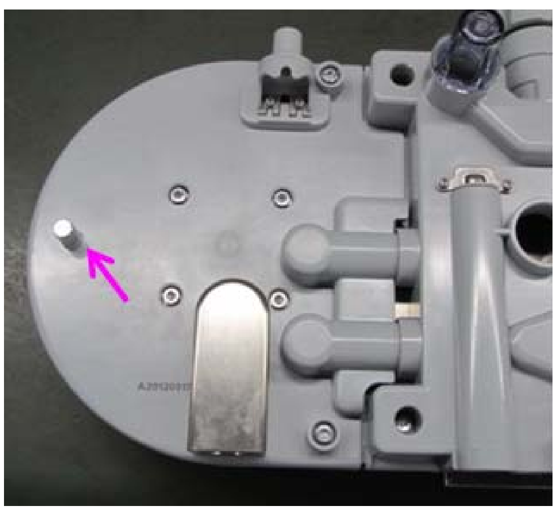


FIGURE 6-196

4. Turn over the circle. Pull up to separate the back upper cover assembly.

FIGURE 6-197

5. Pull leftwards to take out the back lower cover assemblies.

FIGURE 6-198

6.3.16 Remove the Front Upper Cover, Median Plate and Front Lower Cover Assemblies

1. Remove the Back Upper Cover and Back Lower Cover Assemblies as per section 6.3.15.
2. Remove the two screws (respiratory screw 041-002393-00) on the lower cover.

FIGURE 6-199

3. Loosen the six screws on the upper cover.

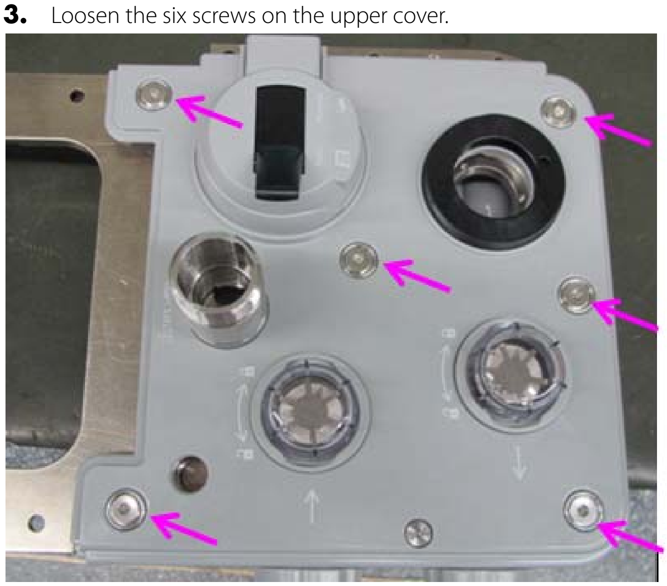


FIGURE 6-200

4. Loosen the captive screws (top cover screw 041-005001-01) on the upper cover.

FIGURE 6-201

5. Hold the upper cover assembly tightly and pull it up to remove it.

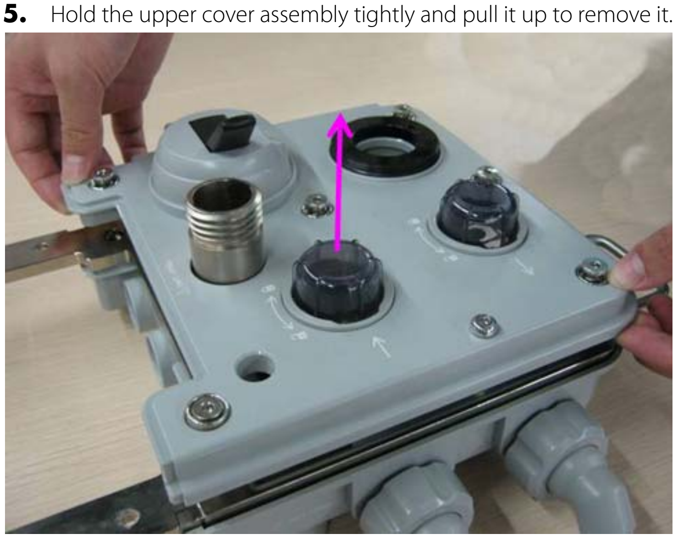


FIGURE 6-202

6. Pull up the median plate assembly to remove it.

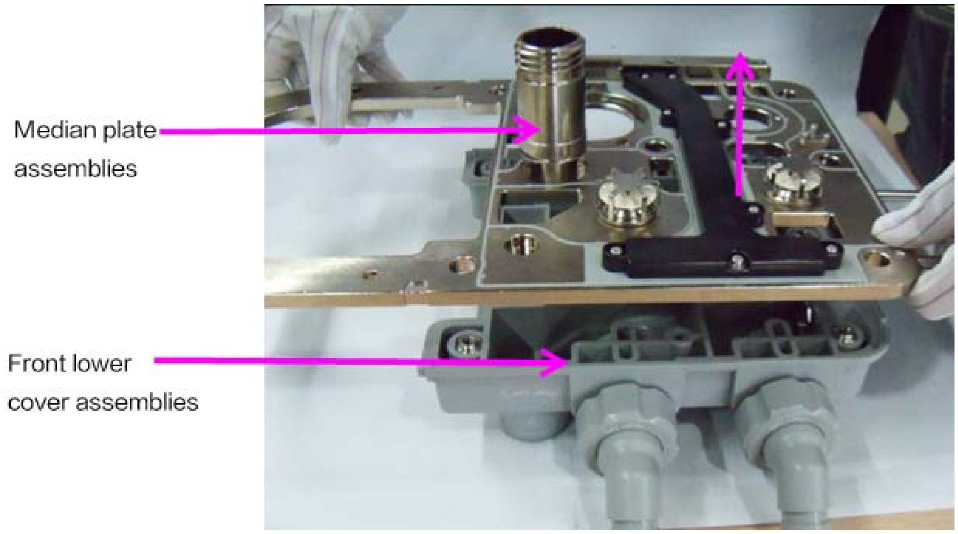


FIGURE 6-203

6.3.17 Disassemble the Automatic/Manual Ventilation Switch Assembly

1. Remove the upper cover as per section "Remove the Front Upper Cover, Median Plate and Front Lower Cover Assemblies" on page 6-93..
2. Turn over the upper cover assembly to access the three screws as shown in the following picture.

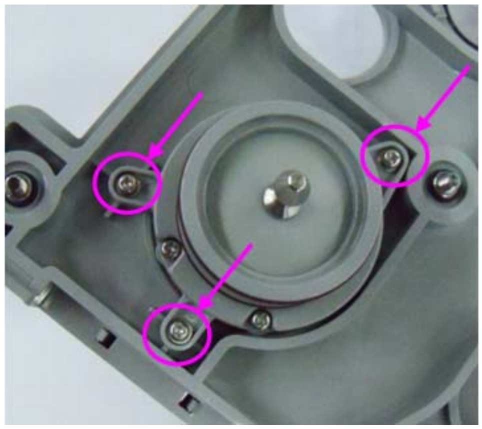



FIGURE 6-204

3. Unscrew the three screws as show in the picture.


FIGURE 6-205

4. Remove the O-Ring and pull out the axis pin.

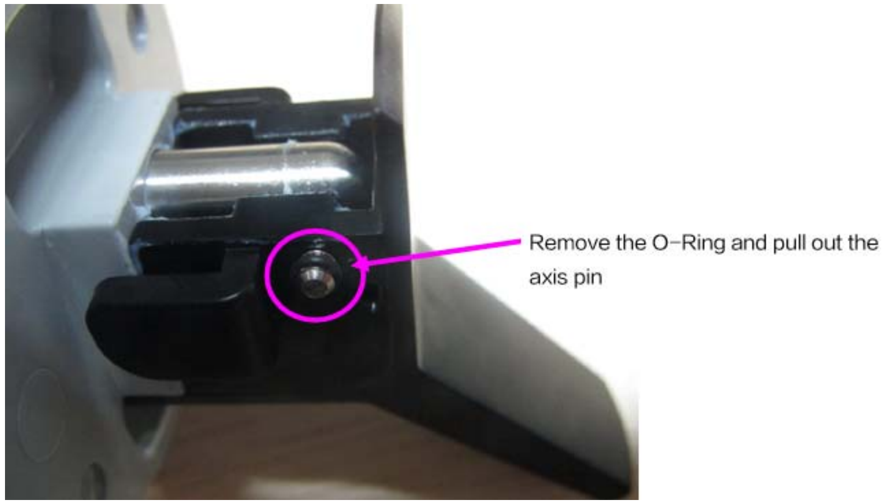


FIGURE 6-206

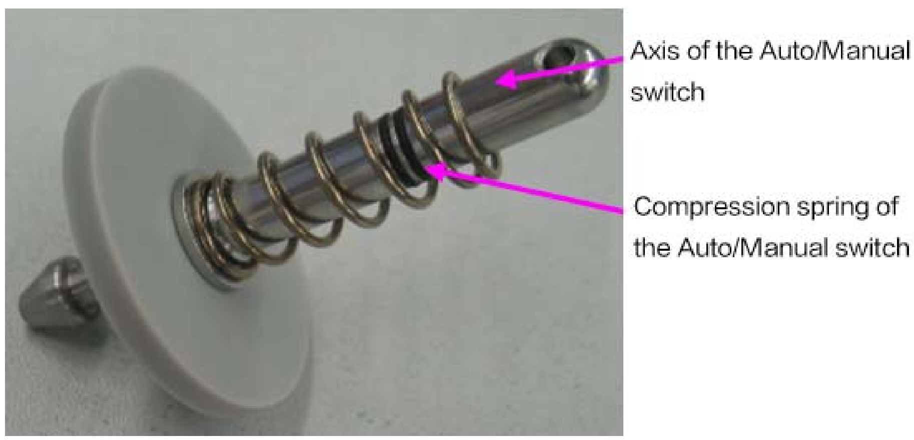


FIGURE 6-207

5. Remove the compression spring and replace the two seals (P/N 0030-10-13077)

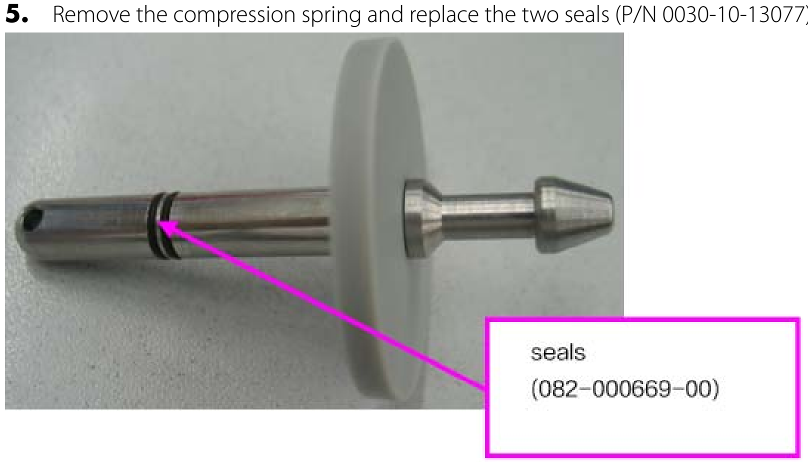


FIGURE 6-208

6.3.18 Remove the APL Valve Assembly

Turn the locking ring counterclockwise and pull the APL valve assembly straight up to remove it.

FIGURE 6-209

7.0

Replacement Parts

Introduction 7-2

7.1 Introduction

The A7 anesthesia system can be broken down into 18 big parts based on its structure and functions. Each big part includes several replaceable parts. Table 9-1 through Table 9-17 list the information about each replaceable part and Figure 9-1 through Figure 9-17 indicate the position of each replaceable part on the A7. The selection of replaceable parts gives consideration to the characteristics of the parts, cost of replacement, and maintenance efficiency. When the parts whose sub components are not convenient to replace (such as the electronic component on the card) are faulty, replacing the card can improve the maintenance efficiency. For example, if a pressure gauge on the instrument panel is faulty, replacing the pressure gauge can reduce the cost.

7.1.1 Ordering Replaceable Parts

Provide the following information to order replaceable parts:

FRU code of the parts;

Number of the parts in the document table;

Description of the feature of the parts.

For example: P/N: 115-018165-00 .... Auxiliary gas supply, NO.1

7.1.2 Diagrams and Tables

7.1.2.1 A7 Structure

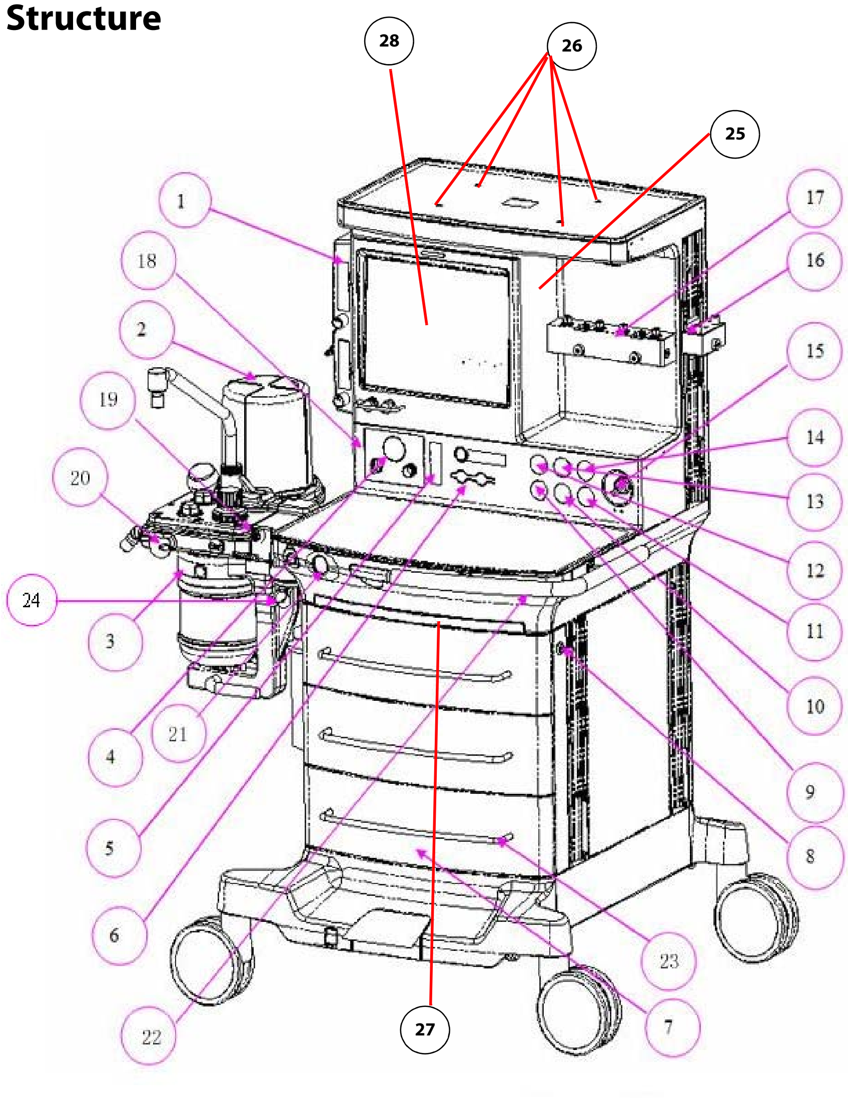


FIG.NO.	DESCRIPTION	PART NUMBER
1	Auxiliary Gas Outlet Assembly	115-018165-00(FDA) 115-018166-00(Canadian)
2	Breathing circuit unit FRU(A7)	115-027250-00
3	CO2 Bypass Assembly, A series	115-036378-00
4	Vacuum control panel assembly (A7)	115-015246-00
5	Total flowmeter	115-014479-00
6	BFCS assembly	115-030000-00(FDA) 115-030001-00(Canadian)
7	Drawer Assembly	115-034451-00
8	Drawer Lock A-series	115-023320-00
/	Drawer rail	031-000041-00

FIG.NO.	DESCRIPTION	PART NUMBER
9	N2O high pressure gauge assembly (A7)(must be ordered together with the copper tube)	115-024851-00 and 115-033639-00
10	Air high pressure gauge assembly (A7)(must be ordered together with the copper tube)	115-024852-00 and 115-033638-00
11	O2 high pressure gauge assembly (A7)(must be ordered together with the copper tube)	115-024850-00 and 115-033637-00
12	N2O supply pressure gauge assembly (A7)	115-024848-00
13	Air supply pressure gauge assembly (A7)	115-024849-00
14	O2 supply pressure gauge assembly (A7)	115-024847-00
15	System switch knob	801-0631-00012-00
16	Backup vaporizer mounting manifold	801-0631-00076-00
17	Vaporizer mounting manifold	801-0631-00024-00
	Three Vaporizer Mounting Manifold	115-020218-00
18	Pressure gauge panel assembly FRU	115-023184-00 (FDA) 115-023185-00(Canadian)
19	O2 cable plug cap (if not using O2 sensor)	043-003033-00 (part of 115-016612-00)
20	O2 sensor cover assembly (if not using O2 sensor)	115-016523-00 (part of 115-016612-00)
21	O2 Flush Button	043-002980-00 (FDA) 043-002981-00 (Canadian)
22	A-Series Handrail	042-002357-00
23	Drawer Handle	801-0631-00140-00
24	Vacuum Suction Tube Fixing Clamp	043-003125-00
25	Front cover of main unit	043-002207-00
26	Top cover screw paster	047-007458-00
27	Entire table	115-036455-00
28	Display panel	043-002982-01
/	Linear rail	032-000504-00

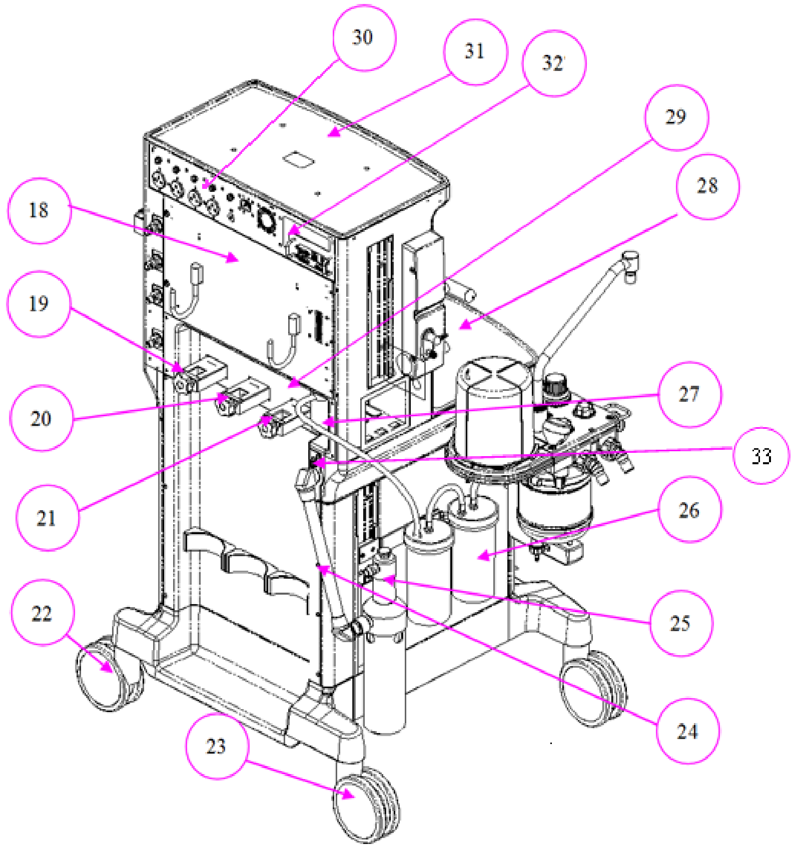
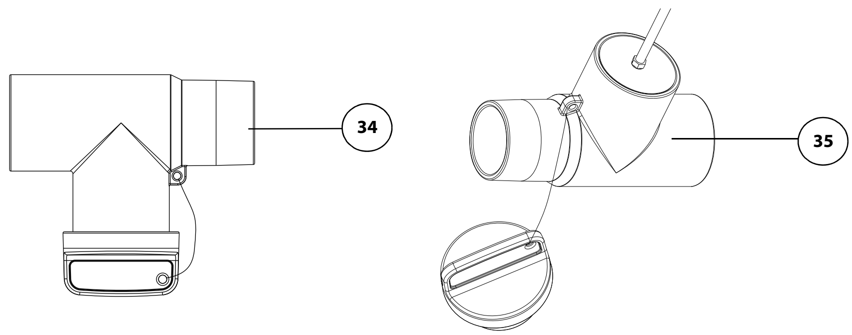


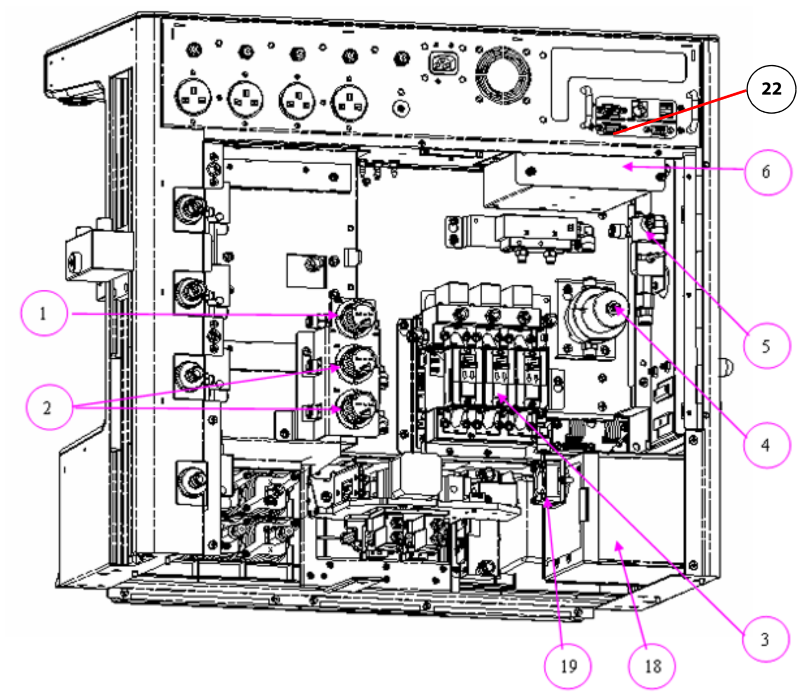
FIG.NO.	DESCRIPTION	PART NUMBER
18	Service door(A7)	115-046744-00
19	O2 cylinder yoke assembly (A7)	115-014476-02
20	N2O cylinder yoke assembly (A7)	115-014477-02
21	Air cylinder yoke assembly (A7)	115-014478-02
22	Caster assembly (right)	034-000285-00
23	Caster assembly (left)	034-000285-00
24	AGSS transfer tube*	801-0631-00074-00*
25	AGSS assembly FRU or DGSS assembly	115-023175-00 or 082-002748-00
26	Vacuum suction liquid collection bottle bracket assembly (A7 Canadian)	115-017947-00
27	Overfill protection cup assembly	115-018131-00
28	Work surface cover plate assembly FRU	801-0631-00120-00
29	Yoke Panel	043-003140-00
30	Rear panel of hardware box	115-015377-00
31	Top deck assembly	115-017037-00
32	Dust filter	045-000241-00
33	Colder fitting	082-001206-00
/	Suction filter	082-001327-00

FIG.NO.	DESCRIPTION	PART NUMBER
/	Negative pressure suction tube (including filters)	115-033264-00
/	Yoke Knobs	043-001266-00
34	AGSS 3-ways connector assembly (for ACGO)	115-026796-00
35	AG exhausting gas outlet assembly (for patient monitor)	115-052162-00

* The assemblies 34 and 35 can be used with 24 assembly.



7.1.2.2 A7 Upper Half



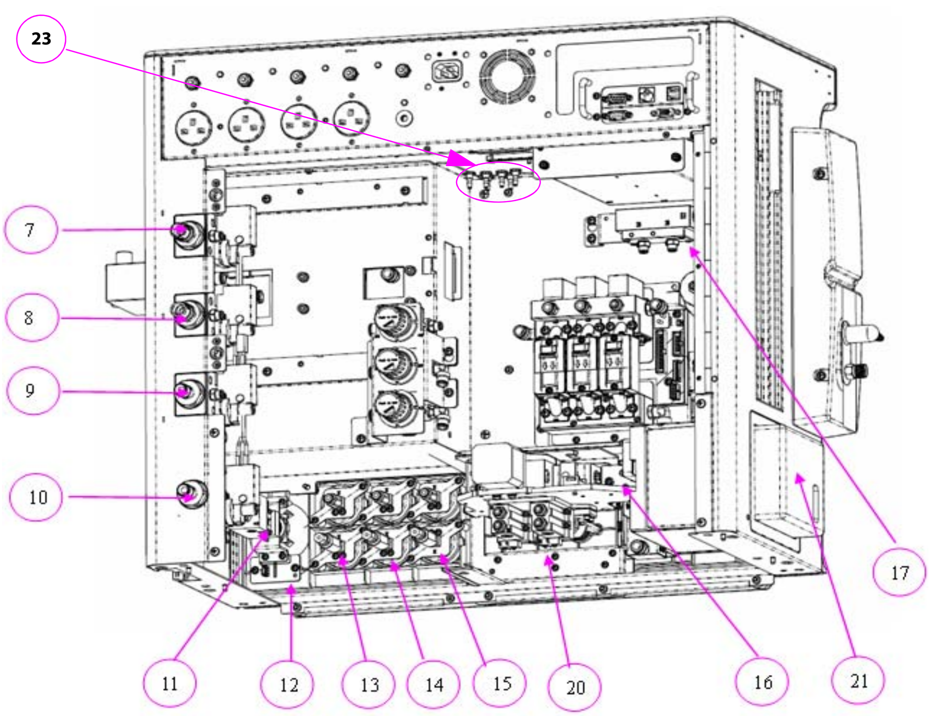


FIG.NO.	DESCRIPTION	PART NUMBER
1	N2O regulator assembly	801-0631-00086-00
2	O2&Air regulator assembly	801-0631-00087-00
3	EFCS system	115-013502-00 (See section 7.1.2.11 (pg. 7-18) "EFCS Assembly")
4	Back pressure valve	115-040040-00
5	3-way valve assembly	115-015898-00
6	Lithium battery 11.1V 4500mAh LI23S002A material package	115-018012-00
7	N2O supply inlet assembly (A7/DISS)	115-014825-00
8	Air supply inlet assembly (A7/DISS)	115-014826-00
9	O2 supply inlet assembly (DISS)	115-014827-00
10	Pipeline negative pressure inlet assembly (DISS)	115-018133-00
11	System switch assembly (A7)	115-017877-00
12	Indicator light board PCBA	051-001257-00
13	Pressure gauge tube (left) (O2)	115-033637-00
14	Pressure gauge tube (middle) (Air)	115-033638-00
15	Pressure gauge tube (right) (N2O)	115-033639-00
16	BFCS drive assembly	115-029847-00
17	Gas mixer assembly(A7)	115-016781-00
18	Gas module rack	115-016480-00
19	Fan 12V 40*40*20mm 6.3CFM 18dB	024-000407-00
20	BFCS assembly (FDA)	115-030000-00
	BFCS assembly (Canadian)	115-030001-00
21	Gas module	6800-30-50842 (3-slot) 115-051561-00 (2-slot)
22	Output bracket for the mother board (VGA)	115-040634-00
23	Tube connector nut Tube connector-	M90-100012- - - 082-000111-00
/	Sampling return quick connector	115-052161-00

7.1.2.3 A7 Hardware Box

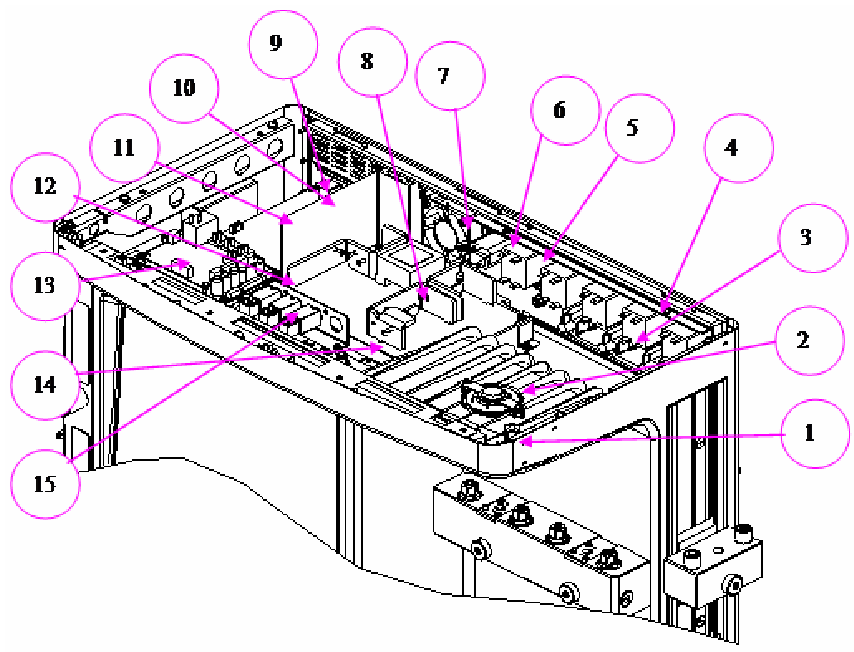


FIG.NO.	DESCRIPTION	PART NUMBER
1	Top lighting board PCBA	801-0631-00039-00
2	Speaker and connecting cable	801-0631-00038-00
3	American-standard auxiliary electrical outlet	801-0631-00032-00
4	Breaker (3.0 A)	801-0631-00031-00
5	Breaker (10.0 A)	801-0631-00030-00
6	10 A filter power panel mount	801-0631-00029-00
7	Fan	801-0631-00028-00
8	Power board (A7)	115-018145-00
9	Wind shield	042-009056-00
10	Button cell Lithium 3V35mAh D12.5*2.0	M05-010R03---
11	A7 CPU board	115-040636-00 (EPSON), for software bundle version 02.13.00 and earlier. 115-052903-00 (DSP), for software bundle version 03.01.00. 115-056939-00 (EPSON, New), for software bundle version 02.13.01 and later. 115-056942-00 (DSP, New), for software bundle version 03.01.01 and later.
12	Battery interface board PCBA	801-0631-00109-00
13	Ventilator control board	801-0631-00027-00 (EPSON) 115-058771-00 (DSP)
14	Mother board PCBA (A7)	051-001259-00 051-002950-00 (VGA)

FIG.NO.	DESCRIPTION	PART NUMBER
15	3-way valve assembly	801-0631-00146-00
/	Fuse on power board	010-000087-00

NOTE: **Follow the two steps below to install the VGA output.**
1.Replace the CPU board (PN: 115-040636-00), the monther board (PN: 051-002950-00), and the output bracket of the mother borad (PN:115-040634-00).
2.Upgrade the software (software bundle version 02.11.00 and later).

7.1.2.4 A7 Work Surface

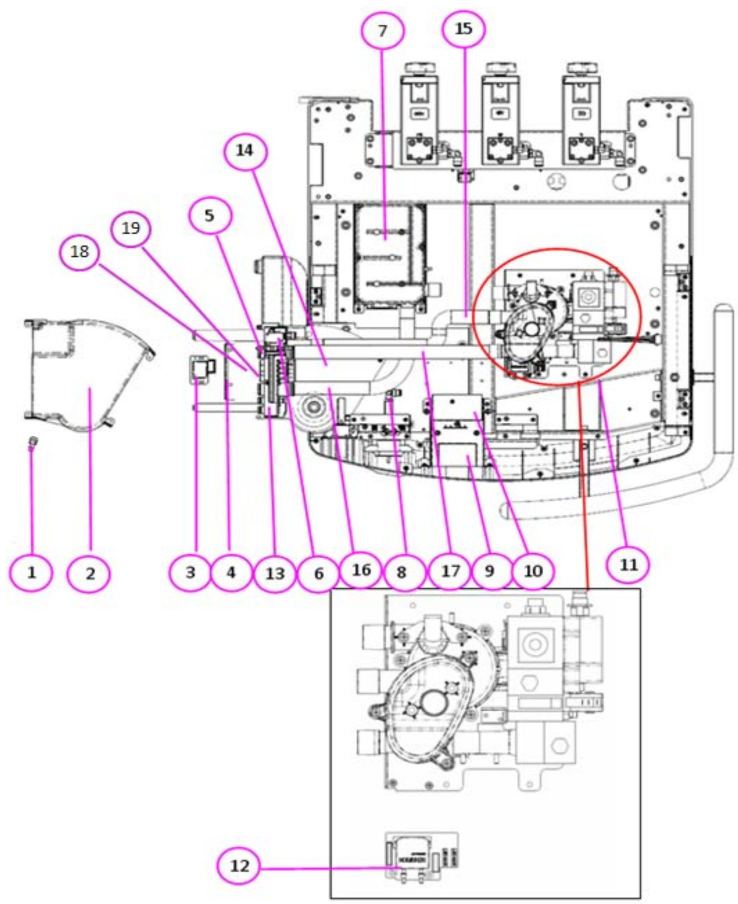


FIG.NO.	DESCRIPTION (English)	PART NUMBER
1	O2 sensor connector	801-0631-00067-00
2	Docking Station Cover	115-027246-00
3	Auto/Manual pin	801-0631-00113-00
4	Circuit Heater	115-034450-00

FIG.NO.	DESCRIPTION (English)	PART NUMBER
5	Auto/Manual spring	801-0631-00114-00
6	Limit switch	801-0631-00101-00
7	Gas reservoir assembly	801-0616-00007-00
8	O2 Flush Assembly	801-0631-00044-00
9	Touchpad	801-0631-00052-00
10	Track Pad Module	115-017032-00
11	Drive gas assembly (A7)	115-026819-00 (120L/min) 115-052763-00 (180L/min)
12	Sensor interface board PCBA	801-0631-00089-00 (EPSON)
13	Docking station plate	041-006279-00
14	Docking station support plate	041-007227-01
15	Exhale spring tube assembly	115-037605-00
16	APL valve spring tube assembly	115-034449-00
17	Driving gas spring tube assembly	115-037606-00
18	Heater spring	0601-20-78922
19	The M3X8 combination Bolt	M04-051140---
/	Breathing System Switch	M90-000162---

7.1.2.5 Patient Circuit Main Body

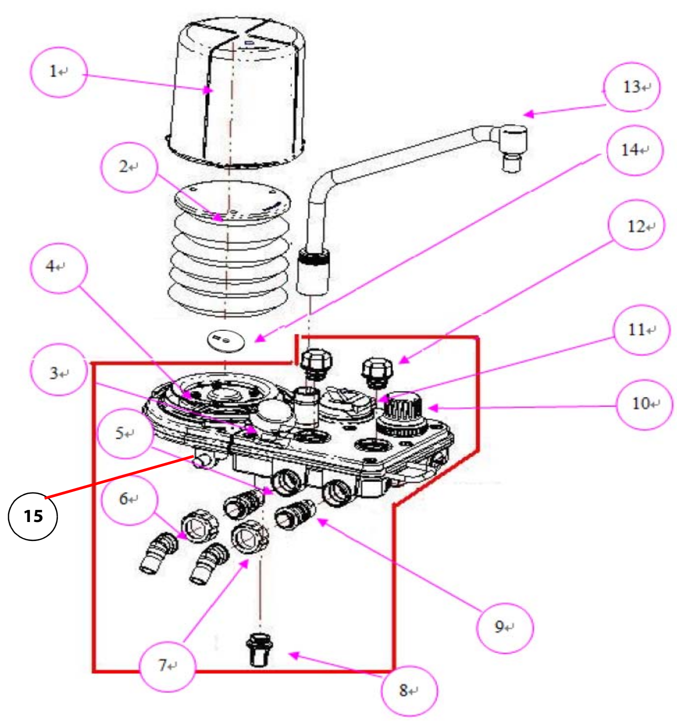
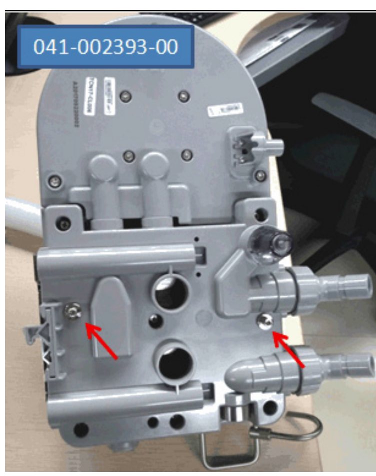


FIG.NO.	DESCRIPTION	PART NUMBER
1	Bellows Dome, A series	801-0631-00054-00
2	Bellows Assembly, A series	0601-30-78968
3	Airway pressure gauge, A series	115-051819-00
4	Breathing circuit unit FRU (A7)	115-027250-00
5	Expiratory Flow Sensor Assembly, A series	801-0631-00056-00
6	Inspiratory / Expiratory Connector, A series	801-0631-00057-00
7	Inspiratory / Expiratory Connector Rotary Cap, A series	801-0631-00059-00
8	Water Collection Cup, A series	801-0631-00058-00
9	Inspiratory Flow Sensor Assembly, A series	801-0631-00060-00
10	Quick release APL valve assembly or APL Valve Assembly	115-046756-00 or 801-0631-00062-00
11	Auto/Manual ventilation switch	801-0631-00065-00
12	One-Way Valve	801-0631-00104-00
13	Bag Arm - Fixed Height, A series	115-048600-00
	Bag Arm -Flexible arm assembly	115-028041-00
14	Bellows check valve membrane weight	0601-20-69772
15	Test port	043-001285-00
/	Respiratory screw	041-002393-00
/	Top cover screw	041-005001-01



7.1.2.6 Pre-pak Absorber Canister Assembly

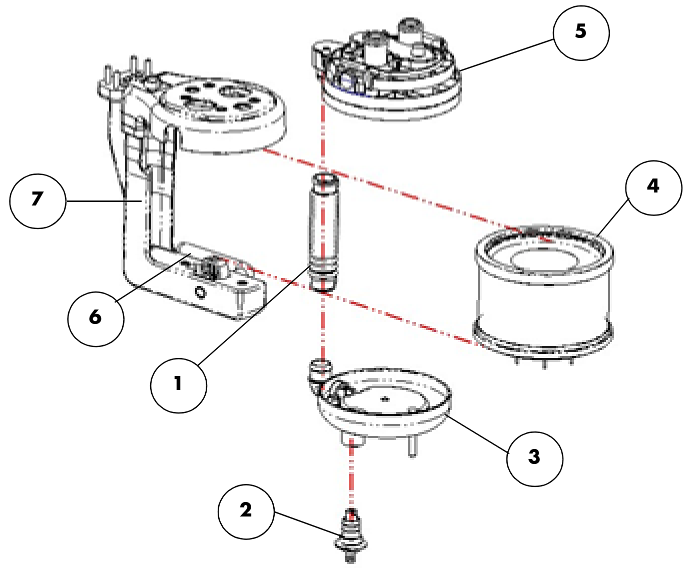


FIG.NO.	DESCRIPTION	PART NUMBER
1	CO2 Absorber Hose, A series	801-0631-00092-00
2	CO2 Absorber Base Drain Valve, A series	801-0631-00112-00
3	CO2 Absorber Base, A series	801-0631-00100-00
4	CO2 Absorbent Canister, A series	801-0631-00066-00
5	CO2 Bypass Assembly, A series	115-036378-00
6	Prepak Handle FRU	115-015765-00
7	L-shape Bracket Assembly	115-017030-00
/	CO2 Canister Switch	010-000024-00

7.1.2.7 Valve assembly

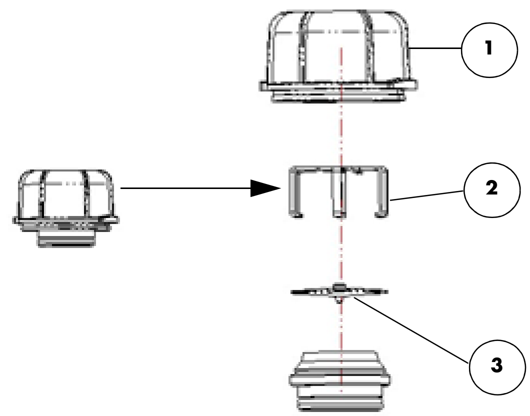


FIG.NO.	DESCRIPTION	PART NUMBER
1	Check valve dome, A series	801-0631-00061-00
2	Valve cover	801-0631-00110-00
3	Disc	801-0631-00111-00

7.1.2.8 A7 Display Assembly

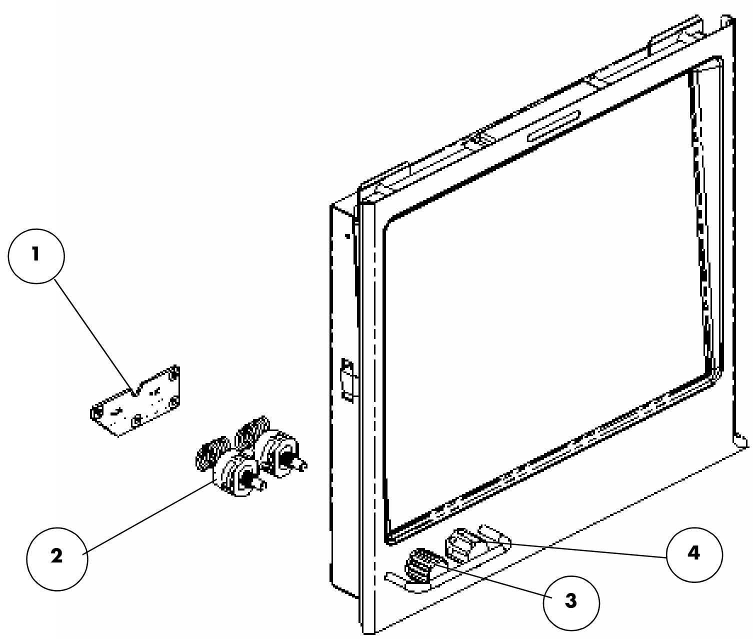


FIG. NO.	DESCRIPTION	PART NUMBER
1	Encoder board	051-001260-00
2	Encoder	010-000150-00
3	Encoder knob (balance gas)	115-015904-00
4	Encoder knob (O2)	115-015903-00

7.1.2.9 A7 Main Body of Display Assembly

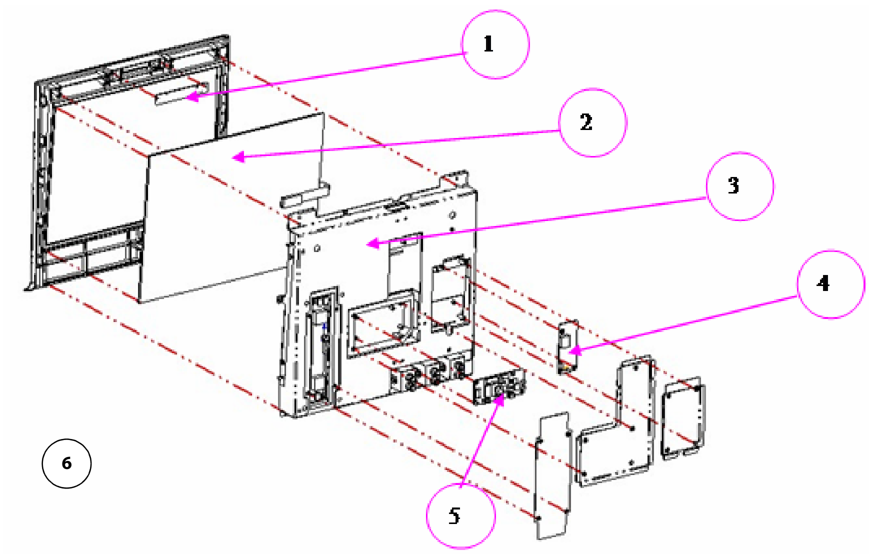


FIG.NO.	DESCRIPTION	PART NUMBER
1	Alarm lamp board PCBA	801-0631-00019-00
2	Touchscreen	801-0631-00014-00
3	Display exchange package A7	115-039181-00
4	Touchscreen control board	801-0631-00018-00
5	Display interface board PCBA (0632)	051-001258-00
6	Display panel	043-002982-01

7.1.2.10 Vaporizer Mounting Minifold

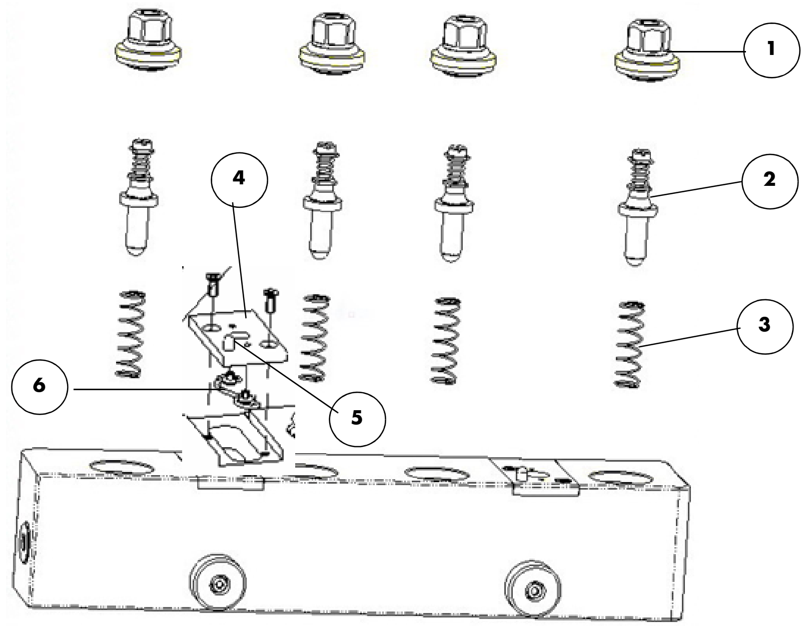


FIG.NO.	DESCRIPTION	PART NUMBER
1	Connector (Vaporizer Mount)	801-0631-00117-00
2	Valve of Vaporizer Mounting Manifold	801-0631-00106-00
3	Spring of Vaporizer Mounting Manifold	801-0631-00107-00
4	Locking plate	041-000166-00
5	Locking pin	0611-20-45417
6	Spring, special for vaporizer, S type	M6T-010009---

7.1.2.11 EFCS Assembly

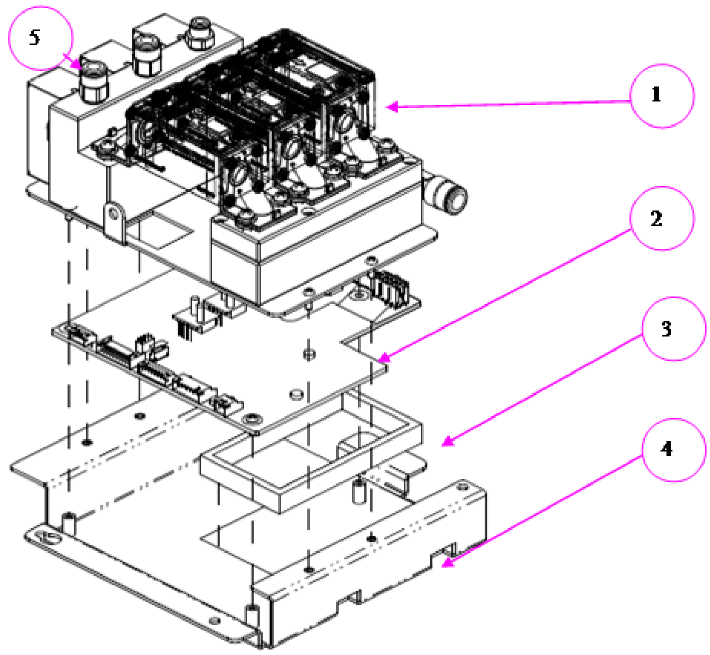


FIG.NO.	DESCRIPTION	PART NUMBER
1	O2/N2O/Air flow sensor board PCBA of the flowmeter	051-002721-00
2	EFCS control board	115-018150-00
3	Isolation pad of the EFCS control board (A7)	048-002801-00
4	Flow sensor holder (A7)	042-005334-00
5	Proportional valve assembly of the EFCS	115-018143-00

NOTE: **If the flow sensor (051-002721-00) or EFCS control board is replaced, upgrade the software bundle version to 02.12.00 and later.**

7.1.2.12 BFCS Assembly

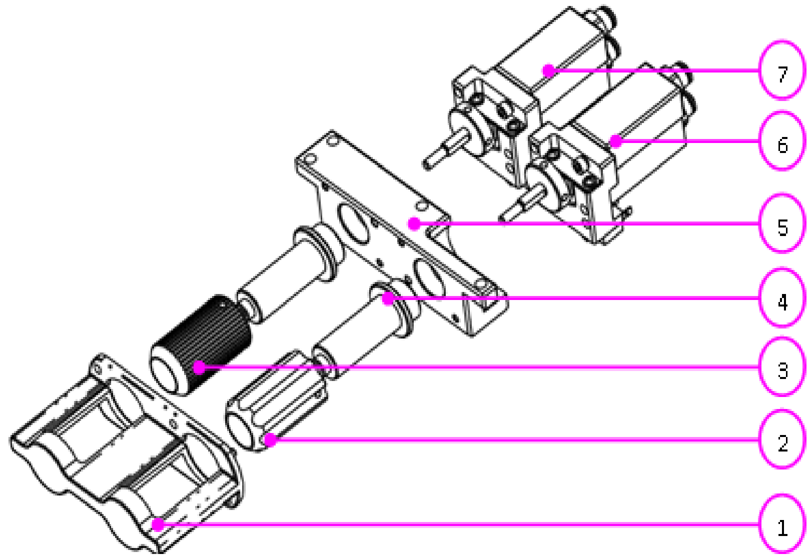


FIG.NO.	DESCRIPTION	PART NUMBER
1	Protection support for the needle valve knob (A7/FDA/silkscreen)	043-006011-00
2	O2 needle valve knob (A7)	041-006773-00
3	Air needle valve knob (A7)	041-006775-00
4	Rolling bearing of the needle valve knob	041-006772-00
5	Fixing block of knob (A7)	041-017715-00
6	O2 needle valve assembly (A7/with basic flow)	115-024630-00
7	Air needle valve assembly (A7)	115-014468-00

7.1.2.13 Built-in AG (EPSON)

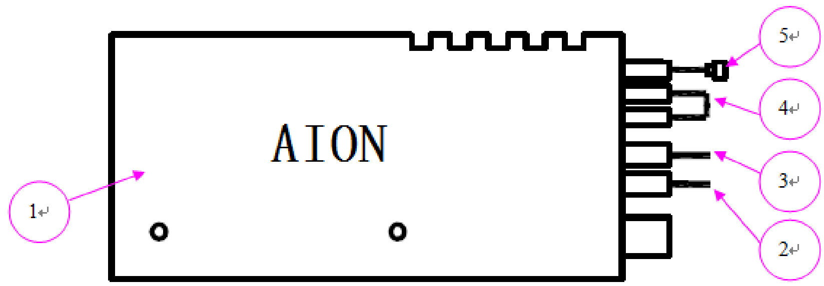


FIG.NO.	DESCRIPTION	PART NUMBER
1	Multigas Analyzer.AION,03-31,60-10331-00	115-002504-00
2	2.2/4.4 mm anesthesia airway sampling line (60-12110-00/used only inside the machine)	9200-10-10557
3	Anesthetic gas inlet tubes assembly(0632)	115-059063-00
4	1.4/2.8 mm anesthesia airway sampling line (60-12110-00/used only inside the machine)	9200-10-10556
5	Plug (AG)	041-007225-00

7.1.2.14 O2 Cable Assembly

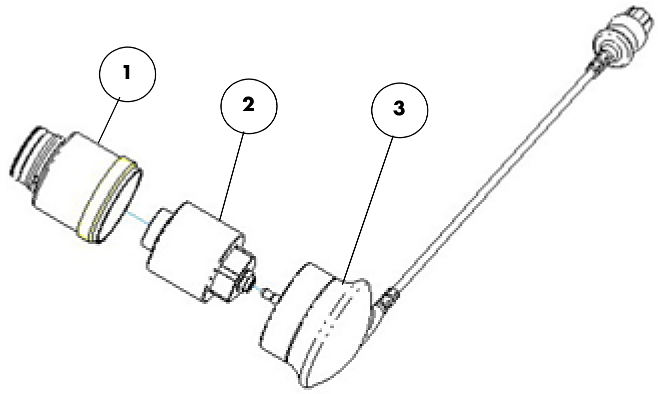


FIG.NO.	DESCRIPTION	PART NUMBER
1	O2 cell cover	801-0631-00090-00
2	Sensor Oxygen (O2 sensor) Medicel MOX-2	040-001270-00
3	O2 Cell Cable	801-0631-00091-00

7.1.2.15 A7 Auxiliary Gas Outlet Assembly

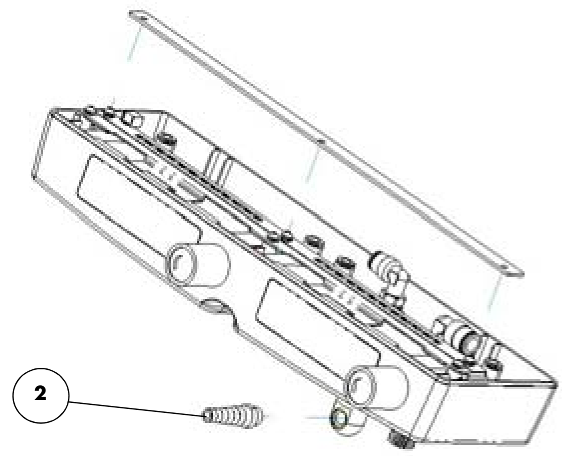
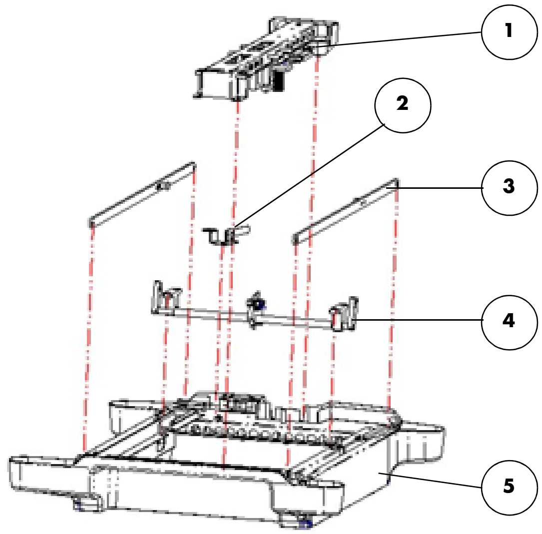


FIG.NO.	DESCRIPTION	PART NUMBER
2	Auxiliary gas outlet fittings	801-0631-00122-00

7.1.2.16 Base Assembly (A7)

Old Version



New Version

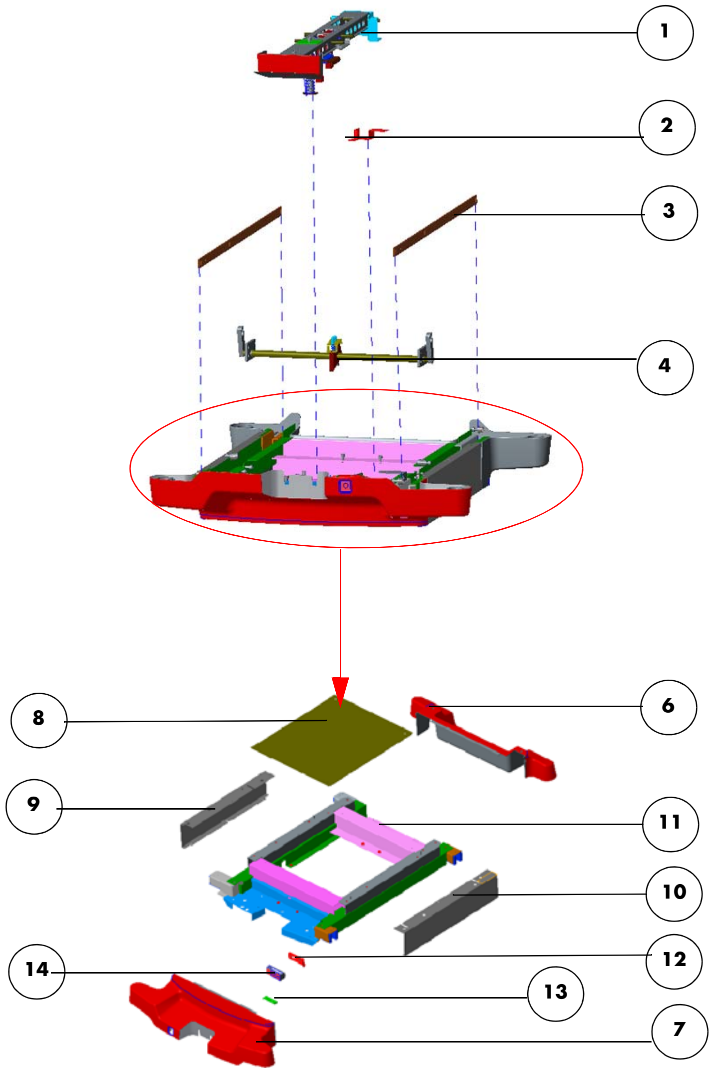


FIG.NO.	DESCRIPTION	PART NUMBER
1	Spare brake assembly (new color)	115-016692-00
2	Indicator Drive Plate	801-0631-00072-00
3	Connector of the Brake	801-0631-00095-00 (old version) 115-047451-00 (new version)
4	Principal Axis of the Brake	801-0631-00096-00 (old version) 115-047452-00 (new version)
5	Base of Chassis Assembly	115-016691-00 (old version)
6	Rear shell of chassis	115-036463-00
7	Front shell of chassis	115-036464-00
8	Cover for chassis	115-047679-00
9	Left decorative plate	115-047038-00
10	Right decorative plate	115-047039-00
11	Base of Chassis	115-036460-00 (new version)
12	Indicator drive plate	042-003043-00

FIG.NO.	DESCRIPTION	PART NUMBER
13	Indication block of brake	043-001125-00
14	Indicator bracket	042-003044-00

NOTE: The parts 6, 7, 8, 9, and 10 are compatible with the old version chassis.

7.1.2.17 A7 Cart Assembly

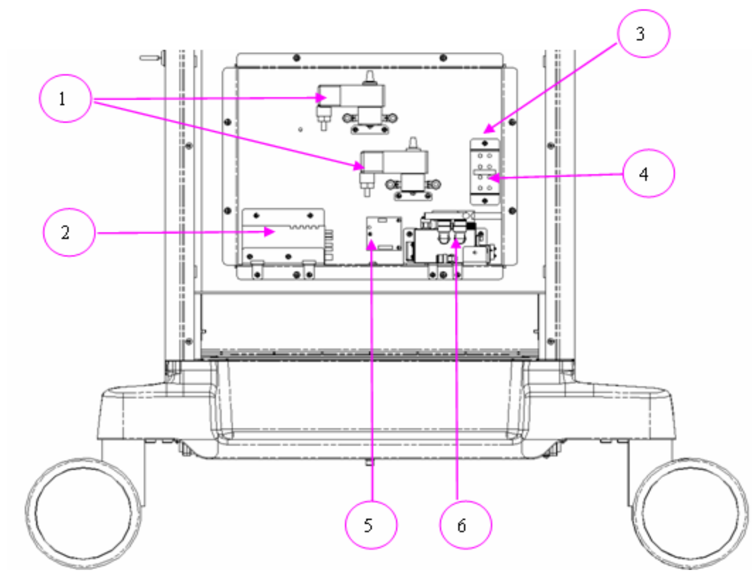


FIG.NO.	DESCRIPTION	PART NUMBER
1	ACGO drive valve assembly	115-015948-00
2	M01A AION AG module (03-31 type)	115-002504-00 (EPSON)
3	Anesthetic gas inlet tubes assembly(0632)	115-059063-00 (EPSON)
4	Filter.0.45um,TP026AATV004AD01	082-003044-00 (EPSON)
5	Anesthesia signal transfer board (service part)	801-0613-00033-00 (EPSON)
6	Electronically ACGO assembly	115-026893-00 (EPSON) 115-052396-00 (DSP)

7.1.2.18 BFCS Motor assembly

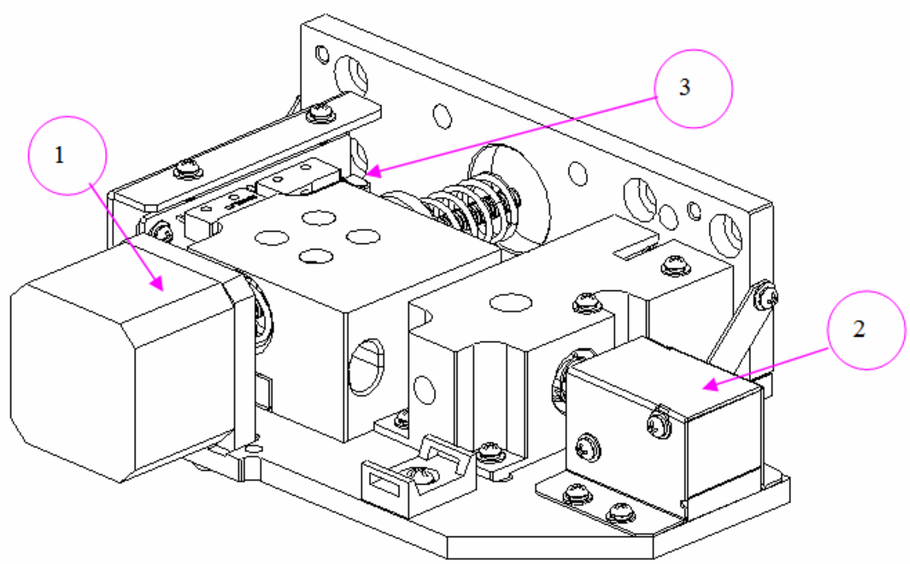


FIG.NO.	DESCRIPTION	PART NUMBER
1	BFCS drive assembly	115-029847-00
2	Solenoid	115-018144-00
3	BFCS position switch board	051-001286-01

7.1.2.19 Other

FIG.NO.	DESCRIPTION	PART NUMBER
1	AGSS 3 ways connector assembly	115-026796-00
2	Gas Cylinder Wrench	115-033063-00
3	A7 Pre-Operation Checklist, English	801-0631-00081-00
4	A7 Auxiliary O2/Air Reference Card	801-0631-00082-00
-	A series cleaning and disinfection card	115-040734-00
-	Preventative Maintenance Kit (12 months)	801-0631-00084-00
-	Periodic Maintenance Kit (36 months)	121-001061-00

7.1.2.20 Tubes

NO.	DESCRIPTION	PART NUMBER
1	Tube.PU (polyether) 7mmX10mm transparent	082-000519-00
2	Silicone,3/32"X7/32"X100ft	A21-000007---
3	Tubing.Soft precision PU tubing, 8mmx5.5mm, transparent	M6G-020045---
4	Silicone 20X25mm	082-002365-00
5	Transparent PU Tube 4*6	M6G-020026---
6	Tubing. Soft precision PU tubing, 4mmx2.5mm, transparent	M6G-020046---
7	System Tubing PUR.AION,1.4/2.8mm,60-12110-00	9200-10-10556
8	System Tubing PUR.AION, 2.2/4.4mm,60-12120-00	9200-10-10557
9	PE Tubing.ID2XOD4	082-002600-00
10	Tubing.MPF tube 2mmX3.5mm (1feet)	M6G-020005---
11	Tube.ID3/32"XOD5/32",Silicon	60-12140-00
12	Hose label (AIR)	047-025129-00
13	Hose label (N2O)	047-025130-00
14	Hose label (O2)	047-025131-00
15	Hose label (neutral)	047-025253-00

7.1.2.21 O-rings

NO.	DESCRIPTION	PART NUMBER	REMARK
1	Seal,valve port	049-000140-00	for CO2 Bypass shaft
2	Gasket, CO2 bypass assembly	049-000142-00	\
3	Gasket, absorber canister exterior	049-000143-00	\
4	Gasket, absorber canister interior	049-000145-00	\
5	CO2 Absorber Hose	049-000146-00	\
6	Bellow check valve membrane	049-000240-00	\
8	Gasket, bellows canister base	049-000243-00	\
9	AGSS filter	082-000506-00	\
10	O-ring 14X2.65	082-000934-00	for Vaporizer mount
11	O-ring 30X2	082-001499-00	bag arm base
12	O-ring 25X2	082-001500-00	APL valve
13	O-ring 27X1.5	082-001501-00	for Check valve dome
14	O-ring 18X2.5	082-001502-00	for rotating block of breathing circuit
15	O-ring 20X1.5	082-001503-00	for Check valve
16	O-ring 23.47X2.95	082-001504-00	for Water Collection Cup + CO2 Bypass Assembly
17	O-ring 52X2	082-001505-00	Auto/Manual ventilation switch
18	O-ring 29X2.62	082-001508-00	Bellows base
19	O-ring 6.07X1.78	082-001514-00	Bottom of the breathing system cover screw
20	O-ring 29.82X2.62	082-001515-00	APL valve
21	O-ring 40X2.2	082-001520-00	Auto/Manual ventilation switch
22	O-ring 8.5X2.0	082-001525-00	O2 cell port
23	O-ring 8.5X2	082-000665-00	for rotating block of breathing circuit
24	O-ring 4.7X1.8	082-000667-00	for rotating block of breathing circuit
25	O-ring 6X1	082-000669-00	for Auto/Manual ventilation switch
26	O-ring 15.54X2.62	082-000673-00	for bag arm +O2 cell cover
27	O-ring 4.47X1.78	082-000679-00	for CO2 Bypass shaft
28	O-ring (for airway pressure gauge)	082-001524-00	\
29	O-ring 16X2	M6M-010058---	for rotating block of breathing circle
30	O-ring 8X1.8	082-001287-00	for suction gauge
31	O-ring 15X1.8	082-001288-00	for suction needle valve
32	O-ring 2X1.8	082-001286-00	for suction needle valve
33	O-ring 18X2.5	049-000813-00	for breathing system base
34	Tank Washer	0348-00-0185	\
35	O-ring, 0.35X1.78 FKM A70	082-000676-00	\
Not Shown	Maintenance Kit for O-rings	801-0631-00141-00	\
Not Shown	O-ring 20X1.5	082-000714-00	for in-and Expiratory flow sensor
Not Shown	O-ring 23X2	082-000712-00	for in-and Expiratory flow sensor
Not Shown	O-ring 23X2.5	082-000713-00	for in-and Expiratory flow sensor

NO.	DESCRIPTION	PART NUMBER	REMARK
Not Shown	Sealed gasket of breathing connector	049-000235-00	\
Not Shown	O-ring, 75.87X2.62 A50	082-001509-00	\
Not Shown	O-ring, 61.6X2.62 A50	082-001511-00	\

7.1.2.22 Cables

NO.	DESCRIPTION	PART NUMBER
1	Cable, Norgren Avm Manifold Assy	009-000066-00
2	Cable, Three Way Valve(ACGO)	009-002592-00
3	Cable, Patient Monitor	009-002927-00
4	Cable, Touchpad	009-000972-00
5	Cable, Display	009-000973-00
6	0631 inverter control high-voltage lines (old) 0632 screen backlight output cable (new)	009-000974-00 (old) 009-006731-00 (new)
7	Cable, Alarm	009-000976-00
8	Cable, Indicator	009-000977-00
9	Cable, Touch Screen	009-000978-00
10	Cable, Ventilator	009-000979-00
11	Cable, Lighting Switch	009-000981-01
12	Cable, Auxiliary Outlet	009-000984-00
13	Cable, Power, AC Internal	009-000985-01
14	Cable, Sodalime Canister Switch Cable	009-000987-00
15	0631 inverter cable B (old) 0635 screen LED backlight input cable (new)	009-000988-00 (old) 009-006382-00 (new)
16	Cable, System Switch	009-001776-00
17	Cable, Top Lighting A	009-000982-00
18	Cable, Display Lighting	009-000986-00
19	Cable, Flow Sensor	009-002481-01
20	Cable, Breathing System	009-002928-00
21	Cable, Flowmeter Switch Signal	009-002929-00
22	Cable, BFCS Position Switch	009-002930-00
23	Cable, Total Flowmeter Backlight	009-002931-00
24	Cable, Encoder Board	009-002932-00
25	Cable, Backup Needle Valve Switch(without N2O)	009-005146-00
26	Cable, Flowmeter 3 way Valve B	009-002937-00
27	Cable, ACGO Valve Status	009-002940-00
28	Cable, Internal AG Module	009-003131-00
29	Line Cord	009-000094-00
30	Cable, O2 Pressure Switch	0621-20-69588
31	Cable, Circuit Switch	0621-20-78593
32	2-pin O2 Sensor Pedestal	801-0631-00067-00
33	Filter Power 250AC 15A Panel Mount	801-0631-00029-00

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8.0 Warranty

Disclaimers 8-2

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Phone Numbers and How to Get Assistance 8-2

Password 8-2

8.1 Disclaimers

Product Improvements - Mindray DS USA, Inc. retains the right to modify the machine and/ or operating instructions without prior notification. These operating instructions explain all features of the A7 system and are correct at time of manufacture. Instructions and models produced at a later stage, may contain improvements or modifications that were not included in previous models.

8.2 Manufacturer's Responsibility

The effects on safety, reliability, and performance of the equipment are the manufacturer's responsibility only if:

a. assembly operations, extensions, readjustments, modifications or repairs are carried out by authorized personnel; and

b. the electrical installation of the relevant room complies with the appropriate requirements; and

c. the equipment is used in accordance with the instructions for use

8.3 Phone Numbers and How to Get Assistance

A network of service representatives and factory-trained distributors is available. Prior to requesting service, perform a complete operational check of the instrument to verify proper control settings. If operational problems continue to exist, contact the Service Department at 877.913.9663 for Technical Support or 650.316.3199 for assistance in determining the nearest field service location.

Please include the instrument model number, the serial number, and a description of the problem with all requests for service.

Warranty questions should be directed to a local representative. A list of offices, along with their phone numbers, is provided at the end of this manual.

NOTE: **Upon request, calibration instructions or other information will be provided to assist the user's appropriately qualified technical personnel in repairing those.**

8.4 Password

A password is required to access different modes within the anesthesia system.

- System password: 1234