

**A8/A9**

**Anesthesia System**

**Service Manual**



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## Revision History

This manual has a revision number. This revision number changes whenever the manual is updated due to software or technical specification change. Contents of this manual are subject to change without prior notice. Revision 1.0 is the initial release of the document.

- Revision number: 2.0
- Release time: 2020-03

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# Preface

## Manual Purpose

This manual provides detailed information about the assembling, disassembling, testing and troubleshooting of the equipment to support effective troubleshooting and repair. It is not intended to be a comprehensive, in-depth explanation of the product architecture or technical implementation. Observance of the manual is a prerequisite for proper equipment maintenance and prevents equipment damage and personal injury.

This manual is based on the maximum configuration. Therefore, some contents may not apply to your monitor. If you have any question, please contact our Customer Service Department.

## Intended Audience

This manual is geared for biomedical engineers, authorized technicians or service representatives responsible for troubleshooting, repairing and maintaining the anesthesia machines.

## Password

A password is required to access different modes within the anesthesia machine.

- Manage Configuration: 789789
- Factory maintenance: 558188

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**FOR YOUR NOTES**

# 1 Safety

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## 1.1 Safety Information

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### DANGER

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- Indicates an imminent hazard that, if not avoided, will result in death or serious injury.
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### WARNING

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- Indicates a potential hazard or unsafe practice that, if not avoided, could result in death or serious injury.
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### CAUTION

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- Indicates a potential hazard or unsafe practice that, if not avoided, could result in minor personal injury or product/property damage.
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### NOTE

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- Provides application tips or other useful information to ensure that you get the most from your product.
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### 1.1.1 Warnings

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#### WARNING

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- Do not operate the anesthesia system before reading this manual.
  - All analog or digital equipment connected to this system must be certified passing the specified IEC standards (such as IEC 60950 for data processing equipment and IEC 60601-1 for medical electrical equipment). All configurations shall comply with the valid version of IEC 60601-1. The personnel who are responsible for connecting the optional equipment to the I/O signal port shall be responsible for medical system configuration and system compliance with IEC 60601-1.
  - This equipment must only be operated by trained, skilled medical staff.
  - Before putting the system into operation, the operator must verify that the equipment, connecting cables, and accessories are in correct working order and operating condition.
  - The equipment must be connected to a properly installed power outlet with protective earth contacts only. If the installation does not provide for a protective earth conductor, disconnect it from the power line or operate from the equipment's internal battery supply.
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## **WARNING**

- **Multiple AC power outlets are provided on the rear of the equipment. These outlets are intended to supply power to additional equipment that form a part of the anesthesia system (i.e. vaporizers, etc.). Do not connect other equipment to these outlets, as patient leakage current may be affected. Each outlet is rated 3 A. The total current that may be drawn through all outlets is 5 A on the system. Do not attempt to exceed these load ratings. Do not connect the additional MPSOs (Multiple Portable Socket Outlets, i.e. multiple outlet extension cords) or extension cords to these outlets.**
- **Do not place MPSOs on the floor.**
- **Connect the anesthesia system to an AC power source before the internal battery is depleted.**
- **Do not open the equipment housings. All servicing and future upgrades must be carried out only by trained and authorized Mindray personnel.**
- **Do not rely exclusively on the audible alarm system for patient monitoring.**
- **Adjustment of alarm volume to a low level may result in a hazard to the patient.**
- **Alarm settings should be customized according to different patient situations. Constantly keeping the patient under close surveillance is the most reliable way for safe patient monitoring.**
- **The physiological parameters and alarm messages displayed on the screen of the equipment are for the caregiver's reference only and cannot be directly used as the basis for clinical treatment.**
- **Dispose the packaging material, observing the applicable waste control regulations and keeping it out of children's reach.**
- **To avoid the possibility of explosion, do not use the equipment in the presence of flammable anesthetic agents, vapors or liquids. Do not use flammable anesthetic agents such as ether and cyclopropane for this equipment. Use only non-flammable anesthetic agents that meet the requirements specified in ISO 80601-2-13. The A8 anesthesia system can be used with Halothane, Isoflurane, Sevoflurane and Desflurane. The A9 anesthesia system can be used with Isoflurane, Sevoflurane and Desflurane. Only one anesthetic agent can be used at a time.**
- **For A8 anesthesia system, fresh gas flow must never be switched off before the vaporizer is switched off. The vaporizer must never be left switched on without a fresh-gas flow. Otherwise, anesthetic agent vapor at a high concentration can get into the equipment lines and ambient air, causing harm to people and materials.**
- **To avoid the risk of electric shock, this equipment must only be connected to a supply mains with protective earth.**
- **The use of anti-static or electrically conductive breathing tubes, when utilizing high frequency electric surgery equipment, may cause burns, and is therefore not recommended in any application of this equipment.**
- **Possible electric shock hazard. The equipment may only be opened by authorized service personnel.**
- **The patient should be visually monitored by qualified personnel. In certain situations, life-threatening circumstances may occur that may not necessarily trigger an alarm.**
- **Set the alarm limits properly based on the patient conditions so that the alarm is triggered before a hazardous situation occurs. Incorrectly set alarm limits may result in operating personnel not being aware of drastic changes in the patient's condition.**
- **Connection of both medical and non-medical equipment to the auxiliary mains socket outlet(s) may increase the leakage currents to values exceeding the allowable**



## **WARNING**

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limits.

- **Electric shock and fire hazard. Do not clean the equipment while it is powered on and/or plugged into an outlet.**
  - **Disconnect the power plug from the mains supply before removing the rear panels or servicing the equipment.**
  - **Malfunction of the central gas supply system may cause more than one or even all devices connected to it to stop their operation simultaneously.**
  - **The anesthesia system will cease to deliver gas when the gas supply pressure is smaller than 200 kPa.**
  - **Standard gas terminal connectors tailored to the attributes of gases should be used on the gas supply hose assembly to avoid damage to people and materials from improper connectors used.**
  - **Use a cleaning and disinfection schedule that conforms to your institution's disinfection and risk-management policies.  
Refer to the material safety data sheet as applicable.  
Refer to the operation and maintenance manuals of all disinfection equipment.  
Do not inhale fumes produced during any disinfection process.**
  - **Use extreme care while handling the CO<sub>2</sub> absorbent as it belongs to caustic irritant.**
  - **Use care in lifting and manipulating vaporizers during the installing process as their weight may be greater than expected, based on their size and shape.**
  - **Do not use talc, calcium stearate, corn starch or similar materials, as these materials may enter the patient's lungs or airway, causing irritation or injury.**
  - **All gas supplies should be of medical grade.**
  - **Single use respiratory hoses, face masks, sensors, soda lime, water traps, sampling lines, airway adapters, and other single use items may be considered potential biologically hazardous items and should not be reused. Dispose of these items in accordance with hospital policy and local regulations for contaminated and biologically hazardous items.**
  - **To avoid endangering the patient, do not perform test or maintenance when the equipment is in use.**
  - **Review the performance specifications of the disposal system that the transferring and receiving systems are intended to be used with, to ensure compatibility.**
  - **The equipment should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, the equipment should be observed to verify normal operation in the configuration in which it will be used.**
  - **Ensure that the current alarm presets are appropriate before use on each patient.**
  - **A hazard can exist if different alarm presets are used for the same or similar equipment in any single area.**
  - **Due to the size and weight of the equipment, it should only be moved by qualified personnel.**
  - **Overloading machine may cause tipping. Equipment attached to the side of the equipment should be within the rated weights to prevent dumping of the machine.**
  - **Excess load may cause a tip hazard while moving the equipment. Before moving, remove all equipment from the top shelf and all monitoring equipment installed to the side of the equipment. Use care when moving the equipment up or down a slope, around a corner, and across threshold. Do not attempt to roll the equipment over hoses, cords, or other obstacles.**
  - **Leaks or internal venting of sampled gas may affect accuracy. Perform proper**
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## **WARNING**

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preoperative tests to ensure that the equipment is operating properly. Leaky circuits can not be used.

- Connecting the equipment's exhaust port to the hospital's waste gas scavenging system is strongly recommended to prevent exposure of hospital personnel to the waste gas.
- Pins of connectors identified with the ESD warning symbol should not be touched. Connections should not be made to these connectors unless ESD precautionary procedures are used.
- Operation of the equipment below the minimum flow values may cause inaccurate results.
- This equipment/system is intended for use by healthcare professionals only. This equipment/system may cause radio interference or may disrupt the operation of nearby equipment. It may be necessary to take mitigation measures, such as reorienting or relocating the equipment, or shielding the location it was placed.
- Ensure that an independent means of ventilation (e.g. a self-inflating manual resuscitator with mask) is available whenever the equipment is in use.
- The use of accessories with damaged packaging may cause biocontamination or failure. The operator should check the integrity of accessory packaging before use.
- Before using the anesthesia system after cleaning or disinfecting, power on the system and follow the on-screen prompts to perform leak test and compliance test.
- Improperly cleaned materials may result in biocontamination. Use a cleaning and disinfection schedule that conforms to your institution's disinfection and risk-management policies.

Refer to the material safety data sheet as applicable.

Refer to the operation and maintenance manuals of all disinfection equipment.

User should follow the recommended disinfection routine for this equipment and any reusable accessories.

- Oxygen, when present in high concentrations, can significantly increase the chance of fire or explosion. Oil and grease may be ignited at the same time. Therefore, oil and grease should not be used where oxygen enrichment may occur.
  - Use of lubricants not recommended by Mindray may increase the danger of fire or explosion. Please use lubricants as approved by Mindray.
  - Low-pressure regulators and flow-meters are susceptible to high pressure, and may burst if improperly maintained or disassembled while under pressure. Changing or disassembling connectors should be performed only by qualified personnel.
  - Do not disassemble the low-pressure regulator, flow-metering device, or connector while under pressure. Sudden release of pressure may cause injury.
  - Check the specifications of the AGSS processing system and the specifications of the anesthesia system to ensure compatibility and to prevent a mismatched processing system.
  - Avoid connecting two or more hose assemblies in series as this may cause a loss of pressure and flow.
  - A hazard may exist due to the use of improper connectors. Ensure all assemblies use the proper connectors.
  - Avoid replacing a high-pressure flexible connection with one of lower nominal inlet pressure.
  - Reusing breathing circuits or reusable accessories that are not disinfected may cause cross-contamination. Disinfect the breathing circuits and reusable accessories before use.
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## **WARNING**

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- **Inspect all breathing system components carefully before each use. Ensure all components contain no obstructions or debris that can cause a potential hazard to the patient.**
  - **Use breathing circuits and manual bags in accordance with ASTM F1208 and compatible with standard 22mm male conical fittings per ASTM specifications F1054.**
  - **The mains plug is used to isolate the anesthesia system circuits electrically from the supply mains. Do not place the anesthesia system to a place where it is difficult to operate the plug.**
  - **Do not touch the patient when connecting external devices via the I/O signal ports or replacing the oxygen cell to prevent patient leakage current from exceeding the requirements specified by the standard.**
  - **If the Drive Gas Pressure Low alarm occurs when the gas supply pressure is greater than 200 kPa, contact your service personnel or Mindray.**
  - **Make sure that CO<sub>2</sub> can be fully absorbed by the absorbent after the CO<sub>2</sub> absorbent is replaced or a CO<sub>2</sub> absorbent canister is installed.**
  - **Before moving the anesthesia system, remove the objects from the top shelf and bracket to prevent the system from tilting.**
  - **AGSS is not recommended to be used when the breathing tubes between the waste gas disposal system and AGSS get clogged, the extracted flow of the waste gas disposal system is deficient or the waste gas disposal system fails to work properly, as the waste gas in the AGSS may flow out to the atmosphere at a rate higher than 100 mL/min.**
  - **When anesthetic gas delivery equipment needs to be configured for the A8 anesthesia system, make sure to configure a monitor that is compliant with the ISO 80601-2-55 standard for monitoring the anesthetic gas concentration monitoring, and make sure that the anesthetic gas concentration monitoring range of the monitor can fully cover the adjustable range of values of the anesthetic gas delivery equipment.**
  - **For A8 anesthesia system, when the Isoflurane anesthetic vaporizer is used, confirm whether the set concentration of the vaporizer exceeds the monitorable range of the AG module. If it is the case, the anesthesia system won't be able to guarantee the monitoring precision of the AG module.**
  - **According to international laws and regulations, the equipment is required to monitor the O<sub>2</sub> concentration when applied to patients. If the equipment you are using is not configured with this feature, please use a monitor compliant with the corresponding international standards for O<sub>2</sub> concentration monitoring. The gas sampling tube of the monitor should be connected to the Y-shaped three-way valve of the breathing system of the equipment.**
  - **CO<sub>2</sub> concentration monitoring is recommended when the equipment is applied to patients. If the equipment you are using is not configured with this feature, please use a monitor compliant with the corresponding international standards for CO<sub>2</sub> concentration monitoring. The gas sampling tube of the monitor should be connected to the Y-shaped three-way valve of the breathing system of the equipment.**
  - **The Anesthesia Machine and its parts shall not be serviced or maintained while in use with a PATIENT.**
  - **Multiple AC power outlets are provided on the rear of the equipment. These outlets are intended to supply power to additional equipment that form a part of the anesthesia system (i.e. vaporizers, Mindray N series monitors, etc.). Do not connect other equipment to these outlets, as patient leakage current may be**
-



## **WARNING**

affected. Each outlet is rated 3 A. The total current that may be drawn through all outlets is 5 A on the system. Do not attempt to exceed these load ratings. Do not connect additional MPSOs (Multiple Portable Socket Outlets, i.e. multiple outlet extension cords) or extension cords to these outlets.

- The anesthesia system may lose its balance if it is tilted more than 10 degrees. Use extreme caution when moving or resting the equipment on slopes of over 10 degrees. Before moving, remove all equipment from the top shelf, all monitoring equipment mounted to the side of this machine, all brackets, cylinders, objects on the top self and worktable and in the drawers.
- Do not move the anesthesia system after unpacking it.
- No modification of this equipment is allowed.
- The service personnel must be properly qualified and thoroughly familiar with the operation of the equipment.
- External exhaust outlets of Anesthesia Machine shall not be located to place which has any electrical component.
- 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.
- Use only an approved lubricant on any O-ring in contact with oxygen. Krytox® is the recommended oxygen service lubricant.
- For continued protection against fire hazard, replace all fuses with the specified type and rating.
- 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).
- To avoid explosion hazard, do not use the equipment in the presence of flammable anesthetic agent, vapors or liquids.
- 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.
- 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.)
- 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.
- Possible electric shock hazard. The machine may only be opened by authorized service personnel.
- 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.
- Avoid exposure to respiratory gases by always directing the fresh gas flow from the fresh gas outlet to the waste gas scavenger.

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## 1.1.2 Cautions

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### CAUTION

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- To ensure patient safety, use only parts and accessories specified in this manual.
  - At the end of its service life, the equipment, as well as its accessories, must be disposed of in compliance with the guidelines regulating the disposal of such products, and in accordance with local regulations for contaminated and biologically hazardous items.
  - Magnetic and electrical fields are capable of interfering with the proper performance of the equipment. Ensure that all external devices operating in the vicinity of the equipment comply with the relevant EMC requirements. Mobile phones, x-ray equipment, and MRI equipment are possible sources of interference as they may emit higher levels of electromagnetic radiation.
  - This system operates correctly at the electrical interference levels identified in this manual. Higher levels can cause nuisance alarms that may stop automatic ventilation. Be aware of false alarms caused by high-intensity electrical fields.
  - Perform the daily checks specified on the checklist. In case of a system fault, do not operate the system until the fault has been corrected.
  - Before starting the equipment, users must be familiar with the information contained in this Operator's Manual and must have been trained by an authorized representative.
  - If the equipment does not function as described, it must be examined and repaired as necessary by qualified service personnel before being put back to use.
  - Handle the equipment with care to prevent damage or functional faults.
  - Ensure that the gas supply of the equipment always complies with the technical specifications.
  - Before clinical use, the equipment must be correctly calibrated and/or the respective tests must be performed, as described in this Operator's Manual.
  - If system faults occur during the initial calibration or testing, the equipment should not be operated until those faults have been corrected by a qualified service personnel.
  - After servicing, functional, sensor, and system tests must be performed before clinical use.
  - Only vaporizers with Selectatec Interlock-Systems may be used with A8 anesthesia system.
  - Each time you replace the vaporizer, please carry out leak test for the breathing circuit.
  - Use cleaning agent sparingly. Excess fluid could enter the equipment and cause damage.
  - Do not autoclave any parts of the equipment unless specifically identified as autoclavable in this manual. Clean the equipment only as specified in this manual.
  - To prevent system damage:  
Refer to the documentations provided by the manufacturer of the cleaning agent. Never use organic, halogenated or petroleum-based solvents, anesthetic agents, glass cleaning agents, acetone or other irritant agents.  
Never use abrasive agents (i.e. steel wool or silver polish) to clean components.  
Keep all liquids away from electronic components.  
Prevent liquid from entering the equipment.  
All cleaning solutions used must have a pH value between 7.0 and 10.5.
  - Never immerse the oxygen sensor or its connector into any type of liquid. Dispose
-



## CAUTION

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the O<sub>2</sub> sensor according to the manufacturer's specifications.

- Do not fumigate using peracetic acid or formaldehyde.
  - The valve disc in each of the inhalation and exhalation valve assemblies on the breathing system is fragile and must be handled with care while disassembling the valve cage from the valve assembly.
  - Only connect Mindray approved devices to the equipment's communication ports. Devices connected to the ethernet ports must comply with IEC 60950.
  - Do not connect any non-isolated devices to the DB9/RS232C interface of the equipment.
  - Do not connect any devices to the SB ports other than Mindray approved USB storage devices and a supported USB mouse.
  - Do not wash the inner surface of the oxygen sensor.
  - Do not perform soaking or high-temperature processing on the O<sub>2</sub> sensor.
  - Users should monitor oxygen percentage (FiO<sub>2</sub>%) when using the Auxiliary O<sub>2</sub>/Air Flow Meters. Without oxygen monitoring, it would be impossible to know the concentration of oxygen delivered to the patient.
  - The equipment is NOT suitable for use in a magnetic resonance imaging (MRI) environment.
  - To ensure measurement accuracy and to avoid possible damage to the equipment, use only Mindray-approved cables and accessories.
  - Use the power cord provided with the product. If a substitute is necessary, use power cord in compliance with the specification.
  - Do not use a damaged device or accessory. Periodically check all cables (e.g., AC line cord and patient connection cables) for damage that may occur through normal use. Replace cables if damaged in any way.
  - Use of other oxygen sensors may cause improper oximeter performance.
  - Unintended movement may occur if the casters are not locked.
  - The operator should lock casters during use of the equipment.
  - Unsecured devices may slide off the top shelf. Devices should be securely attached to the top shelf.
  - The voltage on the auxiliary outlets should be the same voltage as the outlet into which the equipment is plugged. Ensure that devices plugged into the auxiliary outlets are rated for the same supply voltage as the equipment.
  - During the transport and storage of the vaporizer, block the gas inlet and outlet of the vaporizer with plugs to prevent foreign substances from entering the vaporizer.
  - Do not use any flow outlets as handles when moving the equipment. The flow outlets may become damaged. Use the metal side bars on the main body when moving the equipment.
  - Do not push down on the bag arm forcefully or hang heavy objects onto it. Excessive weight may bend and damage the bag arm.
  - Use caution when disconnecting [quick connectors], as the sudden release of pressure may cause injury.
  - Avoid factors that can contribute to deterioration of the hose assemblies. Factors include excessive bending, crushing, abrasion, system pressures and temperatures that exceed hose ratings, and improper installation.
  - Be careful in lifting and manipulating the breathing system during disassembly of the system.
  - When the electronic flow control system is disabled, the backup flow control
-



## CAUTION

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system will be enabled. The initial flow of backup flow control system is 1 L/min of O<sub>2</sub>. The backup flow control system display only has a total flowmeter which can display a maximum flow of 15 L/min.

- Turn the flow control knob of the backup flow control system slowly. To avoid damaging the control valves, do not turn further when the flowmeter reading is out of range. When turning a flow control knob clockwise to decrease flow, the flowmeter should reach 1 L/min before the knob reaches its most clockwise mechanical stop (off) position.
  - Do not turn any further when the knob has reached the off position. Turning a flow control knob counter clockwise increases flow.
  - Prevent or avoid using and storing the gas supply hose assembly in an environment exposed to ultraviolet light or oxidizing agents, or in a high-temperature or moist environment to avoid damage to people and materials because of the release of pressure from aged hoses in the assembly.
  - This device uses high pressure compressed gas. When attaching or disconnecting backup gas cylinders, always turn the cylinder valves slowly. Use the A8/A9 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.
  - 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 A8/A9 gas connection fittings.
  - Refer to Section 3.2 Maintenance Period for assistance when performing scheduled periodic maintenance.
  - 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.
  - Use cleaning agent sparingly. Excess fluid could enter the machine, causing damage.
  - This machine must only be operated by trained, skilled medical staff.
  - 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.
  - After changing the CO<sub>2</sub> absorbent, carry out a system leak test.
  - Only Selectatec™ compatible vaporizers with Interlock-System may be used with the A8/A9 unit.
  - After each exchange of a vaporizer, carry out a system Leak test.
  - Do not clean the machine while it is on and/or plugged in.
  - Pressing “cancel” at any time during the procedure will cancel the session's settings and reload the previously-stored calibration coefficients.
  - Depleted sodalime changes color. Replace the sodalime if approximately 2/3 of the absorber content is discolored. CO<sub>2</sub> absorbent can be safely changed without stopping mechanical ventilation.
  - This equipment contains parts sensitive to damage by electrostatic discharge (ESD). Use ESD precautionary procedures when touching, removing, or inserting parts or assemblies. The ventilator must be inspected and serviced regularly by trained service personnel.
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### 1.1.3 Notes

#### NOTE

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- **Figures in this manual are provided for reference purposes only.**
  - **Screens may differ based on the system configuration and selected parameters.**
  - **Put the equipment in a location where you can easily see the screen and access the operating controls.**
  - **Keep this manual close to the equipment so that it can be obtained conveniently when needed.**
  - **The software was developed in compliance with IEC 60601-1. The possibility of hazards arising from software errors is minimized.**
  - **This manual describes all features and options. Your equipment may not have all of them.**
  - **The equipment is intended to be operated with its integral Breathing Pressure monitoring in use.**
  - **The equipment is intended to be operated with its integral Breathing Pressure limiting devices in use.**
  - **The equipment is intended to be operated with its integral Expiratory Volume monitoring in use.**
  - **The equipment is intended to be operated with its integral Breathing System integrity Alarm System in use.**
  - **The equipment is intended to be operated with its integral Continuous Pressure Alarm in use.**
  - **The equipment is intended to be operated with its integral O2 monitoring in use.**
  - **An Anesthesia Vapor Delivery Device is to be used with an Anesthetic Agent Monitor complying with ISO 80601-2-55. The connection of Patient Circuit and Agent monitor should be made by a sample line.**
  - **Continuously monitor the anesthetic agent concentration when using the anesthesia system to ensure accurate output of the anesthetic agent.**
  - **Check the liquid level of the anesthetic agent before and during all operations. When the liquid level is below the warning line, more anesthetic agent needs to be added. For the A8 anesthesia system, refer to the vaporizer Instructions For Use for filling the vaporizer and other information.**
  - **The system is designed to be equipped with an anesthetic vapor delivery device that complies with ISO 80601-2-13.**
  - **The battery supply of this equipment is not a user serviceable component. Only an authorized service representative can replace the battery supply. If the system is not used for a long time, contact a service representative to have the battery supply disconnected. The disposal of battery should comply with local regulations. At the end of the battery life, dispose of the battery supply in accordance with local regulations.**
  - **Areas designated for the servicing of oxygen equipment shall be clean, free of oil and grease, and not be used for the repair of other equipment.**
  - **Opening the cylinder valve quickly may cause unexpected pressure difference and lead to potential fire or explosion hazard due to the oxygen pressure shock. Open and close the cylinder valve slowly.**
  - **Changes in inlet pressure, outlet resistance, or ambient temperature may affect the accuracy of flow values.**
  - **The power supplies, terminal units and pipeline systems can be supplied by one or**
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## NOTE

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several different manufacturers.

- **Regional or national regulations that apply to manufacturers of medical equipment can exist.**
  - **The product does not contain latex parts.**
  - **The operator should stay right in front of the equipment within four meters away from the display to facilitate observation of the displayed information on the equipment.**
  - **Some alarm settings on this equipment are not configurable by users.**
  - **The tidal volume and minute ventilation displayed on this equipment are measured in BTPS conditions. The fresh gas flow is measured in STPD conditions.**
  - **For the method of connecting this equipment to an external monitor or other devices, please see Anesthesia System Bracket Installation Instructions.**
  - **All the materials of this equipment exposed to gases are compatible with O<sub>2</sub>, air and N<sub>2</sub>O.**
  - **To avoid abnormal gas supply, the anesthesia system has a 758 kPa pressure relief valve installed at the gas supply inlet. When the gas supply pressure is abnormally elevated, the pressure relief valve is turned on to ensure the proper operation of the anesthesia system. When the pressure relief valve is on, the anesthesia system and the O<sub>2</sub> flush are both operating properly, and their P-F (pressure/flow) characteristics are consistent with those under rated conditions.**
  - **The pressure at the high-pressure O<sub>2</sub> outlet will be elevated to 758 kPa, and the maximum flow rate meets requirements in the specifications.**
  - **The defibrillation restoration time is 15 seconds unless otherwise stipulated.**
  - **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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**FOR YOUR NOTES**

# 2 Installation Guide

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## 2.1 Preparations

### 2.1.1 Accessories

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

- Compatible emergency O<sub>2</sub>, N<sub>2</sub>O, and air cylinders
- Anesthetic vaporizers (if not purchased with the anesthesia system) and adapters
- Active O<sub>2</sub>, N<sub>2</sub>O, and air supplies (280–600 kPa (40–87 psi)) and connectors adapting to the hospitals' gas supplies Double-gauge pressure relief valve if the gas supply pressure is greater than 600 kPa
- Negative pressure source and negative pressure source connection hoses (if not purchased with the anesthesia system)

### 2.1.2 Tools

- Phillips screwdriver
- Scissors

## 2.2 Installation Procedure

### NOTE

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- **This section describes other applicable basic information. Use the anesthesia machine with calibrated flow sensors. If the calibrated flow sensors are removed, ensure that they are reinstalled on the original anesthesia machine. If different flow sensors are reinstalled, recalibrate them.**
  - **When unpacking the machine, keep as much of the plastic covering on the machine as possible. When all parts are unpacked, return the packing material to its original box. Place the smaller box inside the larger box.**
-

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## 2.2.1 Unpacking

1. When the A8/A9 is received, immediately inspect the box for any damage.
  - a. If there is no damage and all tip indicators on the box exterior are intact, sign and date the bill of lading or airway bill to indicate safe receipt of the anesthesia machine.
  - b. If there is damage or any of the tip indicators on the box exterior is abnormal, 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.
2. Cut, remove, and discard the white shipping straps from the box.



3. Pull the box top straight up off the box and place it on the floor near the machine. The box top will be used later as a ramp when rolling down the A8/A9 onto the floor.

Top plate



4. Remove the protection carton from the top of the machine.



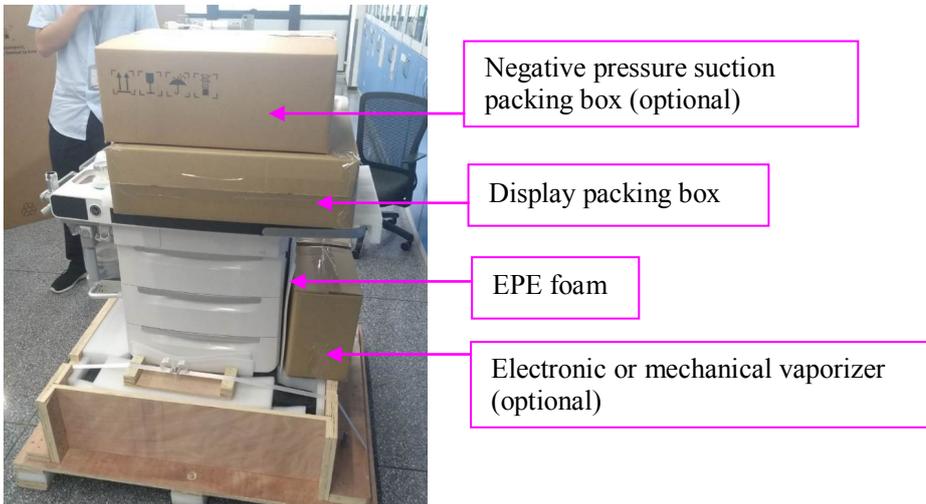
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5. As shown in the figure, press hard on both sides of the snap hook in the arrow direction and then open it outward. Release the five quick snap hooks on the carton in turn and take out the carton.



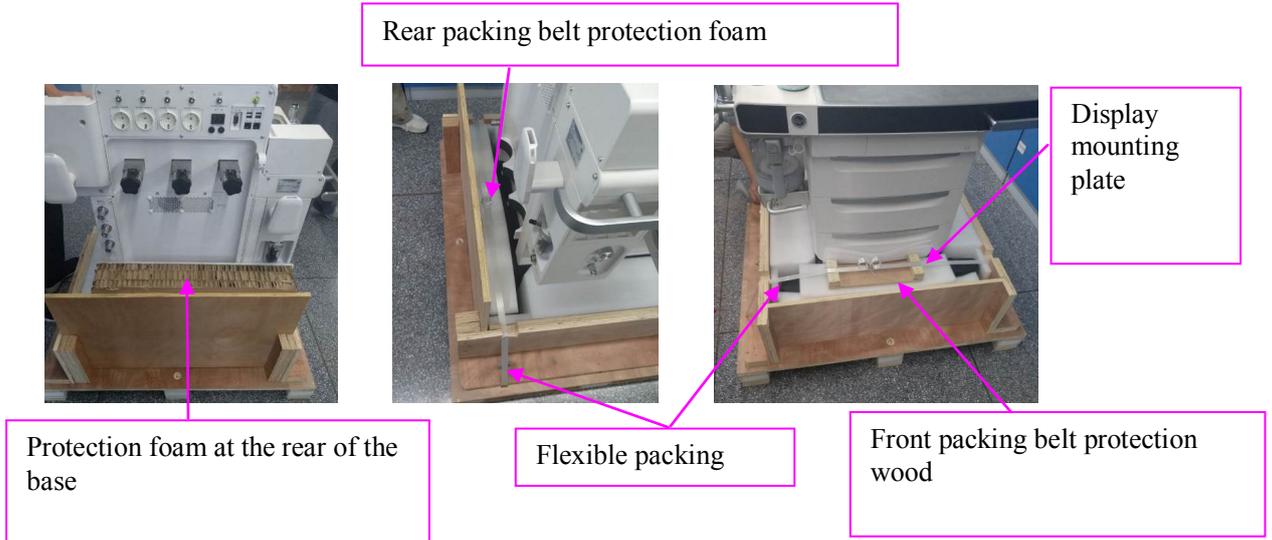
6. Cut the protection film around the A8/A9 with a pair of scissors. Take care not to scratch or otherwise damage the machine.



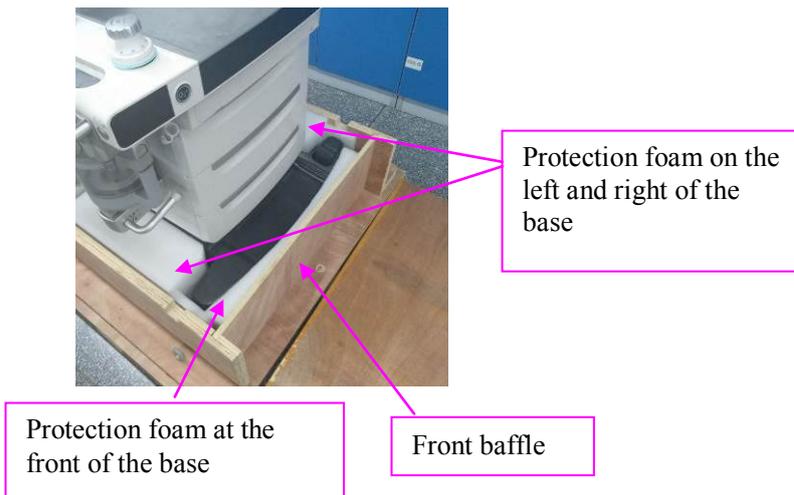
7. Remove and discard the protection film. Verify that the display packing box and negative pressure suction packing box (optional) are placed on the work surface and the electronic or mechanical vaporizer packing box (optional) is placed on the side. Remove all packing boxes and EPE foam.



8. Remove the protection foam at the rear of the base, cut the flexible packing tape at the front and rear of the main unit, and finally remove the display mounting plate protection foam block, front packing belt protection wood, and rear packing belt protection foam.



9. Remove the protection foam and front baffle from the front of the base. Then remove the protection foam from the left and right of the base.



10. Create a ramp by placing the top plate in front of the pallet and gently push the A8/A9 down the ramp.



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## 2.2.2 Installation

1. Check the accessories in the drawers of the cart according to the packing list. The top drawer accommodates the cylinder wrench, hook, O<sub>2</sub> cell holder assembly, and O<sub>2</sub> sensor, as shown in Figure A. The bottom drawer accommodates the gas supply hose and bag arm assembly, as shown in Figure B. The middle drawer accommodates other accessories, as shown in Figure C.

Figure A



Figure B

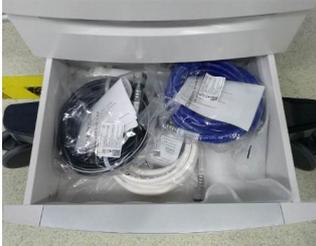


Figure C



2. Take the bag arm assembly out of the bottom drawer. Remove the bubbled film from the bag arm assembly and bag arm mounting base with a pair of scissors.



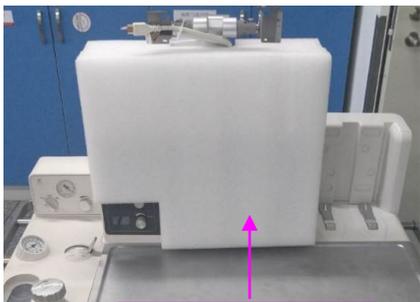
Bubbled film



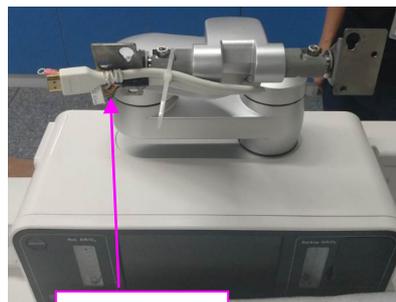
3. Carefully put the bag arm assembly in the groove and tighten the nut clockwise to install the bag arm assembly on the breathing circuit.



4. Remove the protection foam between the arm and the instrument panel, cut the cable strap on the arm, and adjust the position of the display arm assembly to prepare for installing the display assembly.

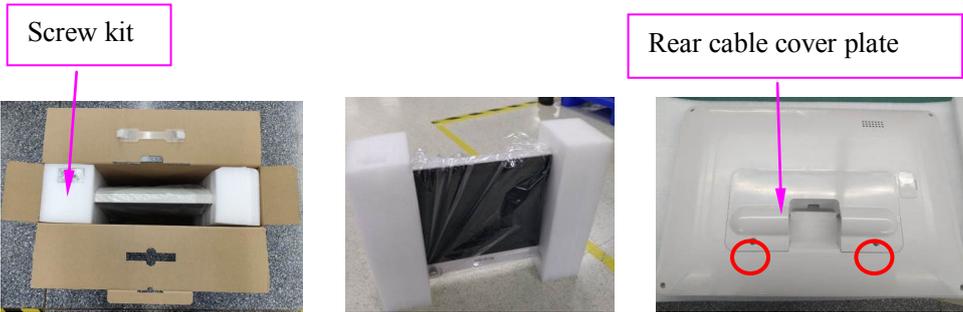


Protection foam



Cable strap

- 
5. Open the display assembly packing box and remove the screw kit. Remove the foam from the left and right of the display to remove it. Remove the two screws with the Phillips screwdriver to remove the rear cable cover plate.



6. Install the display assembly.

- a. Place the two cables of the display arm assembly in the groove and mount the display assembly to the display arm assembly with two pre-tightened screws (marked by  $\Delta$  in Figure B). Tighten the four M4 $\times$ 12 screws (marked by  $\circ$  in Figure B) with the Phillips screwdriver. Then tighten the two pre-tightened screws.
- b. Plug the cable in the corresponding socket of the CPU board in place, ensuring that it is not loose.
- c. Fasten the ground cable with the M3 $\times$ 8 pan head cross recessed screw (marked by  $\square$  in Figure B). Then secure the cable with one M3 $\times$ 8 screw and one cable tie UC-1 (009-000257-00) (marked by  $\diamond$  in Figure B).
- d. Secure the HDMI cable with two M3 $\times$ 8 screws and one HDMI cable restraining plate (0645), as shown in Figure B.
- e. Secure the rear cable cover plate (0645) with two M3 $\times$ 8 pan head cross recessed screws, as shown in Figure D.



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## 2.3 Tests After Installation

Perform tests after installation.

No.	Test Item	Reference Section in the Service Manual	Remarks
1	System check	<b>7.2.1</b>	All electronic vaporizers must be installed on the machine.
2	Gas supply test	<b>7.3</b>	/
3	Cylinder supply test	<b>7.4</b>	/
4	EFCS/BFCS switchover test	<b>7.6.1</b>	/
5	Basal flow test in the BFCS state	<b>7.6.4</b>	/
6	Accuracy confirmation test	<b>7.6.5</b>	/
7	Electronic vaporizer test (for A9)	<b>7.7</b>	This test item can be skipped if no such configuration is available.
8	Mechanical vaporizer test (for A8)	<b>7.8</b>	This test item can be skipped if no such configuration is available.
9	Auxiliary flowmeter test	<b>7.9.1</b>	This test item can be skipped if no such configuration is available.
10	High-flow O2 supply test	<b>7.9.2</b>	This test item can be skipped if no such configuration is available.
11	Internal AG module test	<b>7.9.6</b>	/
12	Auto/manual switch test	<b>7.10.3</b>	/
13	Patient circuit heating test	<b>7.10.4</b>	/
14	Active AGSS check	<b>7.11</b>	This test item can be skipped if no such configuration is available.
15	Negative pressure suction test	<b>7.12</b>	This test item can be skipped if no such configuration is available.
16	Power failure alarm test	<b>7.13.1</b>	/
17	"Breathing Circuit Not Installed" alarm test	<b>7.13.2</b>	/
18	"Volume Exchanger Not Installed" alarm test	<b>7.13.3</b>	/
19	Absorber canister alarm test	<b>7.13.4</b>	/
20	"O2 Supply Failure" and "Balance Gas Branch Flow Not Achieved" alarm test	<b>7.13.5</b>	/
21	System ventilation performance test	<b>7.14</b>	/
22	Electrical test	<b>7.18</b>	/

# 3 Device Maintenance

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## 3.1 Maintenance Overview

Physical check, disposables replacement, and performance check shall be conducted at regular intervals according to the periods listed in the following table. The factory will bear no liability if some parts are damaged or lost because the disposables are not replaced within the suggested period. The preceding content is described in "Maintenance Period".  
Phillips screwdrivers (#2) are required during maintenance.

## 3.2 Maintenance Period

The periodic maintenance package includes:

- Basic maintenance package (A8/A9), P/N: 115-067255-00 (replaced at least every 24 months)
- Complete maintenance package (A8), P/N: 115-067256-00 (replaced as required)
- Complete maintenance package (A9), P/N: 115-067257-00 (replaced as required)

## 3.3 Check and Calibration Before Maintenance

Check Item	Required Device
Appearance check	None
System check	None
Leak test	None
Gas supply test	None
Cylinder supply test	None
EFCS accuracy test	Flow test device
BFCS function test	None
O2 concentration test	None
Electronic vaporizer test (for A9)	None
Pressure range of the electronic vaporizer pressure regulator (for A9)	None (Check the measured values of the electronic vaporizer pressure sensor on the diagnosis screen.)
Internal AG module test	None
Mechanical vaporizer test (for A8)	None
Ventilation performance test	None
Circuit function test	None
AGSS function test	None
ACGO function test	None
Auxiliary O2/air and high-flow O2 supply tests	None
O2 flush test	None
Negative pressure suction test	None
Constant flow test	Flow test device
Constant pressure test	Pressure test device

<b>Calibration (based on the check results)</b>	
Flow calibration	Calibration is required if the flow sensor is replaced.
Pressure calibration	/
O2 sensor calibration	Calibration is required if the O2 sensor is replaced.
Electronic vaporizer pressure regulator calibration	/

### **3.4 Parts of the Maintenance Packages**

The following table lists the parts that need to be replaced regularly inside the periodic maintenance packages. The replacement date is counted from the machine installation date.

#### **3.4.1 Basic Maintenance Package (A8/A9)**

<b>No.</b>	<b>Description</b>	<b>Qty.</b>	<b>P/N</b>
1	SPECIAL SEAL	3	0348-00-0185
2	Sealing cushion for the bypass trigger plate	1	049-000142-00
3	23.47×2.95 O-ring, silicon rubber A70, colorless	3	082-003300-00
4	Sealing ring for the bypass absorber canister	1	049-001491-00

#### **3.4.2 Complete Maintenance Package (A8)**

<b>No.</b>	<b>Description</b>	<b>Qty.</b>	<b>P/N</b>
1	SPECIAL SEAL	3	0348-00-0185
2	Sealing cushion for the bypass trigger plate	1	049-000142-00
3	23.47×2.95 O-ring, silicon rubber A70, colorless	3	082-003300-00
4	Sealing ring for the bypass absorber canister	1	049-001491-00
5	O2 cell holder assembly	1	115-064181-00
6	14×2.65 O-ring, EPDM A70, white	4	082-003225-00
7	85×2.5 O-ring, silicon rubber A70, colorless	1	082-003233-00
8	Flow sensor (resistant to high-temperature disinfection)	1	115-041519-00
9	Air filter, filtering accuracy $\mu\text{m}$ , filtering efficiency $\geq 95\%$ , in compliance with GB8368	1	3001-10-07054

### 3.4.3 Complete Maintenance Package (A9)

No.	Description	Qty.	P/N
1	SPECIAL SEAL	3	0348-00-0185
2	Sealing cushion for the bypass trigger plate	1	049-000142-00
3	23.47×2.95 O-ring	3	082-003239-00
4	Sealing ring for the bypass absorber canister	1	049-001491-00
5	O2 cell holder assembly	1	115-064181-00
6	4.7×1.8 O-ring, EPDM A70, white	4	082-003252-00
7	13.2×1.8 O-ring, EPDM rubber A70, white	4	082-003216-00
8	85×2.5 O-ring, silicon rubber A70, colorless	1	082-003233-00
9	Flow sensor (resistant to high-temperature disinfection)	1	115-041519-00
10	Air filter, filtering accuracy $\mu\text{m}$ , filtering efficiency $\geq 95\%$ , in compliance with GB8368	1	3001-10-07054

### 3.4.4 Battery

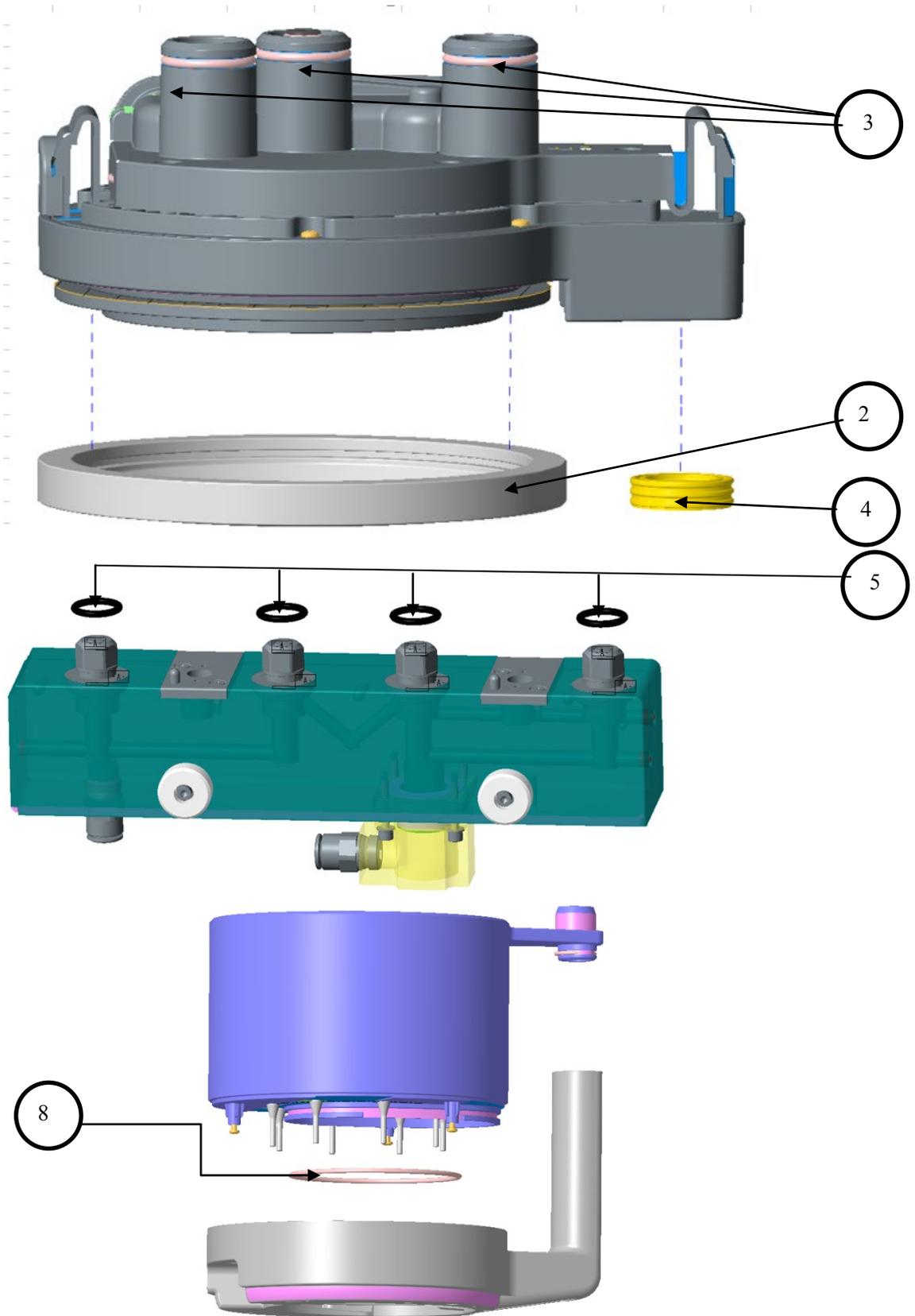
No.	Description	Qty.	P/N
1	Battery box assembly (two batteries)	1	115-066846-00
2	Battery box assembly (one battery)	1	115-066847-00

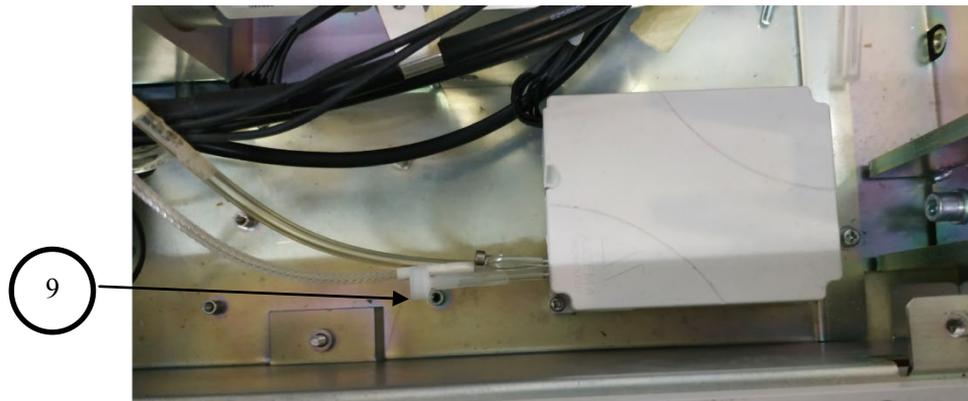
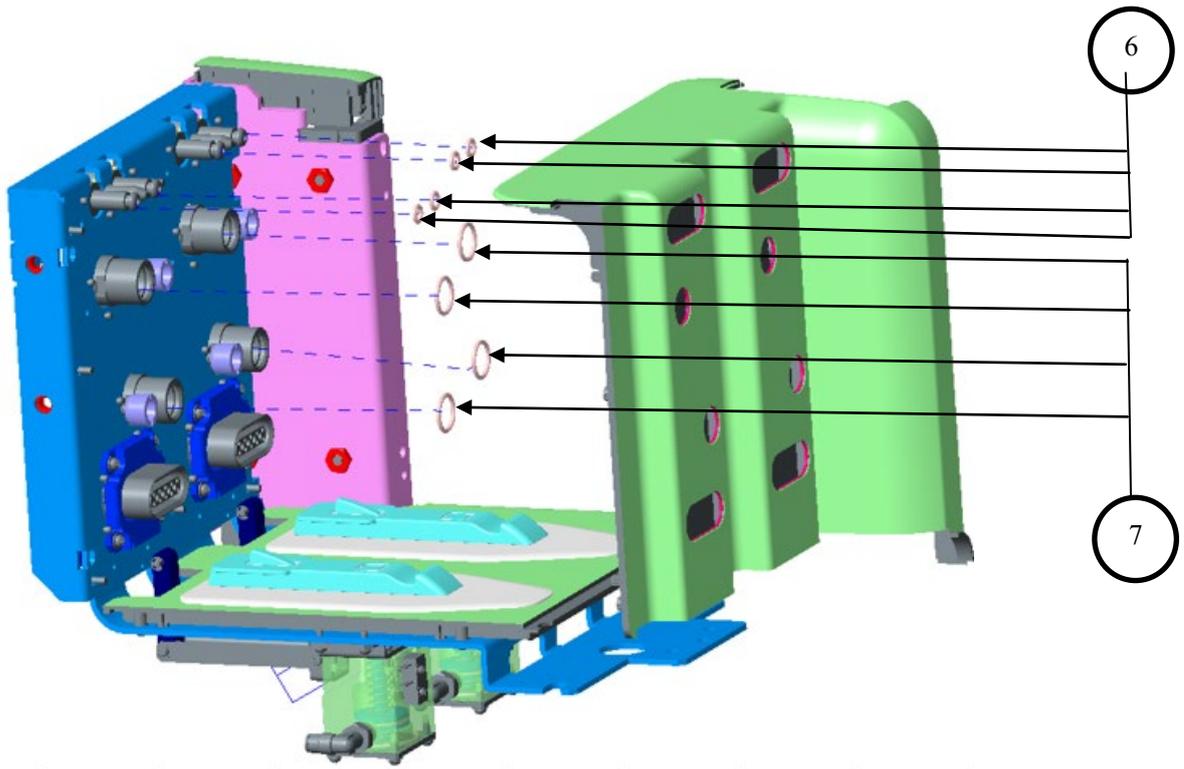
### 3.4.5 Installation Positions of the Sealing Rings and Filters in the Maintenance Packages

No.	Description	Qty.	P/N
1	SPECIAL SEAL	3	0348-00-0185
2	Sealing cushion for the bypass trigger plate	1	049-000142-00
3	23.47×2.95 O-ring, silicon rubber A70, colorless	3	082-003300-00
4	Sealing ring for the bypass absorber canister	1	049-001491-00
5	14×2.65 O-ring, EPDM A70, white	4	082-003225-00
6	4.7×1.8 O-ring, EPDM A70, white	4	082-003252-00
7	13.2×1.8 O-ring, EPDM rubber A70, white	4	082-003216-00
8	85×2.5 O-ring, silicon rubber A70, colorless	1	082-003233-00
9	Air filter, filtering accuracy $\mu\text{m}$ , filtering efficiency $\geq 95\%$ , in compliance with GB8368	1	3001-10-07054



1







O2 cell holder assembly

### 3.5 Test Items After Maintenance

Test Item	Reference Section in the Service Manual	Test Completed
System check	7.2	
Leak test	7.2.2	
Cylinder supply test	7.3	
Electronic vaporizer test (for A9)	7.7	
Mechanical vaporizer test (for A8)	7.8	
Internal AG module test	7.9.6	

# 4 Troubleshooting

## 4.1 Precautions

Before disassembling the machine for internal testing and maintenance, disconnect the power supply and all gas supplies, and shut down the anesthesia machine.

Before connecting or disconnecting cables or probes inside the machine after disassembly, turn off the system power supply to prevent safety risks and damage to the machine.

## 4.2 Power-On Troubleshooting

### 4.2.1 Power-On and Display Failures

Failure Description	Cause Confirmation	Confirmation Result	Solution
When the switch is turned to the <b>ON</b> position, the main screen is off.	1. Check whether the AC power supply is connected properly.	The AC power supply is not connected.	Connect the AC power supply properly.
	2. Check whether the AC and battery indicators are on.	The AC indicator is off.	Continue checking according to step 3.
		The AC indicator is on.	Continue checking according to step 5.
	3. Check whether the AC inlet fuse is blown (skip this check item for American-standard machines without inlet fuses).	The AC inlet fuse is blown.	Replace the AC inlet fuse (refer to 8.1.11).
		The AC inlet fuse is intact.	Continue checking according to step 4.
	4. Check whether the small display functions properly.	The small display is off.	Continue checking according to step 5.
		The small display functions properly.	Continue checking according to step 6.
	5. Check whether the auxiliary O <sub>2</sub> /air or HFNC module can be started.	The auxiliary O <sub>2</sub> /air module can be started.	(1) Replace the system switch (refer to 8.1.3). (2) If the problem persists, replace the DC-DC power board (refer to 8.1.11). (3) If the problem persists, replace the backplane (refer to 8.1.11).
		The auxiliary O <sub>2</sub> /air module cannot be started.	(1) Replace the DC-DC board (refer to 8.1.11). (2) If the problem persists, replace the backplane (refer to 8.1.11).
	6. Observe whether the alarm light blinks, whether alarm sound is generated, and whether the buzzer is ringing.	The alarm light does not blink, and no alarm sound is generated, but the buzzer is ringing.	(1) Remove the rear housing of the display by referring to 9.1.7, open the service door by referring to 9.1.1, and reconnect or replace the cable between the backplane and the display. (2) Replace the main board (refer to 8.1.1).
		The alarm light blinks, and alarm sound is generated.	(1) Remove the rear housing of the display by referring to 9.1.7, and reconnect the LCD cable or replace the LCD assembly (refer to 8.1.1).

Failure Description	Cause Confirmation	Confirmation Result	Solution
			(2) If the problem persists, replace the CPU board (refer to 8.1.1).
When the anesthesia machine is powered on, the main screen is on but displays no content.	Reconnect the display cable and LCD cable (refer to 7.2.1).	The problem is solved.	/
		The problem persists.	Replace the display (refer to 8.1.1).
The screen of the anesthesia machine is on and can display content, but flickers.	Reconnect the LCD cable (refer to 7.2.1).	The problem is solved.	/
		The problem persists.	(1) Replace the DC-DC power board (refer to 8.1.11). (2) If the problem persists, replace the ©AC-DC power board (refer to 8.1.11). (3) If the problem persists, replace the CPU board (refer to 8.1.1).
The primary screen functions properly, but the status screen displays no content.	Check whether the Status Screen Comm Stop alarm is generated.	The Status Screen Comm Stop alarm is generated.	(1) Disassemble the auxiliary outlet by referring to 9.1.2 and reconnect the cable of the instrument panel. (2) If the problem persists, replace the status screen control board (refer to 8.1.5).
		No Status Screen Comm Stop alarm is generated.	(1) Disassemble the instrument panel by referring to 9.1.5 and reconnect the LCD cable in the instrument panel (refer to 8.1.5). (2) If the problem persists, replace the status screen LCD (refer to 8.1.5). (3) If the problem persists, replace the status screen control board (refer to 8.1.5).

#### 4.2.2 Auxiliary Outlet Failures

Failure Description	Cause Confirmation	Confirmation Result	Solution
The auxiliary outlet has no voltage output.	Check whether the breakers (branch and total breakers) of the auxiliary outlet are tripped.	A breaker is tripped.	Connect the device beyond the nominal current to the external power supply and reset the breaker.

#### 4.2.3 Leak Test Failures in Auto Mode

- 1) Check the following items, take countermeasures, and perform the leak test again until the problem is solved:
  - i. Check the pipeline connection:
    - ◆ Whether the corrugated pipe is connected properly;
    - ◆ Whether the leak test plug is connected properly;

- 
- ◆ Whether the sample gas port is sealed or the sampling line is connected properly;
  - ◆ Whether the sample gas return port is connected or sealed.
  - ii. Check whether the components are installed in place:
    - ◆ Whether the gas module watertrap is installed in place;
    - ◆ Whether the absorber canister is installed in place;
    - ◆ Whether the bottom sealing cover of the absorber canister is installed in place;
    - ◆ Whether the bypass module is installed in place;
    - ◆ Whether the circuit is installed in place;
    - ◆ Whether the inspiratory and expiratory knobs loosen;
    - ◆ Whether the circuit valve cover is installed in place;
    - ◆ Whether the water collection cup is installed in place;
    - ◆ Whether the O<sub>2</sub> cell is installed in place;
    - ◆ Whether the vaporizer is installed in place;
    - ◆ Whether the VE is installed;
    - ◆ Whether the airway pressure gauge is installed in place;
    - ◆ Whether the APL valve is installed in place.
  - iii. Clean the sealing rings:
    - ◆ Absorber canister and bypass sealing washers;
    - ◆ Bypass sealing rings:
      - Top sealing ring of the bypass module;
      - Sealing ring for the bottom sealing cover of the absorber canister;
      - Sealing ring for the handle of the absorber canister;
    - ◆ Sealing rings for connectors at the rear of the circuit.
  - 2) Perform the following steps for troubleshooting until the problem is solved:
    - a) Check whether the corrugated pipe is damaged or replace it for the leak test.
      - ◆ If the corrugated pipe is damaged, replace it. If the test succeeds after the replacement, the problem is solved.
    - b) Disable the sampling connector (straight or L-shaped connector) and perform the leak test again.
      - ◆ If the test succeeds, replace the sampling connector.
    - c) Directly connect the expiratory port to the inspiratory port through a single corrugated pipe and perform the leak test.
      - ◆ If the test is passed after the inspiratory port and the expiratory port are directly connected, the corrugated pipe is intact in step (a), and the problem persists after the leak test plug is repeatedly connected, replace the circuit (refer to 8.5.2).
    - d) Perform the leak test without connecting the gas module or sample gas return port.
      - ◆ If the test succeeds:
        - i. Check whether the watertrap is damaged. If yes, replace it.
        - ii. Perform the leak test without connecting the gas module (tie the gas module connectors of the sampling line and gas return line). If the test succeeds, replace the gas module.
      - iii. Open the service door (refer to 9.1.1), tie the middle of the internal gas return silicone tube of the machine to occlude it, and then perform the leak test.
        - ◆ Perform the leak test with the gas module connected. If the test succeeds, replace the CPC gas connector (replace the AGSS assembly by referring to 8.1.14).
    - e) Check whether the valve cover cracks. If yes, replace the valve cover (refer to 8.5.2).
    - f) Remove the absorber canister, fix the locking handle in the locked position, and perform the leak test. If the test succeeds:
      - ◆ Replace the bypass (refer to 8.5.1).
      - ◆ Replace the absorber canister (refer to 8.5.1).
    - g) If the test succeeds without connecting the vaporizer or after the vaporizer is replaced, replace the vaporizer.
    - h) If the test succeeds after the O<sub>2</sub> cell holder is removed, replace the O<sub>2</sub> cell holder (refer to 8.5.1).
    - i) Switch to ACGO, connect the ACGO to the inspiratory port, and set the O<sub>2</sub> flow to 0.2 L/min in diagnostic mode (referring to 4.6.5, set the O<sub>2</sub> switch valve to On and set the AD value of the O<sub>2</sub> proportional valve until the O<sub>2</sub> flow displayed on the left is 0.2 L/min). This is intended to check whether the pressure of the airway pressure gauge can

- 
- rise above 30 cmH<sub>2</sub>O.
- ◆ If the pressure of the airway pressure gauge cannot rise above 30 cmH<sub>2</sub>O:
    - i. Check the internal pipeline connection (refer to step 1):
      - Check whether the internal pipelines loosen. If yes, tighten them.
    - ii. Check whether leakage occurs on the vaporizer dock:
      - Install the vaporizer in another slot.
      - Replace the sealing ring of the vaporizer dock (refer to 8.4.1).
      - Bypass or replace the vaporizer dock (refer to 8.4.1).
    - iii. If the test succeeds after the built-in AG module is bypassed, replace the built-in AG module (refer to 8.1.7).
    - iv. If the test succeeds after the ACGO assembly is bypassed, replace the ACGO assembly (refer to 8.1.6).
    - v. If the test succeeds after the O<sub>2</sub> flush assembly is bypassed, replace the O<sub>2</sub> flush assembly (refer to 8.1.12).
    - j) Replace the airway pressure gauge (refer to 8.1.12).
    - k) Open the service door (refer to 9.1.1), remove the auxiliary outlet (refer to 9.1.2), remove the rear cover plate of the work surface (refer to 9.1.3), and connect the gas supply. Power on the machine with the battery and check whether any pipeline loosens or leaks at the rear of the machine during ventilation. Remove the VE box assembly (refer to 9.3.1) and check whether any internal pipeline loosens or leaks during ventilation.
    - l) Perform the PEEP valve test by referring to 4.6.3. If the test fails, replace the inspiratory valve assembly (refer to 8.1.17).
    - m) Replace the bypass (refer to 8.5.1).
    - n) Replace the circuit (refer to 8.5.1).
    - o) Replace the VE (refer to 8.1.15).
    - p) Replace the water collection cup (refer to 8.5.2).
    - q) Replace the sensor adapter board or 3-way valve assembly (refer to 8.1.16).

#### 4.2.4 Leak Test Failures in Manual Mode

If the auto leak test succeeds, but the manual leak test fails, solve the problem as follows:

- 1) Verify the operations:
  - a) Whether the bag is connected properly;
  - b) Whether the APL valve is adjusted to 30 cmH<sub>2</sub>O or above;
  - c) Whether the bag arm is installed in place and securely;
  - d) Whether the APL valve is installed in place and securely.
- 2) Check the components:
  - a) Check whether the bag is damaged. If yes, replace it.
  - b) Check whether the bag arm breaks or leaks.
  - c) If yes, replace the bag arm (refer to 8.5.1).
  - d) If not, replace the sealing ring of the bag arm (refer to 8.5.1).
  - e) If the problem persists, replace the APL valve (refer to 8.5.1).
  - f) If the problem persists, replace the circuit (refer to 8.5.1).

### 4.3 Technical Alarms

A technical alarm, as apposed to a physiological parameter alarm, is an alarm condition that exists no matter whether a patient is connected to the machine. Technical alarms include:

- Power-on self-test alarms
- CPU board runtime alarms
- Power board runtime alarms
- Electronic flowmeter and BFCS runtime alarms
- VCM runtime alarms
- Electronic vaporizer runtime alarms
- AGSS module runtime alarms

- Auxiliary O2/air module runtime alarms
- HFNC module runtime alarms
- Internal AG module runtime alarms
- Plug-in module runtime alarms

Before troubleshooting the anesthesia machine, check for technical alarm messages. If a technical alarm is generated, evaluate the alarm first.

The following sections detail how to troubleshoot technical alarms related to the modules mentioned above.

For detailed information on possible causes for other alarm and prompt messages, see the user manual.

### 4.3.1 Power-On Self-Test Alarms

Message	Priority	Cause	Solution
The bundle version or software version is incompatible.	High	The incompatible firmware version is installed.	Upgrade the software to the latest version (refer to Chapter 10).
Bundle version: timeout	High	The self-test result cannot be obtained due to the internal communication error.	Check the self-test record, identify the module that encounters the self-test timeout problem, and clear the module self-test timeout alarm according to this section "Technical Alarms".
Electronic flowmeter self-test: Error	High	<ol style="list-style-type: none"> <li>1. VCM self-test error</li> <li>2. Protection module selftest error</li> <li>3. Self-test error of the O2 limb proportional valve</li> <li>4. Self-test error of the balance gas limb proportional valve</li> <li>5. O2 limb flow leak</li> <li>6. Balance gas limb flow leak</li> <li>7. Zero point reading error upon power-on</li> <li>8. Leak of the check valve on the balance gas limb</li> <li>9. Air 3-way valve self-test error</li> <li>10. N2O 3-way valve self-test error</li> <li>11. O2 switch valve self-test error</li> </ol>	<ol style="list-style-type: none"> <li>1. Power on the machine again for a self-test.</li> <li>2. If the problem persists, enter the standby state, check the alarm or log to locate the error code, and handle the problem based on the error code by referring to 4.3.4.1.</li> </ol>
Electronic flowmeter self-test: Timeout	High	The self-test result cannot be obtained due to the internal communication error.	<ol style="list-style-type: none"> <li>1. Power on the machine again for a self-test.</li> <li>2. If the status screen encounters the black screen, blank screen, or communication error, rectify the fault of the auxiliary screen (refer to 4.2.1 and 4.3.2).</li> <li>3. If the problem persists, open the service door (refer to 9.1.1), and reconnect the cable between the</li> </ol>

Message	Priority	Cause	Solution
			backplane and the flowmeter assembly. (For the cable position, refer to 9.13.) 4. If the problem persists, replace the electronic flowmeter board (refer to 9.12).
BFCS self-test error	High	<ol style="list-style-type: none"> <li>1. The BFCS NO two-way valve is faulty.</li> <li>2. The monitored status of the two microswitches that identify the position status of the mechanical door is inconsistent.</li> <li>3. The electromagnet voltage is beyond the normal range, or its control status is inconsistent with the monitored status.</li> </ol>	<ol style="list-style-type: none"> <li>1. Power on the machine again for a self-test.</li> <li>2. If the problem persists, enter the standby state, check the alarm or log to locate the error code, and handle the problem based on the error code by referring to 4.6.5.2.</li> </ol>
VPM self-test: Error/VPM self-test: Failed	High	<ol style="list-style-type: none"> <li>1. An error occurs to the CPU, EEPROM, or WTD.</li> <li>2. After power-on, the CPU board cannot communicate with the VPM.</li> </ol>	<ol style="list-style-type: none"> <li>1. Power on the machine again for a self-test.</li> <li>2. If the problem persists, re-plug the VCM (refer to 9.7.2).</li> <li>3. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
VPM self-test: Timeout	High	The self-test result cannot be obtained due to the internal communication error.	<ol style="list-style-type: none"> <li>1. Power on the machine again for a self-test.</li> <li>2. If the status screen has a communication stop alarm, or encounters the black or blank screen error, rectify the fault of the status screen first (refer to 4.2.1 and 4.3.2).</li> <li>3. If the problem persists, re-plug the VCM (refer to 9.7.2), and reconnect the cable between the backplane and display.</li> <li>4. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
VCM self-test: Error/VCM self-test: Failed	High	<ol style="list-style-type: none"> <li>1. An error occurs to the CPU, RAM, WTD, or EEPROM.</li> <li>2. After power-on, the CPU board cannot communicate with the VCM.</li> </ol>	<ol style="list-style-type: none"> <li>1. Power on the machine again for a self-test.</li> <li>2. If the problem persists, re-plug the VCM (refer to 9.7.2).</li> <li>3. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
VCM self-test: Timeout	High	The self-test result cannot be obtained due to the internal communication error.	<ol style="list-style-type: none"> <li>1. Power on the machine again for a self-test.</li> <li>2. If the status screen has a communication stop alarm, or encounters the black or blank screen error, rectify the fault of the status</li> </ol>

Message	Priority	Cause	Solution
			<p>screen first (refer to 4.2.1 and 4.3.2).</p> <p>3. If the problem persists, re-plug the VCM (refer to 9.7.2), and reconnect the cable between the backplane and display.</p> <p>4. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</p>
PEEP valve failure/PEEP valve: Failed	Med	The PEEP valve voltage is in error. The PEEP valve pressure is in error.	<p>1. Power on the machine again for a self-test.</p> <p>2. If the power board has a voltage error alarm, clear this alarm (refer to 4.3.3).</p> <p>3. Choose Setup &gt; Service &gt; Data Monitors &gt; PEEP Valve to run a PEEP valve test. If the test fails, replace the inspiratory valve assembly (refer to 8.1.17).</p> <p>4. If the PEEP valve test is passed, check whether the PEEP valve or PEEP pressure sensor is faulty by referring to 4.6.3.</p> <p>5. If the pressure sensor is faulty, perform the pressure sensor calibration (refer to 10.3.6).</p> <p>6. If the calibration fails, replace the sensor adapter board (refer to 8.1.16).</p> <p>7. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</p>
Insp Valve Failure/Insp Valve: Failed	Med	The Insp valve voltage is in error. The Insp valve flow is in error.	<p>1. Power on the machine again for a self-test.</p> <p>2. If the power board has a voltage error alarm, clear this alarm (refer to 4.3.3).</p> <p>3. Choose Setup &gt; Service &gt; Data Monitors &gt; PEEP Valve to run a PEEP valve test. If the test fails, replace the inspiratory valve assembly (refer to 8.1.17).</p> <p>4. If the PEEP valve test is passed, check whether the PEEP valve or PEEP pressure sensor is faulty by referring to 4.6.3.</p> <p>5. If the pressure sensor is faulty, perform the pressure sensor calibration (refer to 10.3.6).</p> <p>6. If the calibration fails, replace the sensor adapter board (refer to 8.1.16).</p> <p>7. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</p>
Safety Valve Failure/Safety Valve: Failed	Med	The voltage of the PEEP safety valve is in error. The PEEP safety	<p>1. Power on the machine again for a self-test.</p> <p>2. If the power board has a voltage error alarm, clear this alarm (refer to</p>

Message	Priority	Cause	Solution
		valve cannot be properly closed or opened.	4.3.3). 3. Choose Setup > Service > Data Monitors > PEEP Safety Valve to run a PEEP safety valve test. If the test fails, replace the inspiratory valve assembly (refer to 8.1.17).
Flow Sensor Failure/Flow Sensor: Failed	Low	The flow on the machine side is out of range. The zero point of the flow sensor on the patient side is abnormal.	1. Zero the flowmeter. 2. Diagnose the flow sensor by referring to 4.6.1.2. 3. If the measured value of the flow sensor in step 2 is valid but the error is large, perform the flow calibration. 4. If the measured value of the flow sensor in step 2 is invalid or calibration fails, replace the sensor adapter board (refer to 8.1.16). 5. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).
Calibrate Flow Sensor and Insp Valve	Low	1. The calibration table is not found on the EEPROM. 2. The checksum of the calibration table does not match.	1. Calibrate the flow sensor (refer to 10.3.1). 2. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).
Calibrate Pressure Sensor and PEEP Valve	Low	1. The calibration table is not found on the EEPROM. 2. The checksum of the calibration table does not match.	1. Perform the pressure sensor calibration (refer to 10.3.6). 2. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).
Calibrate O2 Sensor	Low	1. The calibration table is not found on the EEPROM. 2. The checksum of the calibration table does not match.	1. Calibrate the O2 sensor (refer to 10.3.2). 2. If the problem persists, replace the O2 sensor. 3. Calibrate the O2 sensor after the sensor is replaced (refer to 10.3.2).
Drive Gas Pressure Low	High	The drive gas pressure is low.	1. Check whether gas is supplied normally. The gas supply pressure on the O2 pipeline should be within the range of 280- 600kPa (40-87PSI), and the cylinder pressure should be within the range of 6.9-20.0MPa (1000-2900PSI). Check the pressures displayed on the pressure gauge and status screen. 2. Diagnose the safety valve by referring to 4.6.4. If the diagnosis fails, replace the inspiratory valve assembly (refer to 8.1.17). 3. If the safety valve diagnosis succeeds, replace the inspiratory valve assembly (refer to 8.1.17).
O2 Supply Failure/O2 Supply Pressure: Failed	High	O2 Supply Failure	1. Check whether gas is supplied normally. The gas supply pressure on the O2 pipeline should be within the

Message	Priority	Cause	Solution
			<p>range of 280- 600kPa (40-87PSI), and the cylinder pressure should be within the range of 6.9-20.0MPa (1000-2900PSI). Check the pressures displayed on the pressure gauge and status screen.</p> <p>2. If the pressure gauge and electronic pressure monitoring result indicate that the gas supply is sufficient, replace the supply pressure switch (refer to 8.2.1).</p>
Power Supply Voltage Error/Power Board Voltage: Failed	High	The 3.3V, 5V, or 12V voltage is in error.	<p>1. Choose Setup &gt; Service &gt; Data Monitors &gt; Power System and check whether the voltages in the A/D channel fall within the range specified in the A/D channel table. For A8, it is normal if 24 VA is 0. For A9, it is normal if 18 VA is 0.</p> <p>2. Open the service door (refer to 9.1.1), disconnect the internal battery cable at the lower left part on the rear of the cart. Restart the machine 5 minutes after the power board is powered off. Repeat step 1.</p> <p>3. If the problem persists, replace the DC-DC power board (refer to 8.1.11).</p>
The AC power supply is not connected.	Low	The AC power supply is not connected.	<p>1. Check whether the AC mains (including the machine and wall) is connected and the AC indicator is on. Re-connect the cable.</p> <p>2. If the AC mains is properly connected, but the AC indicator is off, check whether the AC inlet fuse is blown. If yes, replace the AC inlet fuse.</p> <p>3. If the fuse is normal, choose Setup &gt; Service &gt; Data Monitors &gt; Power System and check whether the AC-DC output voltage is normal (A8--18VA: 17.4-18.6, A9---ACDC: 21.4-25). If the AC-DC output voltage is abnormal, replace the AC-DC power board (refer to 8.1.11).</p> <p>4. If the problem persists, replace the DC-DC power board (refer to 8.1.11).</p>
Please Reset RT Clock	High	The system does not have the button cell, or the button cell is exhausted.	<p>1. Replace the button cell on the CPU board with a new one (refer to 8.1.1).</p> <p>2. If the problem persists, replace the CPU board (refer to 8.1.1).</p>
RT Clock Failure/RT Clock: Failed	High	The RT clock chip is faulty.	<p>1. Restart the anesthesia machine.</p> <p>2. If the problem persists, replace the CPU board (refer to 8.1.1).</p>
Keyboard Selftest Error	High	Keyboard Selftest Error	1. Power on the machine again for a self-test.
Keyboard Selftest: Timeout	High	The keyboard self-test result cannot be	2. Open the rear housing of the screen (refer to 9.1.7), and check the cable

Message	Priority	Cause	Solution
		obtained due to the communication error.	connection between the keyboard and CPU board. 3. If the problem persists, replace the keyboard (refer to 8.1.1).
External AG Self Test Error	Low	An error occurs during the selftest of the external AG module.	1. Re-plug the external AG module, and power on the machine again for a self-test. 2. Exit the standby state, check the alarm error code of the AG module, and clear the alarm based on the error code (refer to 4.3.10).
Internal AG Error	Low	An error occurs during the selftest of the internal AG module.	1. Power on the machine again for a self-test. 2. Exit the standby state, check the alarm error code of the AG module, and clear the alarm based on the error code (refer to 4.3.11).
External AG module: Timeout	Low	The self-test result of the external AG module cannot be obtained due to the communication error.	1. Power on the machine again for a self-test. 2. Clear the alarm by referring to 4.3.10 "AG Comm Stop".
Internal AG module: Timeout	Low	The self-test result of the internal AG module cannot be obtained due to the communication error.	1. Power on the machine again for a self-test. 2. Clear the alarm by referring to 4.3.11 "Internal AG Error 05".
BIS Self Test Error BIS Self Test Error: Timeout	Low	An error occurs during the selftest of the BIS module.	1. Re-plug the BIS module, or replace the slot. 2. If the problem persists, replace the BIS module. 3. If the problem persists, replace the module rack (refer to 8.1.14).
CO2 module selftest error CO2 module selftest error: Timeout	Low	An error occurs during the selftest of the CO2 module.	1. Re-plug the CO2 module, or replace the slot. 2. If the problem persists, replace the CO2 module. 3. If the problem persists, replace the module rack (refer to 8.1.14).
NMT Self Test Error NMT Self Test Error: Timeout	Low	An error occurs during the selftest of the NMT module.	1. Re-plug the NMT module, power on the machine again for a self-test, and replace the slot. 2. If the problem persists, replace the NMT module. 3. If the problem persists, replace the module rack (refer to 8.1.14).

### 4.3.2 CPU Board Runtime Alarms

Message	Priority	Cause	Solution
IP Address Conflict	Med	The IP address is the same as that of another machine on the local network.	<ol style="list-style-type: none"> <li>1. Set the IP address again (refer to 10.1).</li> <li>2. If the problem persists, upgrade the software (refer to Chapter 10).</li> <li>3. If the problem persists, replace the CPU board (refer to 8.1.1).</li> </ol>
Manual Only	Low	The power-on self-test failed, and the result is "Manual Only".	<ol style="list-style-type: none"> <li>1. Restart the anesthesia machine.</li> <li>2. If the problem persists, refer to 4.3.1.</li> </ol>
Manual Only-Leak Test Failed	Low	The auto/manual circuit leak test failed, and the result is "Manual Only".	<ol style="list-style-type: none"> <li>1. Perform the leak test again.</li> <li>2. If the problem persists, refer to 4.2.3.</li> </ol>
Auto Ventilation is Non-Functional	High	The system is in the auto ventilation non-functional state.	<ol style="list-style-type: none"> <li>1. Restart the anesthesia machine.</li> <li>2. If the problem persists, refer to 4.4.3.</li> </ol>
Status Screen Comm Stop	High	The CPU board lost communication with the status screen for 10s.	<ol style="list-style-type: none"> <li>1. Restart the anesthesia machine.</li> <li>2. If the problem persists, remove the auxiliary electrical outlet and service door (refer to 9.1.1), reconnect the cable between the panel of the instrument and the backplane (backplane socket position: J6 socket on the left).</li> <li>3. If the problem persists, replace the status screen control board (refer to 8.1.5).</li> </ol>
Aux O2/AIR Comm Stop	High	The CPU board lost communication with the auxiliary O2/air module for 10s.	<ol style="list-style-type: none"> <li>1. Restart the auxiliary O2/air module.</li> <li>2. If the problem persists, remove the auxiliary electrical outlet (refer to 9.1.2) and service door (refer to 9.1.1), reconnect the cable between the auxiliary O2/air module and the backplane (backplane socket position: "O2Air" socket on the right).</li> <li>3. If the problem persists, replace the auxiliary O2/air module (refer to 8.1.4).</li> </ol>
HFNC Module Comm Stop	High	The CPU board lost communication with the HFNC module for 10s.	<ol style="list-style-type: none"> <li>1. Restart the HFNC module.</li> <li>2. If the problem persists, remove the auxiliary electrical outlet (refer to 9.1.2) and service door (refer to 9.1.1), reconnect the cable between the HFNC module and the backplane (backplane socket position: "O2Air" socket on the right).</li> <li>3. If the problem persists, replace the HFNC module (refer to 8.1.4).</li> </ol>

### 4.3.3 Power Board Runtime Alarms

Message	Priority	Cause	Solution
Power System Comm Stop	High	The CPU board fails to communicate with the power board for 10s.	<ol style="list-style-type: none"> <li>1. Restart the anesthesia machine.</li> <li>2. Open the display cable cover (refer to 9.1.7), reconnect the display cable, open the service door (refer to 9.1.1), and reconnect the cable between the backplane</li> </ol>

Message	Priority	Cause	Solution
			<p>and display (J5 socket at the lower left part of the backplane).</p> <p>3. If the problem persists, open the service door (refer to 9.1.1), disconnect the internal battery cable at the lower left part on the rear of the cart. Restart the machine 5 minutes after the power board is powered off.</p> <p>4. Choose <b>Setup &gt; Service &gt; Data Monitors &gt; Power System</b> and check whether valid data is available for the A/D channel. (If data is invalid, "---" is displayed.) If yes, a software error has occurred. In this case, upgrade the software (refer to Chapter 10).</p> <p>5. If the problem persists, replace the DC-DC power board (refer to 8.1.11).</p> <p>6. If the problem persists, replace the cable between the backplane and display.</p> <p>7. If the problem persists, replace the CPU board (refer to 8.1.11).</p>
Power Supply Voltage Error	High	3.3 V, 5 V, 12 V voltage error	<p>1. Choose <b>Setup &gt; Service &gt; Data Monitors &gt; Power System</b> and check whether the voltages in the A/D channel fall within the range specified in the A/D channel table. For A8, it is normal if 24 VA is 0. For A9, it is normal if 18 VA is 0. If the auxiliary O2/air module or HFNC module is not started, it is normal if 12 VB is 0.</p> <p>2. Open the service door (refer to 9.1.1), disconnect the internal battery cable at the lower left part on the rear of the cart. Restart the machine 5 minutes after the power board is powered off. Repeat step 1.</p> <p>3. If the problem persists, replace the DC-DC power board (refer to 8.1.11).</p>
Low Battery Voltage!	High	The battery voltage is less than 10.6 V for a consecutive of 5s.	<p>1. If the AC mains is connected, but the "Battery in Use" alarm is generated, clear this alarm.</p> <p>2. Choose <b>Setup &gt; Service &gt; Data Monitors &gt; Power System</b>. Check whether the battery voltage is within the normal range (10.50–14.63 V) and whether T1 and T2 of the battery temperature sensors are within the range of 0°C–65°C.</p> <p>3. If T1 and T2 exceed the normal range, replace the battery assembly (refer to 8.1.9).</p> <p>4. If the temperature sensors and battery voltage are normal, upgrade the software (refer to Chapter 10).</p> <p>5. Check whether the battery charging indicator beside the system switch is on. If</p>

Message	Priority	Cause	Solution
			<p>not, replace the DC-DC power board (refer to 8.1.11).</p> <p>6. If the battery charging indicator is on, charge the battery for more than 20 minutes and then repeat step 2 to check whether the battery voltage increases or returns to the normal range.</p> <p>7. If the battery voltage does not increase after charging, replace the battery assembly (refer to 8.1.9).</p>
System shutting down, battery depleted!	High	The battery voltage is less than 10.2 V.	<ol style="list-style-type: none"> <li>1. If the AC mains is connected, but the "Battery in Use" alarm is generated, clear this alarm.</li> <li>2. Choose <b>Setup &gt; Service &gt; Data Monitors &gt; Power System</b>. Check whether the battery voltage is less than 10.2 V and whether T1 and T2 of the battery temperature sensors are within the range of 0°C–65°C.</li> <li>3. If T1 and T2 exceed the normal range, replace the battery assembly (refer to 8.1.9).</li> <li>4. If the temperature sensors and battery voltage are normal, upgrade the software (refer to Chapter 10).</li> <li>5. Check whether the battery charging indicator beside the system switch is on. If not, replace the DC-DC power board (refer to 8.1.11).</li> <li>6. If the battery charging indicator is on, charge the battery for more than 20 minutes and then repeat step 2 to check whether the battery voltage increases or returns to a value above 10.2V.</li> <li>7. If the battery voltage does not increase after charging, replace the battery assembly (refer to 8.1.9).</li> </ol>
Battery Undetected	Med	No battery is detected.	<ol style="list-style-type: none"> <li>1. Choose <b>Setup &gt; Service &gt; Data Monitors &gt; Power System</b>. Check whether the battery status is <b>Detected</b> and whether the battery voltage is 0.</li> <li>2. If the battery status is <b>Detected</b> or the battery voltage is not 0, upgrade the software (refer to Chapter 10).</li> <li>3. If the battery status is not <b>Detected</b> and the battery voltage is 0, reconnect the battery cable.</li> <li>4. If the problem persists, replace the battery assembly (refer to 8.1.9).</li> <li>5. If the problem persists, replace the DC-DC power board (refer to 8.1.11).</li> </ol>
Battery in Use	Low	AC power fails.	<ol style="list-style-type: none"> <li>1. Check whether the AC mains (including the machine and wall) is connected and the AC indicator is on. Re-connect the cable.</li> <li>2. If the AC mains is properly connected,</li> </ol>

Message	Priority	Cause	Solution
			<p>but the AC indicator is off, check whether the AC inlet fuse is blown. If yes, replace the AC inlet fuse.</p> <p>3. If the fuse is normal, choose <b>Setup &gt; Service &gt; Data Monitors &gt; Power System</b> and check whether the AC-DC output voltage is normal (A8--18VA: 17.4-18.6, A9---ACDC: 21.4-25). If the AC-DC output voltage is abnormal, replace the AC-DC power board (refer to 8.1.11).</p> <p>4. If the problem persists, replace the DC-DC power board (refer to 8.1.11).</p>
Power Board High Temp	High	The power board temperature exceeds 95°C.	<p>1. Check whether the vent under the service door is blocked.</p> <p>2. Stop using the machine for a period of time and then restart it. If the problem persists after the machine runs for a period of time (at least 30 minutes), replace the DC-DC power board (refer to 8.1.11).</p>
Heating Module Failure	Low	<p>1. The temperature difference between two probes exceeds 15°C.</p> <p>2. The temperature of any heater strip exceeds 110°C for consecutive 5s.</p>	<p>1. Restart the machine.</p> <p>2. If the problem persists, choose <b>Setup &gt; Service &gt; Data Monitors &gt; Power System</b> and check whether the heating module temperature and voltage are within the normal ranges (based on the ranges of the A/D channel). If not, replace the DC-DC power board.</p> <p>3. During the check in step 2, if the heating module temperature is invalid, reconnect the cable of the heating module ("huilu" socket in the upper left corner of the backplane).</p> <p>4. If the problem persists, replace the heating module (refer to 8.5.3).</p> <p>5. If the problem persists, replace the DC-DC power board (refer to 8.1.11).</p> <p>6. If the problem persists, upgrade the software (refer to 8.1.9).</p>

#### 4.3.4 Electronic Flowmeter and BFCS Runtime Alarms

Message	Priority	Cause	Solution
Electronic Flow Control Error	Med	<p>1. A main or auxiliary CPU voltage error occurs.</p> <p>2. The 3-way valve in the air or N2O branch is faulty.</p> <p>3. The O2 or balance gas branch flow sensor or the total flow sensor is faulty.</p> <p>4. The O2 or balance gas branch flow is not achieved.</p> <p>5. The flow sensor is</p>	<p>1. Restart the machine.</p> <p>2. If the power supply voltage error alarm is generated, clear this alarm (refer to 4.3.3).</p> <p>3. If the problem persists, choose <b>Setup &gt; Service &gt; Data Monitors &gt; FCS</b> to access the flowmeter data monitoring screen. Check the voltage and sensor flow of the A/D channel.</p> <p>4. If the power supply voltage is out of the normal range, replace the EFCS control board (refer to 8.3.1).</p> <p>5. If the measured value of the flow sensor is "---" or beyond the normal</p>

Message	Priority	Cause	Solution
		subject to a single self-test error. 6. The two-way valve in the EFCS O2 branch is faulty.	range, replace the flow sensor (refer to 8.3.1). 6. If no fault is detected in steps 4 and 5, replace the EFCS assembly (refer to 8.1.14).
No Fresh Gas	Med	Fresh gas is turned off in manual or mechanical ventilation mode.	1. Turn on the fresh gas and set it to a proper value. 2. Check whether gas is supplied normally. 3. If the problem persists, upgrade the software (refer to Chapter 10).
O2 Branch Flow Not Achieved	Low	The O2 flow exceeds the target flow by 10% or 0.2 L/min, whichever is larger.	1. Check whether O2 is supplied normally. The gas supply pressure on the O2 pipeline should be within the range of 280- 600kPa (40-87PSI), and the cylinder pressure should be within the range of 6.9-20.0MPa (1000-2900PSI). 2. Check whether the sensor or valve is faulty by referring to 4.6.5.1. 3. If the sensor is faulty, replace the flow sensor (refer to 8.3.1). 4. If the valve is faulty, replace the electronic flowmeter (refer to 8.1.14).
Balance Gas Branch Flow Not Achieved	Low	The balance gas flow exceeds the target flow by 20% or 0.4 L/min, whichever is larger.	1. Check whether the balance gas is supplied normally. The gas supply pressure on the AIR pipeline should be within the range of 280- 600kPa (40-87PSI), and the cylinder pressure should be within the range of 6.9-20.0MPa (1000-2900PSI). The gas supply pressure on the AIR pipeline should be within the range of 280- 600kPa (40-87PSI), and the cylinder pressure should be within the range of 4.2-6.0MPa(600-870PSI). 2. Check whether the sensor or valve is faulty by referring to 4.6.5.1. 3. If the sensor is faulty, replace the flow sensor (refer to 8.3.1). 4. If the valve is faulty, replace the electronic flowmeter (refer to 8.1.14).
Flowmeter Comm Stop	Med	The CPU board fails to communicate with the electronic flowmeter board for 10s, or the EFCS CPU fails to communicate with the EFCS-PM or VCM for 10s.	1. Restart the machine. 2. If the status screen has a communication stop alarm, or encounters the black or blank screen error, rectify the fault of the status screen first (refer to 4.2.1). 3. If the problem persists, open the service door (refer to 9.1.1), and reconnect the cable between the backplane and the flowmeter assembly. (For the cable position, refer to 9.13.) 4. If the problem persists, replace the electronic flowmeter board (refer to

Message	Priority	Cause	Solution
			9.12).
Total Flow Sensor Self Test Time Out Total Flow Sensor Self Test Time Out	Med	The EFCS CPU and EFCS-PM fail to communicate with the EFCS for 10s. Communication is lost with the CPU board for 10s. Flowmeter Comm Stop shall be detected by both the main board CPU and flowmeter CPU.	<ol style="list-style-type: none"> <li>1. Restart the machine.</li> <li>2. If the problem persists, reconnect the cable of the flow sensor (refer to 9.14).</li> <li>3. If the problem persists, replace the flow sensor (refer to 8.3.1).</li> </ol>
Backup Flow Control Enabled	Low	If the machine functions properly, the backup flow control system is enabled manually. If the electronic flowmeter malfunctions, the backup flow control system is enabled automatically.	<ol style="list-style-type: none"> <li>1. If the electronic flowmeter error or communication alarm exists, clear the alarm according to instructions in this table.</li> <li>2. If the electronic flowmeter error or communication alarm does not exist, turn off the BFCS needle valve, and close the BFCS door or switch to the EFCS on the main screen.</li> <li>2. If the attempt to switch to the EFCS fails, restart the machine.</li> <li>3. If the problem persists, replace the EFCS assembly (refer to 8.1.14).</li> </ol>
Backup Flow Control Error	Med	<ol style="list-style-type: none"> <li>1. The BFCS NO two-way valve is faulty.</li> <li>2. The monitored status of the two microswitches that identify the position status of the mechanical door is inconsistent.</li> <li>3. When the gas supply pressure is normal, the readings of the O2 branch flow sensor and total flow sensor are less than 0.5 L/min for 2s under the BFCS state.</li> <li>4. The electromagnet voltage is beyond the normal range, or its control status is inconsistent with the monitored status.</li> </ol>	<ol style="list-style-type: none"> <li>1. Troubleshoot the BFCS failure by referring to 4.6.5.2.</li> <li>2. If the BFCS valve is faulty, replace the electronic flowmeter (refer to 8.1.14).</li> <li>3. If the BFCS switch is faulty, replace the BFCS switch control board PCBA (refer to 8.1.5).</li> <li>4. If the BFCS electromagnet is faulty, replace the BFCS electromagnet (refer to 8.1.5).</li> <li>5. If the problem persists after performing steps 3 and 4, replace the EFCS control board (refer to 8.3.1).</li> </ol>
Air Supply Failure	Med	The air supply pressure is low, or the pressure sensor is faulty.	<ol style="list-style-type: none"> <li>1. Check the connection of the air supply and ensure that the gas supply is normal. The gas supply pressure on the AIR pipeline should be within the range of 280- 600kPa (40-87PSI), and the cylinder pressure should be within the range of 6.9-20.0MPa (1000-2900PSI). Check the pressures displayed on the pressure gauge and</li> </ol>

Message	Priority	Cause	Solution
			<p>status screen.</p> <p>2. If the gas supply on the pipeline is sufficient, but "Air Supply Failure" is still reported, replace the air supply inlet assembly (refer to 8.1.8).</p> <p>3. If the cylinder pressure gauge indicates that the cylinder pressure is sufficient, but the status screen indicates that the pressure is lower than the normal range, replace the air cylinder yoke (refer to 8.1.2).</p>
N2O Supply Failure	Med	N2O supply pressure is low.	<p>1. Check the connection of the N2O supply and ensure that the gas supply is normal. The gas supply pressure on the AIR pipeline should be within the range of 280- 600kPa (40-87PSI), and the cylinder pressure should be within the range of 4.2-6.0MPa(600-870PSI). Check the pressures displayed on the pressure gauge and status screen.</p> <p>2. If the gas supply on the pipeline is sufficient, but "N2O Supply Failure" is still reported, replace the N2O supply inlet assembly (refer to 8.1.8).</p> <p>3. If the cylinder pressure gauge indicates that the cylinder pressure is sufficient, but the status screen indicates that the pressure is lower than the normal range, replace the N2O cylinder yoke (refer to 8.1.2).</p>

#### 4.3.4.1 EFCS Error Codes

Failure Code	Cause	FRU	Solution
0x00000001	Control module watchdog selftest error	EFCS control board	Restart the machine. If the problem persists, replace the EFCS control board (refer to 8.3.1).
0x00000002	Control module EEPROM selftest error	EFCS control board	Restart the machine. If the problem persists, replace the EFCS control board (refer to 8.3.1).
0x00000004	Protection module selftest error	EFCS control board	Restart the machine. If the problem persists, replace the EFCS control board (refer to 8.3.1).
0x00000008	O2 proportional valve selftest error	EFCS assembly	Restart the machine. If the problem persists, replace the EFCS assembly (refer to 8.1.4).
0x00000010	Balance gas proportional valve error	EFCS assembly	Restart the machine. If the problem persists, replace the EFCS assembly (refer to 8.1.4).
0x00000020	O2 limb leakage	EFCS assembly	Restart the machine. If the problem persists, replace the EFCS assembly (refer to 8.1.4).
0x00000040	Balance gas limb leakage	EFCS assembly	Restart the machine. If the problem persists, replace the EFCS assembly (refer to 8.1.4).

Failure Code	Cause	FRU	Solution
0x00000080	Zero point reading error upon power-on	EFCS assembly	Restart the machine. If the problem persists, replace the EFCS control board (refer to 8.3.1).
0x00000200	Air three-way valve error	EFCS assembly	Restart the machine. If the problem persists, replace the EFCS assembly (refer to 8.1.4).
0x00000400	N2O three-way valve error	EFCS assembly	Restart the machine. If the problem persists, replace the EFCS assembly (refer to 8.1.4).
0x00000800	O2 two-way valve error	EFCS assembly	Restart the machine. If the problem persists, replace the EFCS assembly (refer to 8.1.4).

#### 4.3.4.2 BFCS Error Codes

Failure Code	Cause	FRU	Solution
0x00000001	NO two-way valve error	EFCS assembly	Restart the machine. If the problem persists, replace the EFCS assembly (refer to 8.1.4).
0x00000002	Mechanical door status error	BFCS door BFCS switch control board	1. Open the BFCS door, check whether the magnet inside the BFCS door falls off. If yes, replace the BFCS door (refer to 8.1.5). 2. If the magnet inside the BFCS door does not fall off, replace the BFCS switch control board (refer to 8.1.5).
0x00000004	Electromagnet 1 power-on failure	Power board Electromagnet 1 EFCS control board	1. If a power supply alarm exists, clear the alarm (refer to 4.3.3). 2. Perform steps 1, 3, 6, 7, and 8 in section 4.6.5.2 to identify the faulty electromagnet, and then replace the faulty electromagnet (refer to 8.1.5). 3. If the problem persists, replace the EFCS control board (refer to 8.3.1).
0x00000008	Electromagnet 1 power-off failure	Electromagnet EFCS control board	1. Perform steps 1, 3, 6, 7, and 8 in section 4.6.5.2 to identify the faulty electromagnet, and then replace the faulty electromagnet (refer to 8.1.5). 2. If the problem persists, replace the EFCS control board (refer to 8.3.1).
0x00000010	Electromagnet 2 power-on failure	Power board Electromagnet 2 EFCS control board	1. If a power supply alarm exists, clear the alarm (refer to 4.3.3). 2. Perform steps 1, 3, 6, 7, and 8 in section 4.6.5.2 to identify the faulty electromagnet, and then replace the faulty electromagnet (refer to 8.1.5). 3. If the problem persists, replace the EFCS control board (refer to 8.3.1).
0x00000020	Electromagnet 2 power-off failure	Electromagnet 2 EFCS control board	1. Perform steps 1, 3, 6, 7, and 8 in section 4.6.5.2 to identify the faulty electromagnet, and then replace the faulty electromagnet (refer to 8.1.5). 2. If the problem persists, replace the EFCS control board (refer to 8.3.1).

### 4.3.5 VCM Runtime Alarms

Message	Priority	Cause	Solution
Aux Control Module Comm Stop	High	The CPU board fails to communicate with the auxiliary VCM for 10s.	<ol style="list-style-type: none"> <li>1. Restart the anesthesia machine.</li> <li>2. If the status screen has a communication stop alarm, or encounters the black or blank screen error, rectify the fault of the status screen first (refer to 4.2.1).</li> <li>3. If the problem persists, re-plug the VCM (refer to 9.7), and reconnect the cable between the backplane and display (refer to 9.1.7).</li> <li>4. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
Ventilator Voltage Error	High	The VCM voltage is beyond the normal range.	<ol style="list-style-type: none"> <li>1. Restart the anesthesia machine.</li> <li>2. If the power board has a voltage error alarm, clear this alarm (refer to 4.3.3).</li> <li>3. Choose Setup &gt; Service &gt; Data Monitors &gt; VCM and check whether the voltages in the A/D channel fall within the range specified in the A/D channel table. If yes, the alarm will disappear in 3-5s.</li> <li>4. If the power supply voltage is out of the normal range, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
PEEP Valve Failure	Med	<ol style="list-style-type: none"> <li>1. A PEEP valve voltage error occurs.</li> <li>2. A PEEP valve pressure error occurs.</li> </ol>	<ol style="list-style-type: none"> <li>1. Restart the anesthesia machine.</li> <li>2. If the power board has a voltage error alarm, clear this alarm (refer to 4.3.3).</li> <li>3. Choose Setup &gt; Service &gt; Data Monitors &gt; PEEP Valve to run a PEEP valve test. If the test fails, replace the inspiratory valve assembly (refer to 8.1.17).</li> <li>4. If the PEEP valve test is passed, check whether the PEEP valve or PEEP pressure sensor is faulty by referring to 4.6.2.</li> <li>5. If the pressure sensor is faulty, perform the pressure sensor calibration (refer to 10.3.6).</li> <li>6. If the calibration fails, replace the sensor adapter board (refer to 8.1.16).</li> <li>7. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
Insp Valve Failure	Med	<ol style="list-style-type: none"> <li>1. An inspiratory valve voltage error occurs.</li> <li>2. An inspiratory valve flow error occurs.</li> </ol>	<ol style="list-style-type: none"> <li>1. Restart the anesthesia machine.</li> <li>2. If the power board has a voltage error alarm, clear this alarm (refer to 4.3.3).</li> <li>3. Choose Setup &gt; Service &gt; Data Monitors &gt; Insp Valve to run an Insp valve test. If the test fails, replace the</li> </ol>

Message	Priority	Cause	Solution
			<p>inspiratory valve assembly (refer to 8.1.17).</p> <p>4. If the test is passed, perform the flow calibration (refer to 10.3.1).</p> <p>5. If the flow calibration fails, diagnose the flow sensor by referring to 4.6.1.2. If the sensor is not faulty, replace the inspiratory valve assembly (refer to 8.1.17).</p> <p>6. If the inspiratory valve current is 0 after the inspiratory valve flow is set in step 5, replace the monitoring and controlling assembly (refer to 8.1.11).</p>
PEEP Safety Valve Failure	Med	<p>1. A PEEP safety valve voltage error occurs.</p> <p>2. A PEEP safety valve status detection error occurs.</p> <p>3. The PEEP safety valve cannot be turned on during the automatic circuit leak test.</p>	<p>1. Restart the anesthesia machine.</p> <p>2. If the power board has a voltage error alarm, clear this alarm (refer to 4.3.3).</p> <p>3. Choose Setup &gt; Service &gt; Data Monitors &gt; PEEP Safety Valve to run a PEEP safety valve test. If the test fails, replace the inspiratory valve assembly (refer to 8.1.17).</p> <p>4. If the test is passed, restart the machine.</p>
Flow Sensor Failure	Low	<p>1. The ventilator flow sensor is out of range.</p> <p>2. The zero points of the inspiratory and expiratory flow sensors on the patient side are abnormal.</p>	<p>1. Zero the flowmeter (refer to 10.3.8).</p> <p>2. Diagnose the flow sensor by referring to 4.6.1.2.</p> <p>3. If the measured value of the flow sensor in step 2 is valid but the error is large, perform the flow calibration (refer to 10.3.1).</p> <p>4. If the measured value of the flow sensor in step 2 is invalid or calibration fails, replace the sensor adapter board (refer to 8.1.16).</p> <p>5. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</p>
Check Flow Sensors	High	<p>1. Inspiratory reverse flow is detected.</p> <p>2. Expiratory reverse flow is detected.</p>	<p>1. Check whether the check valve is stuck, and re-install the circuit valve cover (refer to 8.5.2).</p> <p>2. Diagnose the flow sensor by referring to 4.6.1.2.</p> <p>3. If the sensor displays a negative value in step 2, remove the auxiliary output assembly (refer to 9.1.2), remove the VE box (refer to 9.31), and check whether the silicone tube falls off from the three-way valve assembly and circuit adapter board.</p> <p>4. If no sampling line falls off, replace the sensor adapter board (refer to 8.1.16).</p>
Pinsp Not Achieved	Low	Pinsp does not reach the preset value in pressure mode.	Refer to 4.4.5.

Message	Priority	Cause	Solution
Vt Not Achieved	Low	The tidal volume does not reach the preset value in volume mode.	Refer to 4.4.4.
CO2 Absorber Canister Not Locked	High	The CO2 absorber canister is not mounted.	<ol style="list-style-type: none"> <li>1. Re-mount the CO2 absorber canister.</li> <li>2. If the problem persists, replace the switch on the CO2 absorber canister (refer to 8.5.1).</li> <li>4. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
O2 Sensor Disconnected	Low	The O2 sensor is disconnected.	<ol style="list-style-type: none"> <li>1. Check whether the machine uses the O2 cell.</li> <li>2. Make sure that the cable is correctly connected for the O2 sensor.</li> <li>3. If the problem persists, replace the O2 sensor (refer to 8.5.1).</li> <li>4. If the problem persists, replace the O2 sensor cable (refer to 8.1.12).</li> </ol>
Replace O2 Sensor	Med	The output voltage of the O2 sensor is continuously less than the alarm threshold when the O2 cell is installed.	<ol style="list-style-type: none"> <li>1. Check the output voltage of the O2 sensor in the calibration menu.</li> <li>2. Calibrate the O2 sensor again (refer to 10.3.2).</li> <li>3. If the problem persists, replace the O2 sensor (refer to 8.5.1).</li> <li>4. Calibrate the O2 sensor again after the sensor is replaced (refer to 10.3.2).</li> </ol>
Calibrate O2 Sensor	Low	<ol style="list-style-type: none"> <li>1. The O2 sensor self-test fails.</li> <li>2. The O2 concentration exceeds 110% or ranges from 5% to 15% for 4s.</li> </ol>	<ol style="list-style-type: none"> <li>1. Calibrate the O2 sensor again (refer to 10.3.2).</li> <li>2. If the problem persists, replace the O2 sensor (refer to 8.5.1).</li> <li>3. Calibrate the O2 sensor again after the sensor is replaced (refer to 10.3.2).</li> </ol>
Ventilator Comm Stop	High	The CPU board fails to communicate with the VCM for 10s.	<ol style="list-style-type: none"> <li>1. Restart the anesthesia machine.</li> <li>2. If the status screen has a communication stop alarm, or encounters the black or blank screen error, rectify the fault of the status screen first (refer to 4.2.1).</li> <li>3. If the problem persists, re-plug the VCM (refer to 9.7), and reconnect the cable between the backplane and display (refer to 9.1.7).</li> <li>4. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
O2 Supply Failure	High	The O2 supply pressure is low.	<ol style="list-style-type: none"> <li>1. Check whether gas is supplied normally. The gas supply pressure on the O2 pipeline should be within the range of 280- 600kPa (40-87PSI), and the cylinder pressure should be within the range of 6.9-20.0MPa (1000-2900PSI). Check the pressures displayed on the pressure gauge and status screen.</li> <li>2. If the pressure gauge and electronic pressure monitoring result indicate that</li> </ol>

Message	Priority	Cause	Solution
			the gas supply is sufficient, replace the supply pressure switch (refer to 8.2.1).
Drive Gas Pressure Low	High	The drive gas pressure is low.	<ol style="list-style-type: none"> <li>1. Check whether gas is supplied normally. The gas supply pressure on the O<sub>2</sub> pipeline should be within the range of 280- 600kPa (40-87PSI), and the cylinder pressure should be within the range of 6.9-20.0MPa (1000-2900PSI). Check the pressures displayed on the pressure gauge and status screen.</li> <li>2. If the gas supply connection is normal, replace the inspiratory valve assembly (refer to 8.1.17).</li> </ol>
ACGO 3-way Valve Failure	Med	The selection switch status of the ACGO channel is inconsistent with the 3-way valve control status.	<ol style="list-style-type: none"> <li>1. Replace the 3-way valve (refer to 8.1.16).</li> <li>2. If the problem persists, replace the VCM (refer to 8.1.11).</li> </ol>
Auto Ventilation Disabled	Low	The machine fails the power-on self-test, and only manual ventilation is applicable.	Clear the power-on self-test alarm by referring to 4.3.1.
Auto Ventilation Disabled - Leak Test Failed	Low	The automatic circuit leak test fails.	Handle the leak test failure by referring to 4.2.3.
Aux Control Module Voltage Error	Low	3.3 V and 5 V supply voltages of the protective module are abnormal.	<ol style="list-style-type: none"> <li>1. Restart the anesthesia machine.</li> <li>2. If the power board has a voltage error alarm, clear this alarm (refer to 4.3.3).</li> <li>3. Choose Setup &gt; Service &gt; Data Monitors &gt; VPM and check whether the voltages in the A/D channel fall within the range specified in the A/D channel table.</li> <li>4. If the power supply voltage is out of the normal range, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
Pressure Monitoring Channel Failure	Med	<ol style="list-style-type: none"> <li>1. The measured value of the Paw sensor or PEEP sensor is out of range.</li> <li>2. The zero point of the Paw sensor or PEEP sensor zero is abnormal.</li> </ol>	<ol style="list-style-type: none"> <li>1. Disconnect the gas supply, disconnect the patient airway connection, and exit the standby mode. Choose Setup &gt; Service &gt; Data Monitors &gt; Zero Sensors, and check whether the current zero points of the PEEP sensor, Paw sensor, and Pes sensor exceed the stored zero points.</li> <li>2. If the zero point error is large, perform manual zeroing (refer to 10.3.8).</li> <li>3. If manual zeroing fails, remove the auxiliary output assembly (refer to 9.1.2), remove the VE box (refer to 9.31), and check whether the silicone sampling line is folded, blocked, or pressed.</li> </ol>

Message	Priority	Cause	Solution
			<ol style="list-style-type: none"> <li>If the problem persists, restart the machine.</li> <li>If the problem persists, replace the sensor adapter board (refer to 8.1.16).</li> </ol>
Disconnected?	High	<ol style="list-style-type: none"> <li>Check whether the Y-piece is disconnected during ventilation.</li> <li>Check whether the patient circuit is damaged.</li> </ol>	<ol style="list-style-type: none"> <li>Reconnect the patient circuit.</li> <li>Conduct a leak test. If no leakage is detected, the problem is solved.</li> <li>If the leak test fails, handle the leakage problem by referring to 4.2.3 and 4.2.4.</li> </ol>
Patient Circuit Leak		Patient circuit leakage is detected.	Handle the leakage problem by referring to 4.2.3 and 4.2.4.
Calibrate Flow Sensor and Insp Valve	Low	No flow calibration table is found on the VCM.	<ol style="list-style-type: none"> <li>Perform the flow calibration again (refer to 10.3.1).</li> <li>If the problem persists after the calibration, upgrade the software (refer to Chapter 10).</li> <li>If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
Calibrate Pressure Sensor and PEEP Valve	Low	No pressure calibration table is found on the VCM.	<ol style="list-style-type: none"> <li>Perform the pressure calibration again (refer to 10.3.6).</li> <li>If the problem persists after the calibration, upgrade the software (refer to Chapter 10).</li> <li>If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
3-way Valve Failure	High	The zeroing 3-way valve cannot be turned on or off.	<ol style="list-style-type: none"> <li>Perform zeroing again.</li> <li>Open the auxiliary output assembly (refer to 9.1.2), and check whether the connection cable of the 3-way valve is intact.</li> <li>If the problem persists, replace the 3-way valve (refer to 8.1.16).</li> <li>If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
Fresh Gas Flow Too High	Low	In volume control ventilation mode, the fresh gas flow setting exceeds the inspiratory gas supply flow.	<ol style="list-style-type: none"> <li>Decrease the fresh gas flow setting as required.</li> </ol>
Breathing System Not Mounted	High	The breathing circuit is not correctly mounted.	<ol style="list-style-type: none"> <li>Check whether the circuit is installed in place. If necessary, re-install the circuit.</li> <li>After confirming that the circuit is installed in place., choose Setup &gt; Service &gt; Data Monitors &gt; Status Monitor, and check whether the circuit switch is set to On. If yes, the alarm will disappear in 3-5s.</li> <li>If the circuit switch is set to Off in step 2, replace the circuit switch (refer to 8.5.1).</li> </ol>
Volume Reflector	High	The volume reflector is	<ol style="list-style-type: none"> <li>Check whether the volume reflector</li> </ol>

Message	Priority	Cause	Solution
Not Mounted		not correctly mounted.	is installed in place. If necessary, re-install the volume reflector. 2. Disassemble the circuit, open the VE door, push the VE net inward, and check whether the alarm is cleared. If the alarm is not cleared, replace the VE switch (refer to 8.1.15).
AMV: Cannot Meet Target	Low	In AMV mode, the target tidal volume and respiratory rate to minimize the work of breathing cannot be achieved.	1. Check whether IBW is properly set. 2. Check whether the Vt high alarm limit is properly set. 3. Check whether MV% is properly set. 4. If the alarm still exists, the current control target to minimize the patient's work of breathing is beyond the safe range. It is recommended that you switch to another ventilation mode.
Vaporizer Dock Failure	High	1. The fresh air inlet valve of the vaporizer malfunctions. 2. The bypass valve malfunctions.	1. Choose Setup > Service > Data Monitors > Flow Test. On the Diagnostics screen, set the vaporizer BYPASS pilot valve to On, and check whether the status on the left also changes to On. If the status changes to On, replace the vaporizer base valve assembly (refer to 8.1.12). 2. Set the fresh gas pilot valves of vaporizer 1 and vaporizer 2 to On, and check whether the status on the left also changes to On. If the status changes to On, replace the vaporizer base valve assembly (refer to 8.1.12). 3. If the status does not change to On in the preceding step, replace the monitoring and controlling assembly (refer to 8.1.11). If the problem persists, replace the vaporizer base valve assembly (refer to 8.1.12).
Auto/Manual Switch Failure	High	The auto/manual switch malfunctions.	Handle the problem as the switchover failure by referring to 4.4.2 after the auto/manual switch is used.
Vaporizer Lock Device Failure	High	The status of the drive gas pilot valve of the vaporizer is inconsistent with that of the actual position switch.	1. Ensure that the O2 supply is sufficient. 2. Reinstall the electronic vaporizer. 3. If the problem persists, remove the electronic vaporizer. Choose Setup > Service > Data Monitors > Flow Test. On the Diagnostics screen, set the pneumatic locking valves of vaporizer 1 and vaporizer 2 to On. Check whether the pneumatic lock on the guide rail of the electronic vaporizer pops up. 4. If the pneumatic lock cannot pop up, disassemble the drive pipe of the lock, and perform step 3 to check whether any drive gas ejects. 5. If drive gas ejects in step 4, replace

Message	Priority	Cause	Solution
			the pneumatic lock assembly (refer to 8.4.1). 6. If no drive gas ejects in step 4, replace the vaporizer base valve assembly (refer to 8.1.12). If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).
O2 Supply Failure, AA Vaporizer Stopped	High	O2 supply pressure is low, resulting in malfunction of the vaporizer.	Handle the problem in the same way that the "O2 Supply Failure" alarm is handled.
Esophageal Pressure Sensor Failure	Med	The esophageal pressure sensor cannot be detected during use.	1. Check whether the auxiliary pressure accessory is properly installed and connected. 2. Disassemble the auxiliary output assembly (refer to 9.1.2), and check whether the silicone tube of the auxiliary pressure sensor is folded, pressed, or falls off. (The auxiliary pressure sensor is the first sensor on the left of the sensor adapter board.) 3. If the connection of the sampling line is OK, replace the sensor adapter board (refer to 8.1.16).
Calibrate Esophageal Pressure Sensor	Low	No esophageal pressure calibration table is found on the VCM of a machine configured with esophageal pressure.	1. Perform the pressure calibration again (refer to 10.3.6). 2. If the problem persists after the calibration, replace the monitoring and controlling assembly (refer to 8.1.11).

#### 4.3.6 Electronic Vaporizer Runtime Alarms

Message	Priority	Cause	Solution
AA Vaporizer Liquid Level Low	Low	The anesthetic agent liquid level is lower than 50 ml and higher than or equal to 20 ml.	1. Observe the remaining anesthetic agent through the glass tube. If the anesthetic agent is insufficient, fill the anesthetic agent. 2. If the anesthetic agent is sufficient, reinstall the electronic vaporizer. 3. If the problem persists, replace the electronic vaporizer. 4. After the electronic vaporizer is replaced and inserted, conduct the power-on selftest, leak test, and electronic vaporizer test (refer to 7.7).
AA Vaporizer Almost Empty	Med	The anesthetic agent liquid level is lower than 20 ml.	1. Observe the remaining anesthetic agent through the glass tube. If the anesthetic agent is insufficient, fill anesthetic agent. 2. If the anesthetic agent is sufficient, reinstall the electronic vaporizer.

Message	Priority	Cause	Solution
			<p>3. If the problem persists, replace the electronic vaporizer.</p> <p>4. After the electronic vaporizer is replaced and inserted, conduct the power-on selftest, leak test, and electronic vaporizer test (refer to 7.7).</p>
AA Vaporizer Lid is Open	<p>1. Standby state: Information</p> <p>2. Non-standby and non-active state: Information (first 2 min), Low (2 min later)</p> <p>3. Non-standby and active state: Information (first 2 min), Med (2 min later)</p>	The vaporizer lid is open.	<p>1. If the vaporizer lid is open, close it.</p> <p>2. Reinstall the electronic vaporizer.</p> <p>3. If the problem persists, replace the electronic vaporizer.</p> <p>4. After the electronic vaporizer is replaced and inserted, conduct the power-on selftest, leak test, and electronic vaporizer test (refer to 7.7).</p>
AA Vaporizer Failure	High	<p>(1) AA vaporizer boil-off space temperature too high</p> <p>(2) AA vaporizer boil-off space temperature sensor failure</p> <p>(3) AA vaporizer injection branch failure</p> <p>(4) AA vaporizer heating board failure</p> <p>(5) AA vaporizer drive gas branch failure</p> <p>(6) AA vaporizer voltage error</p>	Rectify the fault based on the alarm error code by referring to 4.3.6.2.
AA Vaporizer Selftest Error	High	An AA vaporizer self-test error occurs.	Rectify the fault based on the alarm error code by referring to 4.3.6.1.
AA Vaporizer Comm Stop	High	Communication with the CPU board stops.	<p>1. If the status screen has a communication stop alarm, or encounters the black or blank screen error, rectify the fault of the status screen first (refer to 4.2.1).</p> <p>2. Reinstall the electronic vaporizer.</p> <p>3. Replace the electronic vaporizer slot. If the problem is solved, restart the machine.</p> <p>If the problem persists, replace the electronic dock adapter board (refer to 8.4.1).</p>

Message	Priority	Cause	Solution
			<p>If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</p> <p>4. If the problem persists, replace the electronic vaporizer.</p> <p>5. After the electronic vaporizer is replaced and inserted, conduct the power-on selftest, leak test, and electronic vaporizer test (refer to 7.7).</p>
AA Vaporizer Output Concentration Measure Abnormal	High	The measured output anesthetic agent concentration of the vaporizer greatly deviates from the setting.	<p>1. Reinstall the electronic vaporizer.</p> <p>2. Choose <b>Setup &gt; Service &gt; Data Monitors &gt; Vaporizer</b>. On the vaporizer diagnostics screen, check the pressure of the vaporizer drive gas. If the drive gas pressure is beyond the range of 140-160kPa, replace the electronic vaporizer pressure regulator (refer to 8.1.4).</p> <p>3. If the drive gas pressure is normal, or the problem persists after the adjustment, connect the external AG module, and test the electronic vaporizer concentration according to section 7.8.3. Choose <b>Setup &gt; Service &gt; Data Monitors &gt; AG</b>, and check the measured values of the external and internal AG modules.</p> <p>4. If both the measured values of the external and internal AG modules in step 3 are lower than 0.8% or higher than 1.2%, replace the electronic vaporizer.</p> <p>5. If only the measured value of the internal AG module in step 3 is lower than 0.8% or higher than 1.2%, replace the internal AG module (refer to 8.1.7).</p>

#### 4.3.6.1 AA Vaporizer Selftest Error Codes

Failure Code	Cause	FRU	Solution
00000001	Watchdog selftest error	Electronic vaporizer	<p>1. Reinstall the electronic vaporizer.</p> <p>2. Restart the machine.</p> <p>3. If the problem persists, replace the electronic vaporizer.</p>
00000002	EEPROM selftest error	Electronic vaporizer	<p>1. Reinstall the electronic vaporizer.</p> <p>2. Restart the machine.</p> <p>3. If the problem persists, replace the electronic vaporizer.</p>
00000004	Valve voltage error	Electronic vaporizer	1. Reinstall the electronic vaporizer.
00000008	Injector voltage error		

Failure Code	Cause	FRU	Solution
			2. Restart the machine. 3. If the power board has a voltage error alarm, clear this alarm. 4. If the problem persists, replace the electronic vaporizer.
00000010	Failed to open the safety valve	Electronic vaporizer	1. Reinstall the electronic vaporizer, or replace the slot. 2. Restart the machine. 3. If the problem persists, replace the electronic vaporizer.
00000020	Failed to close the safety valve		
00000040	Failed to open the drive gas safety valve	Electronic vaporizer	1. Reinstall the electronic vaporizer, or replace the slot. 2. Restart the machine. 3. If the problem persists, replace the electronic vaporizer.
00000080	Failed to close the drive gas safety valve		

#### 4.3.6.2 AA Vaporizer Fault Error Codes

Failure Code	Cause	FRU	Solution
00000001	Boil-off space temperature too high	Electronic vaporizer	1. Reinstall the electronic vaporizer, or restart the machine. 2. If the problem persists, replace the electronic vaporizer.
00000002	Boil-off space temperature sensor failure	Electronic vaporizer	1. Reinstall the electronic vaporizer, or restart the machine. 2. If the problem persists, replace the electronic vaporizer.
00000004	Heating Module Failure	Electronic vaporizer	1. Reinstall the electronic vaporizer, or restart the machine. 2. If the problem persists, replace the electronic vaporizer.
00000008	Drive gas pressure error in working state	Electronic vaporizer base valve assembly Secondary pressure regulator Electronic vaporizer	1. Replace the slot. If the alarm disappears, replace the vaporizer base valve assembly (refer to 8.1.12). 2. If the problem persists, insert another vaporizer. If the fault alarm disappears, replace the electronic vaporizer. 3. If the problem persists, replace the pressure regulator of the electronic vaporizer (refer to 8.1.4).
00000010	Drive gas pressure error in standby state	Electronic vaporizer base valve assembly Electronic vaporizer	1. Replace the slot. If the alarm disappears, replace the vaporizer base valve assembly (refer to 8.1.12). 2. If the problem persists, insert another vaporizer. If the fault alarm disappears, replace the electronic vaporizer.
00000020	Failed to collect the drive gas pressure	Electronic vaporizer	Replace the electronic vaporizer.
00000040	Liquid level sensor inconsistent with the ultrasonic sensor	Electronic vaporizer	Replace the electronic vaporizer.
00000080	Valve supply voltage abnormal	Electronic vaporizer	Replace the electronic vaporizer.
00000100	Injector supply	Electronic	Replace the electronic vaporizer.

Failure Code	Cause	FRU	Solution
	voltage abnormal	vaporizer	
00000200	Analog 5V voltage abnormal	Electronic vaporizer	Replace the electronic vaporizer.
00000400	Analog -5V voltage abnormal	Electronic vaporizer	Replace the electronic vaporizer.
00000800	CPU voltage abnormal	Electronic vaporizer	Replace the electronic vaporizer.
00001000	Injector limb failure: The injection times detected by the injection detection device are less than the actual injection times.	Electronic vaporizer	Replace the electronic vaporizer.

### 4.3.7 AGSS Module Runtime Alarms

Message	Priority	Cause	Solution
Scavenging Flow is Too High	Low	The scavenging flow is too high.	<ol style="list-style-type: none"> <li>1. Adjust the AGSS knob.</li> <li>2. Check the hospitals' waste gas disposal system.</li> <li>3. If the problem persists, replace the AGSS (refer to 8.1.14).</li> </ol>
Scavenging Flow is Too Low	Information	The scavenging flow is too low.	<ol style="list-style-type: none"> <li>1. Check the AGSS is connected to the hospitals' waste gas disposal system.</li> <li>2. Check the hospitals' waste gas disposal system. Adjust the AGSS knob.</li> <li>3. If the problem persists, replace the AGSS (refer to 8.1.14).</li> </ol>
Electronic AGSS Failure AGSS Failures	Med	The electronic AGSS function fails.	<ol style="list-style-type: none"> <li>1. Restart the machine.</li> <li>2. If the problem persists, replace the AGSS (refer to 8.1.14).</li> <li>3. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>
Calibrate AGSS Module	Med	No calibration table is found on the AGSS module.	<ol style="list-style-type: none"> <li>1. Restart the machine.</li> <li>2. If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).</li> </ol>

### 4.3.8 Auxiliary O2/Air Module Runtime Alarms

Message	Priority	Cause	Solution
Aux O2/AIR Comm Stop	High	<p>The communication between the CPU board and auxiliary O2/air module stops.</p> <p>The CPU board lost communication with the auxiliary O2/air module for 10s.</p>	<ol style="list-style-type: none"> <li>1. Restart the auxiliary O2/air module.</li> <li>2. If the status screen has a communication stop alarm, or encounters the black or blank screen error, rectify the fault of the status screen first (refer to 4.2.1).</li> <li>3. If the problem persists, remove the auxiliary electrical outlet (refer to 9.1.2) and service door (refer to 9.1.1), reconnect the cable between the auxiliary O2/air module and the backplane (backplane socket position:</li> </ol>

Message	Priority	Cause	Solution
			"O2Air" socket on the right). 4. If the problem persists, replace the auxiliary O2/air module (refer to 8.1.4).
Aux O2/AIR Failure	Med	1. The flow sensor is faulty. 2. The branch switch valve is faulty.	1. Restart the auxiliary O2/air module. 2. Replace the auxiliary O2/air module (refer to 8.1.4).
Aux O2/AIR Selftest Error	Med	1. A module self-test error occurs. 2. A proportional valve self-test error occurs. 3. A power-on zeroing error or zero point reading error occurs.	1. Restart the auxiliary O2/air module and main unit. 2. If the problem persists, remove the auxiliary electrical outlet (refer to 9.1.2) and service door (refer to 9.1.1), reconnect the cable between the auxiliary O2/air module and the backplane (backplane socket position: "O2Air" socket on the right). 3. If the problem persists, replace the auxiliary O2/air module (refer to 8.1.4).
Calibrate Aux O2/AIR Module	Low	The calibration table of the proportional valve or sensor has no data or has an error.	1. Restart the auxiliary O2/air module. 2. If the problem persists, replace the auxiliary O2/air module (refer to 8.1.4).

### 4.3.9 HFNC Module Runtime Alarms

Message	Priority	Cause	Solution
HFNC Module Comm Stop	High	The communication between the CPU board and the HFNC module stops. The CPU board lost communication with the HFNC module for 10s.	1. Restart the HFNC module. 2. If the status screen has a communication stop alarm, or encounters the black or blank screen error, rectify the fault of the status screen first (refer to 4.2.1). 3. If the problem persists, remove the auxiliary electrical outlet (refer to 9.1.2) and service door (refer to 9.1.1), reconnect the cable between the auxiliary O2/air module and the backplane (backplane socket position: "O2Air" socket on the right). 4. If the problem persists, replace the HFNC module (refer to 8.1.4).
HFNC Module Failure	Med	1. The flow sensor is faulty. 2. The branch switch valve is faulty.	1. Restart the HFNC module. 2. If the problem persists, replace the HFNC module (refer to 8.1.4).
HFNC Selftest Error	Med	1. A module self-test error occurs. 2. A proportional valve self-test error occurs. 3. A power-on zeroing error or zero point reading error occurs.	1. Restart the HFNC module and main unit. 2. If the problem persists, remove the auxiliary electrical outlet (refer to 9.1.2) and service door (refer to 9.1.1), reconnect the cable between the auxiliary O2/air module and the backplane (backplane socket position: "O2Air" socket on the right). 3. If the problem persists, replace the HFNC module (refer to 8.1.4).

Message	Priority	Cause	Solution
Calibrate HFNC Module	Low	The calibration table of the proportional valve or sensor has no data or has an error.	<ol style="list-style-type: none"> <li>1. Restart the HFNC module.</li> <li>2. If the problem persists, replace the HFNC module (refer to 8.1.4).</li> </ol>

### 4.3.10 External AG Module Runtime Alarms

Message	Priority	Cause	Solution
AG Hardware Error	Med	The AG hardware malfunctions.	<ol style="list-style-type: none"> <li>1. Re-plug the AG module, or replace the slot.</li> <li>2. If the problem persists or the alarm occurs repeatedly, replace the AG module.</li> </ol>
O2 Sensor Error	Med	The O2 sensor malfunctions.	<ol style="list-style-type: none"> <li>1. Re-plug the AG module, or replace the slot.</li> <li>2. If the problem persists or the alarm occurs repeatedly, replace the AG module.</li> </ol>
External AG Self Test Error	Low	An error occurs during AG module self-test.	<ol style="list-style-type: none"> <li>1. Re-plug the AG module, or replace the slot.</li> <li>2. If the problem persists or the alarm occurs repeatedly, replace the AG module.</li> <li>3. If the problem persists, check the connection cable between the backplane and the display.</li> <li>4. If the problem persists, replace the module rack (refer to 8.1.14).</li> <li>5. If the problem persists, replace the cable between the backplane and display.</li> </ol>
AG Hardware Malfunction	High	The AG module is not properly installed or malfunctions.	<ol style="list-style-type: none"> <li>1. Re-plug the AG module, or replace the slot.</li> <li>2. If the problem persists or the alarm occurs repeatedly, replace the AG module.</li> </ol>
AG Init Error	High	An error occurs during AG initialization.	<ol style="list-style-type: none"> <li>1. Re-plug the AG module, or replace the slot.</li> <li>2. If the problem persists or the alarm occurs repeatedly, replace the AG module.</li> <li>3. If the problem persists, check the connection cable between the backplane and the display.</li> <li>4. If the problem persists, replace the module rack (refer to 8.1.14).</li> <li>5. If the problem persists, replace the cable between the backplane and display.</li> </ol>
AG No Watertrap	Low	The AG watertrap is disconnected from the anesthesia machine.	<ol style="list-style-type: none"> <li>1. Check whether the AG watertrap is in position, and re-install the watertrap.</li> <li>2. If the problem persists, replace the AG watertrap.</li> <li>3. If the problem persists, replace the AG module.</li> </ol>
AG Watertrap	Low	The patient type is	Change the watertrap type.

Message	Priority	Cause	Solution
Type Wrong		infant/neonate, and the watertrap type is adult.	
AG Change Watertrap	Med	The watertrap needs to be replaced.	<ol style="list-style-type: none"> <li>1. Check whether the AG watertrap is in position, and re-install the watertrap.</li> <li>2. If the problem persists, replace the AG watertrap.</li> <li>3. If the problem persists, replace the AG module.</li> </ol>
AG Comm Stop	High	The AG module malfunctions, or the communication fails.	<ol style="list-style-type: none"> <li>1. Re-plug the AG module.</li> <li>2. If the problem persists, replace the slot.</li> <li>3. If the problem persists, replace the AG module.</li> <li>4. If the problem persists, check the connection cable between the backplane and the display.</li> <li>5. If the problem persists, replace the module rack (refer to 8.1.14).</li> <li>6. If the problem persists, replace the cable between the backplane and display.</li> </ol>
AG Airway Occluded	High	The pump rate of the AG module is below 20 mL/min for more than 1s.	<ol style="list-style-type: none"> <li>1. Check whether the sampling line and exhaust pipe of the AG module are folded or blocked. If yes, handle the problem.</li> <li>2. If the problem persists, replace the AG watertrap and sampling line.</li> <li>3. If the problem persists, replace the AG module.</li> </ol>
AG Data Limit Error	Med	The AG module malfunctions.	<ol style="list-style-type: none"> <li>1. Re-plug and start the AG module.</li> <li>2. If the problem persists, replace the AG module.</li> </ol>
AG Zero Failed	Low	Zeroing for the AG module fails.	<ol style="list-style-type: none"> <li>1. Zero the AG module again.</li> <li>2. If the problem persists, replace the AG module.</li> </ol>
AG Cal. Failed	High	Calibration for the AG module fails.	<ol style="list-style-type: none"> <li>1. Calibrate the AG module again.</li> <li>2. If the problem persists, replace the AG module.</li> </ol>
O2 Accuracy Unspecified	Low	The measured values exceed the normal range.	<ol style="list-style-type: none"> <li>1. Calibrate the AG module again.</li> <li>2. If the problem persists, replace the AG module.</li> </ol>
N2O Accuracy Unspecified	Low	The measured values exceed the normal range.	<ol style="list-style-type: none"> <li>1. Calibrate the AG module again.</li> <li>2. If the problem persists, replace the AG module.</li> </ol>
CO2 Accuracy Unspecified	Low	The measured values exceed the normal range.	<ol style="list-style-type: none"> <li>1. Calibrate the AG module again.</li> <li>2. If the problem persists, replace the AG module.</li> </ol>
Enf Accuracy Unspecified	Low	The measured values exceed the normal range.	<ol style="list-style-type: none"> <li>1. Calibrate the AG module again.</li> <li>2. If the problem persists, replace the AG module.</li> </ol>
Iso Accuracy Unspecified	Low	The measured values exceed the normal range.	<ol style="list-style-type: none"> <li>1. Calibrate the AG module again.</li> <li>2. If the problem persists, replace the AG module.</li> </ol>
Sev Accuracy Unspecified	Low	The measured values exceed the normal range.	<ol style="list-style-type: none"> <li>1. Calibrate the AG module again.</li> <li>2. If the problem persists, replace the AG module.</li> </ol>

Message	Priority	Cause	Solution
Hal Accuracy Unspecified	Low	The measured values exceed the normal range.	1. Calibrate the AG module again. 2. If the problem persists, replace the AG module.
Des Accuracy Unspecified	Low	The measured values exceed the normal range.	1. Calibrate the AG module again. 2. If the problem persists, replace the AG module.
Mixed Agent	Low	The AG module detects two and more types of halogenated agents. The measured MAC is less than 3.	Use only one type of halogenated agent.
Mixed Agent	Med	The AG module detects two and more types of halogenated agents. It cannot detect the specific MAC value (invalid value).	1. Check whether only one type of halogenated agent is used. 2. If only one type of anesthetic agent is used, set the fresh gas flow to 6L/min or above, and check 20s later. 3. If the problem persists, replace the AG module.
Mixed Agent and $MAC \geq 3$	Med	The AG module detects two and more types of halogenated agents. The measured MAC is greater than or equal to 3.	1. Check whether only one type of halogenated agent is used. 2. If only one type of anesthetic agent is used, set the fresh gas flow to 6L/min or above, and check 20s later. 3. If the problem persists, replace the AG module.
CO2 Overrange	Low	The monitored value exceeds the measurement range of the module.	1. Decrease the concentration of the monitored gas to the normal range. 2. If the problem persists, calibrate the AG module again. 3. If the problem persists, replace the AG module.
O2 Overrange	Low	The monitored value exceeds the measurement range of the module.	1. Decrease the concentration of the monitored gas to the normal range. 2. If the problem persists, calibrate the AG module again. 3. If the problem persists, replace the AG module.
N2O Overrange	Low	The monitored value exceeds the measurement range of the module.	1. Decrease the concentration of the monitored gas to the normal range. 2. If the problem persists, calibrate the AG module again. 3. If the problem persists, replace the AG module.
N2O Overrange	Low	The monitored value exceeds the measurement range of the module.	1. Decrease the concentration of the monitored gas to the normal range. 2. If the problem persists, calibrate the AG module again. 3. If the problem persists, replace the AG module.
Hal Overrange	Low	The monitored value exceeds the measurement range of the module.	1. Decrease the concentration of the monitored gas to the normal range. 2. If the problem persists, calibrate the AG module again. 3. Replace the AG module.
Enf Overrange	Low	The monitored value exceeds the	1. Decrease the concentration of the monitored gas to the normal range.

Message	Priority	Cause	Solution
		measurement range of the module.	2. If the problem persists, calibrate the AG module again. 3. Replace the AG module.
Iso Overrange	Low	The monitored value exceeds the measurement range of the module.	1. Decrease the concentration of the monitored gas to the normal range. 2. If the problem persists, calibrate the AG module again. 3. If the problem persists, replace the AG module.
Sev Overrange	Low	The monitored value exceeds the measurement range of the module.	1. Decrease the concentration of the monitored gas to the normal range. 2. If the problem persists, calibrate the AG module again. 3. If the problem persists, replace the AG module.
Des Overrange	Low	The monitored value exceeds the measurement range of the module.	1. Decrease the concentration of the monitored gas to the normal range. 2. If the problem persists, calibrate the AG module again. 3. If the problem persists, replace the AG module.
Rate Overrange	Low	The monitored value exceeds the measurement range of the module.	1. Decrease the respiratory rate to the normal range. 2. If the problem persists, calibrate the AG module again (refer to 10.3.11). 3. If the problem persists, replace the AG module.

#### 4.3.11 Internal AG Module Runtime Alarms

Message	Priority	Cause	Solution
Internal AG Error 01	Low	The AG hardware malfunctions.	1. Restart the machine. 2. If the problem persists, disassemble the VE component (refer to 9.31), and then re-connect the cable of the AG module. 3. If the problem persists, replace the internal AG module (refer to 8.1.7).
Internal AG Error 02	Low	An error occurs during AG module self-test.	1. Restart the machine. 2. If the problem persists, disassemble the VE component (refer to 9.31), and then re-connect the cable of the AG module. 3. If the problem persists, replace the internal AG module (refer to 8.1.7).
Internal AG Error 03	Low	The AG module is not properly installed or malfunctions.	1. Restart the machine. 2. If the problem persists, disassemble the VE component (refer to 9.31), and then re-connect the cable of the AG module. 3. If the problem persists, replace the internal AG module (refer to 8.1.7).
Internal AG Error 04	Low	An error occurs during AG initialization.	1. Restart the machine. 2. If the problem persists, disassemble the VE component (refer to 9.31), and then re-connect the cable of the AG

Message	Priority	Cause	Solution
			module. 3. If the problem persists, replace the internal AG module (refer to 8.1.7).
Internal AG Error 05	Low	The AG module malfunctions, or the communication fails.	1. Restart the machine. 2. If the problem persists, disassemble the VE component (refer to 9.31), and then re-connect the cable of the AG module. 3. If the problem persists, replace the internal AG module (refer to 8.1.7).
Internal AG Error 07	Low	Zeroing for the AG module fails.	1. Restart the machine, and zero the AG module again. 2. If the problem persists, disassemble the VE component (refer to 9.31), and then re-connect the cable of the AG module. 3. If the problem persists, replace the internal AG module (refer to 8.1.7).
Internal AG Error 08	Low	Calibration for the AG module fails.	1. Restart the machine, and calibrate the AG module again. 2. If the problem persists, disassemble the VE component (refer to 9.31), and then re-connect the cable of the AG module. 3. If the problem persists, replace the internal AG module (refer to 8.1.7).
Internal AG Error 09	Low	The substitute device of the watertrap of the internal AG module loosens.	1. Restart the machine, and calibrate the AG module again. 2. If the problem persists, disassemble the VE component (refer to 9.31), and then re-connect the AG module cable and the watertrap adapter cable. 3. If the problem persists, replace the internal AG module (refer to 8.1.7).
Internal AG Error 10	Low	The pump rate of the AG module is below 20 mL/min for more than 1s.	1. Check whether the sampling line of the AG module is bent or twisted. 2. Check whether the sampling line of the AG module is occluded. 3. If the problem persists, replace the filter. 4. If the problem persists, replace the AG module (refer to 8.1.7).
Internal AG Error 11	Low	The substitute device of the watertrap needs to be replaced.	1. Restart the machine. 2. If the problem persists, disassemble the VE component (refer to 9.31), and then re-connect the AG module cable and the watertrap adapter cable. 3. If the problem persists, replace the internal AG module (refer to 8.1.7).
Internal AG Error 12	Low	The measured AG module parameter values exceed the normal range.	1. Restart the machine, and calibrate the AG module again. 2. If the problem persists, replace the internal AG module (refer to 8.1.7).

### 4.3.12 BIS Module Runtime Alarms

Message	Priority	Cause	Solution
BIS Init Error	High	The system fails to receive information about BIS module initialization.	<ol style="list-style-type: none"> <li>1. Re-plug the BIS module, or replace the slot.</li> <li>2. If the problem persists, replace the BIS module.</li> <li>3. If the problem persists, check the connection cable between the backplane and the display.</li> <li>4. If the problem persists, replace the module rack (refer to 8.1.14).</li> <li>5. If the problem persists, replace the cable between the backplane and display.</li> </ol>
BIS Comm Abnormal	High	No waveform data packet is received for consecutive 2s, or no data packet of BIS monitored parameters is received for consecutive 4s.	<ol style="list-style-type: none"> <li>1. Re-plug the BIS module, or replace the slot.</li> <li>2. If the problem persists, replace the BIS module.</li> <li>3. If the problem persists, check the connection cable between the backplane and the display.</li> <li>4. If the problem persists, replace the module rack (refer to 8.1.14).</li> <li>5. If the problem persists, replace the cable between the backplane and display.</li> </ol>
BIS Over Range	Low	The monitored value exceeds the measurement range of the module.	Replace the BIS module.
BIS L Over Range			
BIS R Over Range			
BIS High Imped.	Low	The sensor is not properly adhered to the patient skin. The impedance is too high.	<ol style="list-style-type: none"> <li>1. Check the contact between the BIS sensor and the patient skin.</li> <li>2. If the problem persists, replace the BIS sensor.</li> </ol>
BIS Sensor Off	Low	The sensor falls off from the patient.	<ol style="list-style-type: none"> <li>1. Check the contact between the BIS sensor and the patient skin.</li> <li>2. If the problem persists, replace the BIS sensor.</li> </ol>
BIS Electrode 1 High Imped.	Low	The impedance of BIS electrode 1 is too high.	<ol style="list-style-type: none"> <li>1. Check the contact between BIS sensor electrode 1 and the patient skin.</li> <li>2. If the problem persists, replace the BIS sensor.</li> </ol>
BIS Electrode 1 Lead Off	Low	BIS electrode 1 falls off from the patient.	<ol style="list-style-type: none"> <li>1. Check the contact between BIS sensor electrode 1 and the patient skin.</li> <li>2. If the problem persists, replace the BIS sensor.</li> </ol>
BIS Electrode 2 High Imped.	Low	The impedance of BIS electrode 2 is too high.	<ol style="list-style-type: none"> <li>1. Check the contact between BIS sensor electrode 2 and the patient skin.</li> <li>2. Replace the BIS sensor.</li> </ol>
BIS Electrode 2 Lead Off	Low	BIS electrode 2 falls off from the patient.	<ol style="list-style-type: none"> <li>1. Check the contact between BIS sensor electrode 2 and the patient skin.</li> <li>2. If the problem persists, replace the BIS sensor.</li> </ol>

Message	Priority	Cause	Solution
BIS Electrode 3 High Imped.	Low	The impedance of BIS electrode 3 is too high.	1. Check the contact between BIS sensor electrode 3 and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Electrode 3 Lead Off	Low	BIS electrode 3 falls off from the patient.	1. Check the contact between BIS sensor electrode 3 and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Electrode 4 High Imped.	Low	The impedance of BIS electrode 4 is too high.	1. Check the contact between BIS sensor electrode 4 and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Electrode 4 Lead Off	Low	BIS electrode 4 falls off from the patient.	1. Check the contact between BIS sensor electrode 4 and the patient skin. 2. Replace the BIS sensor.
BIS Electrode G High Imped.	Low	The impedance of BIS electrode G is too high.	1. Check the contact between BIS sensor electrode G and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Electrode G Lead Off	Low	BIS electrode G falls off from the patient.	1. Check the contact between BIS sensor electrode G and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Electrode C High Imped.	Low	The impedance of BIS electrode C is too high.	1. Check the contact between BIS sensor electrode C and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Electrode C Lead Off	Low	BIS electrode C falls off from the patient.	1. Check the contact between BIS sensor electrode C and the patient skin. 2. Replace the BIS sensor.
BIS Electrode LE High Imped.	Low	The impedance of BIS electrode LE is too high.	1. Check the contact between BIS sensor electrode LE and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Electrode LE Lead Off	Low	BIS electrode LE falls off from the patient.	1. Check the contact between BIS sensor electrode LE and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Electrode LT High Imped.	Low	The impedance of BIS electrode LT is too high.	1. Check the contact between BIS sensor electrode LT and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Electrode LT Lead Off	Low	BIS electrode LT falls off from the patient.	1. Check the contact between BIS sensor electrode LT and the patient skin.

Message	Priority	Cause	Solution
			2. If the problem persists, replace the BIS sensor.
BIS Electrode RE High Imped.	Low	The impedance of BIS electrode RE is too high.	1. Check the contact between BIS sensor electrode RE and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Electrode RE Lead Off	Low	BIS electrode RE falls off from the patient.	1. Check the contact between BIS sensor electrode RE and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Electrode RT High Imped.	Low	The impedance of BIS electrode RT is too high.	1. Check the contact between BIS sensor electrode RT and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Electrode RT Lead Off	Low	BIS electrode RT falls off from the patient.	1. Check the contact between BIS sensor electrode RT and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS DSC Error	Low	A BIS DSC communication error occurs.	Replace the BIS module.
BIS DSC Malf	Low	BIS DSC malfunctions and turns off automatically.	Replace the BIS module.
BIS No Cable	Low	The BIS cable is not connected.	1. Check the BIS cable. 2. If the problem persists, replace the BIS cable.
BIS No Sensor	Low	The BIS sensor is not connected.	1. Check the BIS sensor. 2. Reinstall the BIS sensor.
BIS Sensor Too Many Uses	Low	The BIS sensor is overused.	1. Check if the use times of the BIS sensor exceed the restricted times (100 times). 2. If the problem persists, replace the BIS sensor.
BIS SQI<50%	Low	SQI is low.	1. Check the contact between the BIS sensor and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS SQI<15%	Low	SQI is very low, prompting the user that the BIS value is not reliable.	1. Check the contact between the BIS sensor and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS SQI L<15%	Low	SQI L is very low, prompting the user that the BIS value is not reliable.	1. Check the contact between the BIS sensor and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS SQI L<50%	Low	SQI L is low.	1. Check the contact between the BIS sensor and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS SQI R<15%	Low	SQI R is very low,	1. Check the contact between the

Message	Priority	Cause	Solution
		prompting the user that the BIS value is not reliable.	BIS sensor and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS SQI R<50%	Low	SQI R is low.	1. Check the contact between the BIS sensor and the patient skin. 2. If the problem persists, replace the BIS sensor.
BIS Sensor Expired	Low	The BIS sensor expires.	1. Check the validity period of the BIS sensor. 2. If the problem persists, replace the BIS sensor.
BIS Electrode Unconnected	Low	The BIS sensor electrode is not connected.	1. Check whether the BIS sensor electrodes are properly connected. 2. If the problem persists, replace the BIS electrode.
BISx Disconnected	Low	The BIS cable is not connected to the plug-in module, or a communication error occurs.	1. Check the connector between the BIS cable and the plug-in module. 2. If the problem persists, replace the BIS cable. 3. If the problem persists, replace the BIS plug-in module.
BIS Wrong Sensor Type	Low	A Mindray undeclared BIS sensor is used.	1. Check the type of the BIS sensor. 2. If the problem persists, replace the BIS sensor.
BIS Sensor Failure	Low	A sensor overcurrent or positive electrode error occurs.	1. Check the BIS sensor. 2. If the problem persists, replace the BIS sensor.
Disconnect/Reconnect BIS	Low	Three overcurrent errors and two positive electrode errors occur in total. The BIS module needs to be powered off and then powered on. The BIS module or BIS plug-in box needs to be re-plugged.	1. Re-plug the BIS sensor. 2. If the problem persists, replace the BIS sensor.
BIS Self Test Error	Low	An error occurs during BIS module self-test.	1. Re-plug the BIS module. 2. If the problem persists, replace the BIS module.

### 4.3.13 CO2 Module Runtime Alarms

Message	Priority	Cause	Solution
CO2 Comm Stop	High	A CO2 module error or communication error occurs.	1. Re-plug the CO2 module, or replace the slot. 2. If the problem persists, replace the CO2 module. 3. If the problem persists, check the connection cable between the backplane and the display. 4. If the problem persists, replace the module rack (refer to 8.1.14). 5. If the problem persists, replace the cable between the backplane and display.

Message	Priority	Cause	Solution
CO2 Sensor High Temp	Low	The CO2 sensor temperature is greater than 63°C.	1. Re-plug the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 Sensor Low Temp	Low	The CO2 sensor temperature is less than 5°C.	1. Re-plug the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 High Airway Press.	Low	The airway pressure is greater than 790 mmHg.	1. Check whether the airway pressure is above 790 mmHg. 2. Reconnect the sampling line. 3. If the problem persists, replace the CO2 module.
CO2 Low Airway Press.	Low	The airway pressure is less than 428 mmHg.	1. Check whether the airway pressure is below 428 mmHg. 2. Reconnect the sampling line. 3. If the problem persists, replace the CO2 module.
CO2 High Barometric	Low	The barometric pressure is greater than 790 mmHg.	1. Re-plug the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 Low Barometric	Low	The barometric pressure is less than 790 mmHg.	1. Re-plug the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 Hardware Error	High	1. External AD 2.5 V error 2. 12 V voltage error 3. Internal AD 2.5 V error 4. Air pump error 5. 3-way valve error	1. Re-plug the CO2 module, or replace the slot. 2. If the problem persists, replace the CO2 module. 3. If the problem persists, replace the module rack (refer to 8.1.14).
CO2 Sampleline Occluded	Low	The sampling line is occluded.	1. Check whether the sampling line is blocked or folded. 2. If the problem persists, replace the CO2 module.
CO2 System Error	Low	A multi-system error occurs.	1. Re-plug the CO2 module, or replace the slot. 2. If the problem persists, replace the CO2 module. 3. If the problem persists, replace the module rack (refer to 8.1.14).
CO2 No Watertrap	Low	The CO2 watertrap is off or disconnected.	1. Check the CO2 watertrap. 2. Re-install the CO2 watertrap. 3. If the problem persists, replace the CO2 watertrap. 4. If the problem persists, replace the CO2 module.
EtCO2 Overrange	Low	The monitored value exceeds the measurement range.	1. Recalibrate the CO2 module. 2. If the problem persists, replace the CO2 module.
FiCO2 Overrange	Low	The monitored value exceeds the measurement range.	1. Recalibrate the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 Zero Failed	Low	The CO2 module fails.	1. Re-zero the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 Init Error	High	A CO2 initialization error occurs.	1. Re-plug the CO2 module. 2. If the problem persists, replace the

Message	Priority	Cause	Solution
			CO2 module. 3. If the problem persists, check the connection cable between the backplane and the display. 4. If the problem persists, replace the module rack (refer to 8.1.14). 5. If the problem persists, replace the cable between the backplane and display.
Incompatible CO2 Software Version	High	The CO2 module is incompatible with the software version.	Replace the CO2 module (M02A module not supported).
CO2 Sensor Error	Low	The mainstream CO2 module sensor fails.	1. Re-plug the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 no sensor	Low	The mainstream CO2 module sensor is disconnected, or a communication error occurs.	1. Check the mainstream CO2 module sensor. 2. Replace the mainstream CO2 module sensor.
CO2 Check Airway	Low	The MiniMedi CO2 airway is abnormal or occluded.	1. Re-plug the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 No Sampleline	Low	No sampling line is connected to the MiniMedi CO2 module.	1. Check the sampling line of the CO2 module. 2. Replace the sampling line of the CO2 module. 3. Replace the CO2 module.
CO2 Main Board Error	High	The MiniMedi CO2 module fails.	1. Re-plug the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 Check Sensor or Main Board	Low	The MiniMedi CO2 module fails.	1. Re-plug the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 Replace Scrubber&Pump	Low	The MiniMedi CO2 module fails.	1. Re-plug the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 Replace Sensor	Low	The MiniMedi CO2 module fails.	1. Re-plug the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 15V Voltage Over Range	High	The MiniMedi CO2 module fails.	1. Re-plug the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 Temp Over Range	Low	The operating temperature of the MiniMedi CO2 module is beyond the normal range.	1. Re-plug the CO2 module. 2. If the problem persists, replace the CO2 module.
CO2 Check Cal.	Low	The MiniMedi CO2 module fails.	1. Re-plug the CO2 module. 2. Recalibrate the CO2 module. 3. If the problem persists, replace the CO2 module.

### 4.3.14 NMT Module Runtime Alarms

Message	Priority	Cause	Solution
NMT No Main Cables	Low	The NMT main cable is disconnected.	Check the connection between the main cable and the NMT module.
NMT No Sensor	Low	The NMT sensor is disconnected.	<ol style="list-style-type: none"> <li>1. Check the connection between the sensor and the NMT main cable to ensure normal connection.</li> <li>2. If the alarm persists, replace the sensor.</li> </ol>
NMT Stimulation Electrode Off	Low	The NMT stimulation electrode falls off.	<ol style="list-style-type: none"> <li>1. Check the connection between the stimulation cable and the main cable to ensure normal connection.</li> <li>2. If the alarm persists, check the connection between the stimulation electrode and the patient.</li> </ol>
NMT Sensor Comm. Error	Low	An NMT sensor communication error occurs.	<ol style="list-style-type: none"> <li>1. Check the connection between the sensor and the NMT main cable to ensure normal connection.</li> <li>2. If the alarm persists, replace the NMT module or sensor.</li> <li>3. If the problem persists, check the connection cable between the backplane and the display.</li> <li>4. If the problem persists, replace the module rack (refer to 8.1.14).</li> <li>5. If the problem persists, replace the cable between the backplane and display.</li> </ol>
NMT Stimulation Current Over Limit	Low	The output stimulation current of the NMT module exceeds the limit.	<ol style="list-style-type: none"> <li>1. Check the connection between the stimulation cable and the main cable to ensure normal connection between the stimulation electrode and the patient.</li> <li>2. If the alarm persists, replace the NMT module or related component.</li> </ol>
NMT Comm. Abnormal	High	NMT communication is abnormal.	<ol style="list-style-type: none"> <li>1. Re-plug the NMT module, main cable, sensor, and stimulation electrode, or plug the NMT module to another machine. Eliminate the error situations one by one.</li> <li>2. If the alarm persists, replace the NMT module or related component.</li> <li>3. If the problem persists, check the connection cable between the backplane and the display.</li> <li>4. If the problem persists, replace the module rack (refer to 8.1.14).</li> <li>5. If the problem persists, replace the cable between the backplane and display.</li> </ol>
NMT Comm. Stop	High	NMT communication stops.	<ol style="list-style-type: none"> <li>1. Re-plug the NMT module, main cable, sensor, and stimulation electrode, or plug the NMT module to another machine. Eliminate the error situations one by one.</li> <li>2. If the alarm persists, replace the</li> </ol>

Message	Priority	Cause	Solution
			NMT module or related component. 3. If the problem persists, check the connection cable between the backplane and the display. 4. If the problem persists, replace the module rack (refer to 8.1.14). 5. If the problem persists, replace the cable between the backplane and display.
NMT Init Error	High	An NMT initialization error occurs.	1. Re-plug the NMT module or restart the anesthesia machine. 2. If the alarm persists, replace the NMT module. 3. If the problem persists, check the connection cable between the backplane and the display. 4. If the problem persists, replace the module rack (refer to 8.1.14). 5. If the problem persists, replace the cable between the backplane and display.
NMT Self Test Error	Low	An NMT self-test error occurs.	1. Re-plug the NMT module or restart the anesthesia machine. 2. If the alarm persists, replace the NMT module. 3. If the problem persists, check the connection cable between the backplane and the display. 4. If the problem persists, replace the module rack (refer to 8.1.14). 5. If the problem persists, replace the cable between the backplane and display.
NMT Power Error	High	The NMT main cable is disconnected, or an NMT communication error occurs.	1. Check the connection between the main cable and the NMT module. 2. If the alarm persists, replace the NMT module or main cable.
ST-Ratio Over Range	Low	An NMT power supply error occurs.	1. Re-plug the NMT module. 2. If the alarm persists, replace the sensor or NMT module.
TOF-Ratio Over Range	Low	ST-Ratio measurement is out of range.	1. Recalibrate the sensor. 2. If the alarm persists, replace the sensor or NMT module.
DBS-Ratio Over Range	Low	TOF-Ratio measurement is out of range.	1. Recalibrate the sensor. 2. If the alarm persists, replace the sensor or NMT module.

## 4.4 Typical Troubleshooting

### 4.4.1 Failure to Exit the Standby Mode

Failure Description	Cause Confirmation	Confirmation Result	Solution
Failure to exit the standby mode	1. Check whether the gas supply is sufficient.	The gas supply pressure is less than 280 kPa.	Connect or replace the gas supply.
	2. Use the touchscreen and	The system does	1. Upgrade the software.

Failure Description	Cause Confirmation	Confirmation Result	Solution
	encoder for the main screen to tap the Exit Standby softkey.	to respond to the touchscreen operation.	2. If the problem persists, replace the display (refer to 8.1.1).
		The system does to respond to the encoder operation.	1. Upgrade the software. 2. If the problem persists, replace the encoder (refer to 8.1.1).
		The system does to respond to both the touchscreen and encoder operations.	1. If other operations are also unavailable, replace the CPU board (refer to 8.1.1). 2. If other operations are available, perform step 3 to locate the cause.
	3. Check whether the system selftest succeeds.	The system selftest fails.	Refer to 4.3.1.
	4. Check whether a technical alarm is generated.	A technical alarm is generated.	Refer to 4.3.

#### 4.4.2 Auto/Manual Switchover Failure

Failure Description	Cause Confirmation	Confirmation Result	Solution
Failure to turn the auto/manual switch	Observe whether there is dirt or debris in the gap of the auto/manual switch.	There is dirt or debris.	Clean the auto/manual switch.
		There is no dirt or debris, or the problem persists after cleaning.	Replace the auto/manual switch (refer to 8.1.12).
Manual Only displayed on the screen	Check whether the system selftest succeeds.	The system selftest fails.	Refer to 4.3.1.
	Check whether the leak test succeeds.	The leak test fails.	Refer to 4.2.3.
No response after the auto/manual switch is turned	Check whether the gas supply is sufficient.	The gas supply pressure is less than 280 kPa.	Connect or replace the gas supply.
	Choose <b>Setup &gt; Service &gt; Data Monitors &gt; Status Monitor</b> to access the switch monitoring screen. Turn the auto/manual switch to Manual and Auto in turn, and check whether the status of the auto/manual position switch, the control status of the auto/manual pilot valve (ON for auto ventilation and OFF for manual ventilation), and the status of the auto/manual valve switch are consistent with the actual position of the auto/manual switch.	The status of either or both of auto/manual position switches 1 and 2 is inconsistent with that of the auto/manual switch.	Replace the auto/manual switch (refer to 8.1.12).
		The status of the auto/manual pilot valve is inconsistent with that of the auto/manual switch.	Replace the auto/manual valve (refer to 8.5.1).
		The status of auto/manual valve switches 1 and 2 is inconsistent with that of the auto/manual switch.	Replace the auto/manual valve switch (refer to 8.5.1).

### 4.4.3 Mechanical Ventilation Stop

Failure Description	Cause Confirmation	Confirmation Result	Solution
Manual Only displayed on the screen	Check whether the gas supply is sufficient.	The gas supply pressure is less than 280 kPa.	Connect or replace the gas supply.
	Check whether a technical alarm is generated.	A technical alarm is generated.	Clear the alarm by referring to 4.3.5 "Mechanical Ventilation Unavailable".

### 4.4.4 Inaccurate Tidal Volume Control

Failure Description	Cause Confirmation	Confirmation Result	Solution
Inaccurate tidal volume control	Check whether the gas supply is sufficient.	The gas supply pressure is less than 280 kPa.	Connect or replace the gas supply.
	Check whether Plimit is too low and the PAW value exceeds Plimit each time.	The PAW value reaches Plimit each time.	Increase Plimit so that the PAW value does not exceed the limit.
	Check for leakage in the breathing system.	The leakage is greater than 200 ml.	Refer to 4.2.3.
	Check the fresh air flow setting.	The fresh air flow setting exceeds twice of the optimizer.	Adjust the fresh air flow setting to be within the optimizer range.
	Remove and check the flow sensor.	There is water in the membrane of the flow sensor.	(1) Remove the water in the flow sensor. (2) If the problem persists, calibrate the flow sensor by referring to 10.3.1.
		The membrane is dirty or deformed. Perform the constant-flow test for further analysis by referring to 7.16.	1. Calibrate the flow sensor by referring to 10.3.1. (2) If the problem persists, replace the sensor (refer to 8.5.2).
	Check the zero point of the sensor by referring to 7.15.	Refer to 7.15.	Zero the sensor by referring to 10.3.8.
	If there is a significant difference (greater than $\pm 10$ mL/min or 5% of the setting) between TVE and TVi displayed on the UI, perform the constant-flow test by referring to 7.16, or perform flow sensor diagnosis by referring to 4.6.1.2.	The difference between TVE/TVi displayed on the UI and the flow setting of the machine exceeds 5% or 0.5 L/min, or the flow difference found in flow sensor diagnosis in 4.6.1.2 exceeds 5%.	1. Calibrate the flow sensor by referring to 10.3.1. (2) If the problem persists, replace the sensor (refer to 8.5.2). (3) If the problem persists, replace the sensor adapter board (refer to 8.1.16).
	Check whether pressure	Make a judgment	(1) Perform pressure

Failure Description	Cause Confirmation	Confirmation Result	Solution
	measurement of the pressure sensor is accurate by referring to 7.17 (device required) or 4.6.1.3 (no device required).	by referring to 7.17 or 4.6.1.3.	calibration by referring to 10.3.6. (2) If the problem persists, replace the sensor adapter board (refer to 8.1.16).
	Open the service door (refer to 9.1.1) and check whether the sensor adapter board and 3-way valve sampling line are connected properly.	The silicone tube loosens or is occluded.	Reconnect the silicone tube and prevent it from occlusion.
	Remove the VE assembly by referring to 9.31 and check whether the sampling line on the work surface is connected properly.	The silicone tube loosens or is occluded.	Reconnect the silicone tube and prevent it from occlusion.
	Check whether other technical alarms are generated.	A ventilation technical alarm is generated.	Refer to 4.3 to clear the alarm.
	The problem persists.	The problem persists.	Replace the inspiratory valve assembly (refer to 8.1.17).

#### 4.4.5 Inaccurate Airway Pressure Control

Failure Description	Cause Confirmation	Confirmation Result	Solution
Inaccurate airway pressure control in pressure mode	Check whether the gas supply is sufficient.	The gas supply pressure is less than 280 kPa.	Connect or replace the gas supply.
	Check for leakage in the breathing system.	The leakage is greater than 200 ml.	Refer to 4.2.3.
	Check the fresh air flow setting.	The fresh air flow setting is beyond the optimizer range.	Adjust the fresh air flow setting to be within the optimizer range.
	Check the zero point of the sensor by referring to 7.15.	Refer to 7.15.	Zero the sensor by referring to 10.3.8.
	Check whether pressure measurement of the pressure sensor is accurate by referring to 7.17 (device required) or 4.6.1.3 (no device required).	Make a judgment by referring to 7.17 or 4.6.1.3.	(1) Perform pressure calibration by referring to 10.3.6. (2) If the problem persists, replace the sensor adapter board (refer to 8.1.16).
	Perform inspiratory valve diagnosis by referring to 4.6.2.	A diagnosis error occurs.	Replace the inspiratory valve assembly (refer to 8.1.17).
	Open the service door (refer to 9.1.1) and check whether the sensor adapter board and 3-way valve sampling line are connected properly.	The silicone tube loosens or is occluded.	Reconnect the silicone tube and prevent it from occlusion.
	Remove the VE assembly	The silicone	Reconnect the silicone tube

Failure Description	Cause Confirmation	Confirmation Result	Solution
	by referring to 9.31 and check whether the sampling line on the work surface is connected properly.	tube loosens or is occluded.	and prevent it from occlusion.
	Check whether other technical alarms are generated.	A ventilation technical alarm is generated.	Refer to 4.3 to clear the alarm.
	The problem persists.	The problem persists.	Replace the inspiratory valve assembly (refer to 8.1.17).

#### 4.4.6 Inaccurate PEEP Control

Failure Description	Cause Confirmation	Confirmation Result	Solution
Inaccurate PEEP control	Check whether the gas supply is sufficient.	The gas supply pressure is less than 280 kPa.	Connect or replace the gas supply.
	Check the zero point of the sensor by referring to 7.15.	Refer to 7.15.	Zero the sensor by referring to 10.3.8.
	Check whether pressure measurement of the pressure sensor is accurate by referring to 7.17 (device required) or 4.6.1.3 (no device required).	Make a judgment by referring to 7.17 or 4.6.1.3.	Perform pressure calibration by referring to 10.3.6.
	Open the service door (refer to 9.1.1) and check whether the sensor adapter board and 3-way valve sampling line are connected properly.	The silicone tube loosens or is occluded.	Reconnect the silicone tube and prevent it from occlusion.
	Remove the VE assembly by referring to 9.31 and check whether the sampling line on the work surface is connected properly.	The silicone tube loosens or is occluded.	Reconnect the silicone tube and prevent it from occlusion.
	Perform PEEP valve diagnosis by referring to 4.6.3.	A PEEP diagnosis error occurs.	Replace the inspiratory valve assembly (refer to 8.1.17).
	Check whether other technical alarms are generated.	A PEEP technical alarm is generated.	Refer to 4.3 to clear the alarm.
	The problem persists.	The problem persists.	Replace the sensor adapter board (refer to 8.1.16) and inspiratory valve assembly (refer to 8.1.17).

#### 4.4.7 Irregular Flow Waveforms

Failure Description	Cause Confirmation	Confirmation Result	Solution
Irregular flow waveforms	Check whether the gas supply fluctuates greatly.	The gas supply fluctuates greatly (the pipeline supply pressure drops by more than	Connect a stable gas supply.

Failure Description	Cause Confirmation	Confirmation Result	Solution
		50 kPa during ventilation).	
	Check for water in the circuit (corrugated tube, flow sensor, water collection cup, and absorber canister).	There is too much water in the corrugated tube, flow sensor, water collection cup, or absorber canister.	Remove the water.
	Visually inspect whether the breathing valve is stuck during ventilation.	The breathing valve is stuck.	(1) Remove and clean the breathing valve by referring to 8.5.2. (2) If the problem persists, replace the breathing valve (refer to 8.5.2).
	Open the service door (refer to 9.1.1) and check whether the sensor adapter board and 3-way valve sampling line are connected properly.	The silicone tube loosens or is occluded.	Reconnect the silicone tube and prevent it from occlusion.
	Remove the VE assembly by referring to 9.38 and check whether the sampling line on the work surface is connected properly.	The silicone tube loosens or is occluded.	Reconnect the silicone tube and prevent it from occlusion.
	Check whether other technical alarms are generated.	A ventilation technical alarm is generated.	Refer to 4.3 to clear the alarm.
	The problem persists.	The problem persists.	(1) Replace the sensor (refer to 8.5.2). (2) If the problem persists, replace the sensor adapter board (refer to 8.1.16). 3. If the problem persists, replace the inspiratory valve assembly (refer to 8.1.17).

#### 4.4.8 BFCS Failures

Failure Description	Cause Confirmation	Confirmation Result	Solution
No response when the BFCS door is opened or closed in the EFCS state	1. Open the BFCS door and check whether the two magnets near the rotating shaft inside the BFCS door cover fall off.	The magnets of the BFCS door fall off.	Replace the BFCS door (refer to 8.1.5).
		The magnets of the BFCS door assembly do not fall off.	Proceed with step 2.
	2. Choose <b>Setup &gt; Service &gt; Data Monitors &gt; FCS</b> to access the flowmeter data monitoring screen. Open and close the BFCS door in turn, and observe the status of BFCS Door Switch 1 and BFCS Door	When the BFCS door is closed, BFCS Door Switch 1 or BFCS Door Switch 2 is On; or when the BFCS door is open, BFCS Door Switch 1 or BFCS Door Switch 2 is	(1) Reconnect the cable of the BFCS switch control board (refer to 8.1.5). (2) Replace the BFCS switch control board PCBA (refer to 8.1.5).

Failure Description	Cause Confirmation	Confirmation Result	Solution
	Switch 2.	Off.	
BFCS door failed to open automatically upon switchover to BFCS	1. Check the joint of the BFCS door for dirt and debris.	There is dirt or debris in the joint of the BFCS door.	Clean the BFCS door and instrument panel. If the problem persists, proceed with step 2.
		There is no dirt or debris in the joint of the BFCS door.	Proceed with step 2.
	2. Manually open the BFCS door to check if it is stuck.	The BFCS door is stuck (possibly due to deformation caused by aging or improper disinfection).	Replace the BFCS door (refer to 8.1.5). If the problem persists, proceed with step 3.
		The BFCS door is not stuck.	Proceed with step 3.
	3 Open the BFCS door and check whether the two electromagnets outside the BFCS door fall off.	The electromagnets of the BFCS door fall off.	Replace the BFCS door (refer to 8.1.5).
		The electromagnets of the BFCS door do not fall off.	Proceed with step 4.
	4. Access the FCS screen (refer to 4.6.5), set Electromagnet 1 and EFPM Electromagnet 1 to ON, and then set Electromagnet 2 and EFPM Electromagnet 2 to ON.	The status of the corresponding electromagnet does not change, or changes from ON to OFF. (Normally, the electromagnet status changes from OFF to ON for 1s.)	(1) Replace the electromagnets of the BFCS door (refer to 8.1.5). (2) If the problem persists, replace the EFCS control board (refer to 8.3.1).
BFCS door automatically open (which is normal in BFCS ventilation mode)	1. Check whether the BFCS door can be fully closed (the rear cover surface is aligned with the housing surface).	1. The BFCS door cannot be fully closed due to deformation (caused by aging or improper disinfection).	(1) Replace the BFCS door (refer to 8.1.5). (2) If the problem persists, proceed with step 2.
		The BFCS door can be fully closed.	Proceed with step 2.
	2. Choose <b>Setup &gt; Service &gt; Data Monitors &gt; FCS</b> to access the flowmeter data monitoring screen. Observe the status of Electromagnet 1 and Electromagnet 2.	The status of Electromagnet 1 and Electromagnet 2 is OFF.	Replace the BFCS door (refer to 8.1.5).
		The status of Electromagnet 1 and Electromagnet 2 blinks and is occasionally ON.	Replace the EFCS control board (refer to 8.3.1).
BFCS switchover failure	Open the BFCS door, tap the screen to cancel the operation, turn the needle valve counterclockwise by one round, and then close the door. Open the BFCS door again and start BFCS.	BFCS can be started.	Replace the BFCS O2 needle valve (refer to 8.1.5).
		BFCS cannot be started.	Replace the EFCS assembly (refer to 8.1.14).

Failure Description	Cause Confirmation	Confirmation Result	Solution
Insufficient BFCS basal flow	Increase the flow of the BFCS O2 needle valve during BFCS ventilation of the machine.	The BFCS flow is always less than 0.5 L/min.	Replace the EFCS assembly (refer to 8.1.14).
		The BFCS flow increases as you adjust the valve.	Replace the BFCS O2 needle valve (refer to 8.1.5).

#### 4.4.9 Electronic Vaporizer Failures

Failure Description	Cause Confirmation	Confirmation Result	Solution
No response after the electronic vaporizer is installed	1. Reinstall the electronic vaporizer in place.	The vaporizer can be started.	The problem is solved.
		The vaporizer cannot be started.	Proceed with step 2 to continue with the check.
	2. Install the electronic vaporizer in another slot.	The vaporizer can be started.	Replace the electronic vaporizer base interface board and its cables (refer to 8.4.1).
		The vaporizer cannot be started.	Proceed with step 3 to continue with the check.
	3. After the vaporizer is installed in place, choose <b>Setup &gt; Service &gt; Data Monitors &gt; Status Monitor</b> to access the data monitoring screen and check the vaporizer status.	The vaporizer status is ON.	Replace the electronic vaporizer.
		The vaporizer status is OFF.	(1) Replace the electronic vaporizer. (2) Replace the electronic vaporizer base interface board and its cables (refer to 8.4.1). (2) If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).
Vaporizer activation failure with successful self-test	1. Check whether the gas supply is sufficient.	The gas supply pressure is less than 280 kPa.	Connect or replace the gas supply.
		The gas supply pressure is greater than 280 kPa.	Proceed with step 2.
	2. Install the electronic vaporizer in another slot and try to activate it.	The vaporizer can be activated.	Replace the electronic vaporizer base interface board and its cables (refer to 8.4.1).
		The vaporizer cannot be activated.	Proceed with step 3 to continue with the check.
	3. Without connecting the vaporizer, set the drive gas 3-way valve to ON, observe the status signal of the drive gas 3-way valve on the left the UI, and check whether drive gas is output from the manifold connector (refer to 4.6.6).	The status of the drive gas 3-way valve is ON, but no drive gas is output.	Replace the vaporizer base valve assembly (refer to 8.4.1).
		The status of the drive gas 3-way valve is ON, and drive gas is output.	Proceed with step 4.

Failure Description	Cause Confirmation	Confirmation Result	Solution
		The status of the drive gas 3-way valve is OFF.	Replace the vaporizer base valve assembly (refer to 8.4.1).
	4. Connect the vaporizer. Check whether the value of the pressure sensor is 0 when the drive gas 3-way valve is set to OFF and is within 150±5 kPa when the drive gas 3-way valve is set to ON (refer to 3.6.6).	The value of the pressure sensor is within 150±5 kPa.	Replace the electronic vaporizer.
		The value of the pressure sensor is beyond 150±5 kPa.	Proceed with step 5.
	5 Open the service door (refer to 9.1.1) and measure the output pressure of the secondary pressure regulator with a manometer.	The output pressure is within 150±5 kPa.	Replace the electronic vaporizer.
		The output pressure is beyond 150±5 kPa.	Adjust or replace the secondary pressure regulator (refer to 8.1.4).
No AA output of the electronic vaporizer	1. Check whether the gas supply is sufficient.	The gas supply pressure is less than 280 kPa.	Connect or replace the gas supply.
	2. Check whether any vaporizer alarm is generated.	A vaporizer alarm is generated.	Refer to 4.3.6 to clear the alarm.
	3. Install the electronic vaporizer in another slot and try to activate it.	Anesthetic agent is output normally.	Replace the vaporizer base valve assembly (refer to 8.4.1).
		Anesthetic agent is not output normally.	(1) Replace the electronic vaporizer. (2) If the problem persists, replace the vaporizer base valve assembly (refer to 8.4.1).
Inaccurate concentration regulating of the electronic vaporizer	Check whether the gas supply is sufficient.	The gas supply pressure is less than 280 kPa.	Connect or replace the gas supply.
	Choose <b>Setup</b> > <b>Service</b> > <b>Data Monitors</b> > <b>Vaporizer</b> to access the data monitoring screen and check the drive gas pressure of Vaporizer 1 (or Vaporizer 2).	The drive gas pressure is within 150±5 kPa.	Replace the electronic vaporizer.
		The drive gas pressure is beyond 150±5 kPa.	Adjust or replace the secondary pressure regulator (refer to 8.1.4).

#### 4.4.10 AGSS Failures

Failure Description	Cause Confirmation	Confirmation Result	Solution
No response from the float when the knob is adjusted during ventilation with AGSS ON	Check whether the AGSS accessories are connected properly.	AGSS accessories are not connected properly.	Connect the AGSS accessories properly.
	Check whether the hospital's waste gas scavenging system is normal.	The hospital's waste gas scavenging system is abnormal.	Properly connect to the waste gas scavenging system.
	Remove the AGSS	The sampling line	Reconnect the sampling

Failure Description	Cause Confirmation	Confirmation Result	Solution
	assembly by referring to 9.36 and check whether the sampling line of the AGSS sensor falls off.	of the AGSS sensor falls off.	line of the AGSS sensor.
		The sampling line of the AGSS sensor does not fall off.	(1) Reconnect the AGSS cable. (2) If the problem persists, replace the AGSS assembly and cable (refer to 8.1.14). (3) If the problem persists, replace the monitoring and controlling assembly (refer to 8.1.11).

#### 4.4.11 Auxiliary O2/Air and HFNC Module Failures

Failure Description	Cause Confirmation	Confirmation Result	Solution
Auxiliary O2/air or HFNC module startup failure (backlight of the segment display and flowmeter is off)	1. Turn on the auxiliary O2/air or HFNC module, power on the main unit, and check for the Aux O2/AIR Comm Stop or HFNC Comm Stop alarm in standby mode.	No Comm Stop alarm is generated.	(1) Reconnect or replace the cable between the auxiliary O2/air or HFNC module and the instrument panel.
		A Comm Stop alarm is generated.	(1) Reconnect or replace the cable between the auxiliary O2/air or HFNC module and the motherboard (refer to 8.1.4). (2) If the problem persists, replace the auxiliary O2/air or HFNC module (refer to 8.1.4). (3) If the problem persists, proceed with step 2.
	2. When the main unit is in standby mode, choose <b>Setup &gt; Service &gt; Data Monitors &gt; Power System</b> and check whether the voltage of the 12VB power supply falls within the normal range.	The 12VB power supply is abnormal.	Replace the DC-DC board (refer to 8.1.11).
		The 12VB power supply is normal.	(1) Reconnect or replace the cable between the auxiliary O2/air or HFNC module and the motherboard (refer to 8.1.4). (2) If the problem persists, replace the module (refer to 8.1.11).
Segment display error of the auxiliary O2/air or HFNC module (no	/	/	(1) Remove the auxiliary outlet (refer to 9.1.2) and reconnect the cable between the auxiliary O2/air or HFNC module

Failure Description	Cause Confirmation	Confirmation Result	Solution
display or display error, with normal backlight of the flowmeter)			and the instrument panel. (2) If the problem persists, remove the instrument panel (refer to 9.1.5) and reconnect the segment display to the status screen control board. (3) If the problem persists, replace the segment display (refer to 8.1.5). (4) If the problem persists, replace the auxiliary O <sub>2</sub> /air or HFNC module (refer to 8.1.4).
Failure to adjust the total flow or O <sub>2</sub> concentration of the auxiliary O <sub>2</sub> /air or HFNC module	Check whether the gas supply is connected properly (O <sub>2</sub> supply is required for the HFNC module), and is sufficient.	The O <sub>2</sub> supply pressure is less than 280 kPa.	Connect or replace the gas supply.
	Check whether the internal airway is connected properly. (Remove the auxiliary outlet by referring to 9.1.2.)	The internal pipeline falls off or leaks, with gas leaking sound.	Reconnect or replace the pipeline.
	Reconnect the encoder cable by referring to 9.57 (remove the instrument panel by referring to 9.1.5).	The parameters can be adjusted after the reconnection.	/
	Exchange the total flow encoder and O <sub>2</sub> concentration encoder to check whether the total flow encoder malfunctions (refer to 9.57).	After the exchange, the original abnormal parameters can be adjusted, but the original normal parameters cannot be adjusted.	Replace the flow encoder (refer to 8.1.5).
		The original abnormal parameters still cannot be adjusted after the exchange.	Replace the auxiliary O <sub>2</sub> /air or HFNC module (refer to 8.1.4).
Auto O <sub>2</sub> concentration or flow change of the auxiliary O <sub>2</sub> /air or HFNC module, with adjustment failure	Check whether the two gas supplies are connected properly and are sufficient.	The O <sub>2</sub> or air supply pressure is below 280 kPa.	Connect or replace the gas supply.
		Both gas supplies are insufficient.	(1) Reconnect the internal pipeline. (2) If the problem persists, replace the auxiliary O <sub>2</sub> /air or HFNC module (refer to 8.1.4).
No gas output of the auxiliary O <sub>2</sub> /air or HFNC module	Check whether the gas supply is sufficient.	The O <sub>2</sub> or air supply pressure is below 280 kPa.	Connect or replace the gas supply.
		The gas supply is sufficient.	(1) Reconnect the internal pipeline.

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Failure Description	Cause Confirmation	Confirmation Result	Solution
			(2) If the problem persists, replace the auxiliary O2/air or HFNC module (refer to 8.1.4).

## 4.5 After-Service Tests

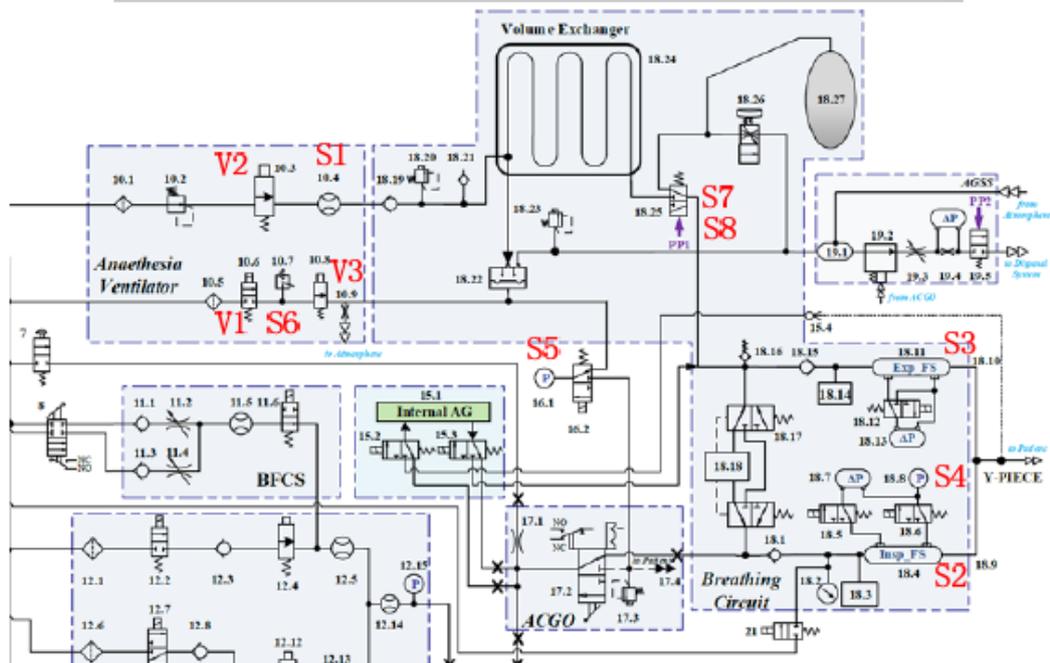
Different test items are required after different troubleshooting. Perform tests based on the requirements of each FRU described in **8 FRUs** after troubleshooting.

## 4.6 Diagnostic Tests

Choose **Setup > Service** from the main screen and enter the service password to access the **Diagnostic Tests** screen.

### 4.6.1 Valves Test

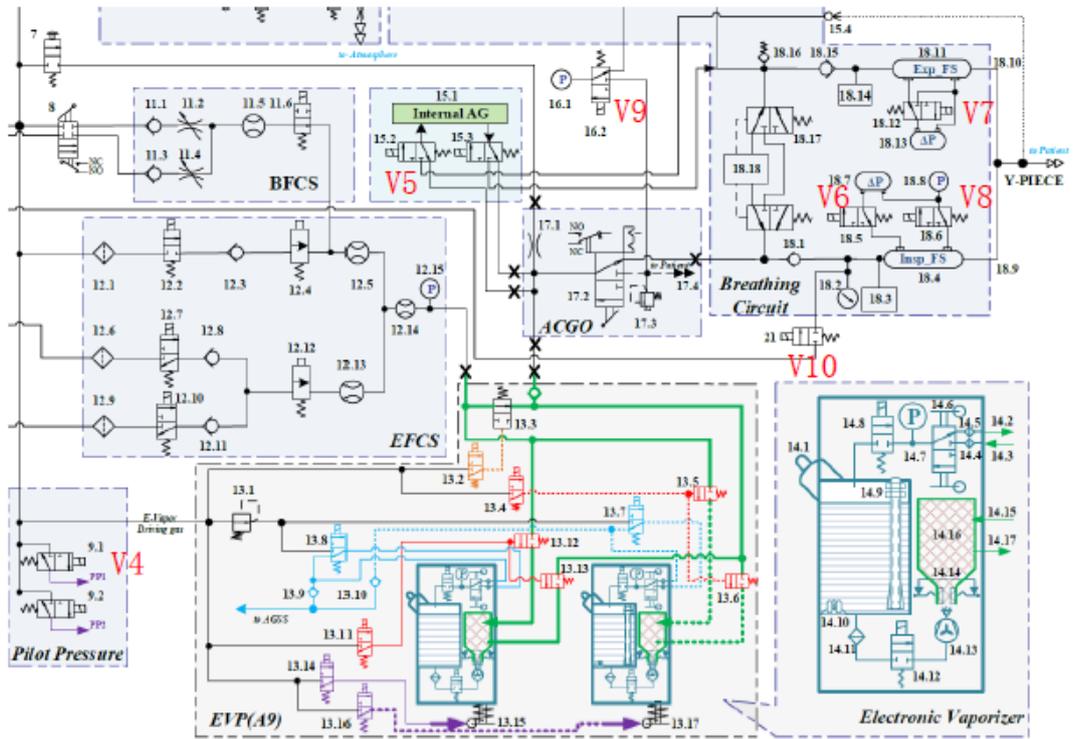
Valves		Valves Test			Valves Test		
	ITEM	COUNTS	ACTUAL	UNIT			
Insp Valve	Insp Flow Sensor	S1	---	L/min	Safety Valve	V1	On ▶
PEEP Valve	Insp Flow Sensor	S2	---	L/min	VPM Safety Valve	V1	On ▶
Safety Valve	Exp Flow Sensor	S3	---	L/min	Insp Valve Flow	V2	0.0 L/min /
FCS Tests	PW Sensor	S4	---	cmH2O	Insp Valve Current	V2	0 mA /
Vaporizer 1 Tests	PEEP Pressure	S5	---	cmH2O	PEEP Valve Pressure	V3	0.0 cmH2O /
Vaporizer 2 Tests	PEEP Valve Current	V3	---	mA	PEEP Valve Current	V3	0 mA /
Aux O2/AR	Insp Valve Current	V2	---	mA	Auto/Manual Valve		Auto ▶
HFNC	Drive Gas Pressure	S6	/	/	VPM Auto/Manual Valve		Auto ▶
Flow Sensor	Safety Valve VCM Status	V1	/	/	Time-Share Sample AG		Internal ▶
	Safety Valve VPM	-	-	-	Insp Flow 3-Way Zero Valve		NZero ▶



Valves		Valves Test			
	ITEM Status	COUNTS	ACTUAL	UNIT	
Insp Valve	Safety Valve VPM Status	V1	/	---	/
PEEP Valve	Auto/Manual Valve VCM Status	V4	/	---	/
Safety Valve	Auto/Manual Valve VPM Status	V4	/	---	/
FCS Tests	Auto/Manual Valve Switch 1	S7	/	---	/
Vaporizer 1 Tests	Auto/Manual Valve Switch 2	S8	/	---	/
Vaporizer 2 Tests	O2 Cal Valve Status	V11	/	---	/
Aux O2/AIR	Insp Flow 3-Way Zero Valve	V6	/	---	/
HFNC	Exp Flow 3-Way Zero Valve	V7	/	---	/
Flow Sensor	Airway Pressure 3-Way Zero Valve	V8	/	---	/

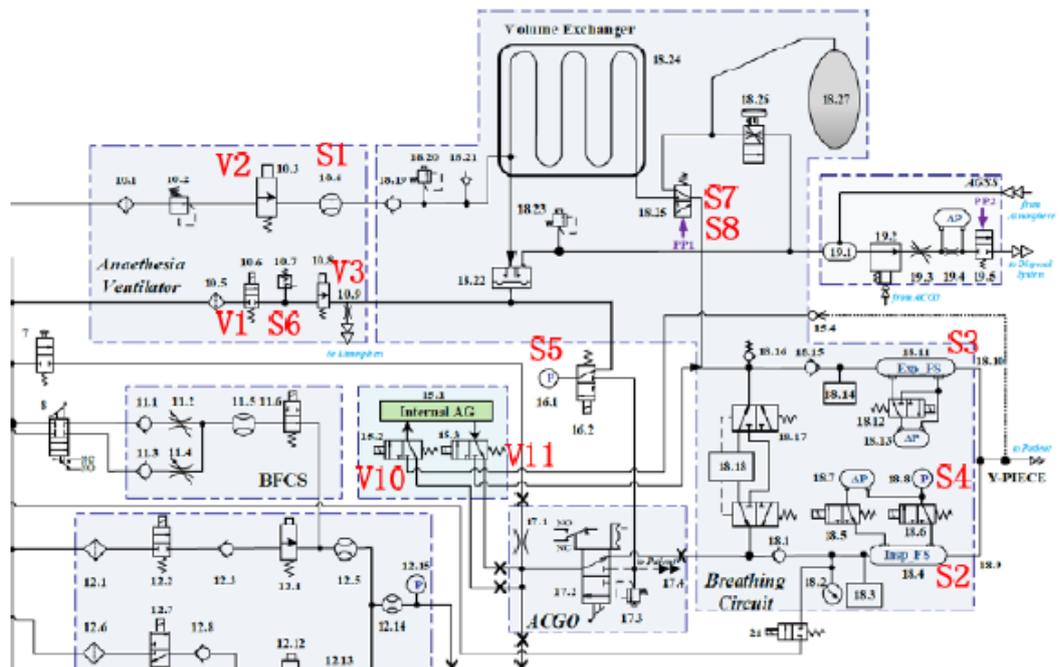
PEEP Valve Current	0 mA
Auto/Manual Valve	V4 Auto ▶
VPM Auto/Manual Valve	V4 Auto ▶
Time-Share Sample AG	V5 Internal ▶
Insp Flow 3-Way Zero Valve	V6 NZero ▶
Exp Flow 3-Way Zero Valve	V7 NZero ▶
Airway Pressure 3-Way Zero Valve	V8 NZero ▶
PEEP Pressure 3-Way Zero Valve	V9 NZero ▶
Pes Pressure 3-Way Zero Valve	NZero ▶
O2 Cal Valve	V10 OFF ▶



Service ✔

Calibrate    Data Monitors    **Diagnostic Tests**    Setup    Information

Values	Values Test					
	ITEM	COUNTS	ACTUAL	UNIT		
Insp Valve	Airway Pressure 3-Way Zero Valve	/	---	/	PEEP Valve Current	0 nA ✔
PEEP Valve	PEEP Pressure 3-Way Zero Valve	<b>V9</b>	---	/	Auto/Manual Valve	Auto ▶
Safety Valve	Res Pressure 3-Way Zero Valve	/	---	/	VPW Auto/Manual Valve	Auto ▶
FCS Tests	AG Valve 1 States	<b>V10</b>	---	/	Time-Share Sample AG	Internal ▶
Vaporizer 1 Tests	AG Valve 2 States	<b>V11</b>	---	/	Insp Flow 3-Way Zero Valve	NZero ▶
Vaporizer 2 Tests	YPM Insp Flow Sensor	<b>S2</b>	---	L/min	Exp Flow 3-Way Zero Valve	NZero ▶
Aux O2/AIR	YPM Exp Flow Sensor	<b>S3</b>	---	L/min	Airway Pressure 3-Way Zero Valve	NZero ▶
HFNC	YPM Airway Pressure Sensor	<b>S4</b>	---	cmH2O	PEEP Pressure 3-Way Zero Valve	NZero ▶
Flow Sensor	YPM PEEP Pressure sensor	<b>S5</b>	---	cmH2O	Res Pressure 3-Way Zero Valve	NZero ▶
					O2 Cal Valve	Off ▶



### 4.6.1.1 Ventilator Valve Control Status Diagnostic Test

- (1) Choose **Setup > Service > Diagnostic Tests > Valves** to access the **Valve Diagnostic Tests** screen.
- (2) Safety valve diagnostic test: If the safety valve is set to On, on the status bar on the left, both the safety valve states monitored by the VCM and VPM should be On. If the safety valve is set to Off, both the safety valve states monitored by the VCM and VPM should be Off. If the preceding requirements are not met, the safety valve is faulty.
- (3) PEEP valve diagnostic test: Set the current of the PEEP valve to 450 mA. The monitored current of the PEEP valve displayed on the left should fall within the range of 450±20 mA. If the preceding requirement is not met, the PEEP valve is faulty.
- (4) Inspiratory valve diagnostic test: Set the current of the inspiratory valve to 450 mA. The monitored current of the inspiratory valve displayed on the left should fall within the range of 450±20 mA. If the preceding requirement is not met, the inspiratory valve is faulty.

### 4.6.1.2 Flow Sensor Test

When no flow measurement device is available, check the flow sensors in the following way:

- (1) Remove the water collection cup (refer to 7.4.3).
- (2) Directly connect the inspiratory port to the expiratory port with a breathing hose.
- (3) As shown in the following figure, ensure that **Safety Valve** is **On** and that **Auto/Manual Valve** and **VPM Auto/Manual Valve** are **Auto**.
- (4) Set **PEEP Valve Pressure** to 100 cmH2O.
- (5) Set **Insp Valve Flow** to 10 L/min, 30 L/min, and 60 L/min in turn. Check whether the flows of **Int-Flow Sensor**, **Insp Flow Sensor**, and **Exp Flow Sensor** are consistent. If the difference between the flow of **Insp Flow Sensor/Exp Flow Sensor** and that of **Int-Flow Sensor** exceeds 1 L or 5%, whichever is greater, the measurement of the flow sensors is inaccurate.
- (6) Install the water collection cup after the test is complete.

Choose **Setup > Service > Diagnostic Tests > Valves**.

Service				
Diagnostic Tests				
Valves		Valves Test		
	ITEM	COUNTS	ACTUAL	UNIT
Insp Valve	Int-Flow Sensor	S1	---	L/min
PEEP Valve	Insp Flow Sensor	S2	---	L/min
Safety Valve	Exp Flow Sensor	S3	---	L/min
FCS Tests	PAW Sensor	S4	---	cmH2O
Vaporizer 1 Tests	PEEP Pressure	S5	---	cmH2O
Vaporizer 2 Tests	PEEP Valve Current	V3	---	mA
Aux O2/AIR	Insp Valve Current	V2	---	mA
HFNC	Drive Gas Pressure	S6	/	/
Flow Sensor	Safety Valve VCM Status	V1	/	/
	Safety Valve VPM			

Safety Valve	V1	On ▶
VPM Safety Valve	V1	On ▶
Insp Valve Flow	V2	0.0 L/min ✎
Insp Valve Current	V2	0 mA ✎
PEEP Valve Pressure	V3	0.0 cmH2O ✎
PEEP Valve Current	V3	0 mA ✎
Auto/Manual Valve		Auto ▶
VPM Auto/Manual Valve		Auto ▶
Time-Share Sample AG		Internal ▶
Insp Flow 3-Way Zero Valve		NZero ▶

### 4.6.1.3 Pressure Sensor Test

When no pressure measurement device is available, check the pressure sensors in the following way:

- 1) Directly connect the inspiratory port to the expiratory port with a breathing hose, or connect the patient circuit to the inspiratory port, expiratory port, and leak test plug in the same way as that in the leak test.
- 2) As shown in the following figure, ensure that **Safety Valve** is **On** and that **Auto/Manual Valve** and **VPM Auto/Manual Valve** are **Auto**.
- 3) Set **PEEP Valve Pressure** to 10 cmH2O, 30 cmH2O, 60 cmH2O, and 100 cmH2O in turn.
- 4) Set **Insp Valve Flow** to 100 L/min and check the values of **PEEP Pressure** and **PAW Sensor**.

If the difference between **PEEP Pressure** on the left and **PEEP Valve Pressure** exceeds 5 cmH2O or 5%, whichever is greater, the PEEP sensor or PEEP valve needs to be calibrated or replaced.

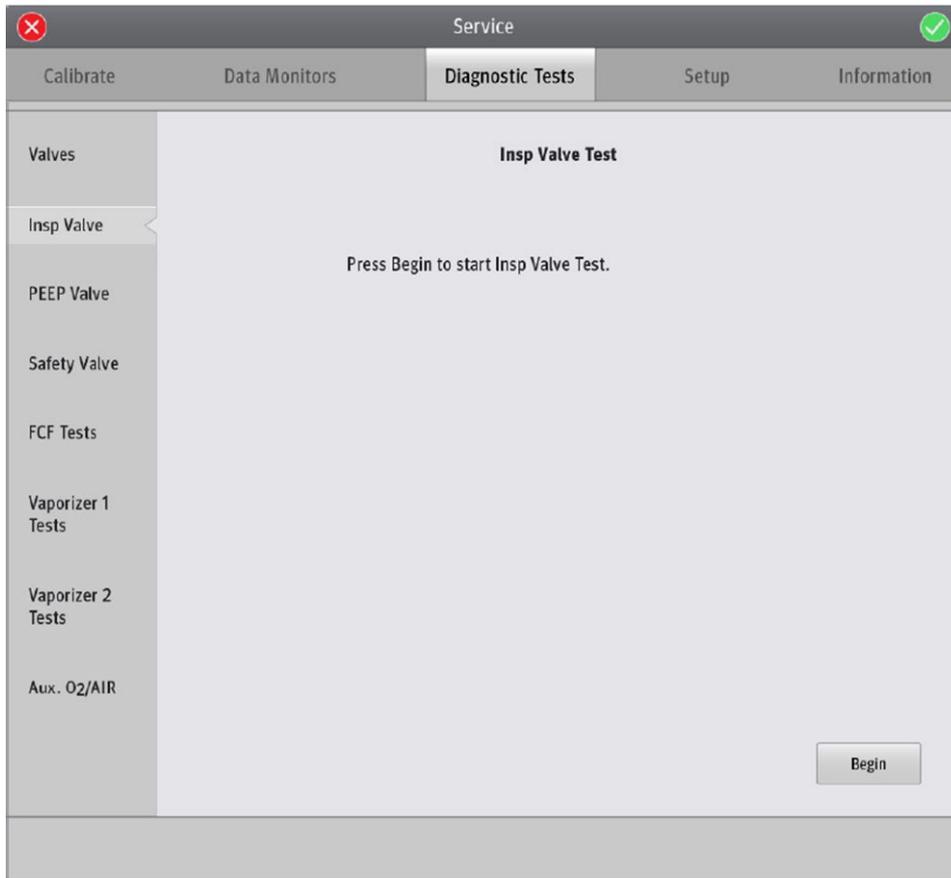
If **PEEP Pressure** is normal but the value of **PAW Sensor** is less than 20 cmH2O or 20%, whichever is greater, the Paw sensor needs to be calibrated or replaced

Valves					Valves Test		
	ITEM	COUNTS	ACTUAL	UNIT			
Insp Valve	Int-Flow Sensor	S1	---	L/min	Safety Valve	V1	On ▶
PEEP Valve	Insp Flow Sensor	S2	---	L/min	VPM Safety Valve	V1	On ▶
Safety Valve	Exp Flow Sensor	S3	---	L/min	Insp Valve Flow	V2	0.0 L/min ✓
FCS Tests	PAW Sensor	S4	---	cmH2O	Insp Valve Current	V2	0 mA ✓
Vaporizer 1 Tests	PEEP Pressure	S5	---	cmH2O	PEEP Valve Pressure	V3	0.0 cmH2O ✓
Vaporizer 2 Tests	PEEP Valve Current	V3	---	mA	PEEP Valve Current	V3	0 mA ✓
Aux O2/AIR	Insp Valve Current	V2	---	mA	Auto/Manual Valve		Auto ▶
HFNC	Drive Gas Pressure	S6	/	/	VPM Auto/Manual Valve		Auto ▶
Flow Sensor	Safety Valve VCM Status	V1	/	/	Time-Share Sample AG		Internal ▶
	Safety Valve VPM		.	.	Insp Flow 3-Way Zero Valve		NZero ▶

Choose **Setup** > **Service** > **Diagnostic Tests** > **Valves**.

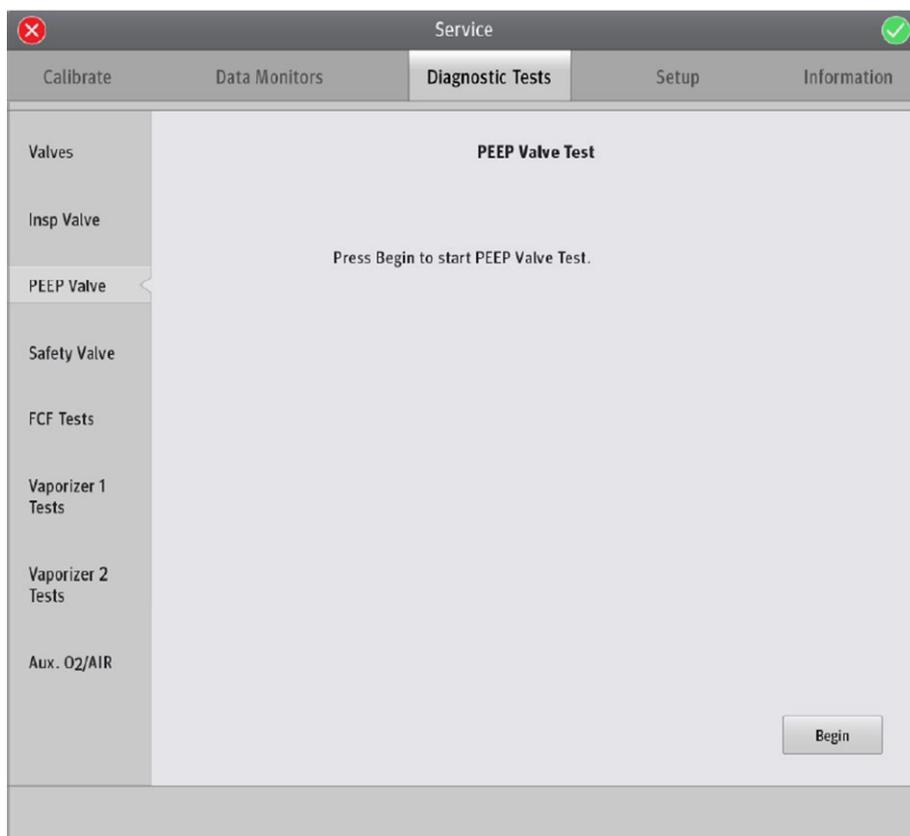
### 4.6.2 Insp Valve Test

Choose **Setup** > **Service** > **Diagnostic Tests** > **Insp Valve**.



### 4.6.3 PEEP Valve Test

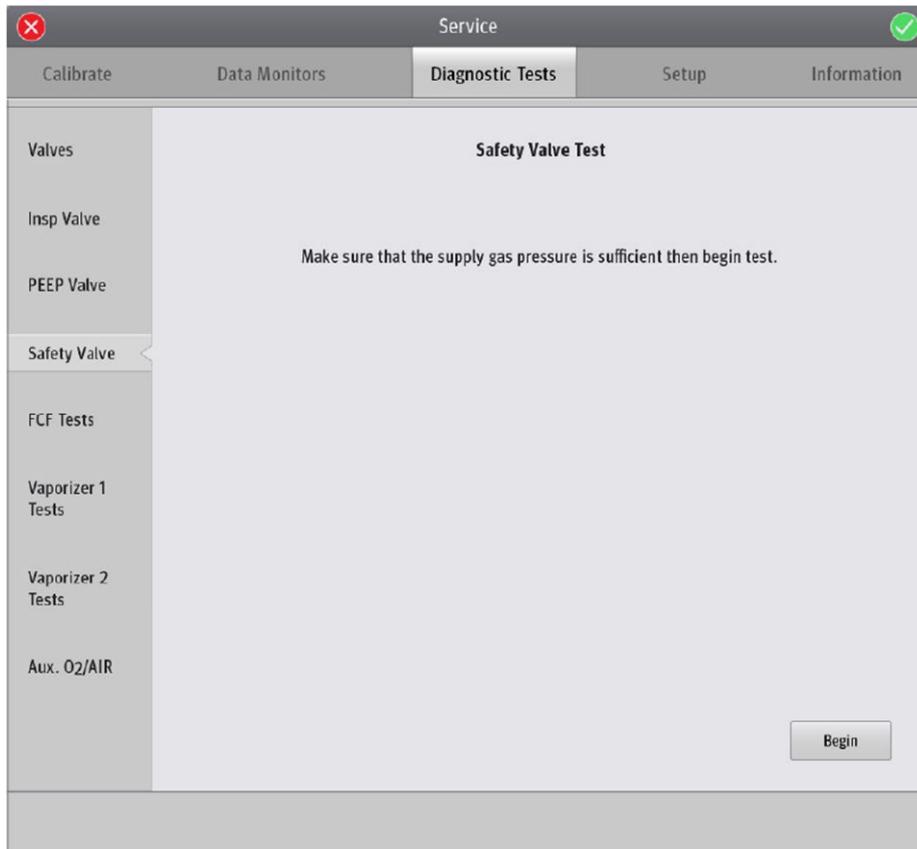
Choose **Setup > Service > Diagnostic Tests > PEEP Valve**.



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## 4.6.4 Safety Valve Test

Choose **Setup** > **Service** > **Diagnostic Tests** > **Safety Valve**.



## 4.6.5 FCS Tests

Choose **Setup** > **Service** > **Diagnostic Tests** > **FCS Tests**.

✖
Service
✔

Calibrate

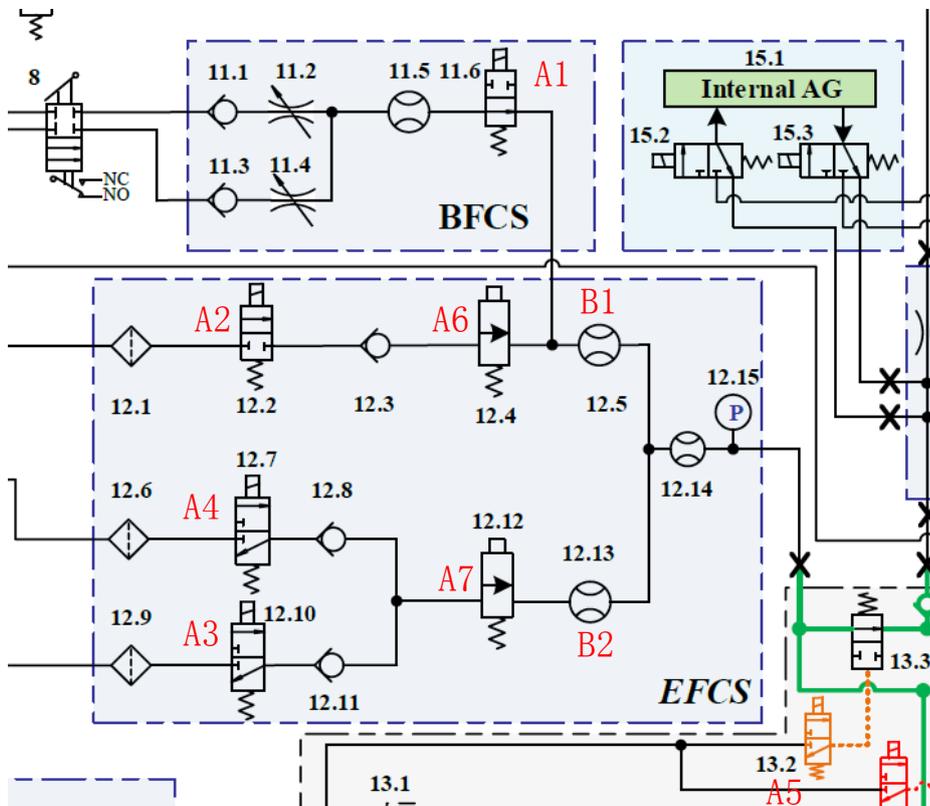
Data Monitors

**Diagnostic Tests**

Setup

Information

	ITEM	ACTUAL	UNIT						
Valves									
	Insp Valve	BFC3 2-Way Valve	A1	---	/	BFC3 2-Way Valve	A1	EFCS	▶
	PEEP Valve	O2 2-Way Valve	A2	---	/	O2 2-Way Valve	A2	Off	▶
Safety Valve									
		N2O 3-Way Valve	A3	---	/	N2O 3-Way Valve	A3	Off	▶
<b>FCS Tests</b>	Air 3-Way Valve	A4	---	/	Air 3-Way Valve	A4	Off	▶	
Vaporizer 1 Tests	Solenoid1	---	/		Solenoid1		Off	▶	
Vaporizer 2 Tests	Solenoid2	---	/		EFPM_Solenoid1		Off	▶	
Aux O2/AIR	Vaporizer BYPASS Pilot Valve	A5	---	/	Solenoid2		Off	▶	
HFNC	O2 Limb Flow	B1	---	L/min	EFPM_Solenoid2		Off	▶	
Flow Sensor					O2 Prop Valve Current	A6	0 mA	✂	
		Balance Limb Flow	B2	---	L/min	Balance Prop Valve Current	A7	0 mA	✂

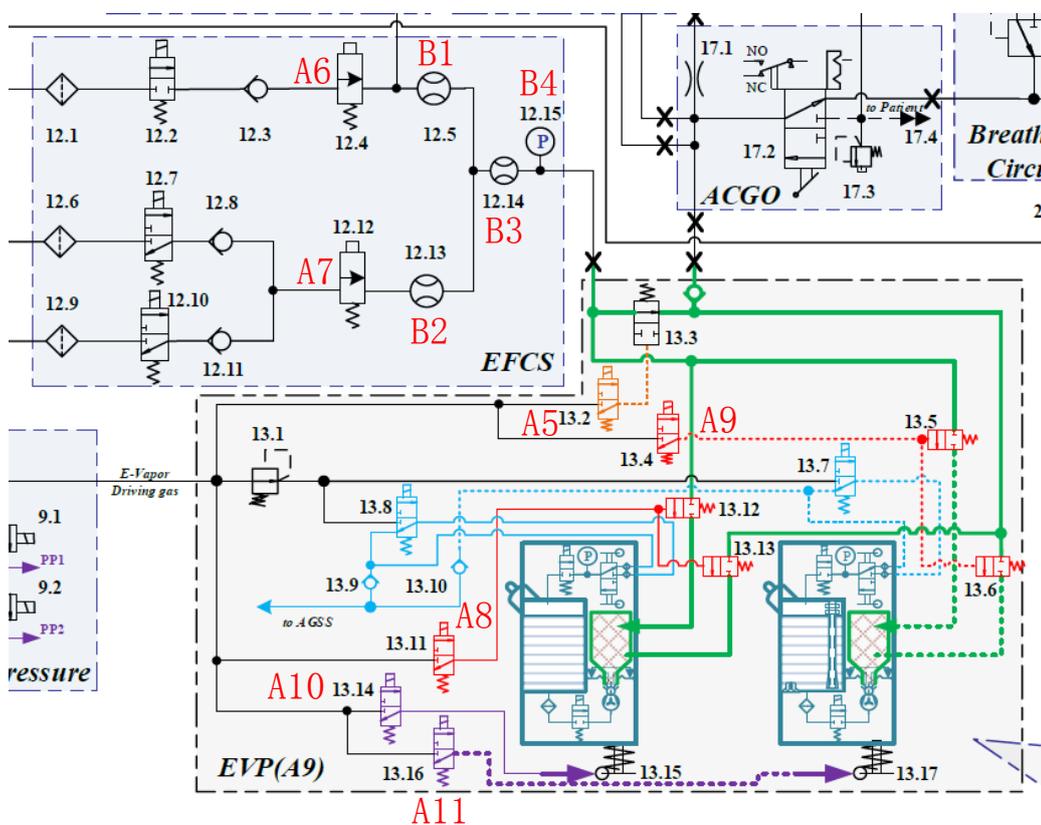


Service ✔

Calibrate    Data Monitors    **Diagnostic Tests**    Setup    Information

ITEM	ACTUAL	UNIT
Vaporizer BYPASS Pilot Valve	A5 ...	/
O2 Limb Flow	B1 ...	L/min
Balance Limb Flow	B2 ...	L/min
Total Flow	B3 ...	L/min
O2 Prop Valve Current	...	mA
Balance Prop Valve Current	...	mA
EFCS Outlet Pressure	B4 ...	cmH2O
Vaporizer1 Fresh Gas Pilot Valve	...	/
Vaporizer2 Fresh Gas Pilot Valve	...	/

EFPM_Solenoid1	Off ▶
Solenoid2	Off ▶
EFPM_Solenoid2	Off ▶
O2 Prop Valve Current	A6 0 mA ✔
Balance Prop Valve Current	A7 0 mA ✔
Vaporizer BYPASS Pilot Valve	A5 Off ▶
Vaporizer1 Fresh Gas Pilot Valve	A8 Off ▶
Vaporizer2 Fresh Gas Pilot Valve	A9 Off ▶
Vaporizer1 Pneumatic Lock Valve	A10 Off ▶
Vaporizer2 Pneumatic Lock Valve	A11 Off ▶



#### 4.6.5.1 FCS Tests

1. Properly connect the gas supply (O2, N2, and AIR), and let the machine enter the standby state.

- 
2. Choose **Setup > Service > Diagnostic Tests > FCS Tests** to access the FCS diagnostic test screen.
  3. Set the BFCS two-way valve to **EFCS** and **BFCS** in turn. On the status bar on the left, the BFCS two-way valve status should be consistent with the settings. Otherwise, the BFCS two-way valve is faulty.
  4. Set the O2 two-way valve to **On** and **Off** in turn. On the status bar on the left, the O2 two-way valve status should be consistent with the settings. Otherwise, the O2 two-way valve is faulty.
  5. Use the preceding method to test the N2O three-way valve and AIR three-way valve. If the monitored status is inconsistent with the settings, the corresponding three-way valve is faulty.
  6. Before the current of the O2 proportional valve is set, the current of the O2 proportional valve displayed on the status bar on the left should not be above 10 mA. Set the current of the O2 proportional valve to 300 mA, the current of the O2 proportional valve displayed on the status bar should fall within the range of 270-330 mA. Otherwise, the O2 proportional valve is faulty.
  7. Before the current of the balance gas proportional valve is set, the current of the balance gas proportional valve displayed on the status bar on the left should not be above 10 mA. Set the current of the balance gas proportional valve to 300 mA, the current of the balance gas proportional valve displayed on the status bar should fall within the range of 270-330 mA. Otherwise, the balance gas proportional valve is faulty.
  8. Set the BFCS two-way valve to **EFCS** and O2 two-way valve to **ON**, and ensure that both the N2O three-way valve and AIR three-way valve are in Off state. Set the current of the O2 proportional valve to 300 mA. The O2 limb flow and the total flow displayed on the left should be above 0.  
If both the O2 limb flow and the total flow are 0, the O2 two-way valve or the O2 proportional valve is faulty.  
If only the reading on one flowmeter is above 0, and the reading on the other flowmeter is the invalid value "---" or 0, the sensor that displays the invalid value or 0 is faulty.  
Or, if the difference between the values of two sensors is greater than 10% or 0.2 L/min, a sensor is faulty. In this case, perform step 9 to identify the faulty sensor.
  9. Set the BFCS two-way valve to **EFCS** and AIR three-way valve to **ON**, and ensure that both the O2 two-way valve and N2O three-way valve are in Off state. Set the current of the balance gas proportional valve to 300 mA. The balance gas limb flow and the total flow displayed on the left should be above 0.  
If both the balance gas limb flow and the total flow are 0, the AIR three-way valve or the balance gas proportional valve is faulty. If no flow is detected in step 10, the balance gas proportional valve is faulty. Otherwise, the AIR three-way valve is faulty.  
If only the reading on one flowmeter is above 0, and the reading on the other flowmeter is the invalid value "---" or 0, the sensor that displays the invalid value or 0 is faulty.  
Or, if the difference between the values of two sensors is greater than 10% or 0.2 L/min, a sensor is faulty. Compare the result with that in step 8. If the total flow is relatively large or small in both tests, the total flow sensor is faulty. Otherwise, the limb sensor is faulty.
  10. Set the BFCS two-way valve to **EFCS** and N2O three-way valve to **ON**, and ensure that both the O2 two-way valve and AIR three-way valve are in Off state. Set the current of the balance gas proportional valve to 300 mA. The balance gas limb flow and the total flow displayed on the left should be above 0.  
If the sensors indicate that no flow is detected, the N2O three-way valve or the balance gas proportional valve is faulty.  
If no flow is detected in step 9, the balance gas proportional valve is faulty. Otherwise, the N2O three-way valve is faulty.

#### 4.6.5.2 BFCS Failure Test

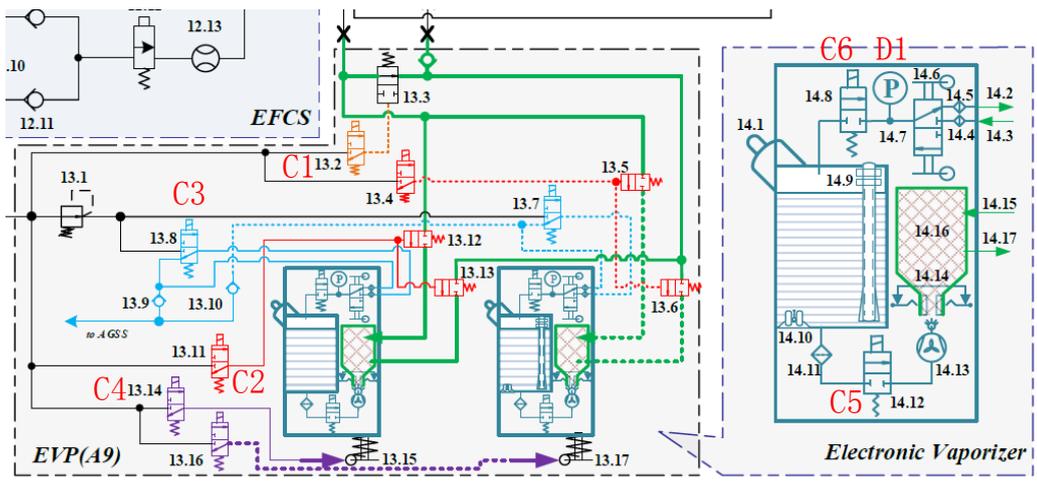
1. Properly connect the gas supply (O2 and AIR), and let the machine enter the standby state.
2. Choose **Setup > Service > Data Monitors > FCS** to access the flowmeter data monitoring screen. Open and close the BFCS door in turn, and observe the status of BFCS Door Switch 1 and BFCS Door Switch 2. A BFCS door switch is faulty if (a) the BFCS door is closed, but one of BFCS Door Switch 1 and BFCS Door Switch 2 is in On state; (b) the BFCS door is

- 
- opened, but one of BFCS Door Switch 1 and BFCS Door Switch 2 is in Off state;.
3. Choose **Setup > Service > Diagnostic Tests > FCS Tests** to access the FCS diagnostic test screen.
  4. Set the BFCS two-way valve to **EFCS**, and ensure that the O2 two-way valve, N2O three-way valve and AIR three-way valve are in Off state. The O2 limb flow and the total flow displayed on the left should not be above 0.1 L/min. Otherwise, the BFCS two-way valve is faulty.
  5. Set the BFCS two-way valve to **BFCS**, and ensure that the O2 two-way valve, N2O three-way valve and AIR three-way valve are in Off state. The O2 limb flow and the total flow displayed on the left should be above 0.5 L/min. If the flow is below 0.5 L/min, open the BFCS door, and adjust the O2 needle valve anti-clockwise. If the flow increases when the O2 need valve is adjusted, the O2 needle valve is faulty. Otherwise, the BFCS two-way valve is faulty.
  6. Check whether Electromagnet 1 and Electromagnet 2 are in Off state. If one or two electromagnets are in On state, the corresponding electromagnets are faulty.
  7. Set Electromagnet 1 and EFPM Electromagnet 1 to On. The state of Electromagnet 1 displayed on the left should change to On for 1s and then change to Off. Otherwise, Electromagnet 1 is faulty.
  8. Set Electromagnet 2 and EFPM Electromagnet 2 to On. The state of Electromagnet 2 displayed on the left should change to On for 1s and then change to Off. Otherwise, Electromagnet 2 is faulty.

#### **4.6.6 Vaporizer Tests**

Choose **Setup > Service > Diagnostic Tests > Vaporizer 1 Test** or **Vaporizer 2 Test**.

Service							
Calibrate		Data Monitors		Diagnostic Tests		Setup	
Valves		Manual Test			Automatic Test		
	ITEM	COUNTS	ACTUAL	UNIT			
Insp Valve	Vaporizer BYPASS Pilot Valve	C1	/	---	/	Vaporizer BYPASS Pilot Valve	C1 Off ▶
PEEP Valve	Fresh Gas Pilot Valve Status	C2	/	---	/	Fresh Gas Pilot Valve Status	C2 Off ▶
Safety Valve	Drive Gas Valve Status	C3	/	---	/	Drive Gas Valve Status	C3 Off ▶
FCS Tests	Pneumatic Lock Status	C4	/	---	/	Pneumatic Lock Status	C4 Off ▶
	Pneumatic Lock Switch		/	---	/	Drug Tank Switch	C6 Off ▶
Vaporizer 1 Tests	Bottom Safety Valve	C5	/	Off	/	Bottom Safety Valve	C5 Off ▶
Vaporizer 2 Tests	Drug Tank Switch	C6	/	Off	/	Heating Foil	Off ▶
Aux O2/AIR	Drive Gas Pressure	D1	0	0.00	kPa		
HFNC	Heating Temp Sensor 1	0	0.00	°C			
Flow Sensor	Heating Temp Sensor 2	0	0.00	°C			



Service

Calibrate    Data Monitors    **Diagnostic Tests**    Setup    Information

---

Valves    Manual Test    Automatic Test

ITEM	COUNTS	ACTUAL	UNIT
Insp Valve	AGSS Pilot Valve <b>C7</b>	/	---
PEEP Valve	AGSS Pump Rate <b>D3</b>	---	L/min
Safety Valve	Internal AG Real Time <b>D4</b>	---	%
	External AG Real Time	---	%
FCS Tests	O2 Limb Flow <b>D2</b>	---	L/min
	Injector Inject Times	0	0.00 /min
Vaporizer 1 Tests	Injector Open Valve Time	0	0.00 ms
	Injector Close Valve Time	0	0.00 ms
Vaporizer 2 Tests	Injector Open Valve Time	0	0.00 ms
	Injector Close Valve Time	0	0.00 ms
Aux O2/AIR	Vaporizer BYPASS Pilot Valve <b>C1</b>	/	---
	Fresh Gas Pilot Valve Status <b>C2</b>	/	---
HFNC	Drive Gas Valve Status <b>C3</b>	/	---

Prepare:

1. Set Auto/Manual switch to Auto position.
2. Plug the wye piece into the leak test port to seal the breathing system.
3. Make sure scavenger is connected.

AGSS    **C7**    Off ▶

**FRESH GAS SETTING**

O2 Limb Flow    **C8**    0 L/min /

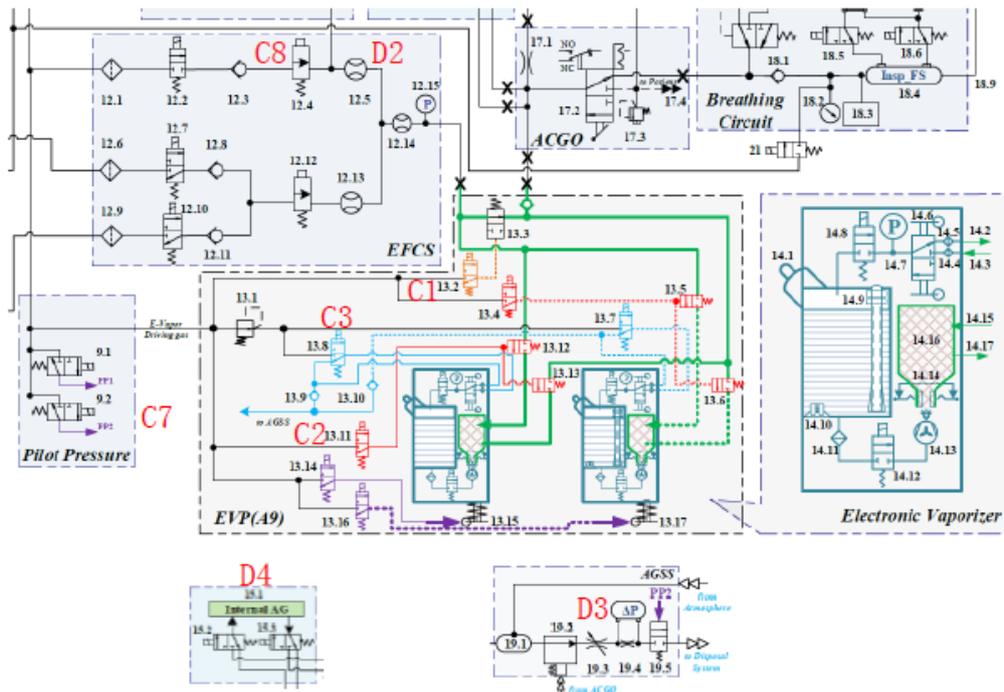
**AA SETTING**

AA%    0 % /

Injector Open Valve Time    0.00    ms

Injector Close Valve Time    0.00    ms

Injector Inject Times    0.00    /min



Service
⊗
⊙

Calibrate
Data Monitors
Diagnostic Tests
Setup
Information

Valves

Insp Valve

PEEP Valve

Safety Valve

FCS Tests

**Vaporizer 1 Tests**

Vaporizer 2 Tests

Aux O2/AIR

HFNC

Flow Sensor

ITEM	COUNTS	ACTUAL	UNIT
AGSS Pilot Valve	C7	/	---
AGSS Pump Rate	D3	---	L/min
Internal AG Real Time	D4	---	%
External AG Real Time	---	---	%
O2 Limb Flow	D2	---	L/min
Injector Inject Times	0	0.00	/min
Injector Open Valve Time	0	0.00	ms
Injector Close Valve Time	0	0.00	ms
Vaporizer BYPASS Pilot Valve	C1	/	---
Fresh Gas Pilot Valve Status	C2	/	---
Drive Gas Valve Status	C3	/	---

Prepare:

- Set Auto/Manual switch to Auto position.
- Plug the wye piece into the leak test port to seal the breathing system.
- Make sure scavenger is connected.

AGSS C7 OFF ▶

**FRESH GAS SETTING**

O2 Limb Flow C8 0 L/min ↗

**AA SETTING**

AA% 0 % ↗

Injector Open Valve Time 0.00 ms

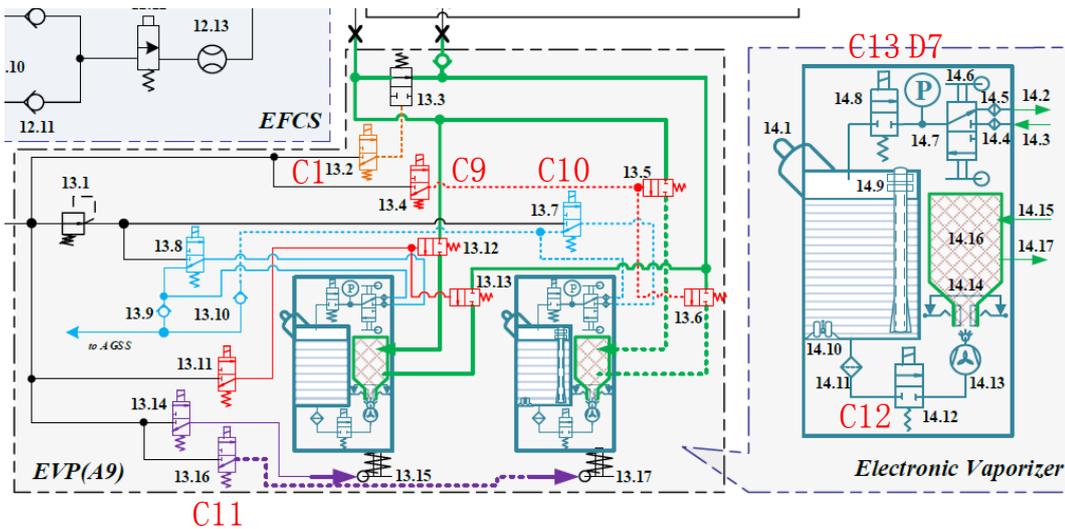
Injector Close Valve Time 0.00 ms

Injector Inject Times 0.00 /min

The diagram illustrates the complex piping and control systems of the breathing apparatus. It shows the flow of gases from the ACGO (Ambient Gas Control) through various valves and sensors (C1-C8, D2-D4) to the Electronic Vaporizer (EVP) and the Breathing Circuit. The EFCS (Electronic Flow Control System) and Pilot Pressure sections are also detailed, showing how they interact with the main gas flow. The diagram uses color-coded lines to trace the paths of different gas streams and control signals.

4-68

Service							
Calibrate		Data Monitors		Diagnostic Tests		Setup	
Valves	Manual Test			Automatic Test			
	ITEM	COUNTS	ACTUAL	UNIT			
Insp Valve	Vaporizer BYPASS Pilot Valve	C1	/	---	/	Vaporizer BYPASS Pilot Valve	C1 Off ▶
PEEP Valve	Fresh Gas Pilot Valve Status	C9	/	---	/	Fresh Gas Pilot Valve Status	C9 Off ▶
Safety Valve	Drive Gas Valve Status	C10	/	---	/	Drive Gas Valve Status	C10 Off ▶
FCS Tests	Pneumatic Lock Status	C11	/	---	/	Pneumatic Lock Status	C11 Off ▶
Vaporizer 1 Tests	Pneumatic Lock Switch		/	---	/	Drug Tank Switch	C13 Off ▶
	Bottom Safety Valve	C12	/	Off	/	Bottom Safety Valve	C12 Off ▶
<b>Vaporizer 2 Tests</b>	Drug Tank Switch	C13	/	Off	/	Heating Foil	Off ▶
Aux O2/AIR	Drive Gas Pressure	D7	0	0.00	kPa		
HFNC	Heating Temp Sensor 1		0	0.00	°C		
	Heating Temp Sensor 2		0	0.00	°C		
Flow Sensor							



Service

Calibrate    Data Monitors    **Diagnostic Tests**    Setup    Information

Manual Test
Automatic Test

Valves	ITEM	COUNTS	ACTUAL	UNIT
Insp Valve	AGSS Pilot Valve	C7	/	---
PEEP Valve	AGSS Pump Rate	D3	---	L/min
Safety Valve	Internal AG Real Time	D4	---	%
FCS Tests	External AG Real Time	---	---	%
Vaporizer 1 Tests	O2 Limb Flow	D2	---	L/min
Vaporizer 2 Tests	Injector Inject Times	0	0.00	/min
	Injector Open Valve Time	0	0.00	ms
Aux O2/AIR	Injector Close Valve Time	0	0.00	ms
HFNC	Vaporizer BYPASS Pilot Valve	C1	/	---
Flow Sensor	Fresh Gas Pilot Valve Status	C9	/	---
	Drive Gas Valve Status	C10	/	---

Prepare:

1. Set Auto/Manual switch to Auto position.
2. Plug the wye piece into the leak test port to seal the breathing system.
3. Make sure scavenger is connected.

AGSS C7    Off ▶

**FRESH GAS SETTING**

O2 Limb Flow C8    0 L/min /

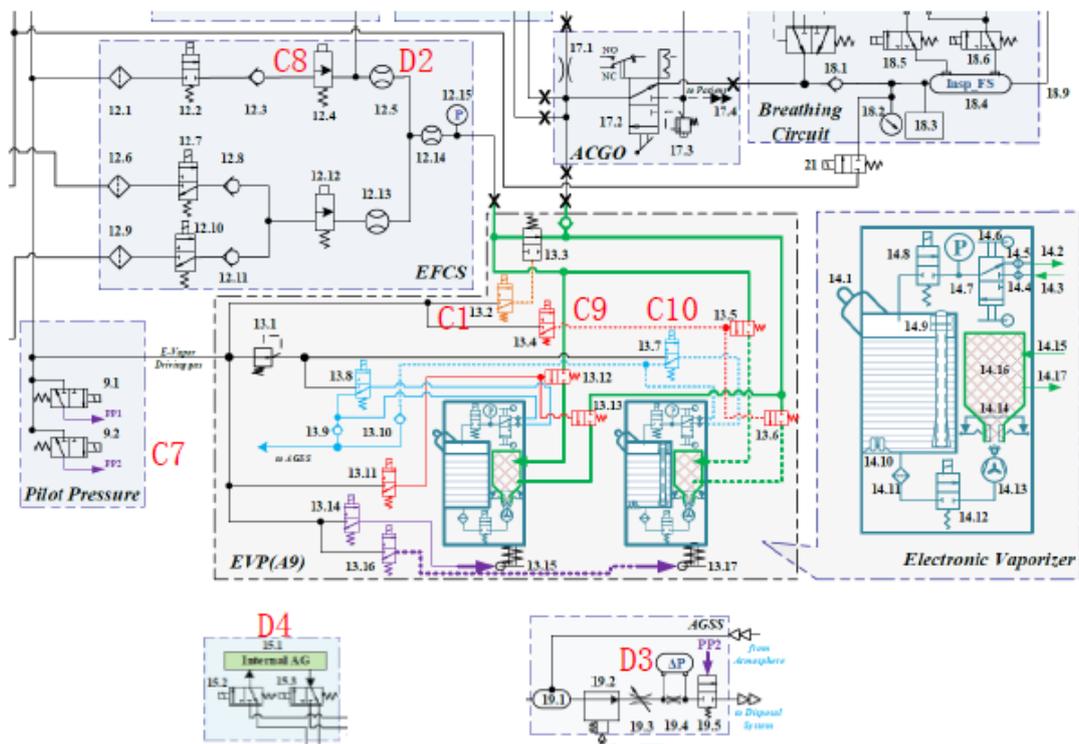
**AA SETTING**

AA%    0 % /

Injector Open Valve Time    0.00    ms

Injector Close Valve Time    0.00    ms

Injector Inject Times    0.00    /min



Service

Calibrate    Data Monitors    **Diagnostic Tests**    Setup    Information

Valves	Manual Test			Automatic Test		
	ITEM	COUNTS	ACTUAL	UNIT		
Insp Valve	Drive Gas Valve Status	<b>C10</b>	---	/		
PEEP Valve	Pneumatic Lock Status	<b>C11</b>	---	/		
Safety Valve	Pneumatic Lock Switch	/	---	/		
	Bottom Safety Valve	<b>C12</b>	Off	/		
FCS Tests	Drug Tank Switch	<b>C13</b>	Off	/		
Vaporizer 1 Tests	Drive Gas Pressure	<b>D7</b>	0	0.00	kPa	
Vaporizer 2 Tests	Heating Temp Sensor 1	0	0.00	°C		
	Heating Temp Sensor 2	0	0.00	°C		
Aux O2/AIR	Lid Switch	/	Off	/		
HFNC	Single Point Liquid Level	<b>D8</b>	/	No	/	
Flow Sensor	Liquid Level	<b>D9</b>	0	0.00	mm	

Prepare:

1. Set Auto/Manual switch to Auto position.
2. Plug the wye piece into the leak test port to seal the breathing system.
3. Make sure scavenger is connected.

AGSS    **C7**    Off ▾

**FRESH GAS SETTING**

O2 Limb Flow    **C8**    0 L/min ▾

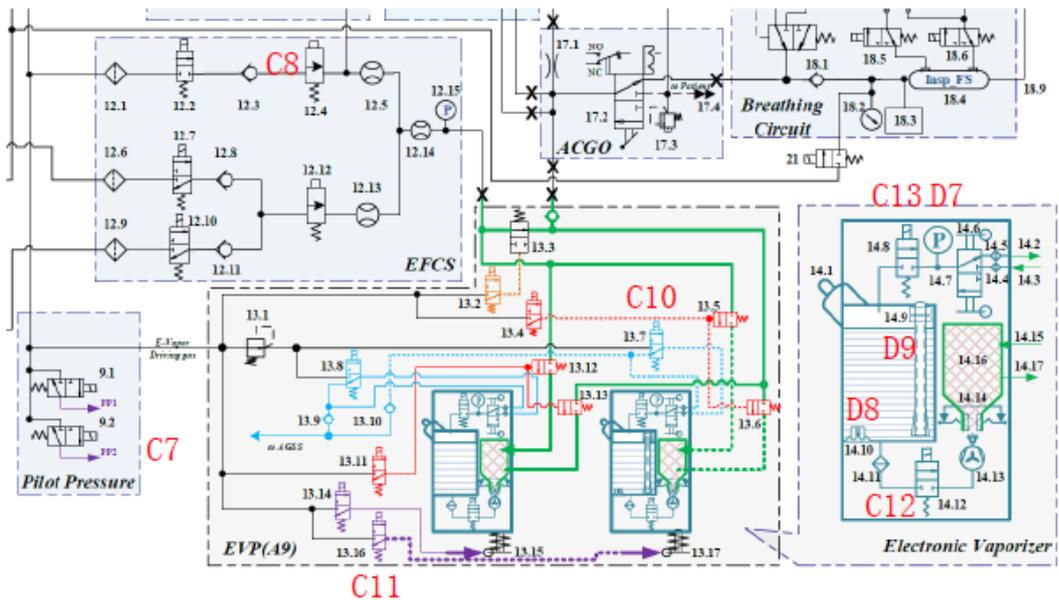
**AA SETTING**

AA%    0% ▾

Injector Open Valve Time    0.00    ms

Injector Close Valve Time    0.00    ms

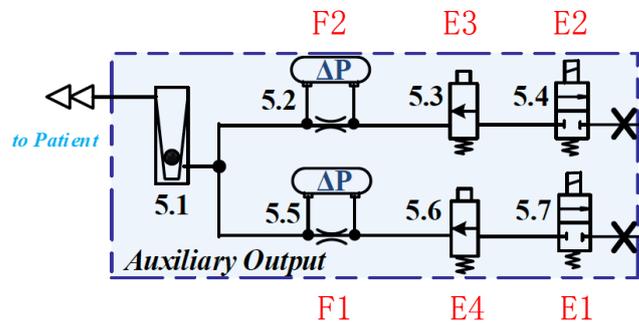
Injector Inject Times    0.00    /min



## 4.6.7 Aux O2/AIR Test

Choose **Setup** > **Service** > **Diagnostic Tests** > **Aux O2/AIR**.

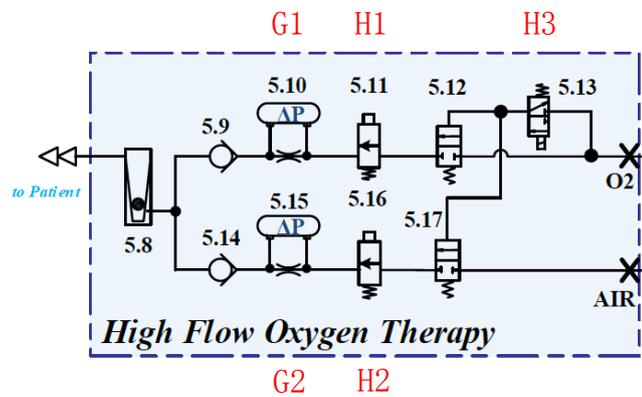
		Service				
		Calibrate	Data Monitors	Diagnostic Tests	Setup	Information
		Auxiliary O2/AIR Test				
		ITEM	ACTUAL	UNIT		
Insp Valve	Air 3-Way Valve	E1 ...	/	Air Prop Valve Current	E4	0 mA ✓
PEEP Valve	O2 3-Way Valve	E2 ...	/	O2 Prop Valve Current	E3	0 mA ✓
Safety Valve	Air Limb Flow	F1 ...	L/min	Air 3-Way Valve	E1	Off ▶
FCS Tests	O2 Limb Flow	F2 ...	L/min	O2 3-Way Valve	E2	Off ▶
Vaporizer 1 Tests	O2 Limb Pressure Difference	F2 ...	Pa			
Vaporizer 2 Tests	Air Limb Pressure Difference	F1 ...	Pa			
<b>Aux O2/AIR</b>	O2 Prop Valve Current	E3 ...	mA			
HFNC	Air Prop Valve Current	E4 ...	mA			
Flow Sensor						



## 4.6.8 HFNC Test

Choose **Setup** > **Service** > **Diagnostic Tests** > **HFNC**.

Service				
Calibrate	Data Monitors	Diagnostic Tests	Setup	Information
<b>HFNC Test</b>				
Valves	ITEM	ACTUAL	UNIT	
Insp Valve	O2 Limb Flow	G1 ...	L/min	Air Prop Valve Current H2 0 mA ✓
	Air Limb Flow	G2 ...	L/min	O2 Prop Valve Current H1 0 mA ✓
PEEP Valve	O2 Prop Valve Current	H1 ...	mA	3-Way Pilot Valve H3 Off ▶
	Air Prop Valve Current	H2 ...	mA	
Safety Valve	3-Way Pilot Valve	H3 ...	/	
	O2 Supply Pressure	G3 ...	/	
FCS Tests	O2 Limb Pressure Difference	G1 ...	Pa	
	Air Limb Pressure Difference	G2 ...	Pa	
Vaporizer 1 Tests				
Vaporizer 2 Tests				
Aux O2/AIR				
Flow Sensor				



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**FOR YOUR NOTES**

# 5 Software Function Activation

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The functions in the following table can be activated. If you need to activate one of the following functions, contact the manufacturer to apply for the activation code.

Functions That Can Be Activated	Description
PCV	Pressure control ventilation
PCV-VG	Pressure regulated volume control (PRVC) ventilation
SIMV-PC	Synchronized intermittent mandatory ventilation - pressure control
SIMV-VC	Synchronized intermittent mandatory ventilation - volume control
SIMV-VG	Synchronized intermittent mandatory ventilation - volume control
APRV	Airway pressure release ventilation
Bypass	CPB
Spirometry	Spirometry loop
Recruitment	Lung recruitment
Optimizer	Optimal flow
CPAP/PS	Continuous positive airway pressure/pressure support ventilation
AMV	Adaptive minute ventilation
Prediction	Anesthesia prediction
AgentUsage	Anesthesia calculation
TCA	ACA
PS	Pressure support ventilation

## 5.1 Application of Software Function Activation Codes

### NOTE

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- Provide the following information of the anesthesia machine when applying for an activation code: machine ID, current configurations, and functions to be activated.
- 

If you need to activate functions listed in the above table, contact the service department of Mindray to apply for the activation codes. Detailed steps are as follows:

1. Record the anesthesia machine SN.
2. Choose **Main > System > Information** to access the **Information** menu. Record the machine ID and current configurations of the anesthesia machine.

System				
Calibrate	Setup	Profiles	Network	Information
Machine ID	12345678901234			
MAC	30:9c:23:51:d9:d5			
Function	STATUS			
VCV	Activated			
PCV	Inactivated			
PCV-VG	Inactivated			
SIMV-VC	Inactivated			
SIMV-PC	Inactivated			
SIMV-VG	Inactivated			
PS	Inactivated			
CPAP/PS	Inactivated			
APRV	Inactivated			
AMV	Inactivated			
Bypass	Inactivated			
Spirometry	Inactivated			
Recruitment	Inactivated			
Prediction	Inactivated			
Agent Usage	Inactivated			
Optimizer	Inactivated			
ACA	Inactivated			

- Record the functions that need to be activated and search for the P/N.
- Provide the information above for the service department of Mindray when you issue a software function upgrade order.

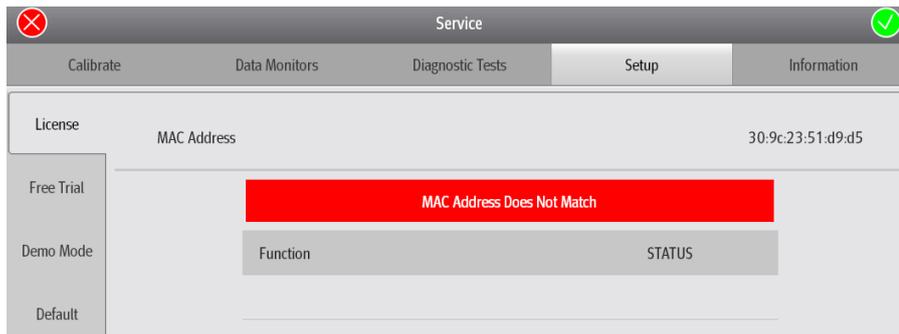
## 5.2 Activation Procedure

### NOTE

- Record the current configurations and functions to be activated before activation.
- Prepare the function configurations to be added for the corresponding model and save it to a USB drive.
- When you prepare the function configurations to be activated via a USB drive, ensure that the MAC address is the same as that of the to-be-upgraded machine; otherwise, activation will fail.

Perform the following steps to activate the function configurations via a USB drive:

- Create the **PMLS** folder under the root directory of the USB drive. Create a folder named after the MAC address of the machine under the **PMLS** folder.
- Place the prepared function activation file under the folder named after the MAC address of the machine.
- Insert the USB drive in the machine on which the function configurations need to be activated. Access the **License** menu as follows: Choose **Main** > **Service**, enter the correct password, and choose **Setup** > **License**, as shown below:



4. Click **Install** to activate the function configurations via the USB drive. When the activation is completed, the system displays "New functions activated, please restart! "

### **NOTE**

- **Ensure the anesthesia machine is powered on before the activation is completed or an error message appears; otherwise, the BIOS program of the CPU board on the anesthesia machine will be damaged.**
  - **After the activation success message is displayed, restart the anesthesia machine for the new functions to take effect.**
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**FOR YOUR NOTES**

# 6 Theory of Operation

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## 6.1 System Overview

### 6.1.1 Introduction

The A8/A9 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 A8/A9 Anesthesia System provides the following ventilation modes:

- Volume Control Ventilation (VCV)
- Pressure Control Ventilation (PCV)
- Pressure Control Ventilation - Volume Guarantee (PCV-VG)
- Synchronized Intermittent Mandatory Ventilation - Volume Control (SIMV-VC)
- Synchronized Intermittent Mandatory Ventilation - Pressure Control (SIMV-PC)
- Synchronized Intermittent Mandatory Ventilation - Volume Guarantee (SIMV-VG)
- Continuous Positive Airway Pressure/Pressure Support (CPAP/PS)
- Airway Pressure Release Ventilation (APRV)
- Adaptive Minute Ventilation (AMV)
- Spontaneous ventilation in Manual mode with the Airway Pressure Limit (APL) fully open
- Manual Ventilation through the use of a breathing bag
- Electronic Positive End Expiratory Pressure (PEEP) is available in all ventilation modes. Control over inspiratory flow (Tslope) is possible in PCV, SIMV, and PS modes. Automatic fresh gas compensation helps patients suffer less from manual changes in fresh gas flow rate. The traditional bellows system is driven by gas and makes patient ventilation clearly visible.

The A8/A9 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 O<sub>2</sub> flow meter is placed on the upper left to make it convenient to read the O<sub>2</sub> flow rate. The O<sub>2</sub> flush button is in the traditional position near the front left corner of the table top.

Safety systems within the A8/A9 work to prevent hypoxic mixtures from being delivered to the patient. Nitrous oxide will not be delivered unless oxygen pressure is present. The O<sub>2</sub> ratio controller (ORC) of a mechanical safety system ensures that the oxygen content in the gas mixture exceeds 21%.

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The heating system of the A8/A9 patient breathing circuit minimizes condensed water and sends 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. An O<sub>2</sub> sensor is used to monitor the inspired oxygen concentration. 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 A8/A9.

When the A8/A9 uses AC power supply, the A8/A9 power management system supplies power for its main system while charging its internal battery. In case of an AC power failure, the A8/A9 operates on battery power. The main system switch can power on and off the system. The four auxiliary AC sockets on the A8/A9 at the rear of the machine operate independent of the main system switch.

## **NOTE**

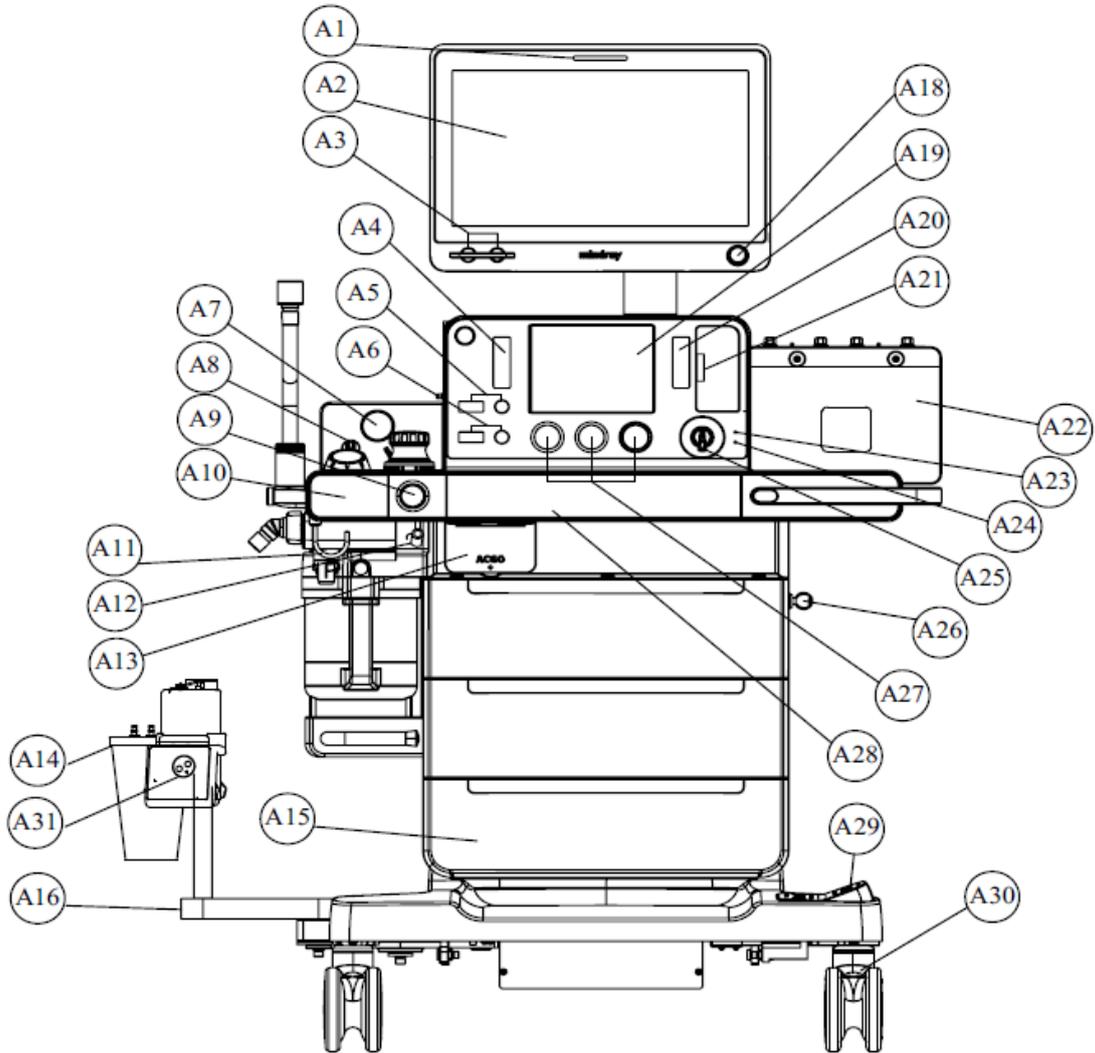
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- **The heater for the patient breathing circuit system does not operate when the A8/A9 is working on battery power.**
-

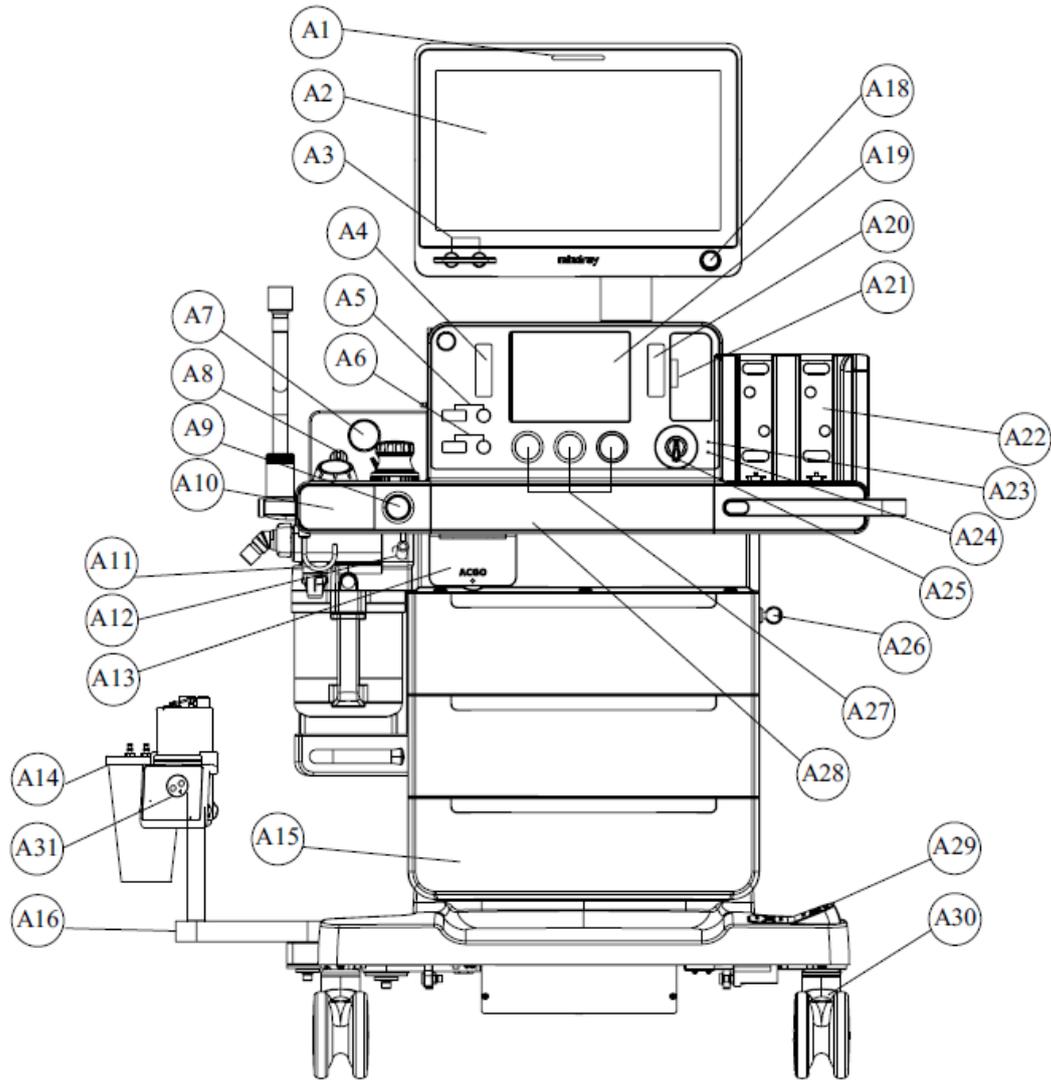
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## 6.1.2 Appearance

### 6.1.2.1 Main Unit (Front View)



Front view of the A8 anesthesia machine.



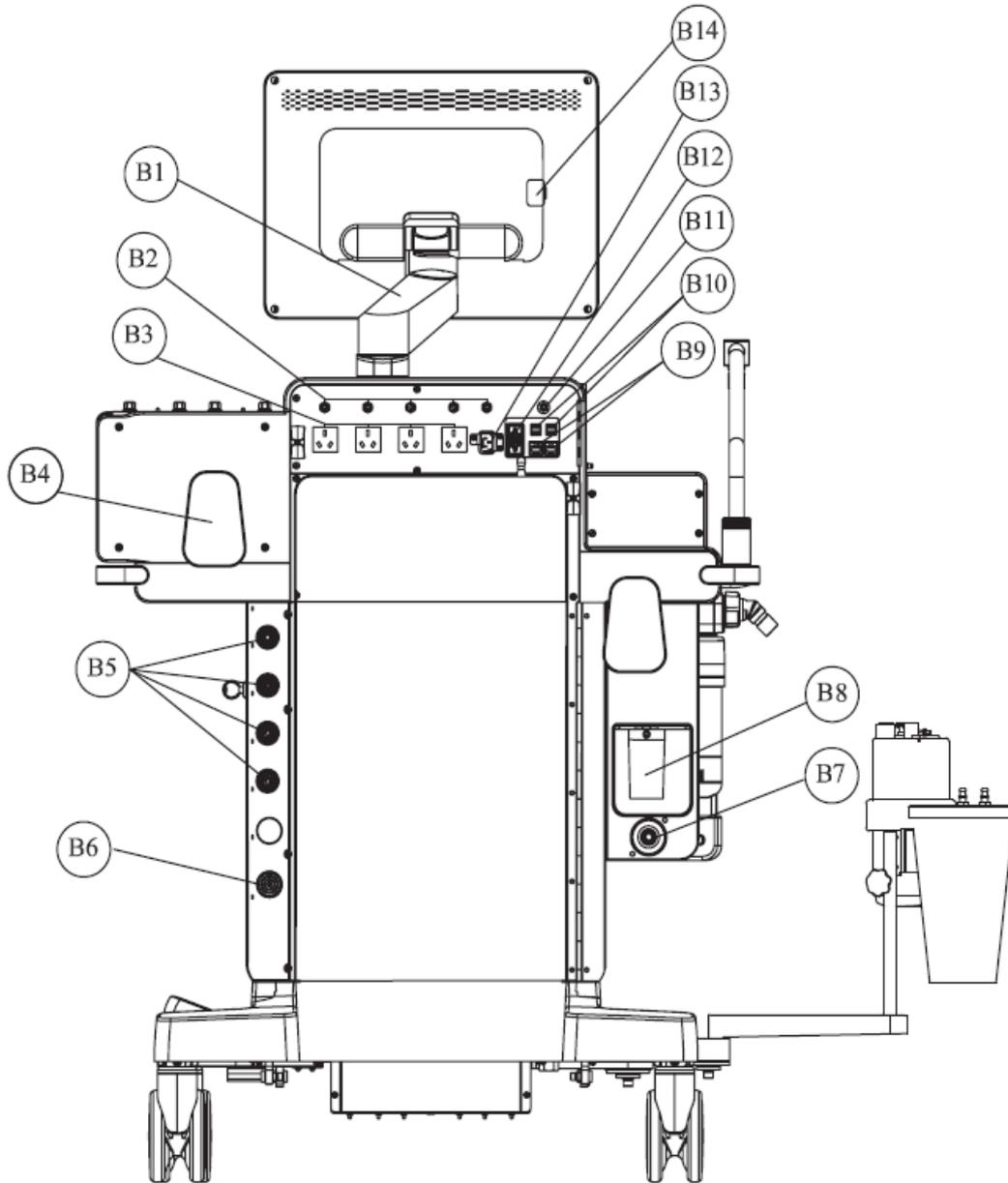
Front view of the A9 anesthesia machine.

Part		Description
A1	Alarm lamp	In case of an alarm, the alarm lamp is turned on in red, yellow, or cyan, indicating different alarm priorities. Red indicates a high priority, yellow indicates a middle priority, and cyan indicates a low priority. If the alarm lamp is off, no alarm is generated.
A2	Main display	/
A3	Flow or O2 concentration control knob of the electronic flow control system (EFCS)	You can rotate the knob to adjust the flow or O2 concentration.
A4	Auxiliary flowmeter (O2/air) or high-flow O2 supply	There is a float in the flow tube. The scale corresponding to the middle of the float is the current gas flow. The flowmeter has a flow control knob to control the flow. The gas flow increases when you rotate the knob counterclockwise, and decreases when you rotate the knob clockwise.

Part		Description
A5	Total flow control knob of the auxiliary flowmeter	You can rotate the knob to adjust the total flow of the auxiliary flowmeter.
A6	O2 concentration control knob of the auxiliary flowmeter	You can rotate the knob to adjust the O2 concentration in the total flow of the auxiliary flowmeter.
A7	Negative pressure gauge	The gauge is used to indicate the negative pressure.
A8	Negative pressure suction switch	The switch is used to change the working mode of the negative pressure suction device. It can be set to FULL, OFF, or REG. FULL indicates that the negative pressure suction device works continuously at maximum pressure, and the regulating knob does not work. OFF indicates that negative pressure is disabled and the negative pressure suction device does not work. REG indicates that you can rotate the negative pressure regulating knob to adjust the pressure of the negative pressure suction device. The negative pressure increases when you rotate the negative pressure regulating knob counterclockwise, and decreases when you rotate the negative pressure regulating knob clockwise.
A9	O2 flush button	The O2 flush button is used to supply oxygen at high flow through the inspiratory limb of the breathing system.
A10	O2 sensor door cover	You can install the O2 sensor after opening the door cover.
A11	Hook	The hook is used to suspend the pipeline of the breathing system.
A12	Negative pressure suction tube fastener	The fastener is used to fasten the pipeline of the negative pressure suction device.
A13	ACGO (standalone outlet and switch)	The ACGO switch is used to enable/disable the ACGO function. The ACGO standalone outlet is used to output fresh gas.
A14	Negative pressure suction liquid collection bottle	The liquid collection bottle is used to collect effusions, hemothorax, pus, and other contaminants from the patient.
A15	Storage drawers	Three (3) storage drawers that can be locked are provided.
A16	Liquid collection bottle and humidifier bracket	The bracket is used to fasten the negative pressure suction liquid collection bottle and humidifier.
A18	Display control knob	You can press the control knob to select a menu item or confirm the settings. You can scroll the menu items or change the settings by rotating the control knob clockwise or counter clockwise.
A19	Status display	A8: used to display the status of the gas supply pressure, volume exchanger, electronic AGSS, and heating module of the breathing system. A9: used to display the status of the gas supply pressure, volume exchanger, electronic AGSS, electronic

Part		Description
		anesthetic vaporizer, and heating module of the breathing system.
A20	Main flowmeter of the backup flow control system (BFCS)	The main flowmeter displays the total flow of the BFCS.
A21	BFCS switch	You can press the switch button to pen the BFCS control door. The flow regulating knob can be used to control the air and O2 flow. The gas flow increases when you rotate the knob counterclockwise, and decreases when you rotate the knob clockwise.
A22	Vaporizer mounting manifold	A8: used to install two Selectatec vaporizers. The mounting bar supports two vaporizers. There is an interlock mechanism inside the vaporizers, so that only one vaporizer is used to deliver one anesthetic agent at a time. A9: used to install and lock electronic vaporizers (two electronic vaporizers can be installed).
A23	Battery charge indicator	The indicator is on when the battery is being charged.
A24	AC power status indicator	The indicator is on when the system is connected to AC power.
A25	System switch	The system switch is used to turn on or off the system.
A26	Key and lock	The key and lock are used to lock the drawer.
A27	Pipeline supply pressure gauge	The gauge is used to indicate the pressure at the O2, air, and N2O pipeline inlets.
A28	Volume exchanger door cover	You can open the volume exchanger door cover by pulling the unlock button at the bottom right outward as instructed.
A29	Caster lock	The caster lock is a brake used to lock/release all casters when you step on it.
A30	Caster	The system is moved with the casters. The caster lock of the machine is controlled by the central brake.
A31	Humidifier	The humidifier must be connected to the pipeline when you enable high-flow O2 supply.

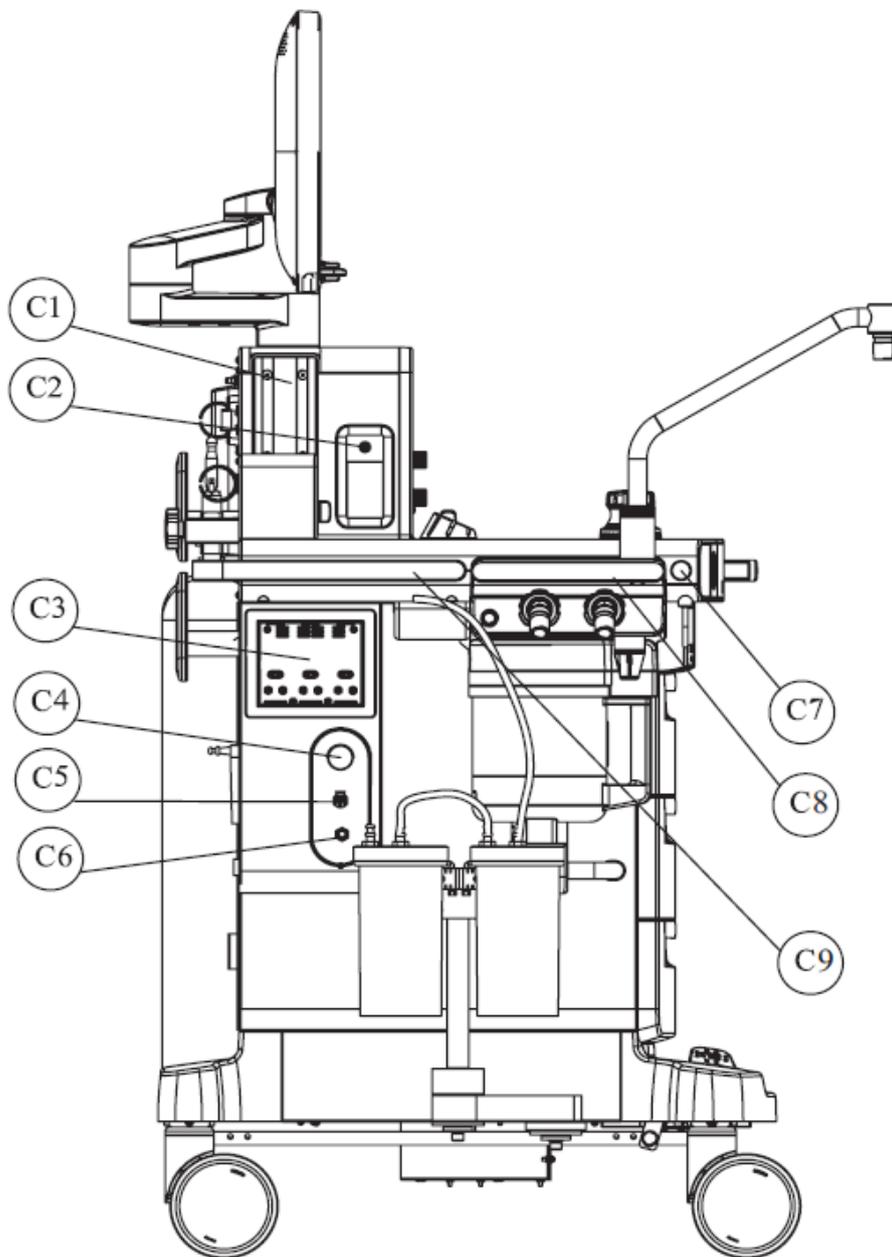
### 6.1.2.2 Main Unit (Rear View)



Part		Description
B1	Display support arm	The support arm is used to install the display.
B2	Fuse	Each auxiliary power outlet is equipped with a fuse.
B3	Auxiliary AC power outlet	Four auxiliary AC power outlets are provided.
B4	Cable hook	The hook is used to suspend cables.
B5	Gas pipeline connector	O <sub>2</sub> , air, and N <sub>2</sub> O pipeline connectors are provided.
B6	Negative pressure source connector	The connector is used to connect to the negative pressure source on the hospital's wall.

Part		Description
B7	Waste gas scavenging connector	The connector is used to connect to the waste gas disposal system. Use a waste gas disposal system that conforms to ISO 8835-3.
B8	Overfill protection	Overfill protection of the negative pressure suction device is used to prevent overfill of waste liquid, so as to ensure pipeline safety.
B9	Network ports (CS1 and CS2)	The network ports are used to connect to other devices through network cables.
B10	SB ports (SB1, SB2, SB3, and SB4)	The SB ports are used to connect to USB devices. Do not connect any devices to the SB ports of the machine, except Mindray-approved USB devices and supported USB mice.
B11	Equipotential pillar	The equipotential pillar provides a grounding point. It eliminates the potential difference between ground cables of different devices to ensure safety.
B12	Communication port (SP1)	An RS232 communication port is provided.
B13	Power inlet	The power inlet is used to connect a supply mains cable.
B14	VGA connector	The VGA connector is used to connect to an external display.

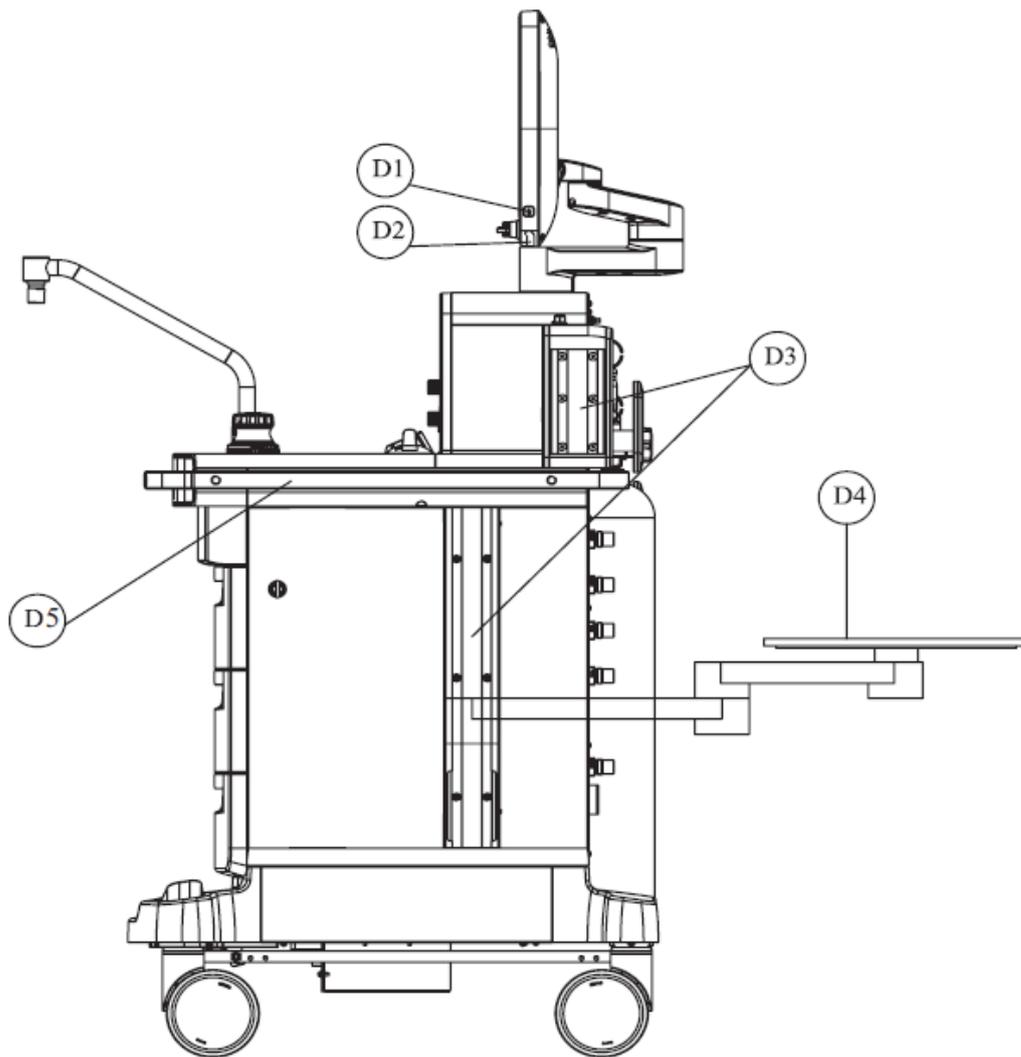
### 6.1.2.3 Main Unit (Left View)



Part		Description
C1	Mounting rail	The mounting rail is a standard accessory arm for installing the monitor and other devices. Two mounting rails are provided on the left and right of the machine.
C2	Auxiliary O <sub>2</sub> /air outlet or high-flow O <sub>2</sub> outlet	The outlet is used to output auxiliary O <sub>2</sub> /air when the anesthesia machine is configured with the auxiliary O <sub>2</sub> /air function. The outlet is used to output O <sub>2</sub> when the anesthesia machine is configured with the high-flow O <sub>2</sub> supply function.

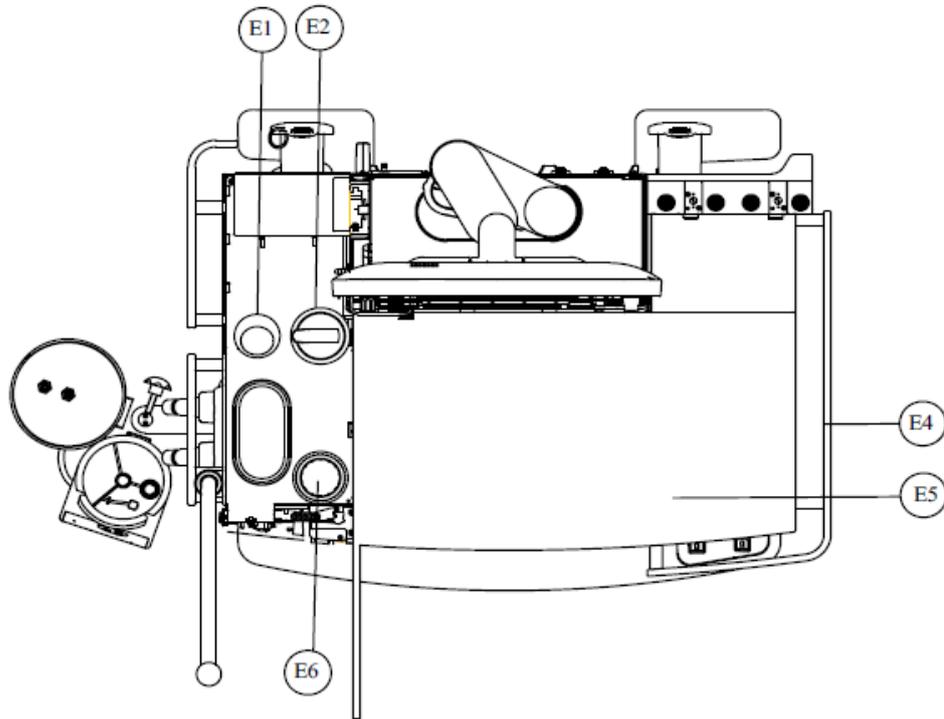
Part		Description
C3	Module slot	The module slot is used to install and identify the NMT, CO <sub>2</sub> , AG, BIS, and ESI module described in this manual.
C4	Electronic AGSS flow regulating knob	You can rotate the knob clockwise or counterclockwise to adjust the flow in the AGSS, until the float on the status display is between the Min and Max scales.
C5	Sample gas return port	A sample gas return port is provided for the gas module.
C6	Auxiliary high-pressure O <sub>2</sub> outlet	The outlet is used to connect to an external device, for example, a jet ventilator.
C7	O <sub>2</sub> sensor door cover switch	The switch is used to open the O <sub>2</sub> sensor door cover.
C8	Handle	The handle can bear maximum force of 10 kgf. The handle is only used for disassembling the breathing system, but not for pushing/pulling/lifting the anesthesia machine.
C9	Handle	The handle is used for pushing/pulling/turning the anesthesia machine. It can bear maximum force of 80 kgf.

### 6.1.2.4 Main Unit (Right View)



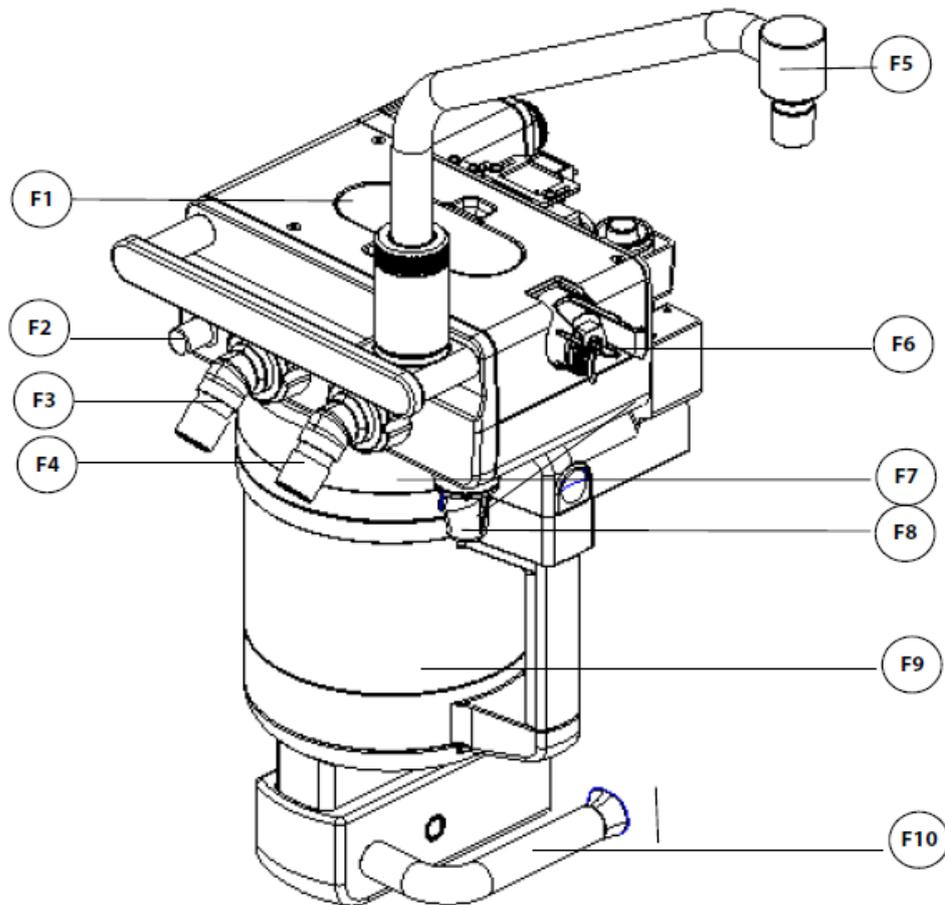
Part		Description
D1	Work lamp switch	The switch is used to turn on/off the work lamp. Three settings are provided: Off, Low, and High. You can turn on the work lamp only when the system switch is turned on.
D2	Work lamp	The work lamp is located under the display to illuminate the work surface.
D3	Mounting rail	The mounting rail is a standard accessory arm for installing the monitor and other devices.
D4	Collapsible work surface	The collapsible work surface can be rotated horizontally for 180 degrees. It bears maximum load of 14 kg.
D5	Handle	The handle is used for pushing/pulling/turning the anesthesia machine. It can bear maximum force of 80 kgf.

### 6.1.2.5 Main Unit (Top View)



Part		Description
E1	Airway pressure gauge 1	The gauge is used to indicate the patient's airway pressure. A slight difference between the readings of the airway pressure gauge and the electronic readings is normal. Contact the after-sales service department of Mindray if the difference exceeds 15%
E2	Manual/auto switch	The manual/auto switch is used to switch between mechanical ventilation and manual ventilation.
E4	Handrail	The handrail is an encircling metal bar used for moving the machine.
E5	Work surface	The stainless steel work surface bears maximum force of 30 kgf.
E6	APL valve 1	The APL valve is a rotary regulator for setting the pressure limit of the breathing system during manual ventilation. The scales on the APL valve indicate approximate pressure. The APL valve is set to the SP position during spontaneous breathing. If necessary, lift the APL valve to release pressure quickly. At the flow of 3 L/min, the pressure of the APL valve under a dry or wet condition must be greater than 1 cmH <sub>2</sub> O and less than 3 cmH <sub>2</sub> O. At the flow of 30 L/min, the pressure of the APL valve under a dry or wet condition must be greater than 1 cmH <sub>2</sub> O and less than 5 cmH <sub>2</sub> O.
Values on the APL valve and airway pressure gauge are for reference only. The calibrated patient's airway pressure is displayed on the user interface.		

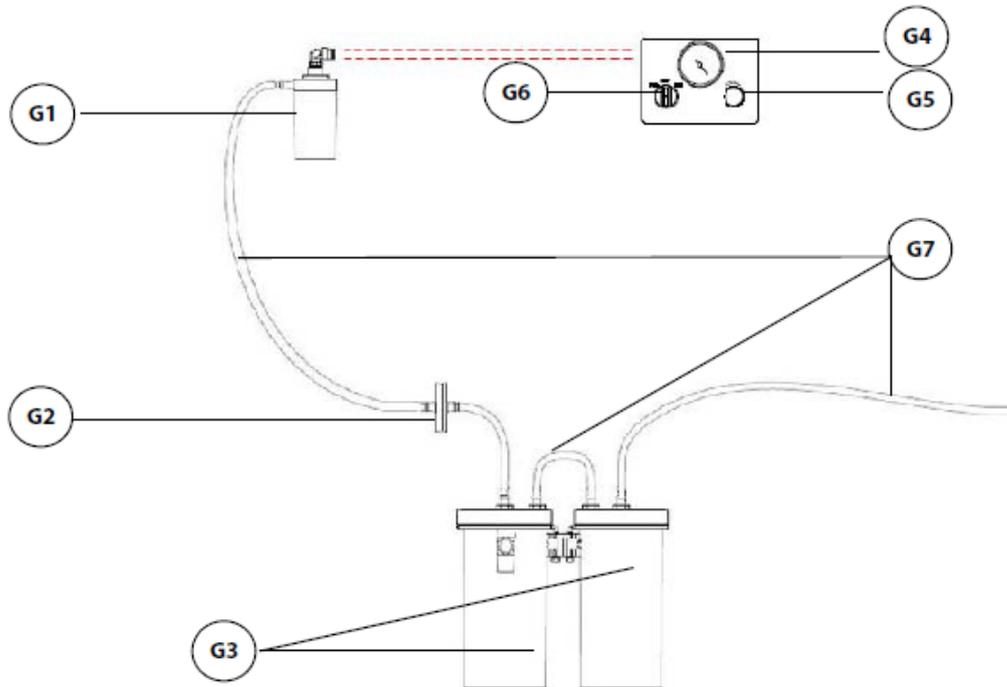
### 6.1.2.6 Breathing System



Part		Description
F1	Breathing check valve inspection window	You can inspect the status of the inspiratory and expiratory check valves from outside the machine.
F2	Leak test plug	The leak test plug is used to connect the breathing tube for the leak test.
F3	Expiration connector	The breathing circuit has an expiration connector.
F4	Inspiration connector	The breathing circuit has an inspiration connector.
F5	Bag arm	The bag arm is used to connect the manual ventilation bag.
F6	O2 sensor	The O2 sensor is used to monitor the O2 concentration.
F7	Absorber bypass assembly	The absorber bypass assembly is used to retain the pressure in the breathing circuit when you replace the sodalime in the CO2 absorber canister.
F8	Water collection cup	The water collection cup is used to collect condensate from the breathing system. It must be periodically removed and emptied.
F9	CO2 absorber canister	The CO2 absorber canister is a container for holding the CO2 absorbent (bulk or Pre-pak CO2 absorbent).

Part		Description
F10	Canister lock	The canister lock is a lever locking mechanism for locking (in the horizontal position)/unlocking (in the vertical position) the canister.

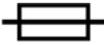
### 6.1.2.7 Negative Pressure Suction Device



Part		Description
G1	Overfill protection	Overfill protection is used to prevent overfill of waste liquid, so as to ensure pipeline safety.
G2	Filter	The filter is used to filter out moisture and impurities.
G3	Liquid collection bottle	The liquid collection bottle is used to collect effusions, hemothorax, pus, and other contaminants from the patient.
G4	Negative pressure gauge	The gauge is used to indicate the negative pressure.
G5	Negative pressure regulating knob	The knob is used to adjust the pressure of the negative pressure suction device.
G6	Selection switch	The switch is used to change the working mode of the negative pressure suction device. It can be set to FULL, OFF, or REG. FULL indicates that the negative pressure suction device works continuously at maximum pressure, and the regulating knob does not work. OFF indicates that negative pressure is disabled and the negative pressure suction device does not work. REG indicates that you can rotate the negative pressure regulating knob to adjust the pressure of the negative pressure suction device. The negative pressure

Part		Description
		increases when you rotate the negative pressure regulating knob counterclockwise, and decreases when you rotate the negative pressure regulating knob clockwise.
G7	Suction tube	The suction tube is used to deliver effusions, hemothorax, pus, and other contaminants out of the patient. The inner diameter of the suction tube is $\Phi 8$ (5/16"). The suction tube is directly inserted in the connector.

### 6.1.3 Labels

Symbol	Description	Symbol	Description
	CAUTION!		WARNING
	Environment: temperature range		Environment: humidity range
	Electricity: alternating current (AC)		Electricity: internal battery
	Electricity: equipotential pillar		Electricity: protective ground
	Electricity: fuse or circuit breaker		VGA connector
	Electricity: powered on		Electricity: powered off
	Electricity: input/output		Gas flow: flow control knob
	Pipeline gas		Gas cylinder
	Gas outlet		Gas inlet
<b>MAX</b>	Maximum value	<b>MIN</b>	Minimum value
>PPSU<	Material: polyphenylsulfone	>PSU<	Material: polysulfone

Symbol	Description	Symbol	Description
	Remove the volume exchanger		Remove the O2 sensor
<b>O<sub>2</sub>%</b>	O2 sensor connector	<b>O<sub>2</sub>+</b>	Gas: O2 flush button
	Lock/Unlock: lock		Lock/Unlock: unlock
	Manual ventilation		Mechanical ventilation
	Drainage		Water trap
	No weight: Do not press against it.		Do not add fuel.
134°C	Resistance to high temperature/high pressure/disinfection		No resistance to high temperature/high pressure/disinfection
	Caution: heat		Direction
	Electricity: light	 5 kg MAX 11 lbs MAX	Bearing capacity
	ACGO mode		Mechanical ventilation mode
	Connect the filter	 APL ≈ cmH <sub>2</sub> O Δ	APL valve
	Absorber canister on		Absorber canister off
	Negative pressure suction device		Negative pressure gas supply
IPX14	Degree of protection against harmful ingress of water for the anesthesia	IPX4	Degree of protection against harmful ingress of water for the BIS module

Symbol	Description	Symbol	Description
	machine equipped with the BIS module		
	Identifier: manufacturer reference number/catalog number		Identifier: serial number
	CF-type defibrillator-proof applied part		BF-type defibrillator-proof applied part
	The battery is full. The AC power supply has been connected to power the system.		Alarm Audio Off icon
	The battery is not full. The AC power supply has been connected to charge the battery and power the system.		Alarm Audio Pause icon
	The battery is full and is powering the system. The AC power supply is disconnected.		Alarm Off icon
	The battery is not full and is powering the system. The AC power supply is disconnected.		Low-priority information
	The battery is low and is powering the system. You are advised to charge the battery. The AC power supply is disconnected.		Middle-priority information
	No battery		High-priority information
	Identifier: manufacturer		Refer to instruction manual/booklet
	The product complies with EU Medical Devices Directive (93/42/EEC) and meets the basic requirements in Annex I of the directive, so it has the CE mark.		
	Electrical: WEEE (Waste of Electrical and Electronic Equipment) Marking. Separate treatment from general waste at end of life.		

## 6.1.4 Acronyms and Abbreviations

Acronym or Abbreviation	Description
AA	Anesthetic agent
ACGO	Auxiliary common gas outlet
AGSS	Anesthesia gas scavenging system
Alpha	Power of the Alpha waveband/Total power
AMV	Adaptive minute ventilation
APL	Airway pressure limit
Apnea I:E	Apnea inspiratory time:expiratory time ratio
APRV	Airway pressure release ventilation
BC	Burst count
Beta	Power of the Beta waveband/Total power
BIS	Bispectral index
BSR	Burst suppression rate
BTPS	Body temperature and pressure, saturated gas
C	Dynamic compliance
CPAP/PS	Continuous positive airway pressure/pressure support ventilation
CPB	Cardiopulmonary bypass
DBS	Double burst stimulation
Delta	Power of the Delta waveband/Total power
EMG	Muscle activity and high frequency artifacts
ESI	EEG anesthesia depth index
Exp%	Inspiratory termination level
FiO <sub>2</sub>	Fraction of inspired oxygen
Flow	Flow
F-Trig	Flow trigger level
IBW	Ideal body weight
I:E	Inspiratory time:Expiratory time ratio
MEAN	Mean pressure
MF	Median frequency
Min RR	Minimum respiratory rate
MV	Minute volume
MV%	Minute volume in percentage
MV <sub>i</sub>	Inspiratory minute volume
MV <sub>leak</sub>	Leakage minute volume
N <sub>2</sub> O	Nitrous oxide

<b>Acronym or Abbreviation</b>	<b>Description</b>
NMT	Neuromuscular transmission
O <sub>2</sub>	Oxygen
P <sub>insp</sub>	Pressure control level of inspiration
P <sub>limit</sub>	Pressure limit level
PAW	Airway pressure
PCV	Pressure control ventilation
PCV-VG	Pressure control ventilation with volume guarantee
PEAK	Peak pressure
PEEP	Positive end-expiratory pressure
PLAT	Plateau pressure
PPF	Peak power frequency
$\Delta$ Papnea	Pressure of apnea ventilation
$\Delta$ P <sub>supp</sub>	Pressure support level
PTC	Post tetanic counting
P-Trig	Pressure trigger level
R	Airway resistance
RR	Respiratory rate
SEF	Spectral edge frequency
SIMV-PC	Synchronized intermittent mandatory ventilation - pressure control
SIMV-VC	Synchronized intermittent mandatory ventilation - volume control
SIMV-VG	Synchronized intermittent mandatory ventilation - volume guarantee
SP	Spontaneous breathing
SQI	Signal quality index
ST	Single twitch stimulation
T1	First stimulus response value
T1%	Ratio of T1 to the reference value
Theta	Power of the Theta waveband/Total power
T <sub>insp</sub>	Inspiratory time
TOF	Train-of-four
TP	Total power
T <sub>pause</sub>	Percentage of inspiratory pause time
T <sub>slope</sub>	Time for the pressure to rise to target pressure
Trig Window	Trigger window
VCV	Volume control ventilation
V <sub>t</sub>	Tidal volume



Electrical circuit diagram

<b>Parts List</b>			
B1	CPU board	B2	Alarm lamp board
B3	Key lighting board	B4	Host encoder board
B5	DC-DC power board	B6	Battery adapter board
B7	External I/O interface board	B8	Backlight board
B9	Small-display CPU board	B10	Auxiliary O2/air keyboard
B11	BFCS switch control board	B12	Power indicator board
B13	Gas inlet sensor board	B14	High-flow sensor board
B15	Auxiliary flowmeter monitoring board	B16	High-flow O2 therapy monitoring board
B17	Sensor adapter board (with transpulmonary pressure)	B18	Motherboard
	Sensor adapter board (without transpulmonary pressure)		
B19	APL indicator board	B20	Monitoring board
B21	EFCS outlet pressure sensor board	B22	Electronic vaporizer base interface board
B23	AGSS sensor board	B24	Module rack backplane
B25	EFCS flowmeter monitoring board	/	/
P1	Speaker	P2	Wi-Fi module
P3	Display assembly	P4	Electronic flowmeter encoder
P5	Auxiliary outlet	P6	One-way circuit breaker
P7	Main circuit breaker	P8	Fuse
P9	Lead-acid battery	P10	System position switch
P11	Electromagnet	P12	8.4-inch display
P13	Segment display	P14	Auxiliary flowmeter encoder
P15	Gas inlet pressure switch	P16	Cylinder pressure sensor
P17	Proportional valve	P18	Three-way valve
P19	Zeroing three-way valve	P20	Intrapulmonary pressure zeroing three-way valve and line
P21	O2 cell	P22	Circuit switch
P23	Sodalime canister switch	P24	ACGO switch
P25	Heater	P26	O2 cell calibration valve
P27	Auto/manual valve	P28	Auto/manual valve position switch and line
P29	Manual/auto switch and line	P30	PEEP switch
P31	Safety valve	P32	Inspiratory proportional valve
P33	PEEP proportional valve	P34	Ventilator flow sensor
P35	VR switch	P36	Pneumatic lock switch and line of the vaporizer
P37	AGSS pilot valve and line	P38	AG switch three-way valve
P39	Flow sensor	P40	Proportional valve
P41	NC two-way valve	P42	NO two-way valve
P43	Three-way valve	P44	AC-DC power board
C1	Connection line between the display and the CPU board	C2	Connection line between the touchscreen and the CPU board
C3	Connection line between the alarm lamp board and the CPU board	C4	Connection line between the main encoder board and the CPU board
C5	AC inlet and line	C6	AC input line
C7	AC input interconnection line	C8	AC-to-DC line
C9	Connection line between the battery adapter board and the DC-DC board	C10	Connection line between the CPU board and motherboard
C11	HDMI network cable	C12	Connection line between the

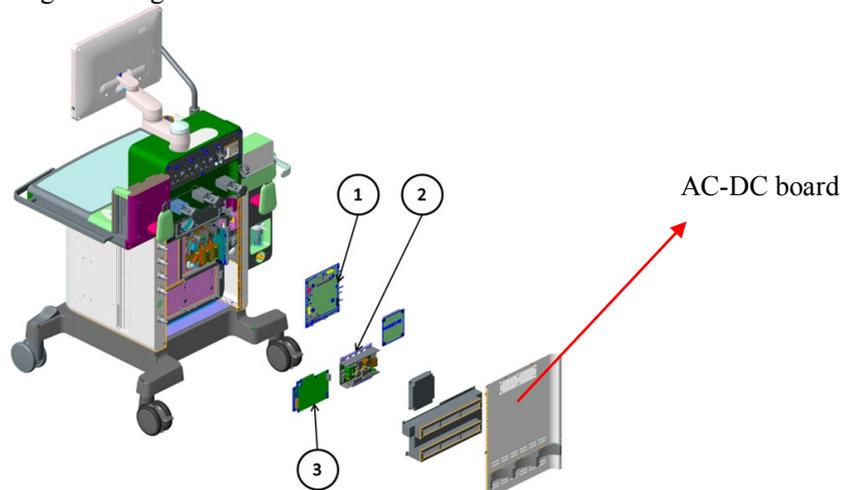
			motherboard and the I/O interface board
C13	Connection line between the motherboard and the small-display CPU board	C14	System switch line
C15	Backlight board connection line	C16	Connection line between the auxiliary O2/air assembly and the small-display CPU board
C17	I/O display connection line	C18	Connection line of the auxiliary O2/air keyboard
C19	Connection line between the auxiliary O2/air assembly and the small-display CPU board	C20	Connection line between the motherboard and the gas supply pressure monitoring board
C21	Connection line of the O2 pressure switch at the gas inlet	C22	High-flow sensor connection line
C23	Connection line of the auxiliary O2/air valve	C24	Connection line between the motherboard and the auxiliary O2/air assembly
	High-flow valve connection line		
C25	Connection line between the motherboard and the sensor adapter board	C26	Connection line of the zeroing three-way valve
C27	Pneumatic assembly connection line	C28	APL indicator connection line
C29	Circuit switch line	C30	Sodalime canister switch line
C31	O2 cell connection line	C32	Connection line of the expiratory valve assembly
C33	VR switch connection line	C34	Electronic vaporizer power line
C35	Electronic vaporizer communication line	C36	Connection line between the motherboard and the AGSS
C37	Connection line between the motherboard and the internal AG module	C38	Three-way valve line of the internal AG module
C39	Connection line between the motherboard and the module rack	C41	Electronic flowmeter sensor line
C42	Electronic flowmeter valve line	C43	Auxiliary output connection line
C44	Auxiliary outlet line	/	/
M1	Electronic vaporizer	M2	Vaporizer base valve assembly
M3	Internal AG module	M4	Module rack

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## 6.2.2 Power System

### 6.2.2.1 AC-DC Board

The AC-DC board converts AC power into DC power to power the anesthesia machine. The AC-DC board of the A8 provides 19 V output, and that of the A9 provides 24 V output. The two AC-DC boards have different part numbers and are not interchangeable. Pay attention to the part numbers during servicing.



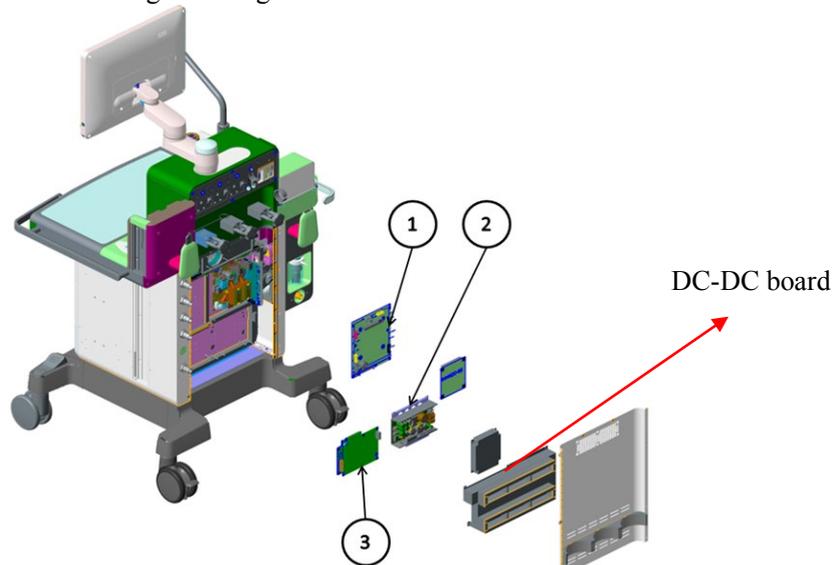
Installation position of the AC-DC board



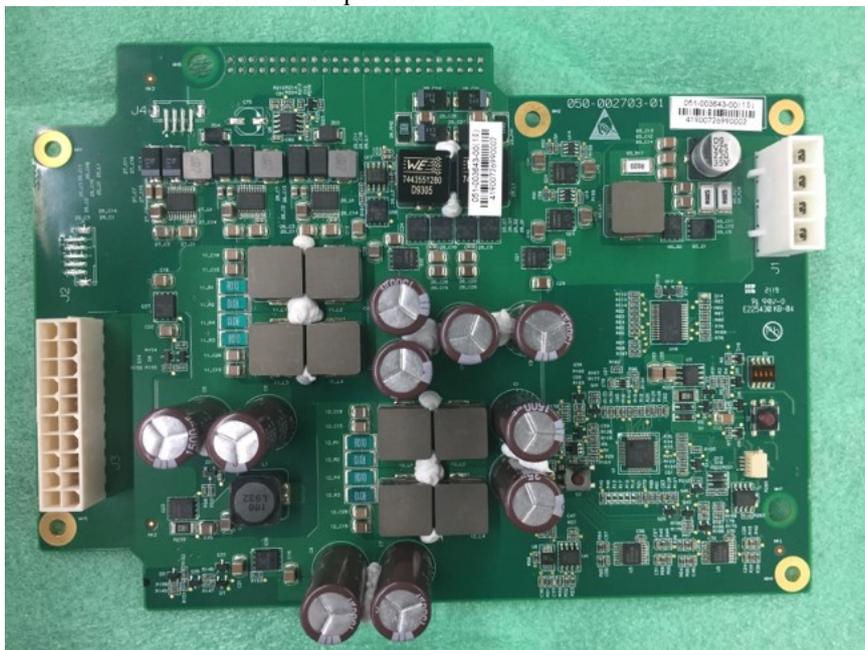
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### 6.2.2.2 DC-DC Board

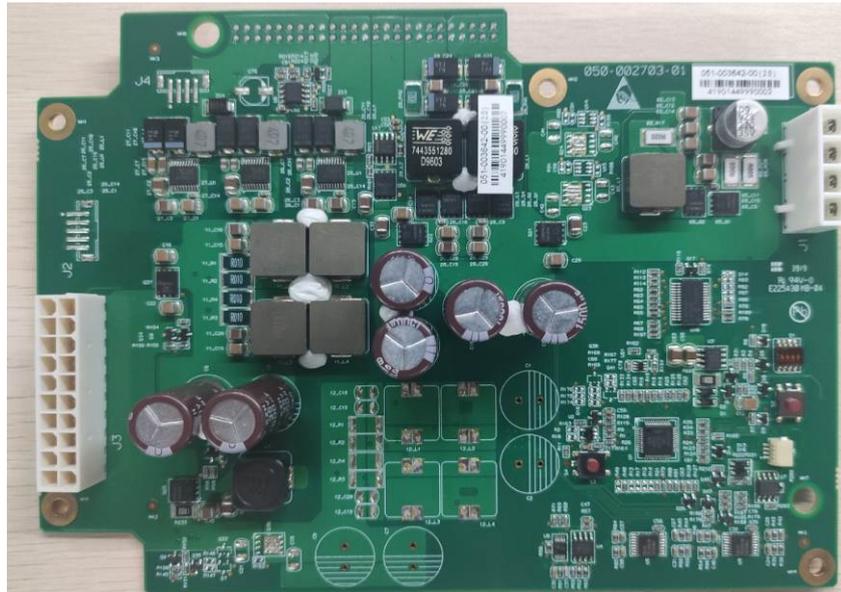
Under control of the system switch, the DC-DC board converts the DC power outputted by the AC-DC board or the lead-acid battery power into the DC power required by the system to produce 5 V, 12 V, or 24 V, and manages charging of the lead-acid battery. This board is configured with power board software. In addition, the power boards of the A8 and A9 basically have the same appearance, as shown in the figure below. Pay attention to the part numbers during servicing.



Installation position of the DC-DC board



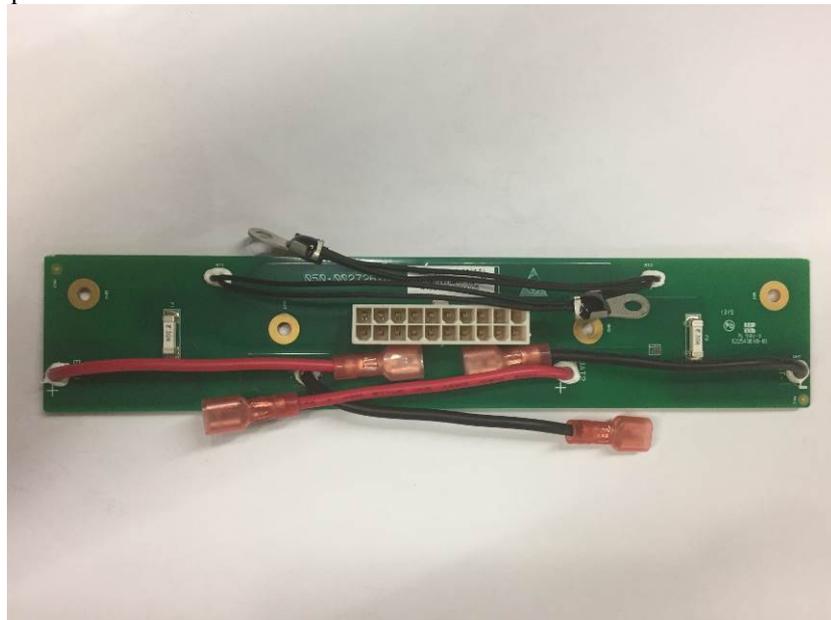
DC-DC board (A9)



DC-DC board (A8)

### 6.2.2.3 Battery Adapter Board

Two types of battery adapter boards are available: dual-battery adapter board and single-battery adapter board. The battery adapter board is an optional part installed inside the battery box. The battery adapter board transfers battery signals to the motherboard and provides the following functions: battery in-position detection, temperature detection, and current protection.



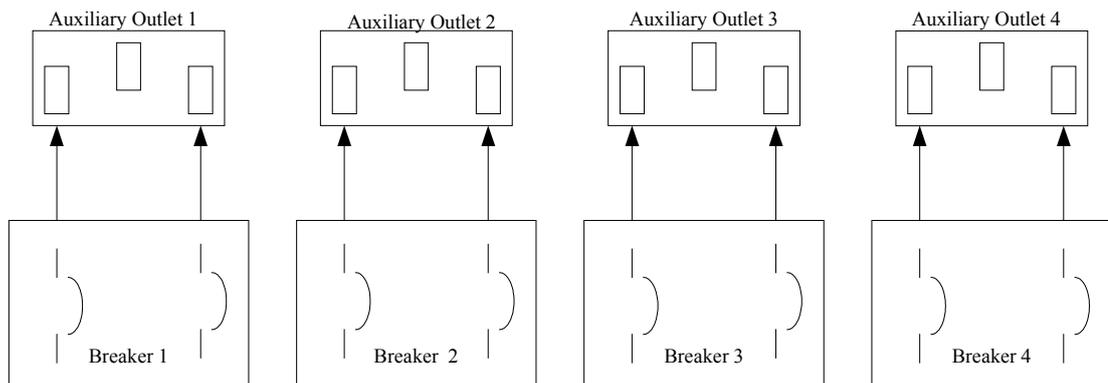
Dual-battery adapter board



Single-battery adapter board

### 6.2.2.4 Auxiliary Output

Auxiliary outputs supply power for other devices or instruments. The voltage ranges and frequencies of the power supplies should be the same as those of the input mains supply for the anesthesia machine. The auxiliary output system has four auxiliary outputs (three auxiliary outputs for anesthesia machines complying with Indian and South African standards), each with a circuit breaker.



### 6.2.2.5 Others

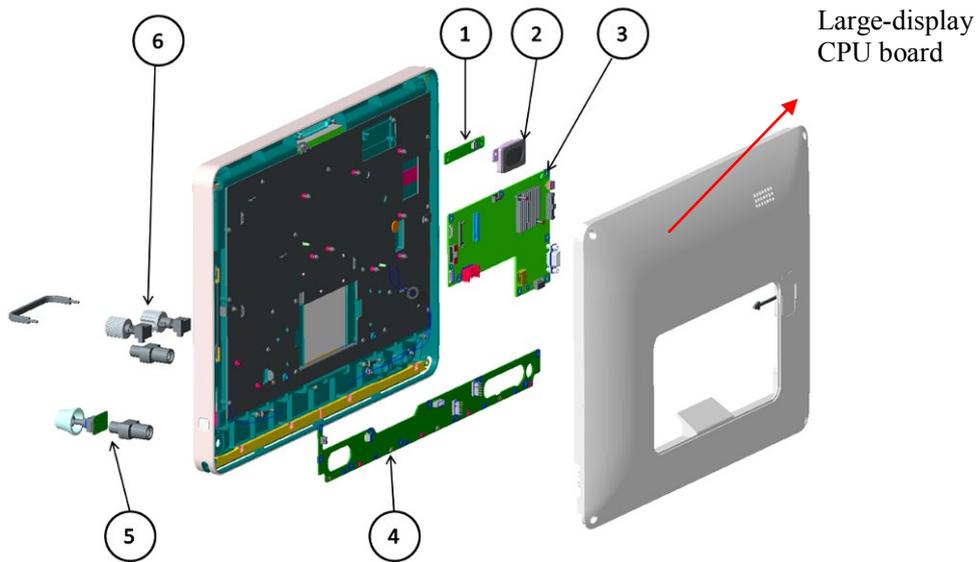
The anesthesia machine also contains the heating module, lead-acid battery, and other parts. The heating module is driven by the power board and provides dual overheating protection by means of software and hardware. The lead-acid battery ensures that the anesthesia machine can operate properly when the mains supply is unavailable or abnormal.

## 6.2.3 Display System

### 6.2.3.1 Large-Display CPU Board

The CPU board implements GUI man-machine interaction; provides power management for the VPM, VCM, electronic flowmeter, electronic vaporizer, auxiliary O<sub>2</sub>/air board, and small-display CPU board; and protects parameter modules. It mainly consists of the CPU core system and peripheral interface circuits.

This board is configured with large-display control software.



Installation position of the large-display CPU board



Large-display CPU board (top view)



Large-display CPU board (bottom view)

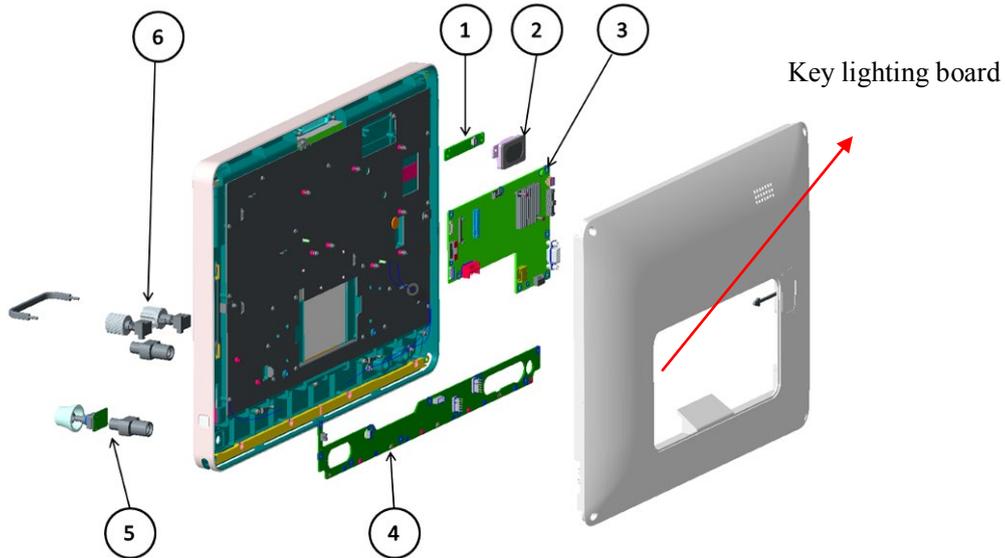
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### 6.2.3.2 Display and Touchscreen

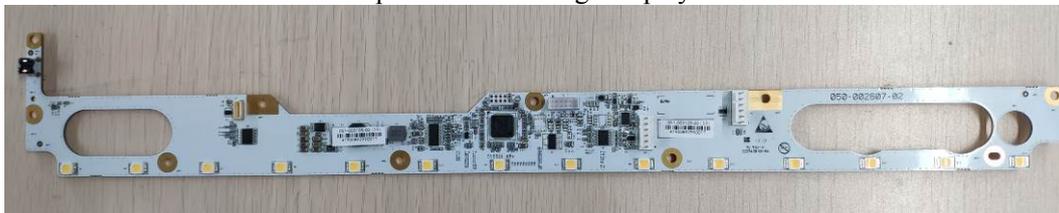
An 18.5-inch 1920×1080 full laminated display assembly is used, consisting of a display and a touchscreen. It acts as the main input/output part for man-machine interaction.

### 6.2.3.3 Key Lighting Board

The key lighting board is installed at the bottom of the display assembly for the lighting of the work surface. It provides a key to switch between the three light settings: high brightness, low brightness, and off. In addition, the key lighting board is connected to the main encoder board and the flowmeter encoder to identify the encoder, and communicates with the host computer (CPU board) through the serial port. This board is configured with software



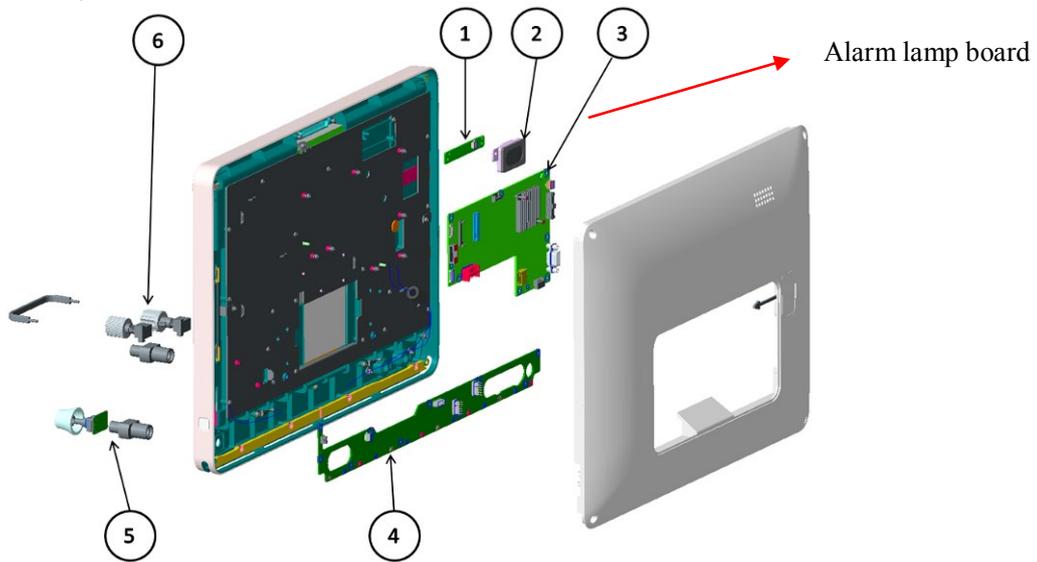
Installation position of the large-display CPU board



Key lighting board

### 6.2.3.4 Alarm Lamp Board

The alarm lamp board is mainly used to display the alarm status of the machine by blinking in red, yellow, or blue.



Installation position of the alarm lamp board



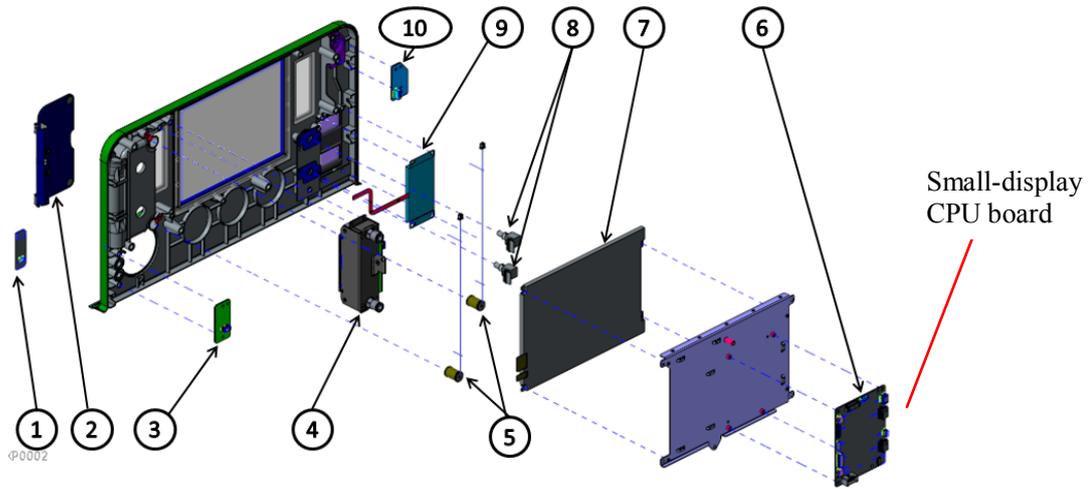
Alarm lamp board (top view)



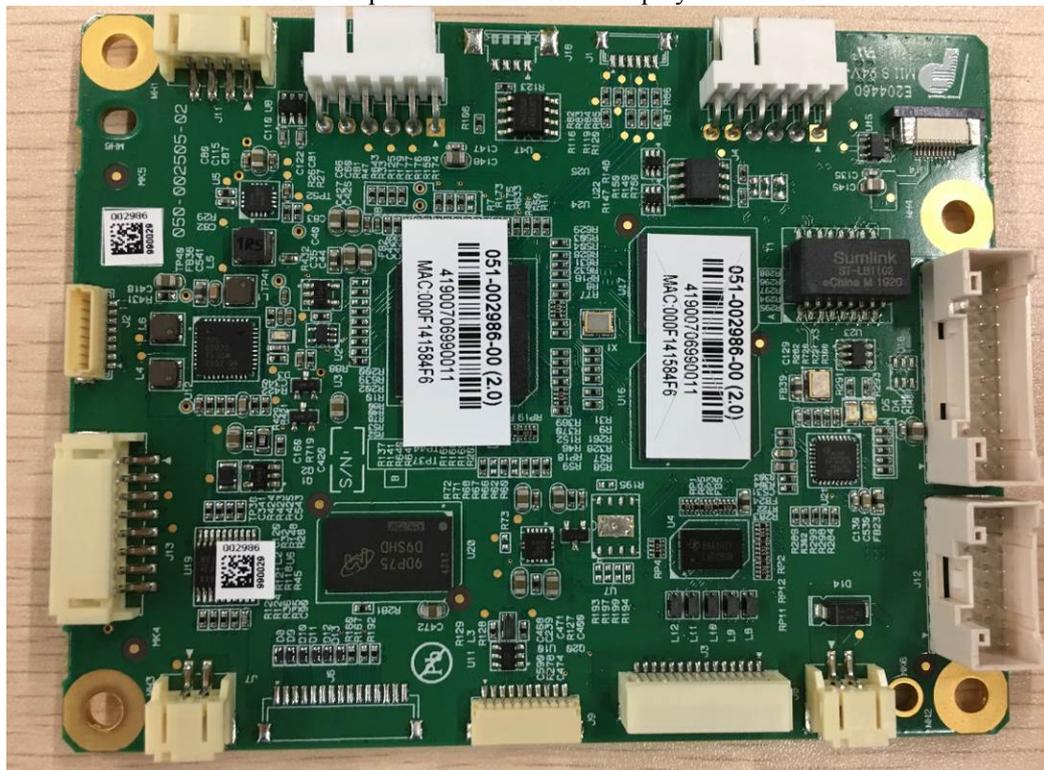
Alarm lamp board (bottom view)

### 6.2.3.5 Small-Display CPU Board

The small-display CPU board is mainly used to drive small-screen display and transfer auxiliary O2/air signals. This board is configured with small-display control software.



Installation position of the small-display CPU board



Small-display CPU board

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### 6.2.3.6 Small Display

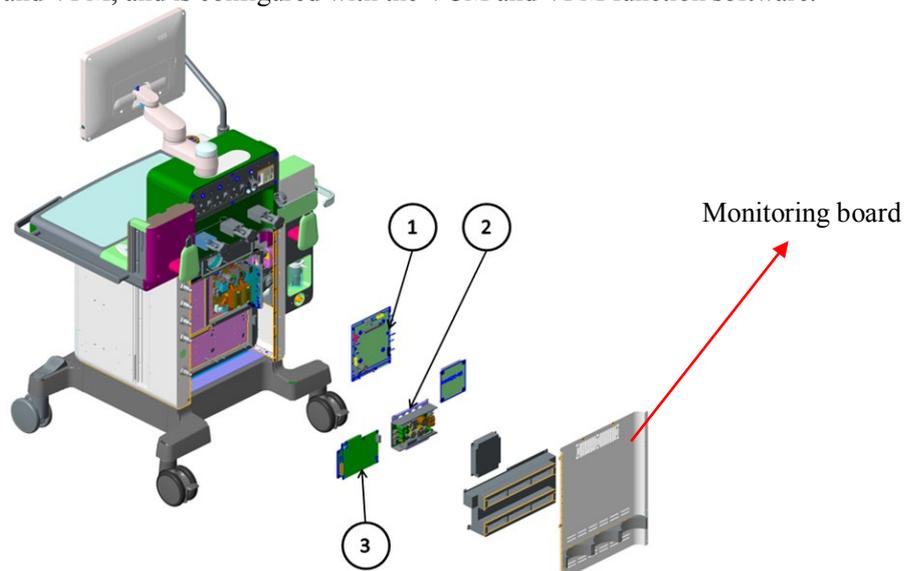
An 8.4-inch 800×600 display with an LVDS connector is used to display the dynamic graph of ventilation, gas supply pressure, and vaporizer working status.

## 6.2.4 Monitoring System

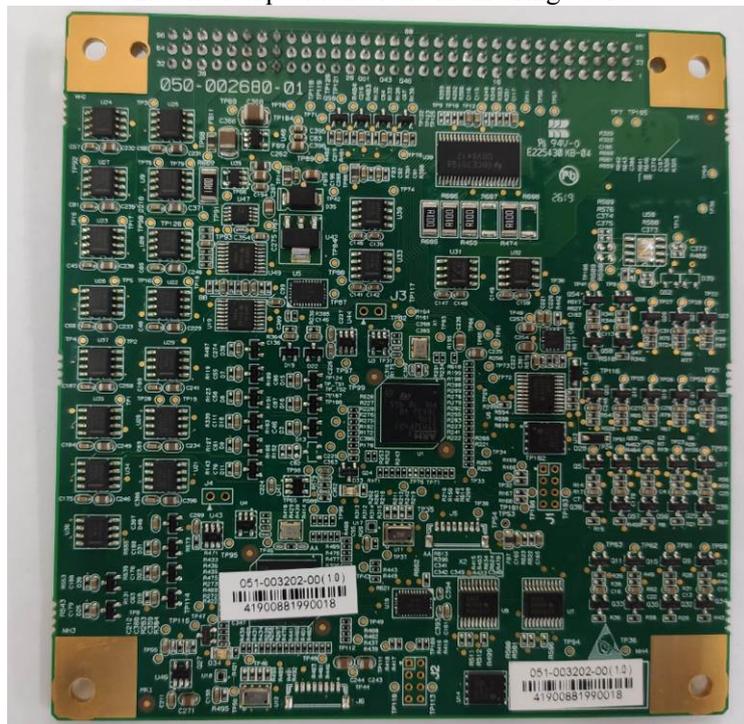
### 6.2.4.1 Monitoring Board

The monitoring board detects the pressure and flow of the anesthesia ventilator and anesthesia breathing system, controls valves, monitors and collects the status, reads the O<sub>2</sub> concentration, reads the switch status, monitors the pressure and flow in the circuit, and accurately controls the tidal volume.

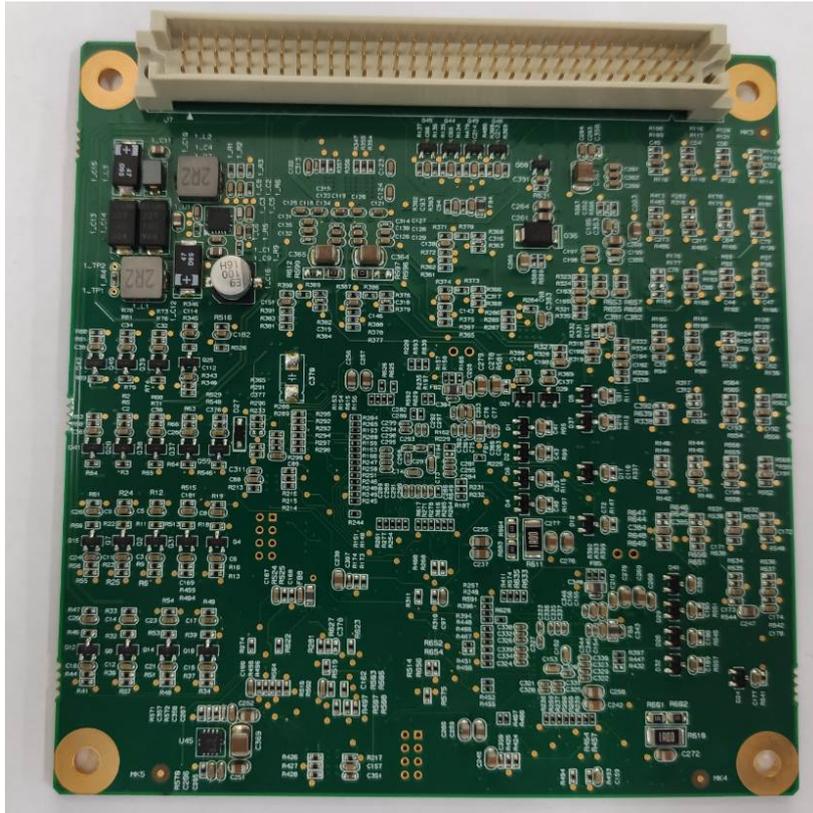
The monitoring board is buckled to the motherboard. The monitoring board consists of the VCM and VPM, and is configured with the VCM and VPM function software.



Installation position of the monitoring board



Monitoring board (top view)



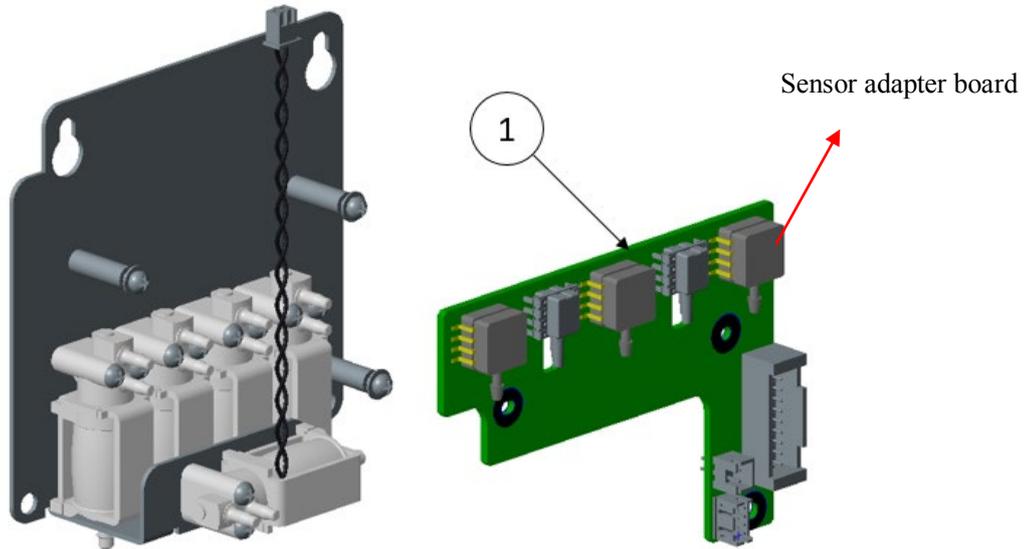
Monitoring board (bottom view)

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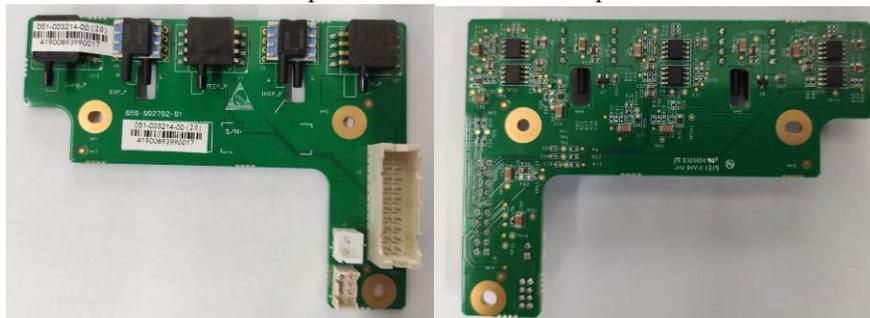
### 6.2.4.2 Sensor Adapter Board

Two types of sensor adapter boards are available: one with intrapulmonary pressure and the other without intrapulmonary pressure.

The sensor adapter board is mainly used to process inspiratory and expiratory differential pressure sensor signals, PEEP sensor signals, PAW pressure sensor signals, intrapulmonary pressure sensor signals, and adapter three-way valve control signals.



Installation position of the sensor adapter board



Sensor adapter board (with intrapulmonary pressure)



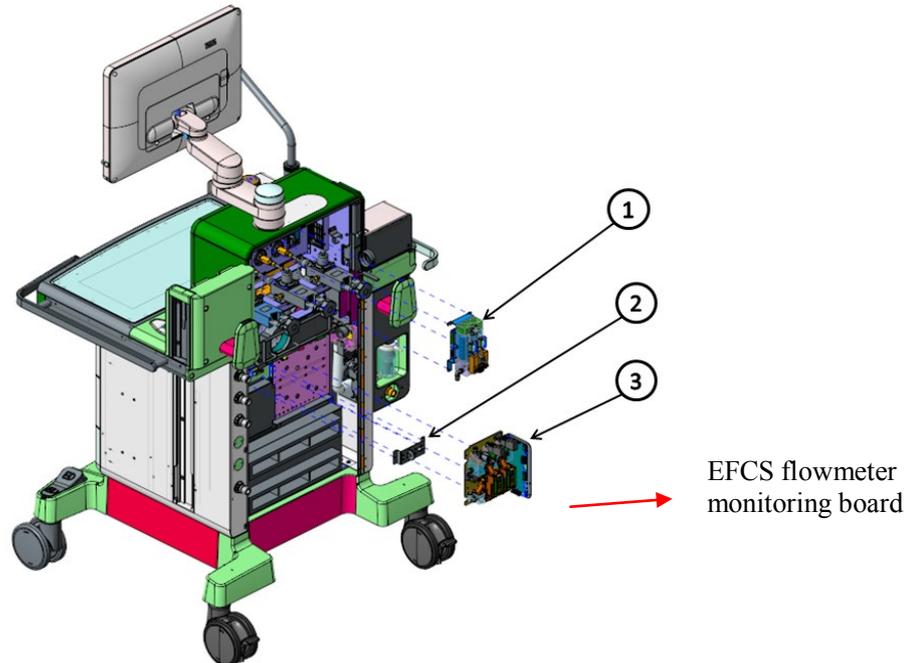
Sensor adapter board (without intrapulmonary pressure)

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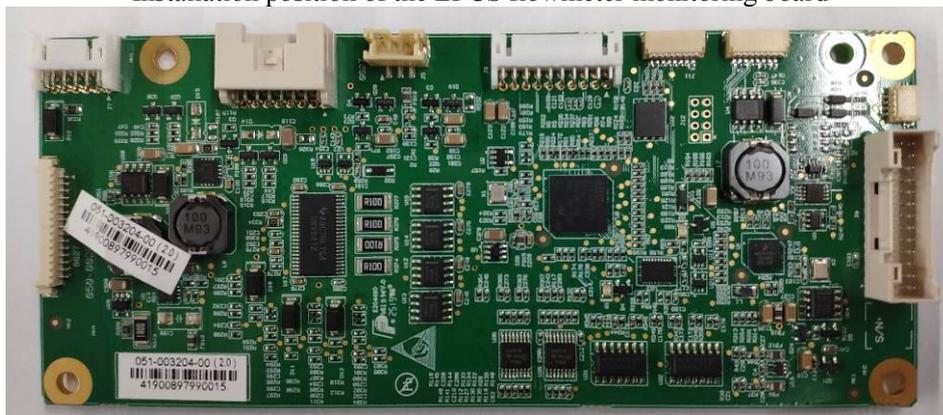
## 6.2.5 EFCS Flowmeter System

### 6.2.5.1 EFCS Flowmeter Monitoring Board

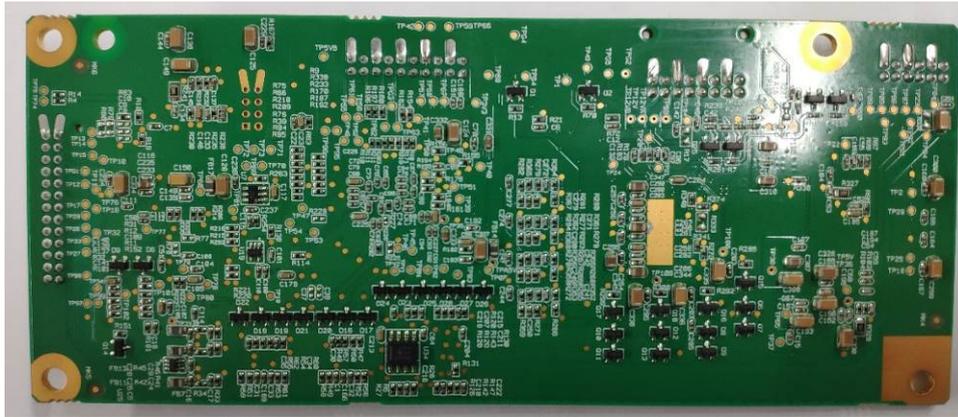
The EFCS flowmeter monitoring board is the core control part of the EFCS flowmeter of the anesthesia machine. The EFCS flowmeter monitoring board controls the O<sub>2</sub>/N<sub>2</sub>O/air flow through the proportional valve, and monitors and feeds back the O<sub>2</sub>/N<sub>2</sub>O/air flow through the flow sensor. In addition, the total flow monitored by the O<sub>2</sub> flow sensor is processed by the EFCS flowmeter monitoring board. Moreover, the EFCS flowmeter monitoring board drives the three-way valve, switch valve, and electromagnet, so as to switch to the mechanical BFCS when the proportional valve, flow sensor, and other electrical components fail. This board is configured with EFCS flowmeter software.



Installation position of the EFCS flowmeter monitoring board



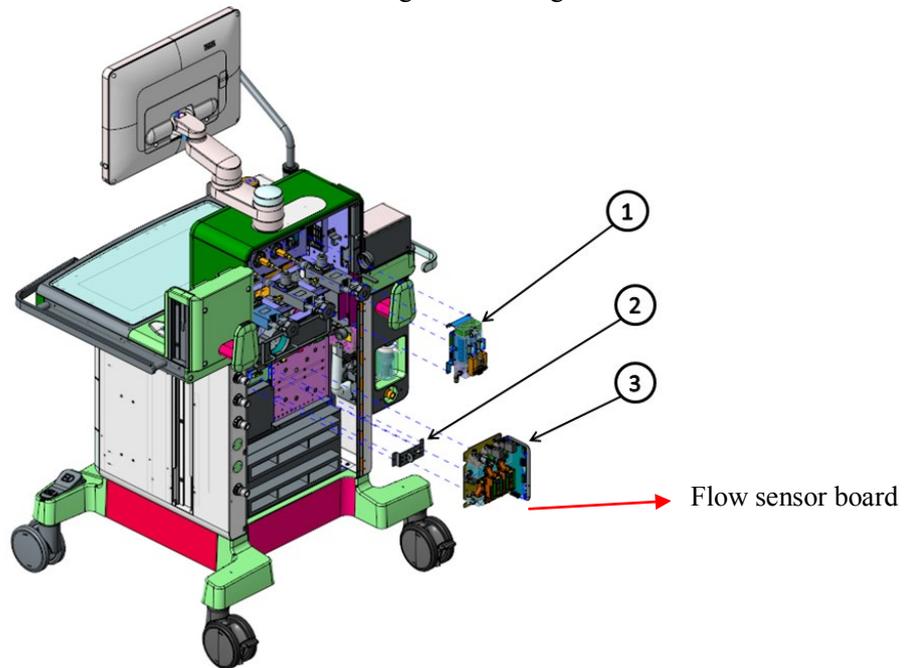
EFCS flowmeter monitoring board (top view)



EFCS flowmeter monitoring board (bottom view)

### 6.2.5.2 Flow Sensor Board

The flow sensor board is mainly used to monitor the O<sub>2</sub>/N<sub>2</sub>O/air flow and feed back the detected signals to the EFCS flowmeter monitoring board through the I<sup>2</sup>C bus.



Installation position of the flow sensor board



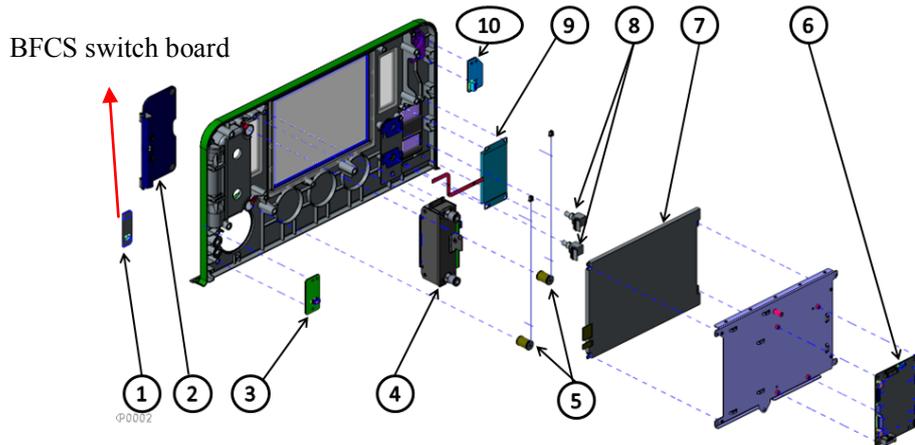
Flow sensor board (top view)



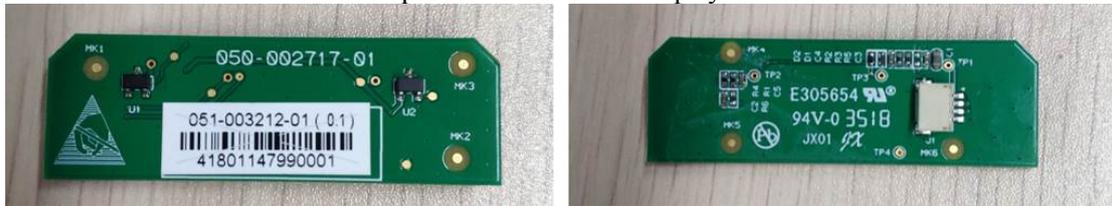
Flow sensor board (side view)

### 6.2.5.3 BFCS Switch Board

The BFCS switch board is mainly used to monitor the open/closed status of the BFCS door. Two Hall switches are used to feed back the status signals of the BFCS door to the EFCS flowmeter monitoring board.



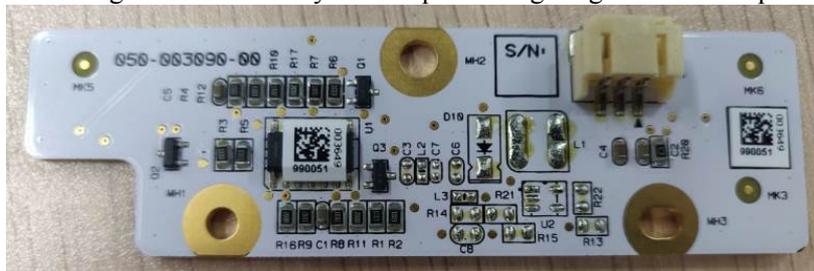
Installation position of the small-display CPU board



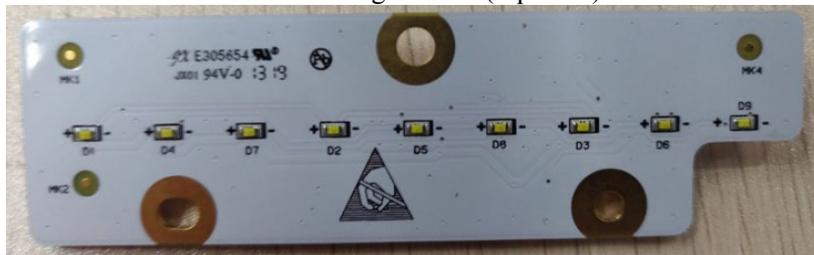
BFCS switch board

### 6.2.5.4 BFCS Backlight Board

The BFCS backlight board is mainly used to provide lighting for the backup flowmeter.



BFCS backlight board (top view)



BFCS backlight board (bottom view)

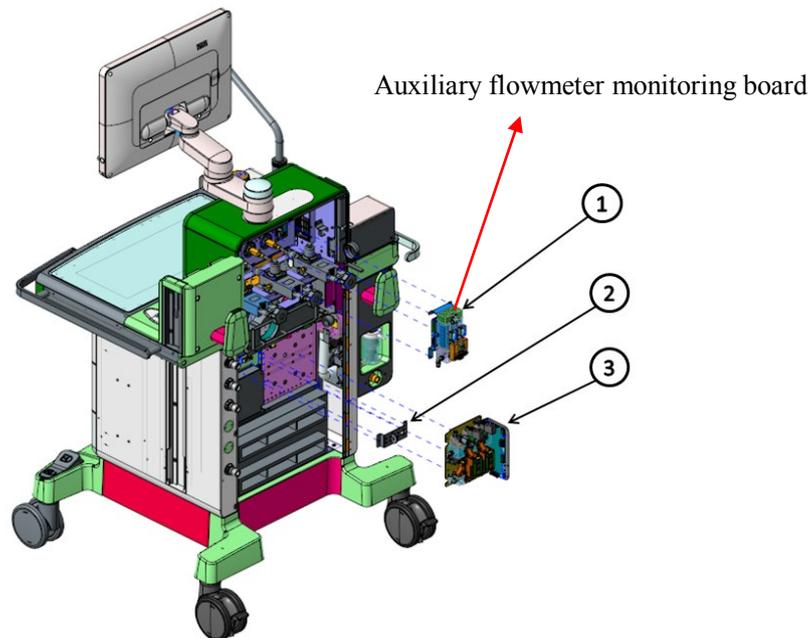
## 6.2.6 Auxiliary O2/Air System

2.1.35.

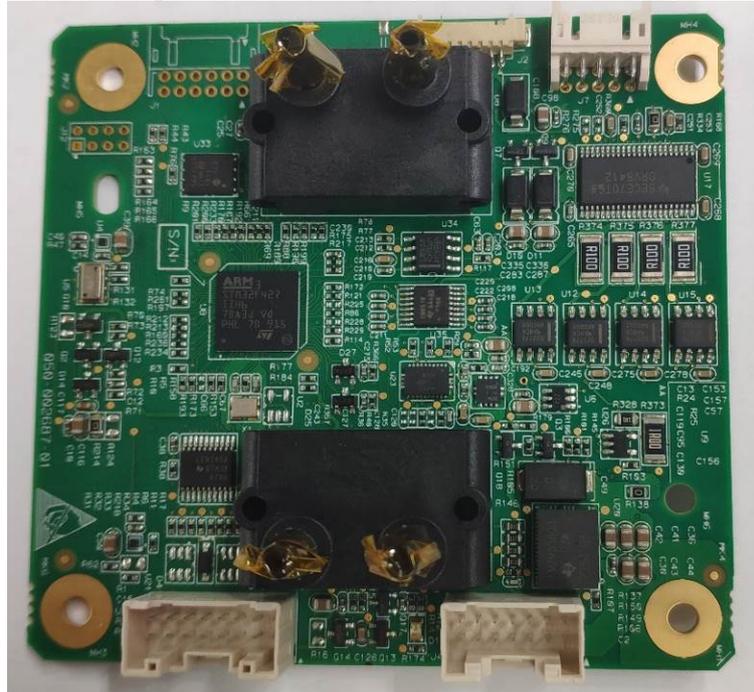
### 6.2.6.1 Auxiliary Flowmeter Monitoring Board

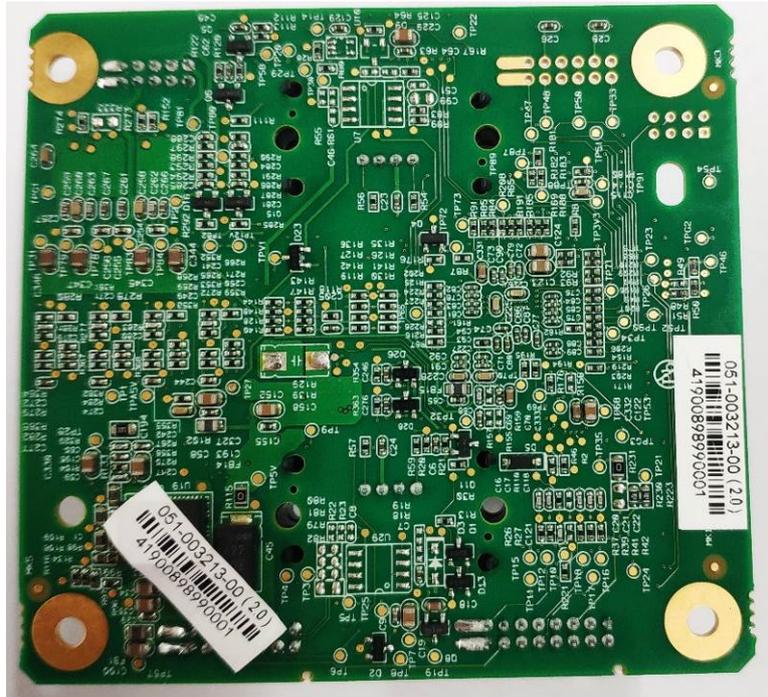
The auxiliary flowmeter monitoring board is the core control part of the auxiliary flowmeter of the anesthesia machine. It is mainly used at a low flow of 0–15 L/min and can work independently. The flow sensor is welded on the board. The auxiliary flowmeter monitoring board controls the O<sub>2</sub>/air flow through the proportional valve, and monitors and feeds back the O<sub>2</sub>/air flow through the flow sensor. In addition, the auxiliary flowmeter monitoring board also drives the three-way valve. This board is configured with auxiliary O<sub>2</sub>/air software.

Pagalbinė O<sub>2</sub>/oro sistema  
Pagalbinio srauto matuoklio stebėjimo plokštė  
Pagalbinio srauto matuoklio stebėjimo plokštė yra pagrindinė anestezijos aparato pagalbinio srauto matuoklio valdymo dalis. Jis daugiausia naudojamas esant mažam 0–15 l/min srautui ir gali veikti savarankiškai. Srauto jutiklis yra suvirintas ant plokštės. Pagalbinė srauto matuoklio stebėjimo plokštė valdo O<sub>2</sub>/oro srautą per proporcinį vožtuvą ir stebi bei grąžina O<sub>2</sub>/oro srautą per srauto jutiklį. Be to, pagalbinė srauto matuoklio stebėjimo plokštė taip pat valdo trijų krypčių vožtuvą. Ši plokštė sukonfigūruota su pagalbine O<sub>2</sub>/oro programine įranga.



Installation position of the auxiliary flowmeter monitoring board



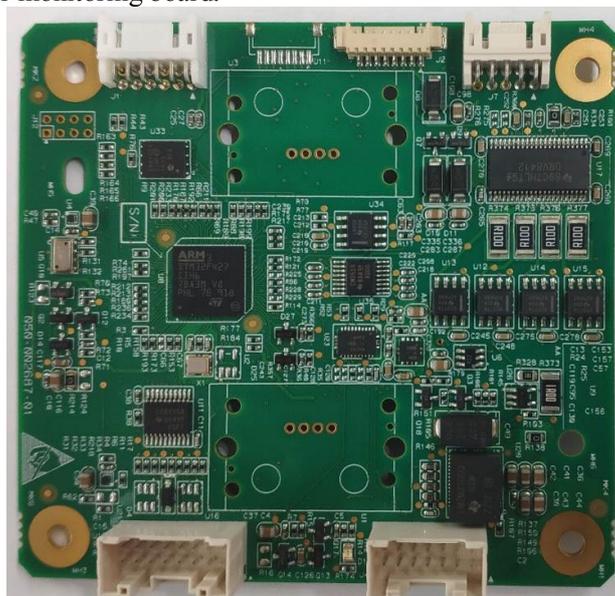


Auxiliary flowmeter monitoring board (bottom view)

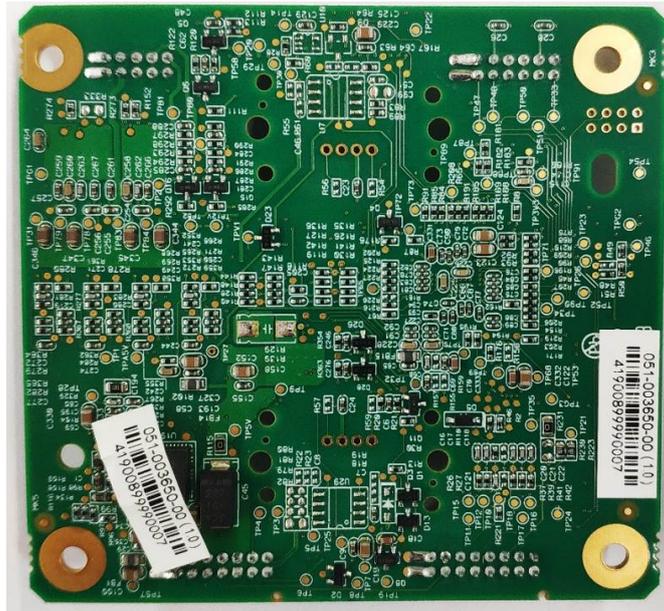
### 6.2.6.2 High-Flow O<sub>2</sub> Therapy Monitoring Board

The high-flow O<sub>2</sub> therapy monitoring board is the core control part of high-flow O<sub>2</sub> therapy of the anesthesia machine. It is mainly used at a low flow of 0–60 L/min and can work independently. The flow sensor is not welded on the board. The high-flow O<sub>2</sub> therapy monitoring board controls the O<sub>2</sub>/air flow through the proportional valve, and monitors and feeds back the O<sub>2</sub>/air flow through the flow sensor. In addition, the high-flow O<sub>2</sub> therapy monitoring board also drives the three-way valve. This board is configured with high-flow O<sub>2</sub> therapy software.

The high-flow O<sub>2</sub> therapy monitoring board is installed in the same position as the auxiliary O<sub>2</sub>/air flowmeter monitoring board.



High-flow O<sub>2</sub> therapy monitoring board (top view)



High-flow O2 therapy monitoring board (bottom view)

### 6.2.6.3 High-Flow Sensor Board

The high-flow sensor board is mainly used to monitor the O<sub>2</sub>/air branch flow of the high-flow O<sub>2</sub> therapy module and feed back the detected signals to the high-flow O<sub>2</sub> therapy monitoring board through the I2C bus.

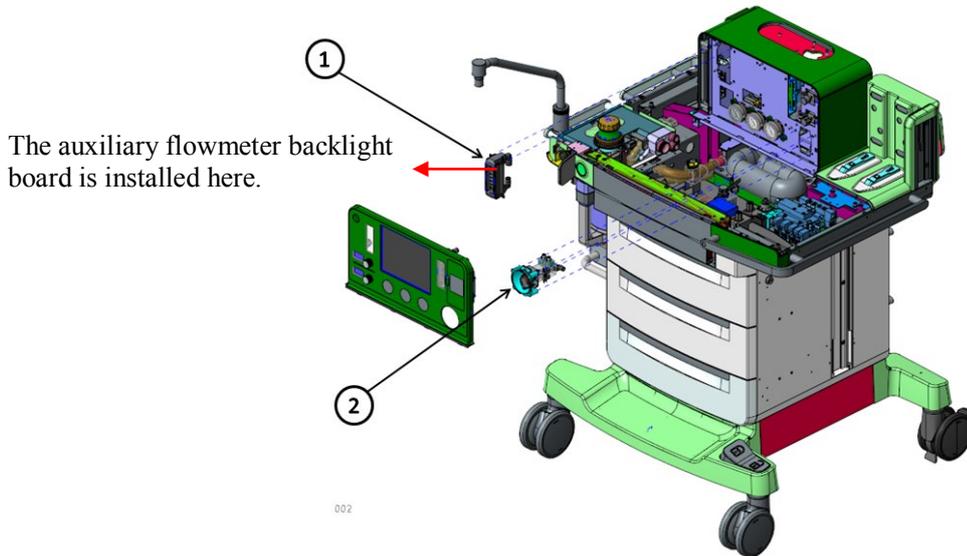
This board is installed inside the high-flow O<sub>2</sub> therapy module.



High-flow sensor board

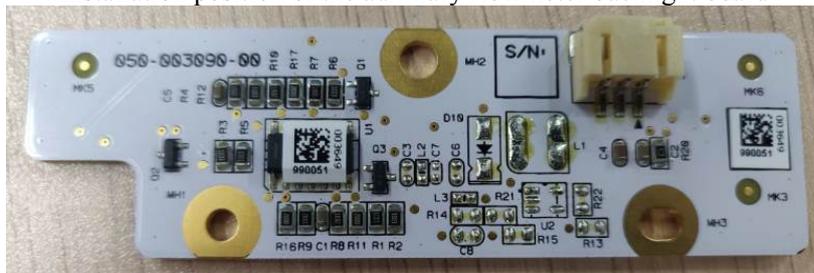
### 6.2.6.4 Auxiliary Flowmeter Backlight Board

The auxiliary flowmeter backlight board is mainly used to provide lighting for the auxiliary flowmeter.

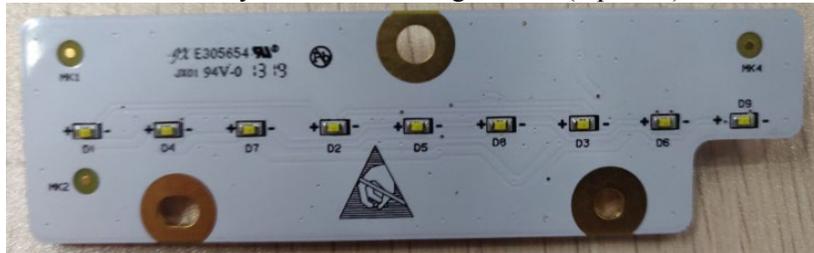


The auxiliary flowmeter backlight board is installed here.

Installation position of the auxiliary flowmeter backlight board



Auxiliary flowmeter backlight board (top view)

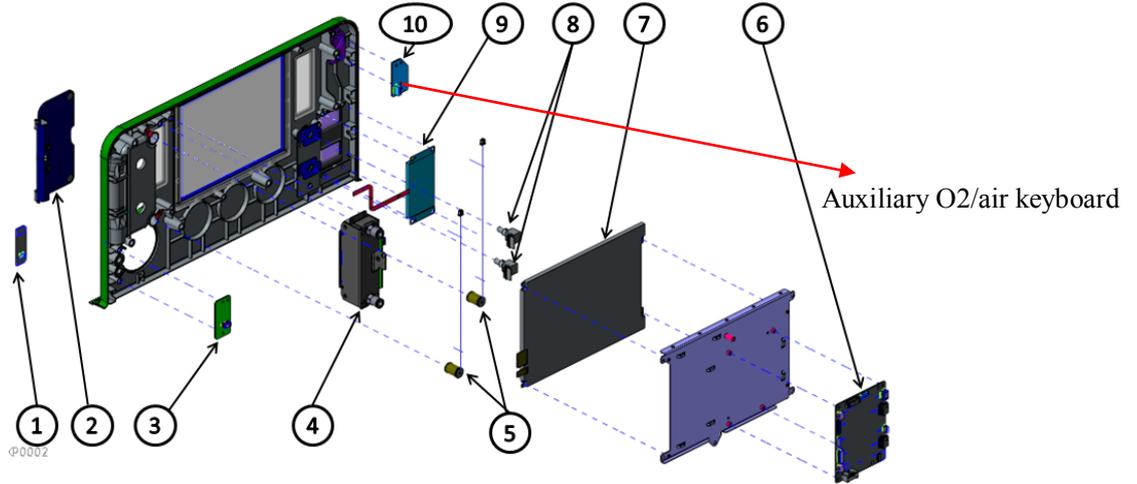


Auxiliary flowmeter backlight board (bottom view)

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### 6.2.6.5 Auxiliary O2/Air Keyboard

The auxiliary O2/air keyboard is mainly used to turn on or off the auxiliary O2/air module.



Installation position of the auxiliary O2/air keyboard

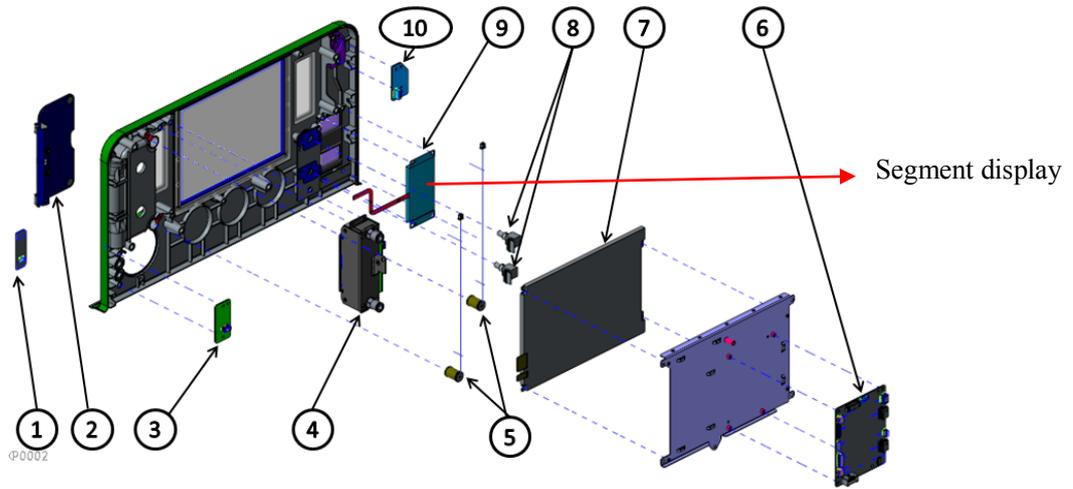


Auxiliary O2/air keyboard

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### 6.2.6.6 Segment Display

The segment display is used to display the total O<sub>2</sub>/air flow and O<sub>2</sub> concentration of the auxiliary O<sub>2</sub>/air module.



Installation position of the segment display



Segment display

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## 6.2.7 Electronic Vaporizer System

### 6.2.7.1 Electronic Vaporizer Base Interface Board

The electronic vaporizer base interface board is used to connect the electronic vaporizer only for signal transfer. Two electronic vaporizer base interface boards are configured for each machine.



Electronic vaporizer base interface board

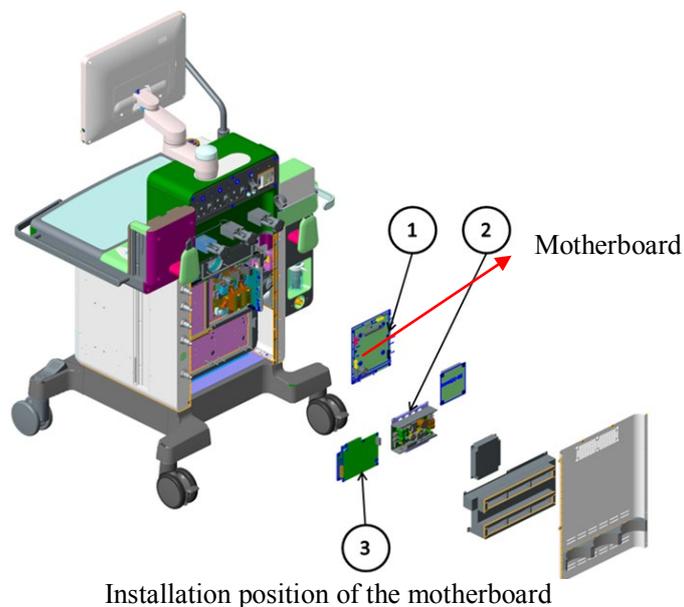
### 6.2.7.2 Electronic Vaporizer

The electronic vaporizer subsystem is located on the right side of the work surface, consisting of the electronic vaporizer, electronic vaporizer base, and filler. The electronic vaporizer subsystem is mainly used to accurately output the anesthetic gas concentration, enable users to install, remove, fill, and drain the vaporizer, as well generate related alarms. The electronic vaporizer supports three anesthetic agents: isoflurane, sevoflurane, and desflurane. The electronic vaporizer base provides two canister installation positions.

## 6.2.8 Other Parts

### 6.2.8.1 Motherboard

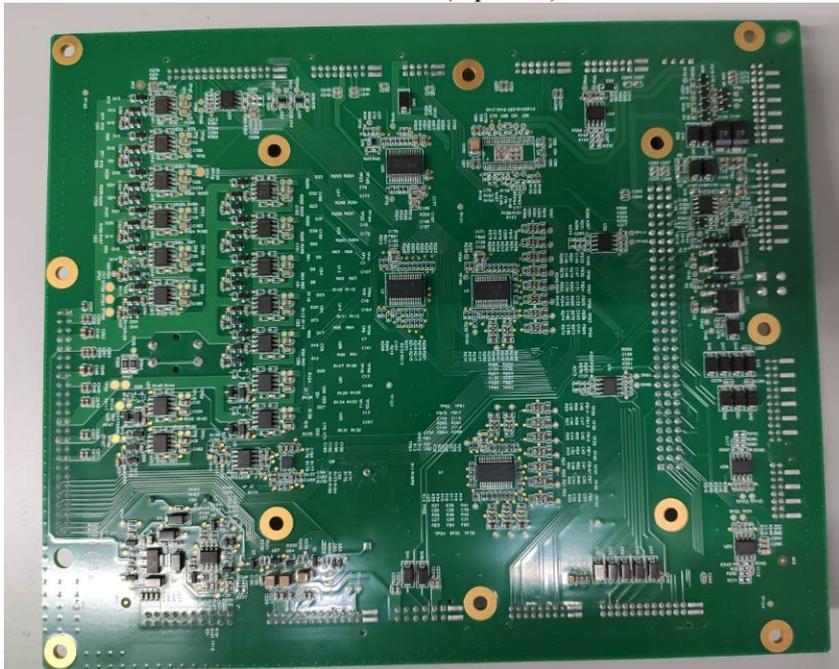
Similar to cable materials, the motherboard is mainly used for signal transfer and power adaptation for modules. It also contains some current limiting circuits and buzzer alarm circuits.



Installation position of the motherboard



Motherboard (top view)



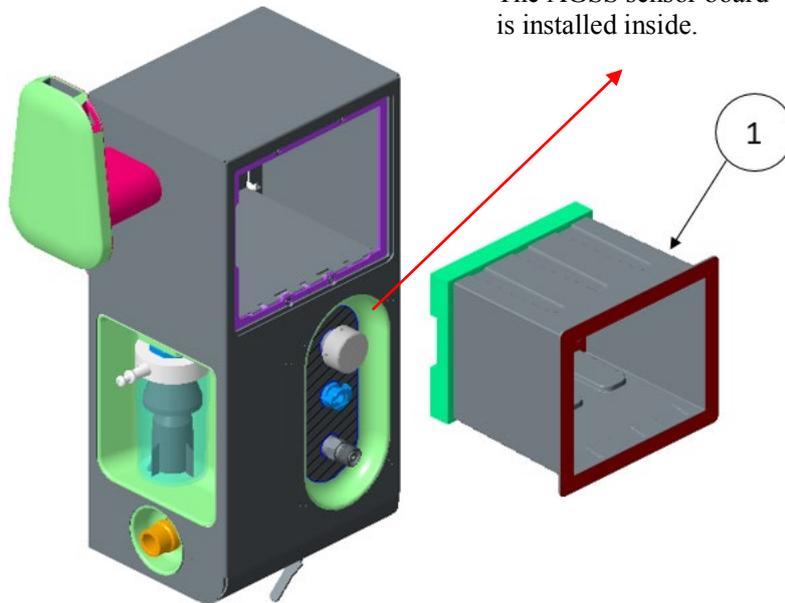
Motherboard (bottom view)

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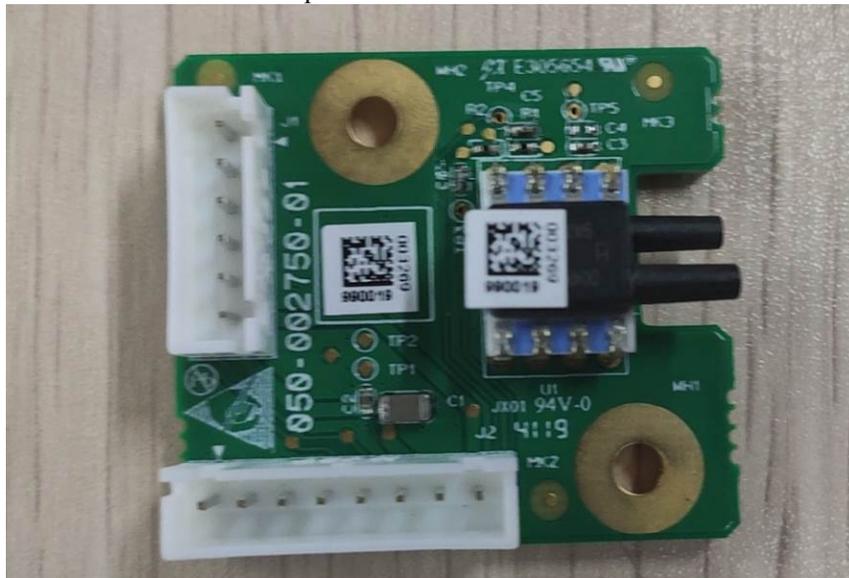
### 6.2.8.2 AGSS Sensor Board

The AGSS sensor board is used to test the AGSS waste gas flow, which refers to the total flow of the "drive gas + gas that escapes from the patient circuit + air that is pumped into the hospital connection pipeline under negative pressure".

The AGSS sensor board is installed inside.

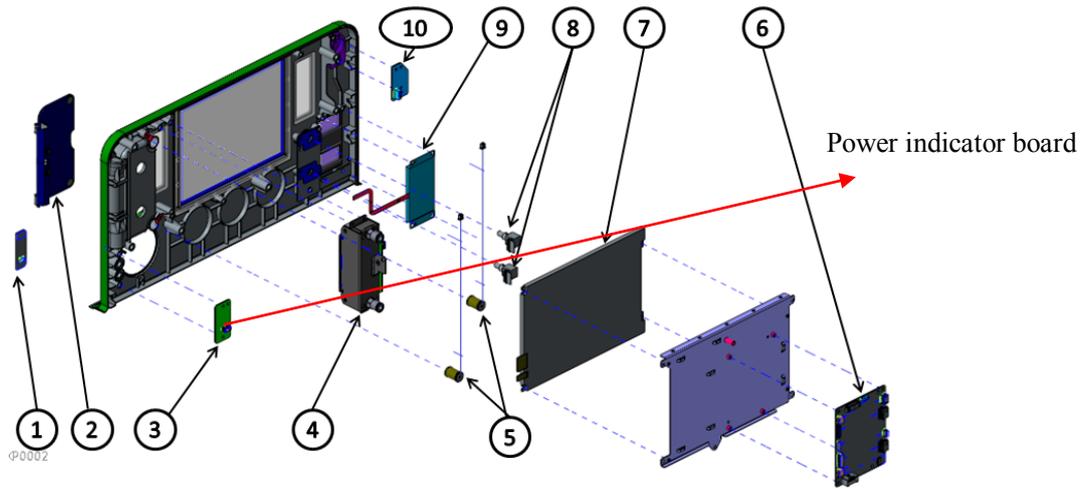


Installation position of the AGSS sensor board



AGSS sensor board

### 6.2.8.3 Power Indicator Board



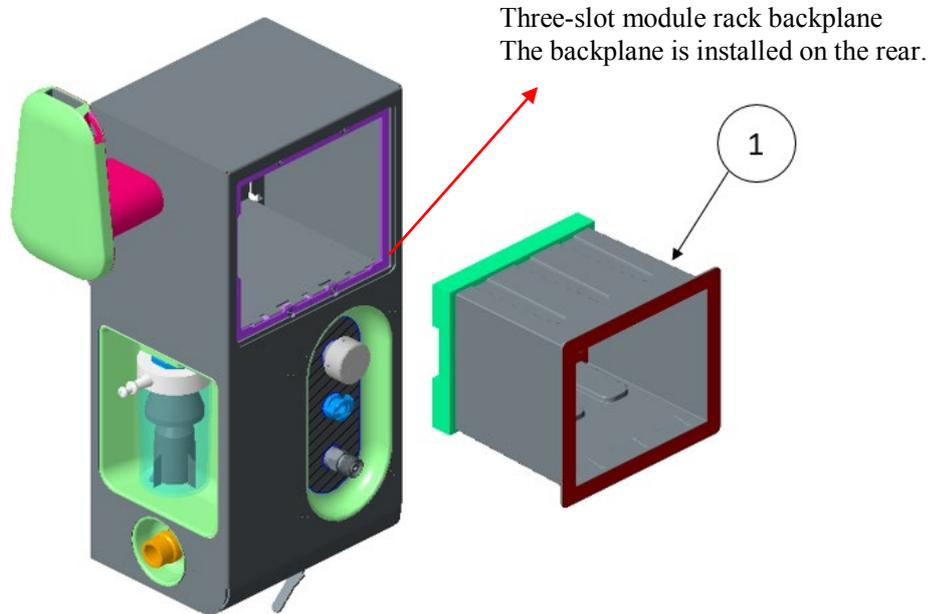
Installation position of the power indicator board



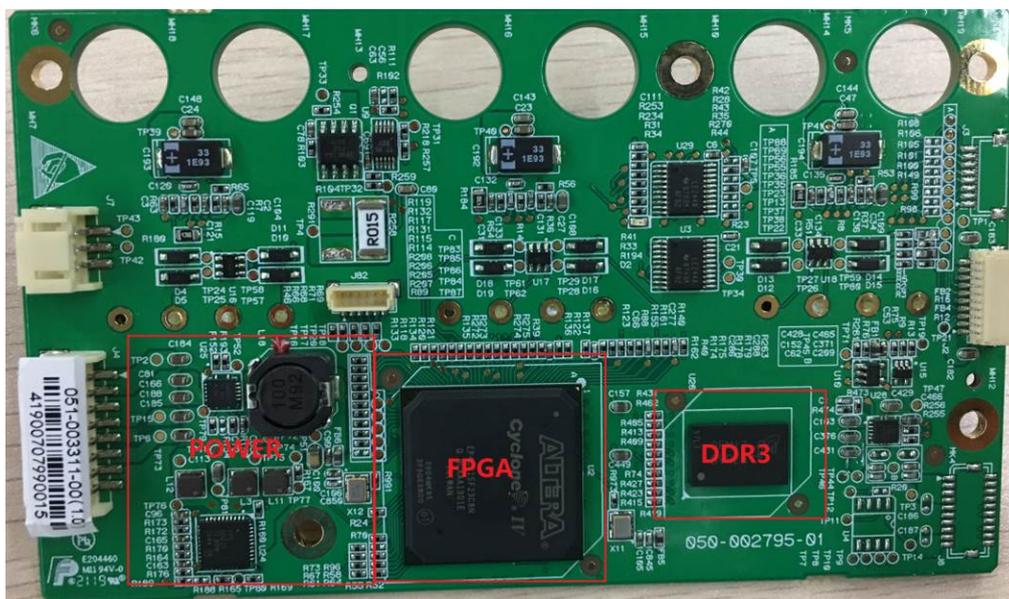
Power indicator board

### 6.2.8.4 Three-Slot Module Rack Backplane

The three-slot module rack backplane is a logical forwarding data board mainly used to power and communicate with the module rack. This board is configured with module rack software.



Installation position of the three-slot module rack backplane

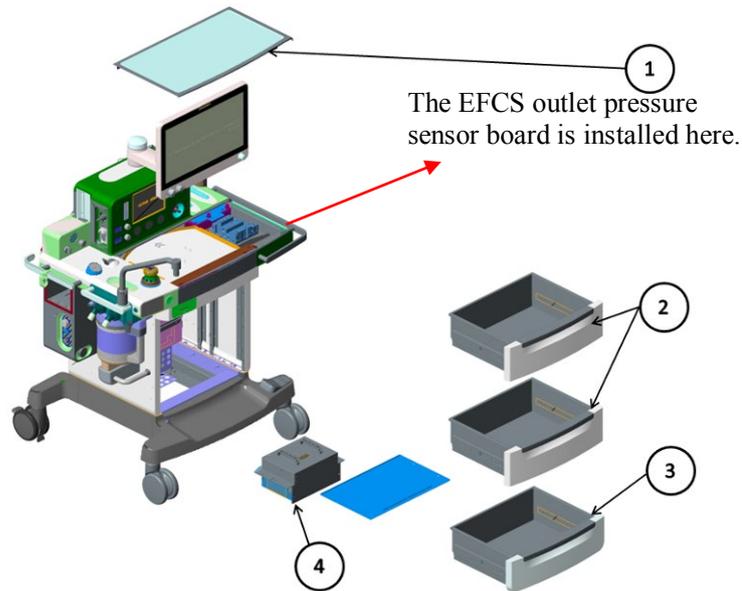


Three-slot module rack backplane

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### 6.2.8.5 EFCS Outlet Pressure Sensor Board

The EFCS outlet pressure sensor board is used to detect the pressure at the EFCS outlet.



Installation position of the EFCS outlet pressure sensor board



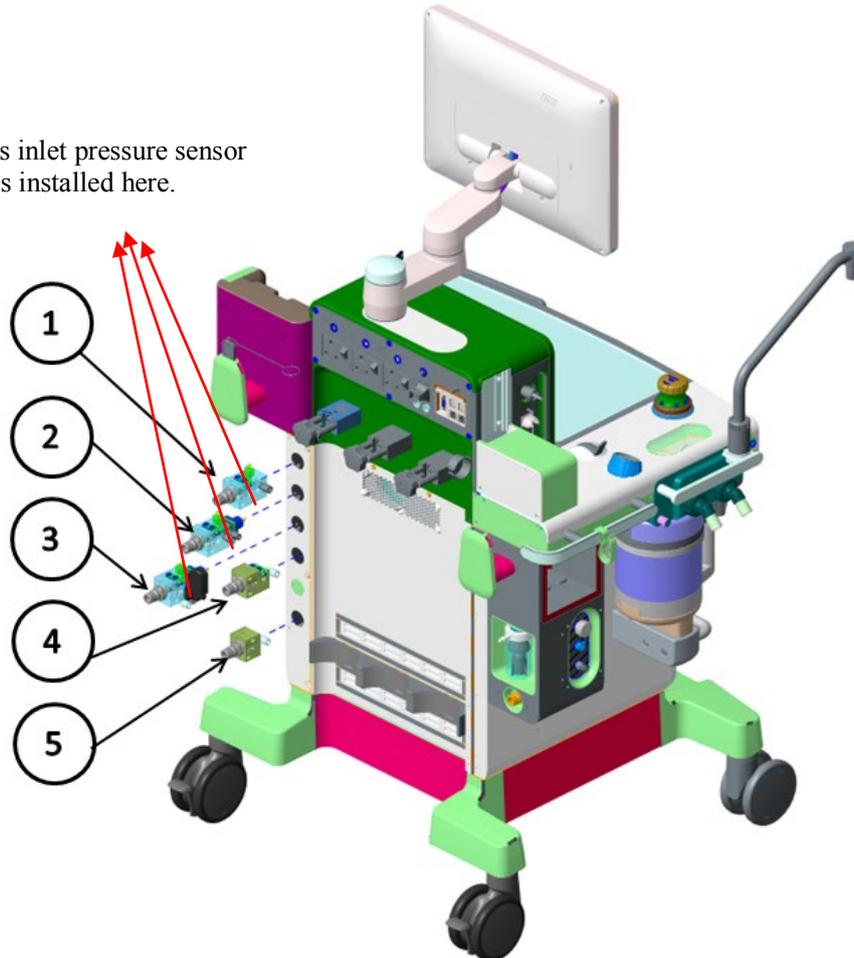
EFCS outlet pressure sensor board

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### 6.2.8.6 Gas Inlet Pressure Sensor Board

The gas inlet pressure sensor board is used to detect the pressure at the pipeline gas inlet. It has the same appearance as the EFCS outlet pressure sensor board but has a different measurement range. Pay attention to the part numbers during servicing.

The gas inlet pressure sensor board is installed here.



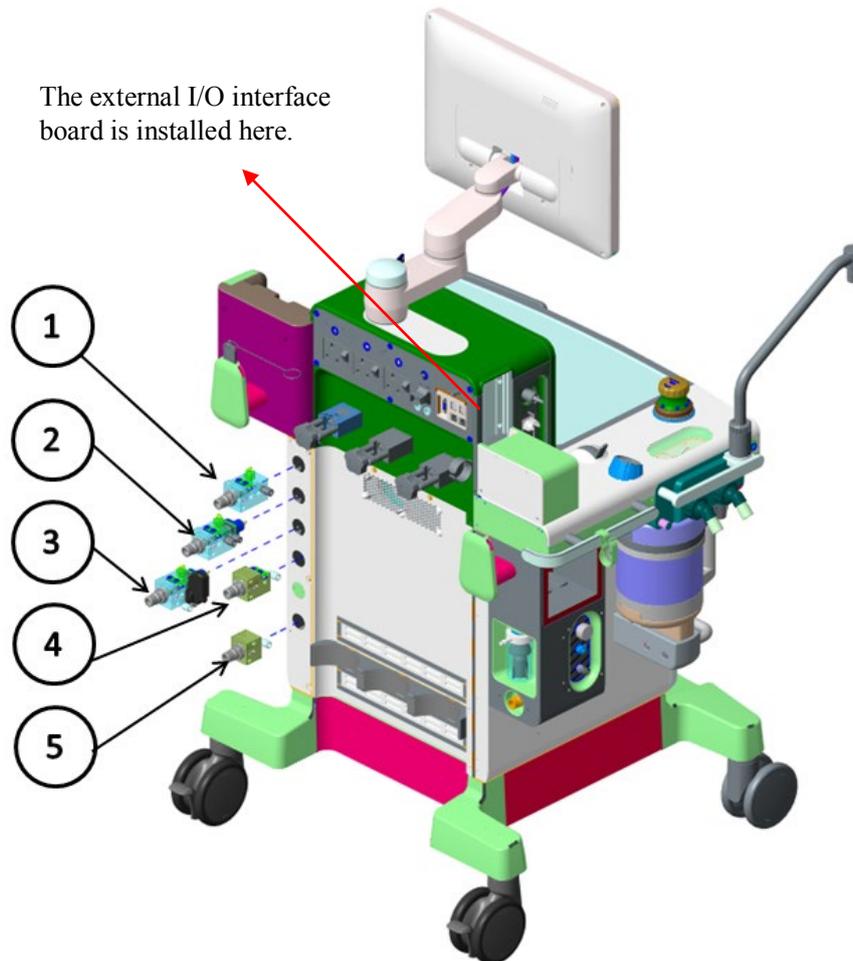
Installation position of the gas inlet pressure sensor board



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### 6.2.8.8 External I/O Interface Board

The external I/O interface board provides external ports, including four USB ports, two network ports, and one DB9 port (for calibration and device interconnection). No software is configured for this board.



Installation position of the external I/O interface board

## 6.3 Pneumatic Part

The Avatar anesthesia machine consists of seven subsystems: gas supply, flowmeter, vaporizer, breathing, auxiliary gas supply, AGSS, and negative pressure suction. The pneumatic diagram and the list of related parts are shown below.

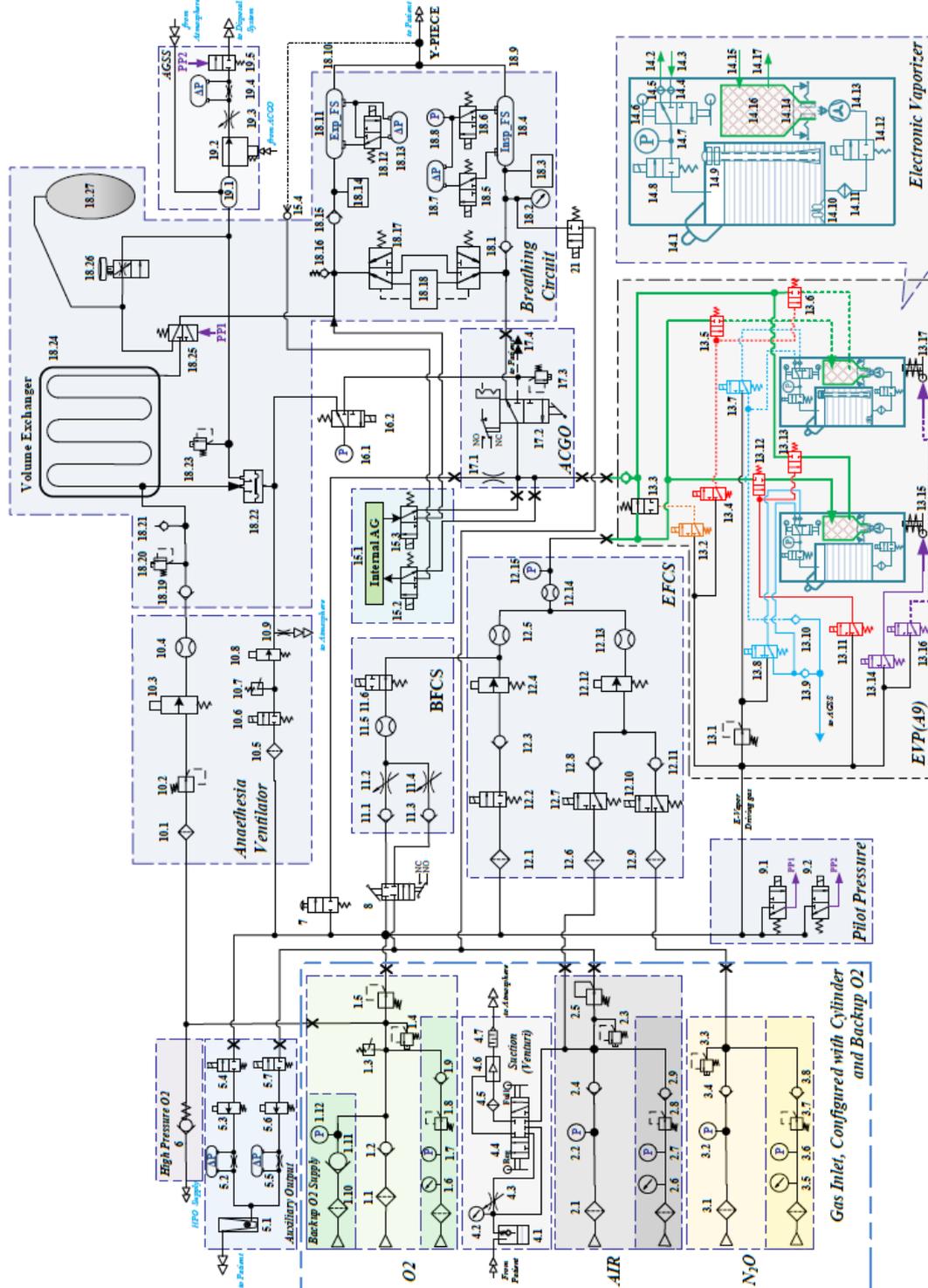


Figure 1 Pneumatic diagram

No.	Description	No.	Description
1.1	Filter	3.4	Check valve

1.2	Check valve	3.5	Cylinder pressure gauge
1.3	Pressure switch	3.6	Electronic cylinder pressure sensor
1.4	Pressure-relief valve	3.7	Cylinder pressure regulator
1.5	Regulator	3.8	Check valve
1.6	Cylinder pressure gauge	3.9	Filter
1.7	Electronic cylinder pressure sensor	3.10	Large cylinder pressure gauge
1.8	Cylinder pressure regulator	3.11	Check valve
1.9	Cylinder check valve	4.1	Overfill protection cup
1.10	Filter	4.2	Negative pressure gauge
1.11	Check valve	4.3	Negative pressure regulating switch
1.12	Electronic pipeline pressure sensor	4.4	Mode selection switch
1.13	Pipeline pressure gauge	4.5	Filter
1.14	Filter	4.6	Venturi negative pressure generator
1.15	Large cylinder pressure gauge	4.7	Muffler
1.16	Check valve	5.1	Float flowmeter (0–15 LPM)
2.1	Filter	5.2	Differential pressure gauge
2.2	Electronic pipeline pressure sensor	5.3	Proportional valve
2.3	Pressure-relief valve	5.4	NC switch valve
2.4	Check valve	5.5	Differential pressure gauge
2.5	Regulator	5.6	Proportional valve
2.6	Cylinder pressure gauge	5.7	NC switch valve
2.7	Electronic cylinder pressure sensor	5.8	Float flowmeter (0–60 LPM)
2.8	Cylinder pressure regulator	5.9	Check valve
2.9	Check valve	5.10	Differential pressure gauge
2.10	Electronic pipeline pressure sensor	5.11	Proportional valve
3.1	Filter	5.12	Pilot NC switch valve
3.2	Electronic pipeline pressure sensor	5.13	Pilot 2/3 switch valve
3.3	Pressure-relief valve	5.14	Check valve
5.15	Differential pressure gauge	12.9	Filter
5.16	Proportional valve	12.10	2/3 switch valve
5.17	Pilot NC switch valve	12.11	Check valve
6	High-pressure O2 outlet	12.12	Proportional valve
7	O2 flush	12.13	Flow sensor
8	System switch	12.14	Flow sensor
9.1	Auto/manual switch pilot valve	12.15	Pressure sensor
9.2	Electronic AGSS start/stop pilot valve	13.1	Drive gas regulating valve

10.1	Filter	13.2	Fresh gas switch pilot valve
10.2	Regulator	13.3	NO switch valve
10.3	Proportional valve	13.4	2/3 switch valve
10.4	Flow sensor	13.5	NC switch valve
10.5	Filter	13.6	NC switch valve
10.6	NC switch valve	13.7	2/3 switch valve
10.7	Pressure switch	13.8	2/3 switch valve
10.8	Proportional valve	13.9	Check valve
10.9	Resistor	13.10	Check valve
11.1	Check valve	13.11	2/3 switch valve
11.2	O2 needle valve	13.12	NC switch valve
11.3	Check valve	13.13	NC switch valve
11.4	Air needle valve	13.14	2/3 switch valve
11.5	Float flowmeter (0–15 LPM)	13.15	Pneumatic self-locking valve
11.6	NO switch valve	13.16	2/3 switch valve
12.1	Filter	13.17	Pneumatic self-locking valve
12.2	NC switch valve	14.1	Filling opening
12.3	Check valve	14.2	Drive gas outlet
12.4	Proportional valve	14.3	Drive gas inlet
12.5	Flow sensor	14.4	Filter
12.6	Filter	14.5	Filter
12.7	2/3 switch valve	14.6	Pressurization/relief valve linked to the switch cover
12.8	Check valve	14.7	Pressure sensor
14.8	NC switch valve	18.9	Inspiratory port
14.9	Capacitive liquid level sensor	18.10	Expiratory port
14.10	Ultrasonic liquid level sensor	18.11	Expiratory differential pressure gauge
14.11	Filter	18.12	2/3 switch valve
14.12	NC switch valve	18.13	Expiratory flow sensor
14.13	Spray control valve	18.14	Water collection cup
14.14	Infrared counter	18.15	Check valve
14.15	Fresh gas inlet	18.16	Self-sealing sampling port
14.16	Anesthetic agent mixing chamber	18.17	Bypass
14.17	Mixed gas outlet	18.18	CO2 absorber canister
15.1	Internal AG module	18.19	Check valve
15.2	2/3 switch valve	18.20	11 kPa relief valve

15.3	2/3 switch valve	18.21	Check valve
15.4	Self-sealing sampling port	18.22	Expiratory valve
15.5	External AG module	18.23	1 kPa relief valve
16.1	Pressure sensor	18.24	Volume exchanger (VE)
16.2	2/3 switch valve	18.25	Auto/manual switch valve
17.1	Pneumatic resistor	18.26	APL valve
17.2	ACGO switch	18.27	Manual bag
17.3	11 kPa relief valve	19.1	Gas reservoir
17.4	ACGO port	19.2	Waste gas scavenging three-way port
18.1	Check valve	19.3	Negative pressure regulator
18.2	Airway pressure gauge	19.4	Differential negative pressure gauge
18.3	O2 sensor	19.5	Pilot NC switch valve
18.4	Inspiratory differential pressure gauge	20.1	Vaporizer bypass
18.5	2/3 switch valve	20.2	Mechanical vaporizer
18.6	2/3 switch valve	20.3	Check valve
18.7	Inspiratory flow sensor	21	NC switch valve
18.8	Pressure sensor		

### 6.3.1 Symbols

	Filter		Regulator
	Pressure gauge		Check valve c
	Gas supply connector		Pressure relief valve
	Flowmeter		Flow control valve
	Pressure switch		Flow restrictor

### 6.3.2 Gas Supply Subsystem

The gas supply subsystem is mainly used to provide fresh gas for the patient and drive gas for the anesthesia ventilator. It consists of the gas inlet assembly, cylinder yoke assembly, ACGO assembly, O2 flush assembly, and system switch assembly.

#### 6.3.2.1 Gas Inlet Assembly

The gas inlet assembly provides three gases for the anesthesia machine: O2, N2O, and air. Three types of gas inlet assemblies are available based on different types of gases: O2 inlet assembly, N2O inlet assembly, and air inlet assembly. The main configuration difference lies in that the O2 inlet assembly is equipped with a gas supply pressure switch and the O2 and air inlet assemblies each are equipped with a pressure regulating valve. The following figure shows the pneumatic diagram of the gas inlet assembly based on different configurations and types:

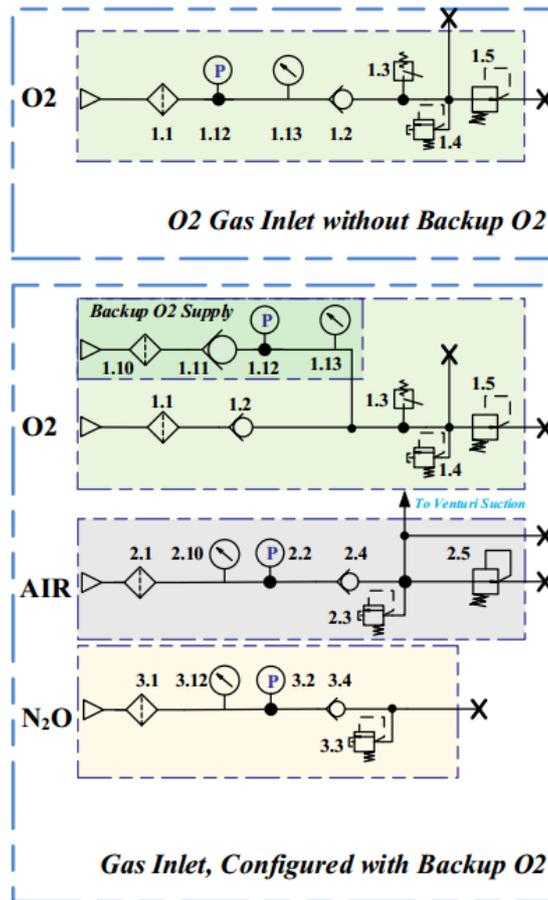


Figure 2 Pneumatic diagram of the gas inlet assembly  
 As shown in the above figure, the gas inlet assembly consists one or more of the following components based on different configurations: gas hose connector, filters (1.1, 1.10, 2.1, and 3.1), check valves (1.2, 1.11, 2.4, and 2.9), pressure relief valves (1.4, 2.3, and 3.3), regulators (1.5 and 2.5), pressures switch (1.3), and pressure sensors (1.12, 2.10, and 3.2). Structural diagrams of the gas inlet assemblies are shown below.

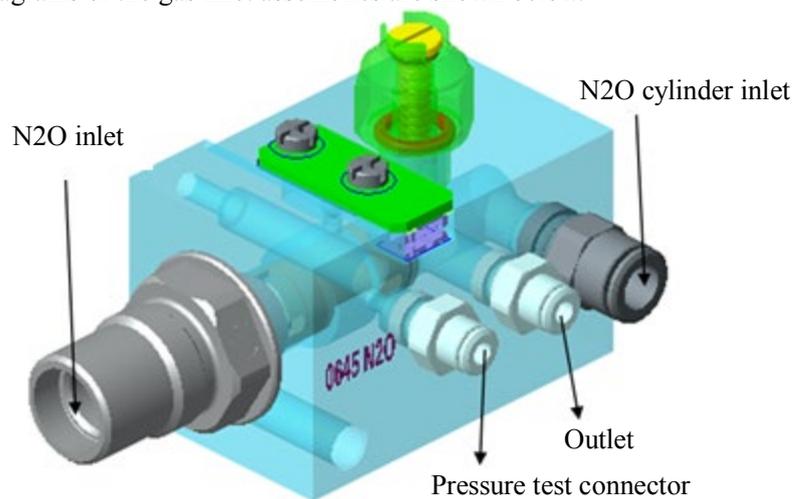


Figure 3 Structural diagram of the N2O inlet assembly

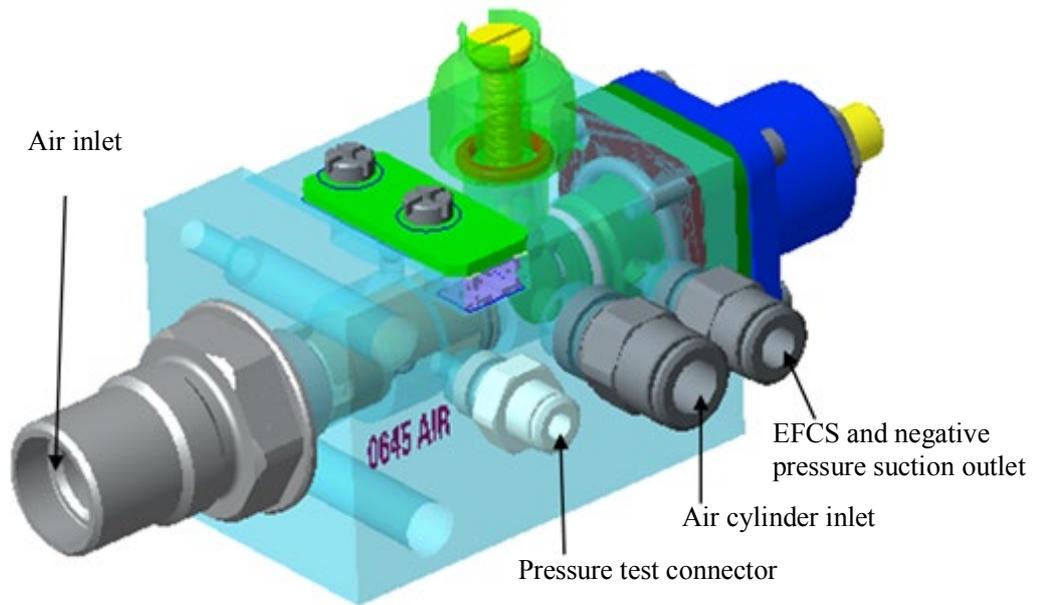


Figure 4 Structural diagram of the air inlet assembly

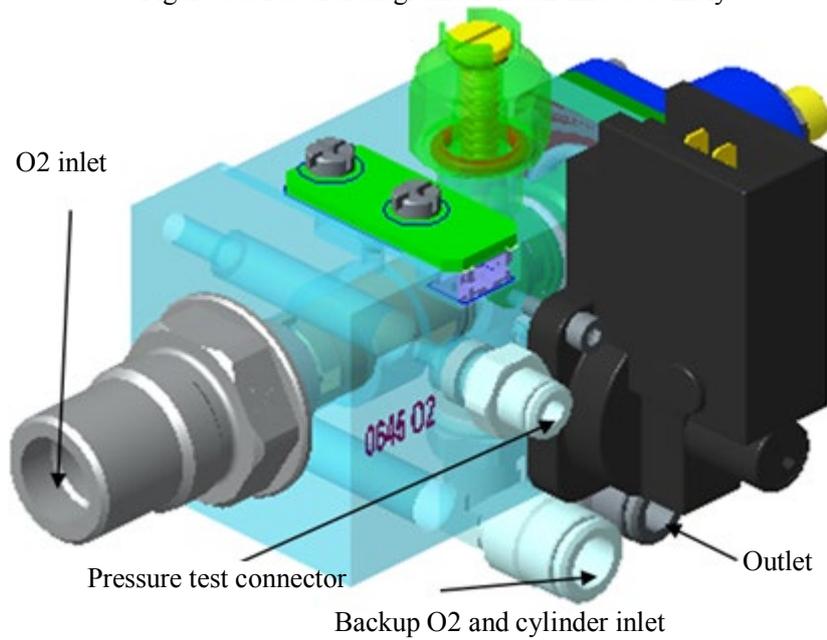


Figure 5 Structural diagram of the O2 inlet assembly

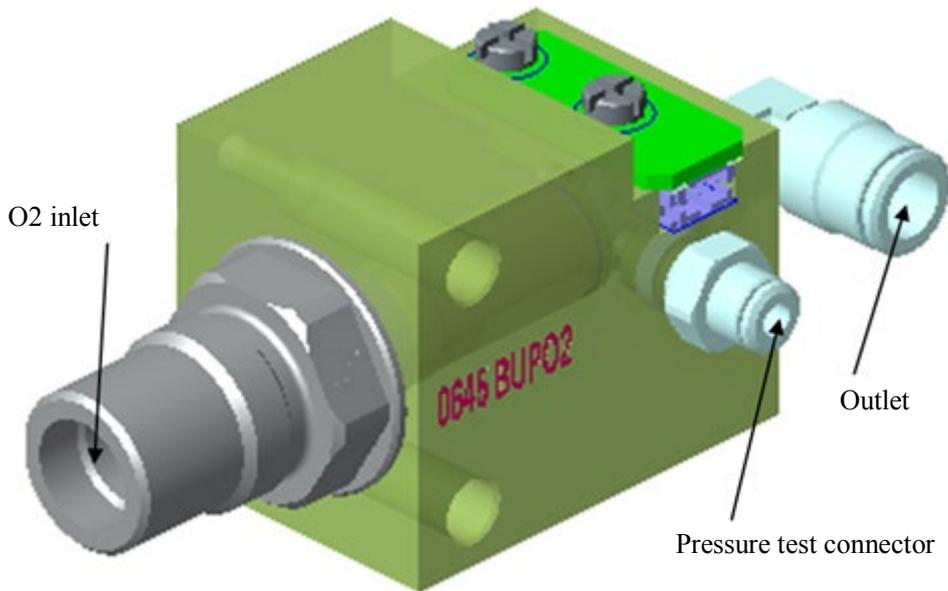


Figure 5 Structural diagram of the backup O2 inlet assembly

### 6.3.2.2 Cylinder Yoke Assembly

The cylinder yoke assembly is used to connect a high-pressure cylinder to the anesthesia machine, so that the anesthesia machine can use O<sub>2</sub>, air, and N<sub>2</sub>O supplied by the high-pressure cylinder. The high-pressure cylinder is connected to the cylinder yoke by means of pin-indexed yoke connection, which is sealed by the end face of a nylon pad and tightened by using a pentagon knob. High-pressure gas in the cylinder is purified through the filter in the cylinder yoke and then enters the pressure reducing valve. Low-pressure gas flows into the gas inlet assembly through the check valve. The high pressure gauge and the cylinder yoke assembly are connected through a high-pressure-resistant copper tube and a corresponding connector to monitor the pressure of the gas output from the cylinder. In a cylinder yoke equipped with a high pressure gauge and an electronic pressure sensor, the high pressure gauge displays the gas pressure, and the electronic pressure sensor also displays the detected pressure on the display. The following figure shows the pneumatic diagram (O<sub>2</sub>) of the cylinder yoke assembly:

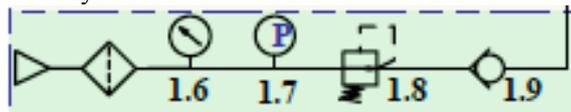


Figure 6 Pneumatic diagram of the cylinder yoke assembly

The cylinder yoke assembly consists of four components: pressure reducing valve (1.8), high pressure gauge (1.6), electronic pressure sensor (1.7), and check valve (1.9). For a cylinder yoke equipped with only a mechanical pressure gauge but no electronic pressure sensor, a plug with the same threads is provided in the position of the connector. The structural diagram of the cylinder yoke assembly is shown below.

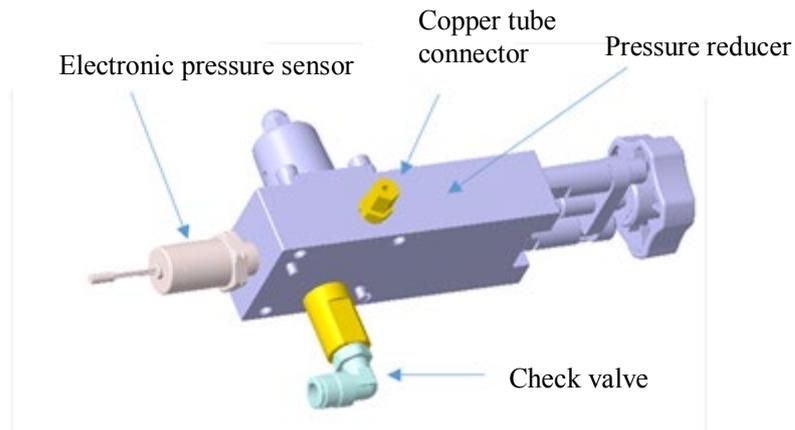


Figure 7 Structural diagram of the cylinder yoke assembly

### 6.3.2.3 ACGO Assembly

The ACGO assembly outputs the gas flowing through the vaporizer manifold and the flushed O<sub>2</sub> to the breathing circuit or directly to the independent ACGO outlet. The ACGO assembly also provides an AG module sampling connector. The pneumatic diagram of the ACGO assembly is shown below.

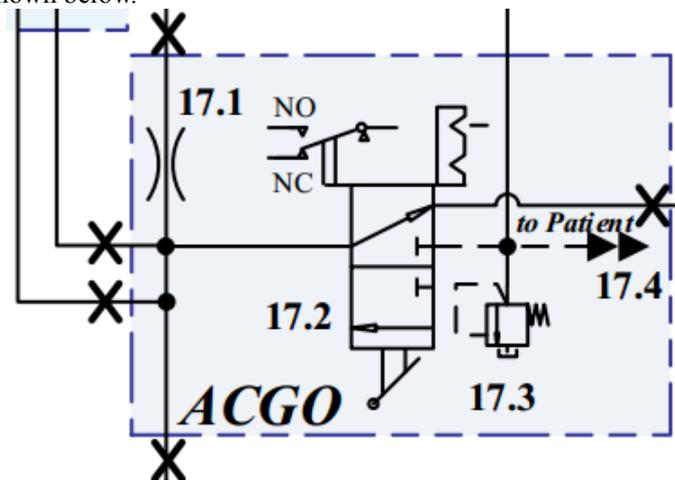


Figure 8 Pneumatic diagram of the ACGO assembly

The ACGO assembly consists of the knob, 11 kPa pressure relief valve (17.3), microswitch (17.2), AG module sampling connector, O<sub>2</sub> flush inlet, fresh gas inlet, and common gas outlet. The structural diagram of the ACGO assembly is shown below.

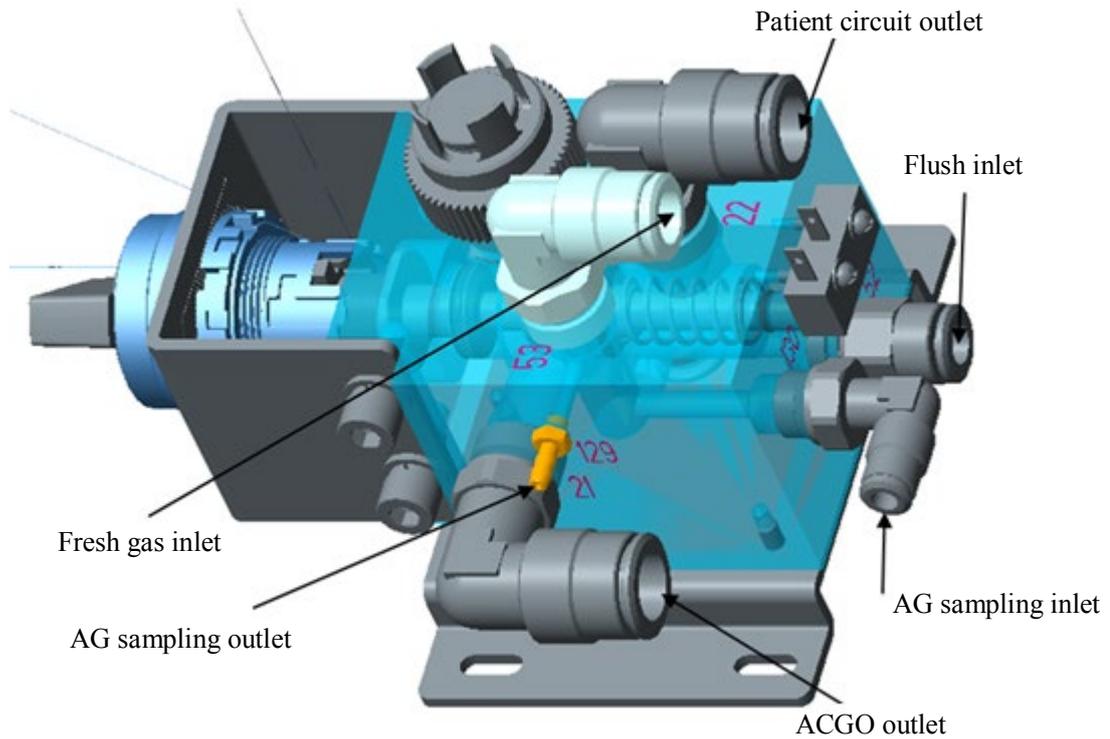


Figure 9 Structural diagram of the ACGO assembly

#### 6.3.2.4 O2 Flush Assembly

The O2 flush assembly contains two connectors for connecting to the pressure-regulated output end of the O2 inlet assembly and the ACGO assembly. The O2 flush assembly controls O2 supply through a manual push-button switch. It can supply O2 to the breathing system at the flow of 35–50 L/min regardless of whether the machine is turned on or off. The O2 flush assembly consists of the O2 flush bracket, O2 flush piston, reset spring, and quick connector. The structural diagram of the O2 flush assembly is shown below.

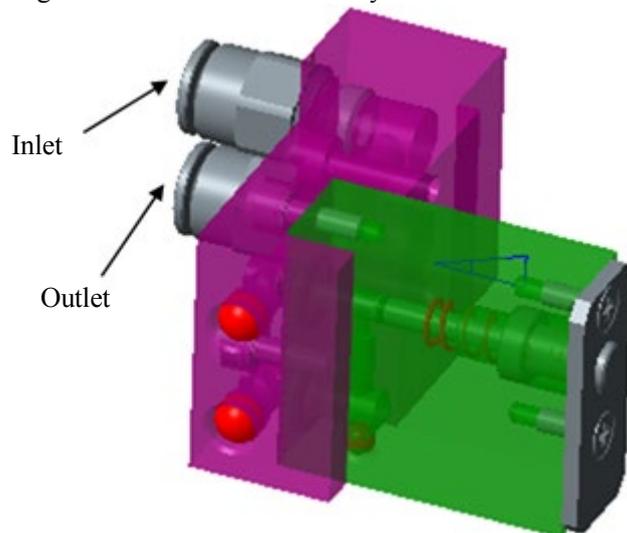


Figure 10 Structural diagram of the O2 flush assembly

### 6.3.2.5 System Switch Assembly

The system switch assembly controls fresh gas supply of the breathing system. In addition, it provides electrical signals of the system switch to realize synchronous on/off control on the pneumatic system and the circuit system of the anesthesia machine. The system switch outputs gas for the BFCs. The pneumatic diagram of the system switch assembly is shown below.

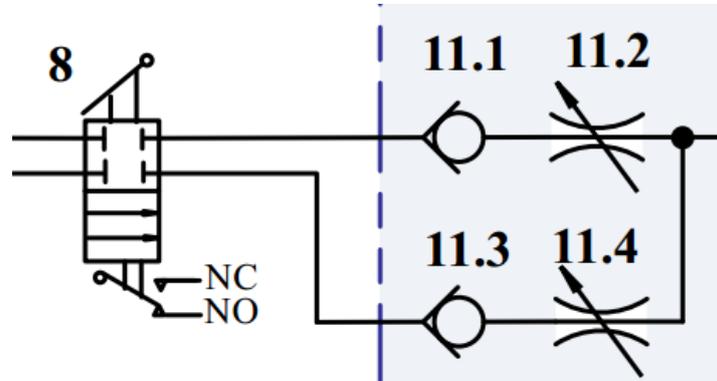


Figure 11 Pneumatic diagram of the system switch assembly

The system switch assembly controls O<sub>2</sub> and air supply. Both branches are controlled by a purchased switch knob. During switching, the two limit switches disposed symmetrically also switch on or off at the same time, realizing on-off control based on electrical signals of the system. Two check valves (11.1 and 11.3) are integrated at the system switch outlet to prevent air and O<sub>2</sub> inversion. The structural diagram of the system switch assembly is shown below.

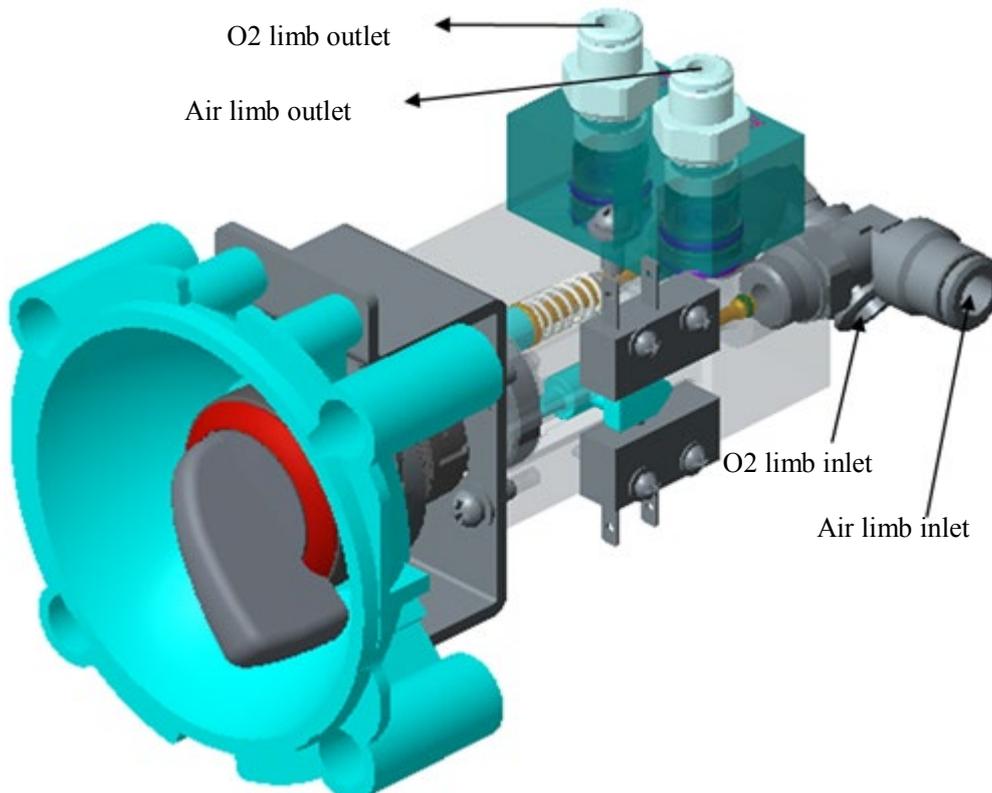


Figure 12 Structural diagram of the system switch assembly

### 6.3.3 Flowmeter Subsystem

The flowmeter subsystem is mainly used to control the flow of fresh gas and also provides backup flow control in case of power failure. It consists of the EFCS assembly and BFCS assembly.

#### 6.3.3.1 EFCS Assembly

The EFCS assembly is used for electronic regulation and monitoring feedback on the flows of the O<sub>2</sub>, air, and N<sub>2</sub>O branches. In addition, it controls the gas mixing ratio, outputs single or mixed gas, and displays it on the screen. The pneumatic diagram of the EFCS assembly is shown below.

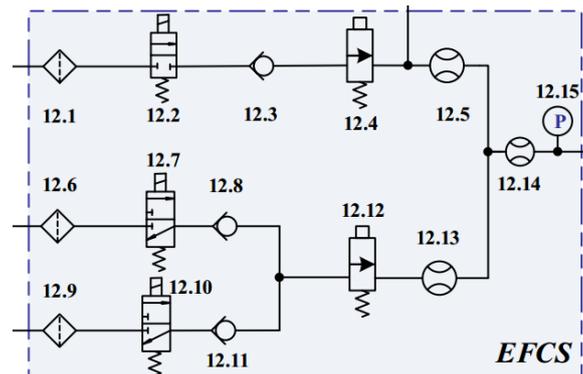


Figure 13 Pneumatic diagram of the EFCS assembly

The EFCS assembly consists of the inlet assembly, outlet assembly, flow sensors (12.5, 12.13, and 12.14), and pressure sensor (12.15), to control O<sub>2</sub>, air, and N<sub>2</sub>O supply separately. In addition, it provides the input interface and on-off control for the BFCS assembly. The structural diagram of the EFCS assembly is shown below.

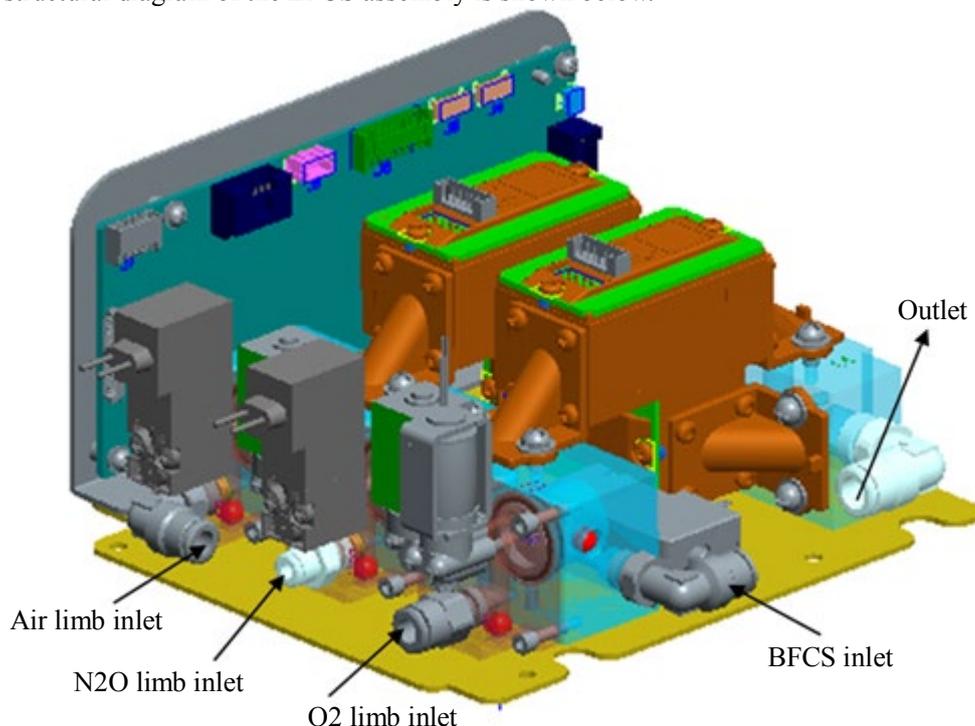


Figure 14 Structural diagram of the EFCS assembly

#### 6.3.3.2 BFCS Assembly

The BFCS assembly is used in case of system failure or EFCS assembly failure resulting from power failure. The BFCS contains two branches: air branch and O<sub>2</sub> branch, which are

separately controlled by two needle valves. The gas is supplied by the system switch assembly. The rear ends of the air needle valve (11.4) and O<sub>2</sub> needle valve (11.2) are joined and connected to the backup flowmeter (11.5), which is a mechanical float flowmeter for indicating the current flow. The downstream is connected to the EFCS assembly through an NO switch valve (11.6), which is powered on and closed during normal operation. When the BFCS assembly is activated, the valve is powered off and automatically open for ventilation. The backup flowmeter is configured with a backlight board on the rear, which emits light after the BFCS assembly is activated. The pneumatic diagram of the BFCS assembly is shown below.

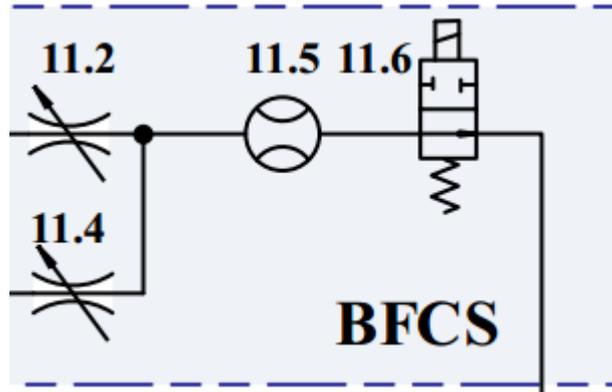


Figure 15 Pneumatic diagram of the BFCS assembly

### 6.3.4 Vaporizer Subsystem

The vaporizer subsystem is mainly used to provide the patient with anesthetic gas at certain concentration. Different vaporizer subsystems are configured for the A8 and A9 anesthesia machines. The vaporizer subsystem of the A8 anesthesia machine consists of a mechanical vaporizer and a mechanical vaporizer manifold assembly. The vaporizer subsystem of the A9 anesthesia machine consists of an electronic vaporizer and an electronic vaporizer manifold assembly.

#### 6.3.4.1 Mechanical Vaporizer Manifold Assembly (for A8)

The mechanical vaporizer manifold assembly provides a mounting location for the mechanical vaporizer (installation mode: Selectatec), mixes the anesthetic gas with the O<sub>2</sub>/air mixture at the input end to form fresh gas, and delivers the fresh gas to the common gas outlet. The assembly contains two connectors: one gas inlet connected to the EFCS assembly outlet, and one common gas outlet serving as an inlet of the ACGO assembly.

In principle, the mechanical vaporizer manifold assembly is a combination of a series of two-position three-way valves, which are controlled by the springs and vaporizer. When the vaporizer is not installed, the valves are in a certain state due to the spring force, and the mechanical vaporizer manifold assembly is a path. When the vaporizer is installed, the status of the two-position three-way valves switches to make the gas flow through the vaporizer. The pneumatic diagram is shown below.

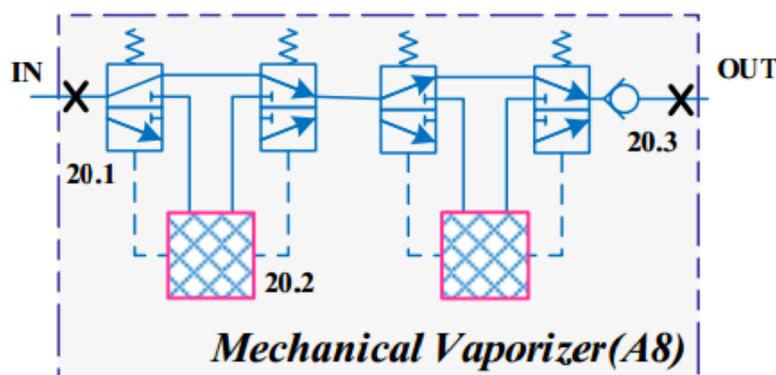


Figure 18 Pneumatic diagram of the mechanical vaporizer manifold assembly  
The mechanical vaporizer manifold assembly consists of the check valve assembly, connector

assembly, locking plate assembly, vaporizer manifold, vaporizer pad, and inlet/outlet quick connectors. The structural diagram of the mechanical vaporizer manifold assembly is shown below.

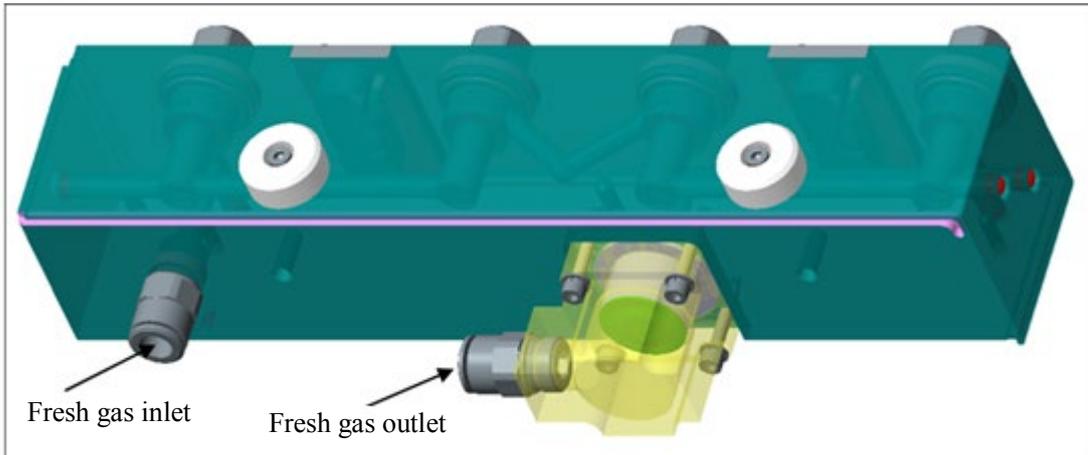


Figure 19 Structural diagram of the mechanical vaporizer manifold assembly

### 6.3.4.2 Electronic Vaporizer (for A9)

The electronic vaporizer can accurately feed the anesthetic agent into the anesthesia breathing circuit at certain concentration. During operating of the electronic vaporizer, the electronic vaporizer manifold provides 150 kPa drive gas, which flows through the drive gas inlet (14.3), mechanical pressure relief valve (14.6), pressure sensor (14.7), and drug pool entrance switch valve (14.8) into the drug pool of the vaporizer. The drive gas drives the anesthetic liquid in the drug pool to flow through the filter (14.11) and exit safety valve (14.12) into the injector (14.13), which injects pure anesthetic liquid to the mixing chamber (14.16) at certain frequency. In addition, the fresh gas of the anesthesia machine enters the mixing chamber through the fresh air inlet (14.15), and is fully mixed with the anesthetic gas. Then the mixed gas is delivered to the patient side through the fresh gas outlet (14.17). The pneumatic diagram of the electronic vaporizer is shown below.

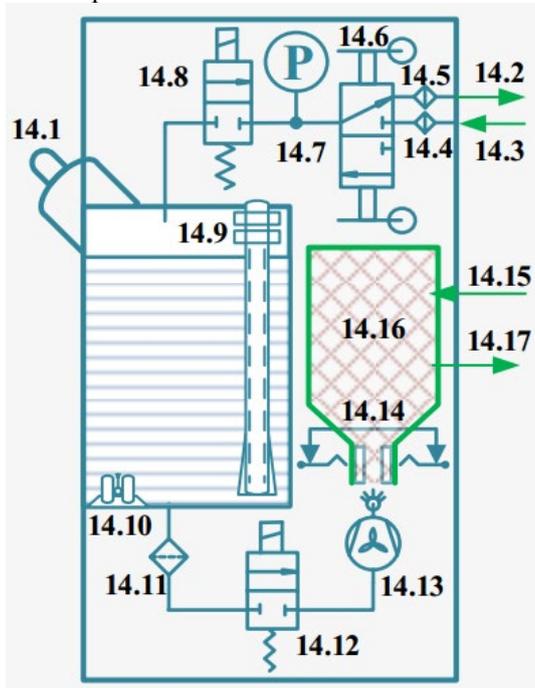


Figure 20 Pneumatic diagram of the electronic vaporizer

The electronic vaporizer consists of the drive gas interfaces (14.2 and 14.3), mechanical pressure relief assembly (14.6), filling unit (14.1), main pneumatic block assembly, drug pool entrance safety valve (14.8), drug pool, liquid level monitoring units (ultrasonic low liquid

level monitoring (14.10), capacitive continuous liquid level monitoring (14.9), and glass tube liquid level display), locking unit, drug pool exit safety valve (14.12), base assembly, and mixing chamber assembly (14.16). The structural diagram of the electronic vaporizer is shown below.

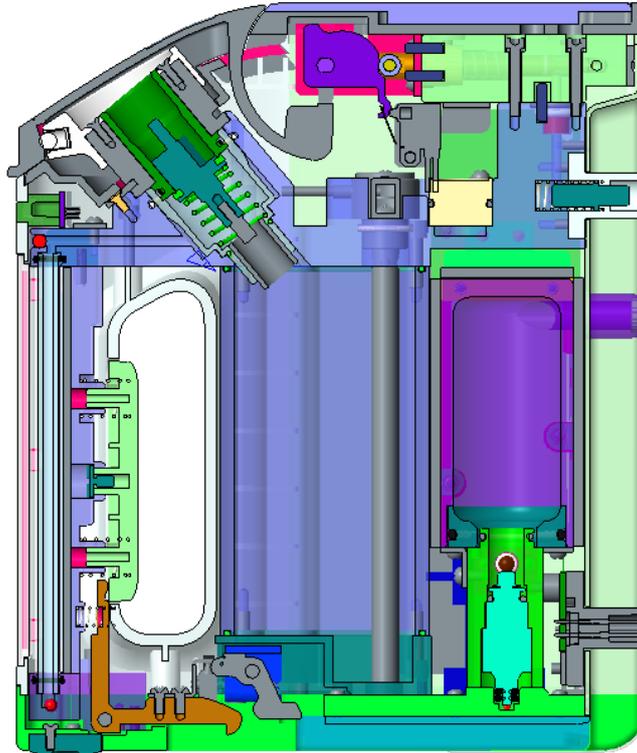


Figure 21 Structural diagram of the electronic vaporizer

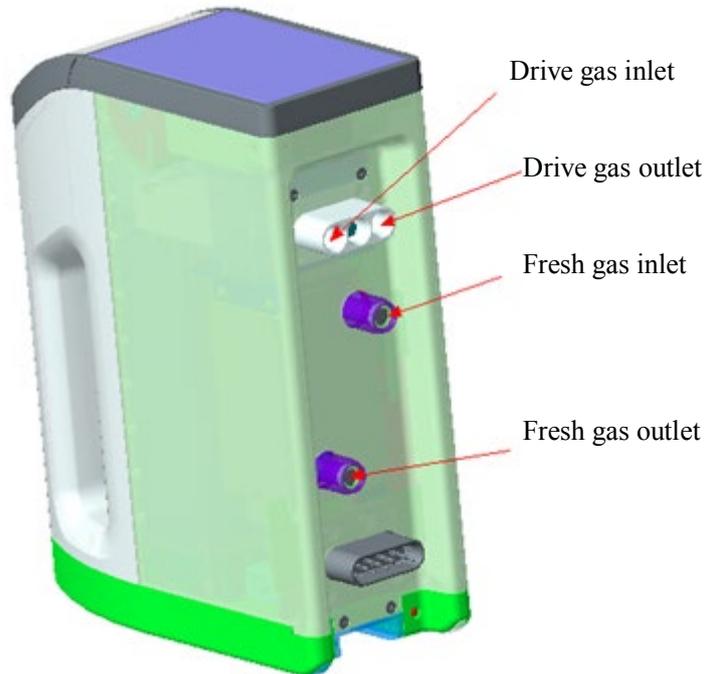


Figure 22 Interfaces of the electronic vaporizer

### 6.3.4.3 Electronic Vaporizer Manifold Assembly (for A9)

The electronic vaporizer manifold assembly provides a mounting location for the electronic vaporizer, provides driving pressure for the drug pool of the electronic vaporizer, mixes the

O<sub>2</sub>/air mixture at the input end with the anesthetic gas in the electronic vaporizer to form fresh gas, and delivers the fresh gas to the common gas outlet.

The schematic diagram of the electronic vaporizer manifold assembly is shown below. The drive gas from the front gas inlet is divided into six ways. Three ways provide driving pressure for the large-diameter valve (13.3) in the bypass branch, the large-diameter valves (13.12 and 13.13) in the branch of canister 1, and the large-diameter valves (13.5 and 13.6) in the branch of canister 2. Two ways provide driving pressure for the pneumatically-controlled lock (13.15) of canister 1 and the pneumatically-controlled lock (13.17) of canister 2. The remaining one way provides driving pressure for the electronic vaporizer after the pressure is regulated to  $150 \pm 5$  kPa through the regulator (13.1). The three-way valve (13.2) is used to switch on/off the bypass branch. The three-way valve (13.11) is used to switch on/off the branch of canister 1. The three-way valve (13.4) is used to switch on/off the branch of canister 2. The three-way valve (13.8) is used to control the pressurization/relief of the drive gas in canister 1. The three-way valve (13.7) is used to control the pressurization/relief of the drive gas in canister 2. The three-way valve (13.14) is used to control the pressurization/relief of the pneumatically-controlled lock drive gas in canister 1. The three-way valve (13.16) is used to control the pressurization/relief of the pneumatically-controlled lock drive gas in canister 2. The large-diameter valves and three-way valves are integrated in the electronic vaporizer control module for controlling the gas from the electronic vaporizer to flow through the branch of canister 1, the branch of canister 2, or the bypass branch, and controlling the pressurization/relief of the electronic vaporizer drive gas as well as the locking/unlocking of the pneumatically-controlled lock. The pneumatically-controlled lock (13.15) of canister 1 and pneumatically-controlled lock (13.17) of canister 2 are used to lock the electronic vaporizer during the operation of the electronic vaporizer, to prevent accidental unplugging during the operation.

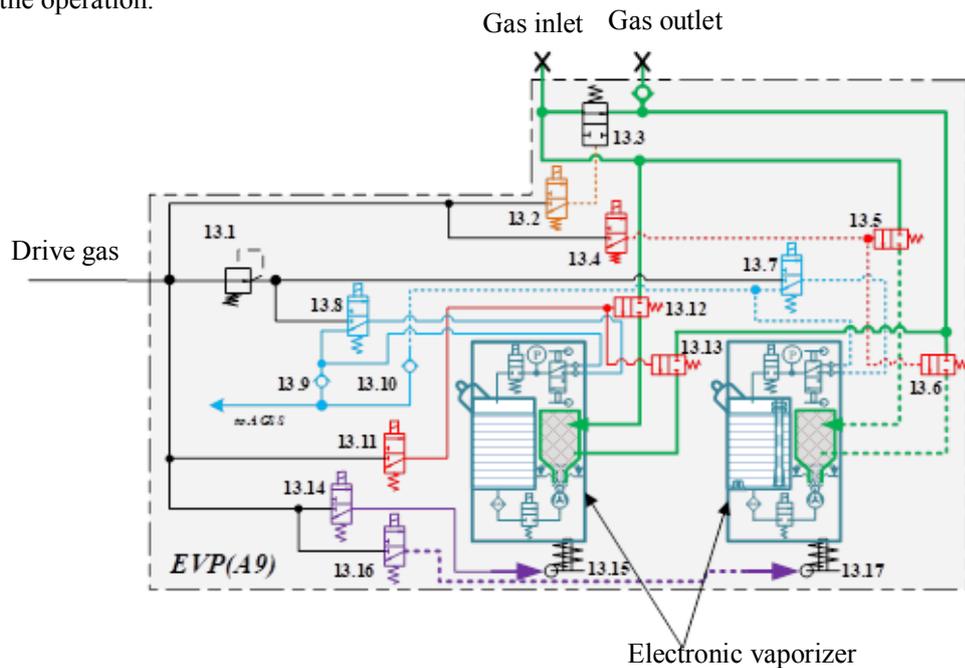


Figure 23 Pneumatic diagram of the electronic vaporizer manifold assembly

The electronic vaporizer manifold assembly consists of the electronic vaporizer manifold, pneumatically-controlled locks (13.15 and 13.17), pressure regulator (13.1), and control module. The structural diagram is shown below.

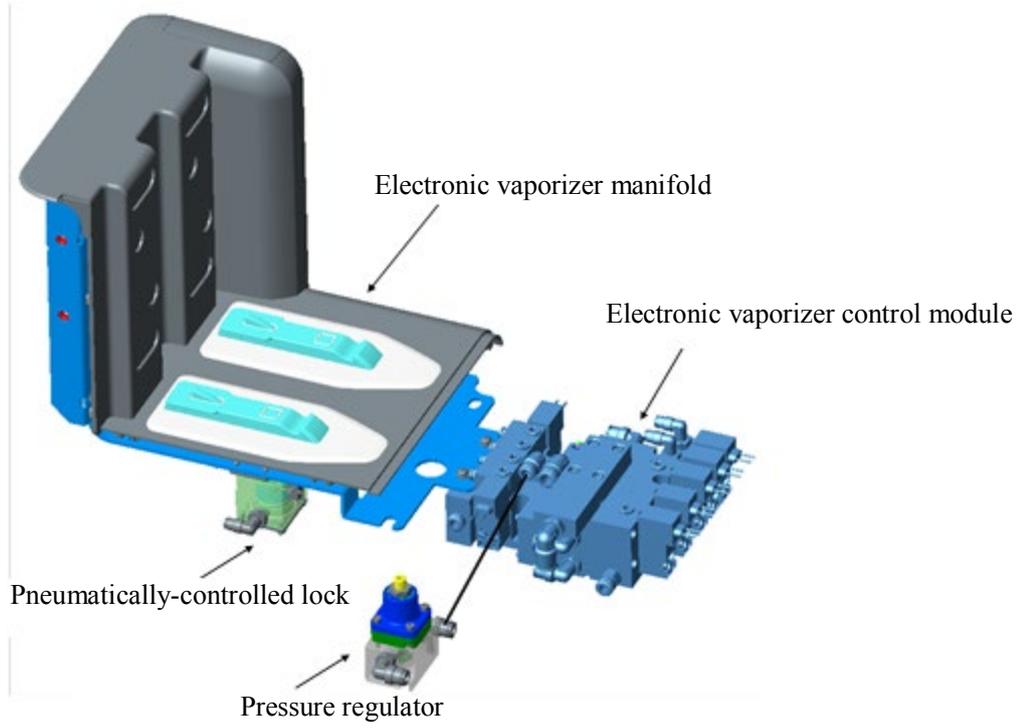


Figure 24 Structural diagram of the electronic vaporizer manifold assembly

### 6.3.5 Breathing Subsystem

The breathing subsystem is an inspiratory and expiratory channel through which the gas flows under breathing pressure between the fresh gas inlet, the patient connection port, and the exhaust valve/port. The breathing subsystem provides a closed loop for the anesthetic gas, making the expired gas from the patient enter the patient's breathing circuit again after the CO<sub>2</sub> in the gas is absorbed, to control the patient's anesthesia depth. It consists of the patient circuit assembly, airway pressure gauge assembly (18.2), auto/manual switch assembly, auto/manual drive valve assembly (18.25), APL valve assembly (18.26), absorber canister (18.18), bypass assembly (18.17), volume exchanger assembly (18.24), O<sub>2</sub> cell calibration valve assembly, and inspiratory valve assembly. The pneumatic diagram of the breathing subsystem is shown below.

In auto mode, during inspiration, the drive gas drives the mixed gas in the volume exchanger (18.24) to flow through the auto/manual valve (18.25) and absorber canister (18.18) and then mix with the fresh gas. The mixed gas flows through the inspiratory check valve (18.1) and inspiratory flow sensor (18.4), and is pressurized into the patient's lungs through the breathing tube connected to the inspiratory port (18.9). The CO<sub>2</sub> in the mixed gas is absorbed by the absorbent (such as soda lime) in the absorber canister when passing through the absorber canister, to prevent the CO<sub>2</sub> from being inspired by the patient. During expiration, the mixed gas in the patient's lungs flows through the breathing tube connected to the expiratory port (18.10), passes through the expiratory flow sensor (18.11), expiratory check valve (18.15), and auto/manual valve (18.25), and enters the volume exchanger (18.24) again, to pressurize the drive gas from the last inspiratory cycle out of the volume exchanger (18.24) and drain it through the expiratory valve (18.22), so as to complete a breathing cycle. In manual mode, the auto/manual valve (18.25) is driven by the pilot valve to switch to the manual state. In this case, you can control the patient's breathing by pressing the manual bag, and the excess gas escapes through the APL valve (18.26).

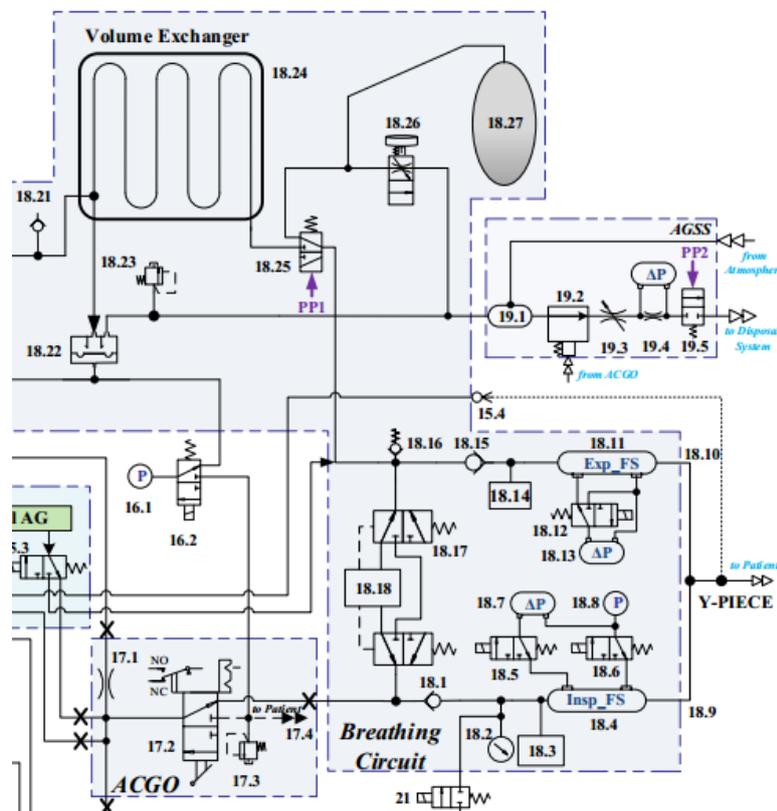


Figure 25 Schematic diagram of the breathing subsystem

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### 6.3.5.1 Patient Circuit Assembly

The patient circuit assembly consists of the inspiratory flow sensor (18.7), expiratory flow sensor (18.13), inspiratory check valve (18.1), expiratory check valve (18.15), expiratory valve (18.22), auto/manual valve (18.25), APL valve (18.26), bag arm, and leak detection plug. The patient circuit assembly is assembled with the guiding post of the circuit adapter block through two mounting holes, is connected to the gas interface on the adapter block to realize pneumatic connection, and is stopped by the bypass assembly. A position switch is provided on the circuit adapter block to detect whether the patient circuit is in place. The structural diagrams of the patient circuit assembly and the circuit adapter block are shown below.

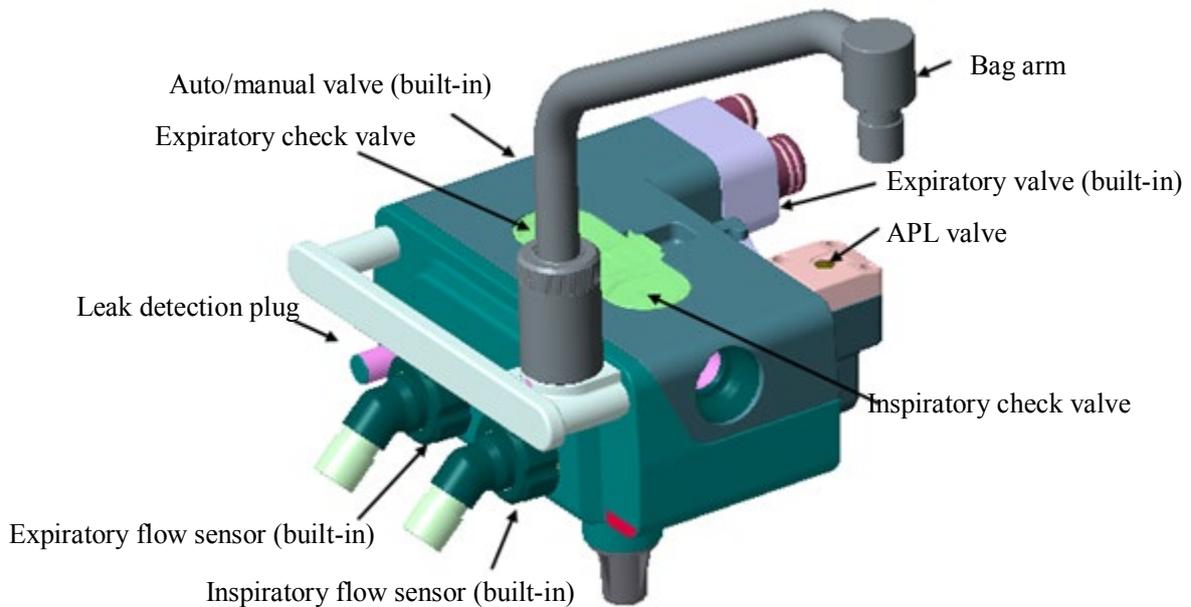


Figure 26 Structural diagram of the patient circuit assembly

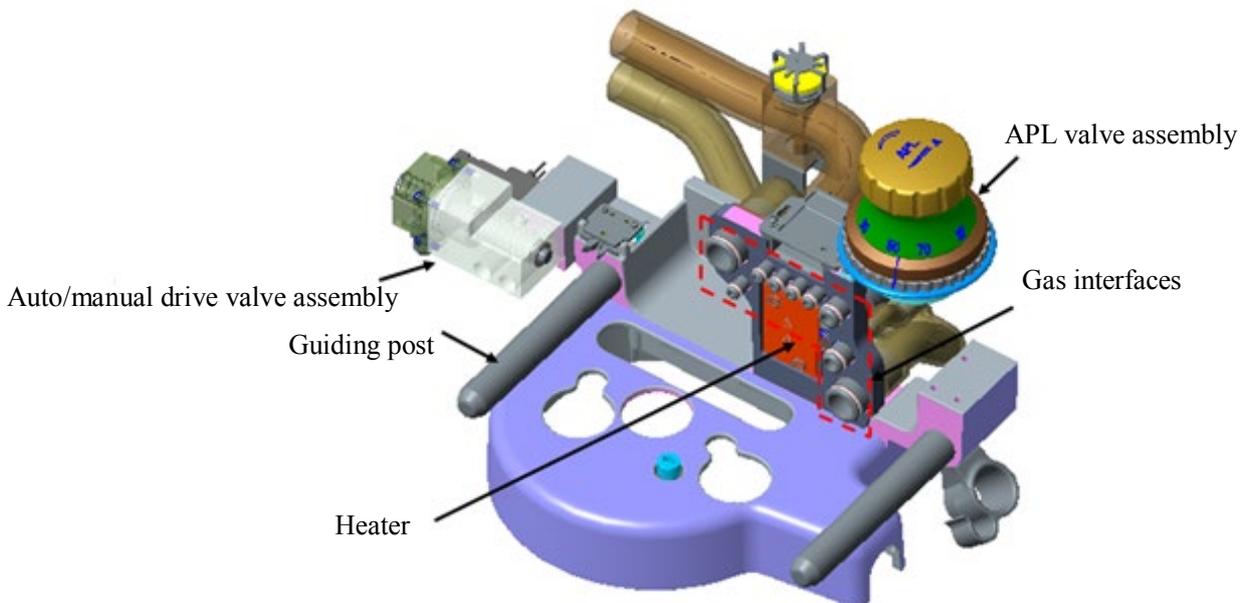


Figure 27 Structural diagram of the circuit adapter block

### 6.3.5.2 Airway Pressure Gauge Assembly

The airway pressure gauge assembly is located on the left cover plate assembly of the work

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surface and is connected to the circuit through the internal pipeline to display the inspiratory airway pressure. The core of the pressure gauge is made of purchased materials. The measurement unit of the pressure gauge is cmH<sub>2</sub>O. The measurement range is -20 cmH<sub>2</sub>O to + 100 cmH<sub>2</sub>O. The accuracy is  $\pm(4\%$  of the full-scale reading + 4% of the actual reading). The upper and lower housings and glass of the airway pressure gauge are designed by Mindray to fasten the core and meet the appearance requirements. The structural diagram of the airway pressure gauge assembly is shown below.



Figure 28 Structural diagram of the airway pressure gauge assembly

### 6.3.5.3 Auto/Manual Switch Assembly

The auto/manual switch assembly is a device driven by a mechanical structure to generate electrical signals. An internal bistable structure is used so that the handle can be adjusted to either the left or right position, to turn on or off the limit switch. After reading the status signal fed back by the limit switch, the system controls the auto/manual switch assembly to enter the corresponding working state, and switches the system operating mode to auto or manual.

The auto/manual switch assembly consists of the drive handle, bistable limit structure, reset spring, limit switch, and drive shaft. The structural diagram of the auto/manual switch assembly is shown below.

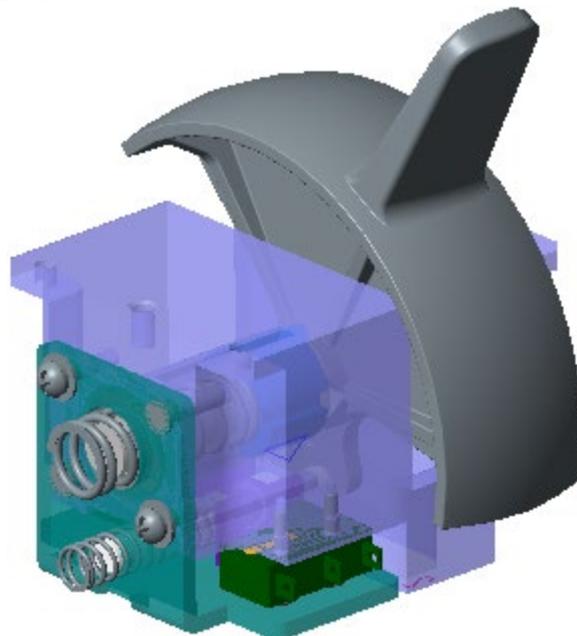


Figure 29 Structural diagram of the auto/manual switch assembly

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#### 6.3.5.4 Auto/Manual Drive Valve Assembly

The auto/manual drive valve assembly controls gas supply through a pilot three-way valve, as shown in the figure below. When the three-way valve is powered on, the pressure acts on the left end face of the piston, and the piston ejects against the spring force, to push the auto/manual valve cartridge in the patient circuit assembly to the auto state. When the three-way valve is powered off, no pressure acts on the left side of the piston, and the piston retracts under the spring force. In this case, the auto/manual valve cartridge moves to the left under the spring force, to switch to the manual state. The structural diagram of the auto/manual drive valve assembly is shown below.

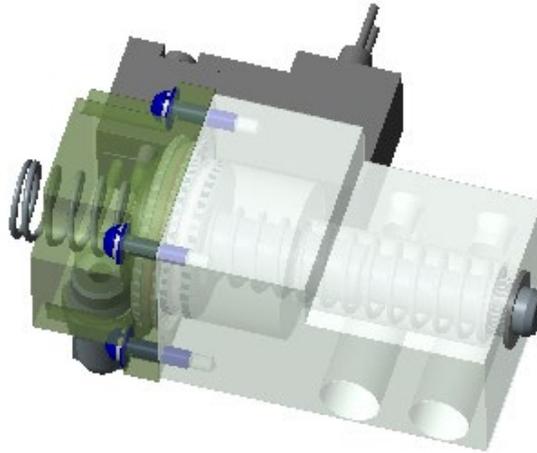


Figure 30 Structural diagram of the auto/manual drive valve assembly

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### 6.3.5.5 APL Valve Assembly

The APL valve assembly is an adjustable pressure limit valve for setting the maximum limited pressure during manual ventilation of the anesthesia machine. The valve has a mechanical structure. When adjusting the pressure, it changes the compression rate of the internal spring to change the force of the pressure actuating device and act on the sealing valve. The structural diagram of the APL valve assembly is shown below.

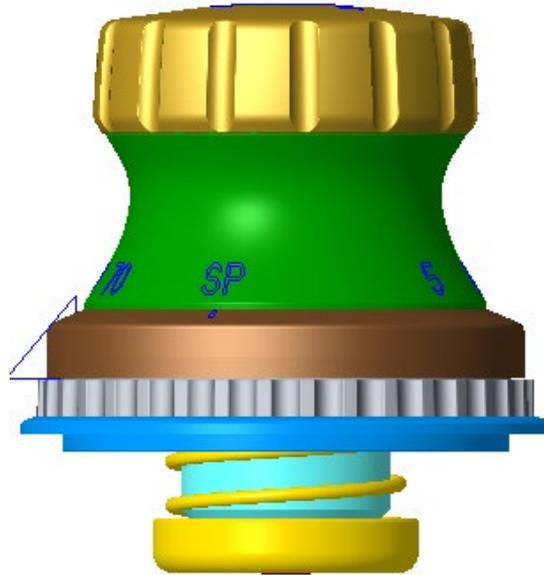


Figure 31 Structural diagram of the APL valve assembly

### 6.3.5.6 Absorber Canister and Bypass Assemblies

The absorber canister is used to hold the absorbent (such as sodalime). The absorbent absorbs the CO<sub>2</sub> exhaled by the patient during surgery, allowing the gas to circulate. When the absorber canister is removed, the valve in the bypass assembly switches, to keep the breathing system in the airtight state and allowing the mechanical ventilation of the anesthesia machine to continue.

The bypass assembly is mounted to the circuit adapter assembly through a hook structure. The absorber canister assembly is assembled and disassembled by using a poppet device, which is equipped with a position switch to detect whether the absorber canister is in place.

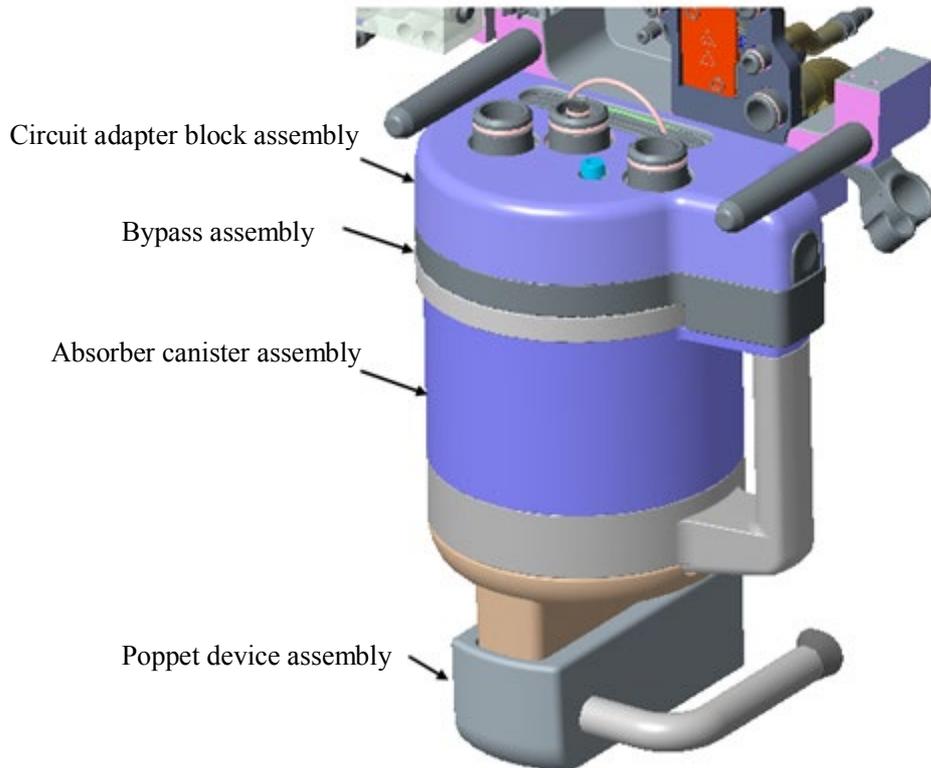


Figure 32 Structural diagram of the absorber canister and bypass assemblies

### 6.3.5.7 Volume Exchanger Assembly

The volume exchanger assembly is used to isolate the breathing gas from the drive gas, similar to bellows. In the expiratory phase, the patient's exhaled gas enters the volume exchanger, which has a volume of 1500 mL and therefore can contain the patient's exhaled gas. In the inspiratory phase, the drive gas from the inspiratory valve pushes the patient's exhaled gas that enters the volume exchanger in the expiratory phase into the soda lime absorber canister so that the gas is returned to the patient.



Figure 33 Structural diagram of the volume exchanger assembly

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### 6.3.5.8 O2 Cell Calibration Valve Assembly

During O2 cell calibration, the O2 cell calibration valve is turned on to supply air to the O2 cell for calibration. In the non-calibration state, the O2 cell calibration valve is turned off.

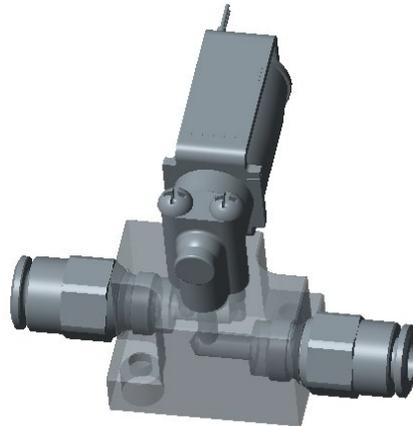


Figure 34 Structural diagram of the O2 cell calibration valve assembly

### 6.3.5.9 Inspiratory Valve Assembly

The inspiratory valve assembly drives the patient's breathing process. The input is O2 from the gas supply. The output includes the drive gas to the breathing system, PEEP control gas to the expiratory valve, and PEEP exhausted gas to the gas reservoir. The inspiratory valve assembly is used to implement various ventilation modes to prevent excessive airway pressure from harming the patient. The pneumatic diagram of the inspiratory valve assembly is shown below.

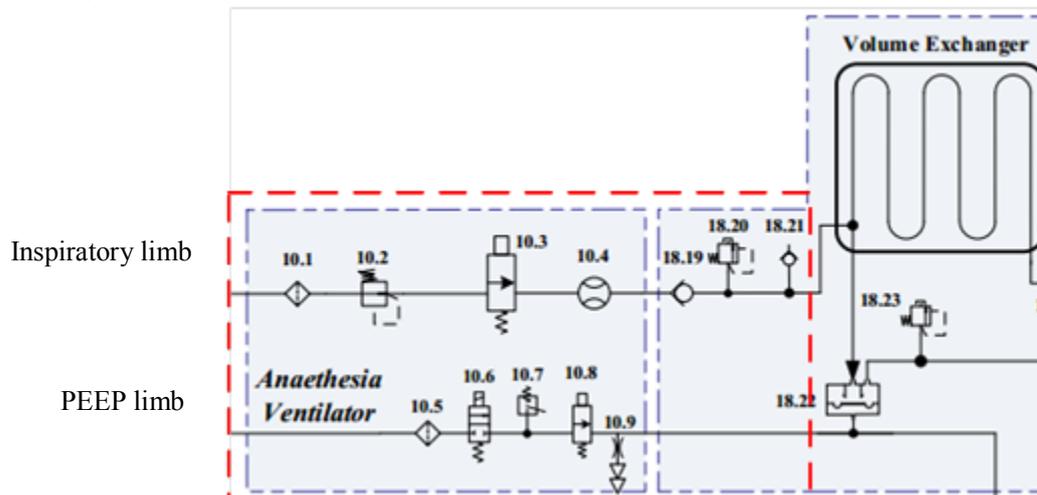


Figure 35 Pneumatic diagram of the inspiratory valve assembly

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The inspiratory valve assembly consists of the pneumatic block, flow sensor (10.4), pressure switch (10.7), 110 cmH<sub>2</sub>O pressure relief valve (18.20), 4 cmH<sub>2</sub>O negative pressure valve (18.21), and check valve (18.19). It is connected to other components of the anesthesia machine through the inspiratory limb gas inlet, PEEP limb gas outlet, PEEP control gas outlet, drive gas outlet, and PEEP exhaust port. The functions of the components are as follows: The flow sensor (10.4) is used to monitor and feed back the gas flow output controlled by the inspiratory flow proportional valve (10.3). The 110 cmH<sub>2</sub>O pressure relief valve (18.20) is used to control the pressure of the drive airway within the normal operating pressure, so as to avoid damage to the operating components. The pressure relief threshold is 110±10 cmH<sub>2</sub>O. The negative pressure valve (18.21) opens when the patient actively inhales and closes when the patient exhales, to support free breathing. The check valve (18.19) is used to prevent reverse diffusion of the mixed gas in the breathing subsystem from contaminating the flow sensor. The structural diagram of the inspiratory valve assembly is shown below.

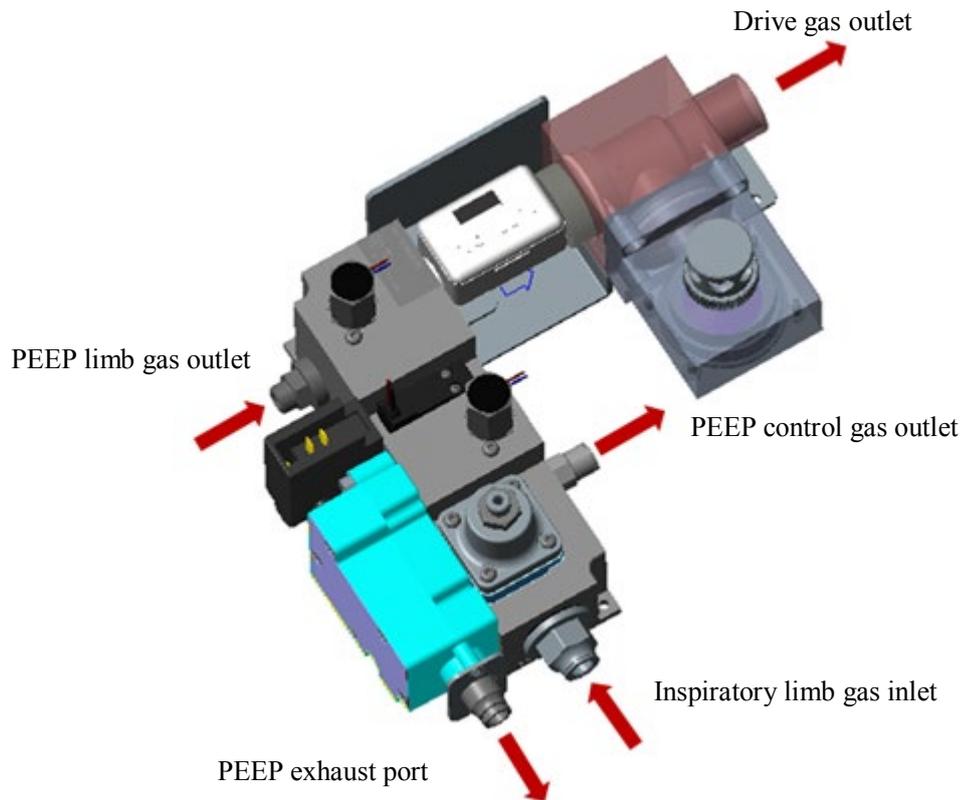


Figure 36 Structural diagram of the inspiratory valve assembly

### 6.3.6 Auxiliary Gas Supply Subsystem

The auxiliary gas supply subsystem is used for auxiliary gas output on the patient side. It consists of the auxiliary O<sub>2</sub>/air assembly and high-flow O<sub>2</sub> supply assembly.

### 6.3.6.1 Auxiliary O2/Air Assembly

The auxiliary O<sub>2</sub>/air assembly can provide patients with O<sub>2</sub> and air at adjustable concentration. The input includes O<sub>2</sub> and air obtained after pressure adjustment by the pipeline gas inlet assembly. The flows of the two gases are adjusted through independent proportional valves (5.3 and 5.6) and measured through independent differential pressure sensors (5.2 and 5.5). After the O<sub>2</sub> and air are mixed, the flow is indicated by the mechanical float flowmeter (5.1). As a pneumatic electronically-controlled component, the auxiliary O<sub>2</sub>/air assembly controls the flow and O<sub>2</sub> concentration through a rotary encoder. To reduce the risk of proportional valve failure, the switch valves (5.4 and 5.7) are added to the front of the proportional valves in the two branches to ensure safety in case of proportional valve failure. The auxiliary O<sub>2</sub>/air assembly consists of the flow control module, auxiliary flowmeter, and outlet assembly, which are independent components installed in different positions of the system and connected through PU tubes. The pneumatic diagram of the auxiliary O<sub>2</sub>/air assembly is shown below.

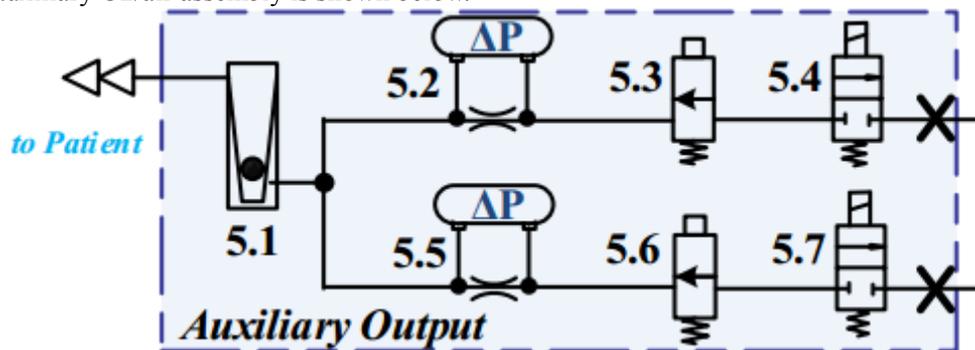


Figure 37 Pneumatic diagram of the auxiliary O<sub>2</sub>/air assembly

### 6.3.6.2 High-Flow O<sub>2</sub> Supply Assembly

The high-flow O<sub>2</sub> supply assembly can provide patients with O<sub>2</sub> and air at adjustable concentration. The input includes O<sub>2</sub> and air obtained after pressure adjustment by the pipeline gas inlet assembly. The flows of the two gases are adjusted through independent proportional valves (5.11 and 5.16) and measured through independent differential pressure sensors (5.10 and 5.15). After the O<sub>2</sub> and air are mixed, the flow is indicated by the mechanical float flowmeter (5.8). To reduce the risk of proportional valve failure, the pilot control switch valves (5.12 and 5.17) are added to the front of the proportional valves in the two branches to ensure safety in case of proportional valve failure. The maximum flow of the proportional valves is increased to 60 L/min, and the designed overall output flow of the module is 100 L/min. The high-flow O<sub>2</sub> supply assembly consists of the flow control module, high-flow O<sub>2</sub> therapy flowmeter, and outlet assembly, which are independent components installed in different positions of the system and connected through PU tubes. The pneumatic diagram of the high-flow O<sub>2</sub> supply assembly is shown below.

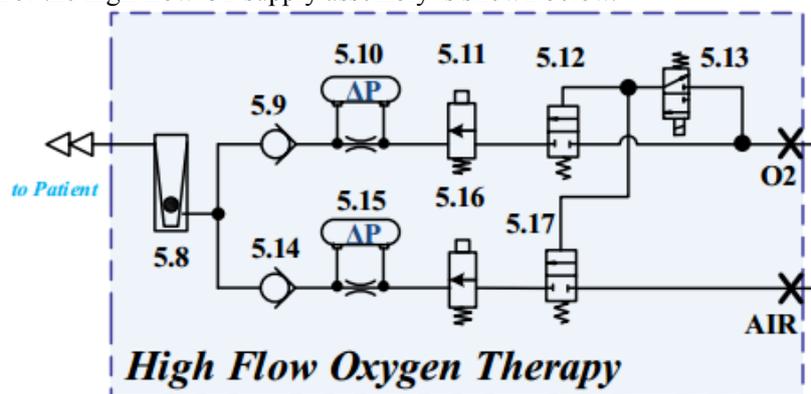


Figure 38 Pneumatic diagram of the high-flow O<sub>2</sub> supply assembly

### 6.3.7 AGSS Subsystem

The AGSS subsystem is connected to the breathing circuit and the hospital's negative pressure suction system for waste gas scavenging of the anesthesia machine. It consists of the gas reservoir assembly (19.1) and AGSS pneumatic block assembly.

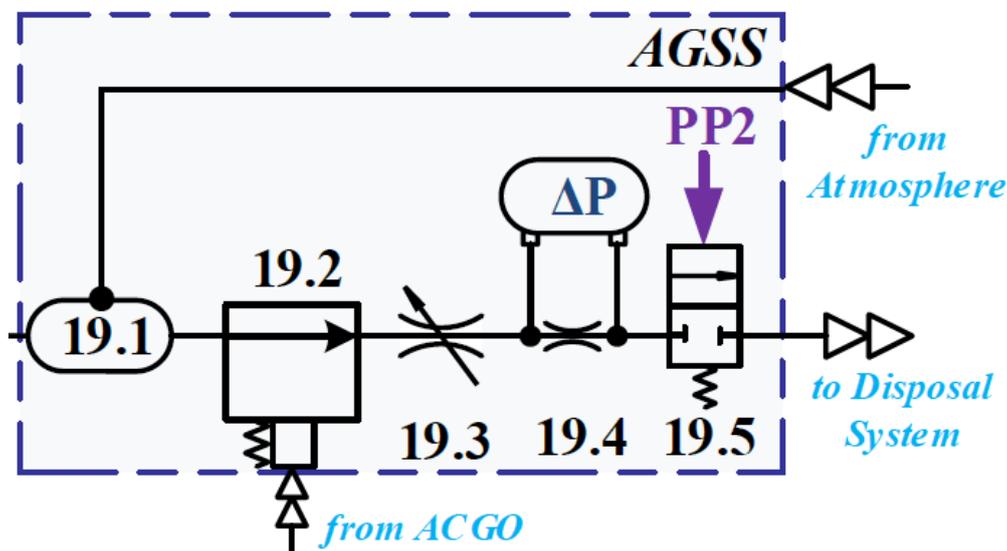


Figure 39 Pneumatic diagram of the AGSS

#### 6.3.7.1 Gas Reservoir Assembly

The gas reservoir is used to prevent the anesthetic gas from overflowing out of the AGSS during peak anesthetic gas scavenging of the anesthesia machine, and is used to receive and buffer the exhausted gas and eliminate the noise generated by the breathing gas. The input of the gas reservoir includes: drive gas from the anesthesia ventilator, PEEP limb gas from the anesthesia ventilator, returned sample gas of the gas module, and excess gas from the breathing system.

Gas reservoir assemblies are classified into active and passive AGSS gas reservoir assemblies depending on whether there is an overfill port. The active AGSS gas reservoir assembly is used to pump waste gas from the anesthesia machine with a negative pressure source of the hospital. The passive AGSS gas reservoir assembly is used to passively exhaust waste gas to air without a negative pressure source. The negative pressure source is the key to distinguishing between active and passive AGSS gas reservoir assemblies.

For the active AGSS gas reservoir assembly, the outlet, namely, the waste gas scavenging port, is connected to the AGSS pneumatic block assembly through a silicone tube. When positive or negative pressure different from the atmospheric pressure is generated in the AGSS gas reservoir, gas intake or exhaust is performed to ensure the pressure balance. In addition, when the negative pressure source pumps the waste gas, it is ensured that the inlet pressure is higher than a certain value and the induced flow is lower than a certain value. These are key factors in the design of gas reservoir assemblies.

The active AGSS gas reservoir assembly consists of three parts: AGSS inlet gas reservoir, AGSS pump box, and AGSS airway. The AGSS pump box is connected to the pneumatic block through a silicone tube. After the waste gas enters the gas reservoir, it is pumped to the AGSS pneumatic block assembly under the action of the gas reservoir. The AGSS gas reservoir is connected to the work surface through the bottom metal sheet. The overfill port is connected to the metal sheet through a silicone part. Exchange with the outside air is enabled through the meshes of the rear cover plate. The structural diagram of the active AGSS gas reservoir assembly is shown below.

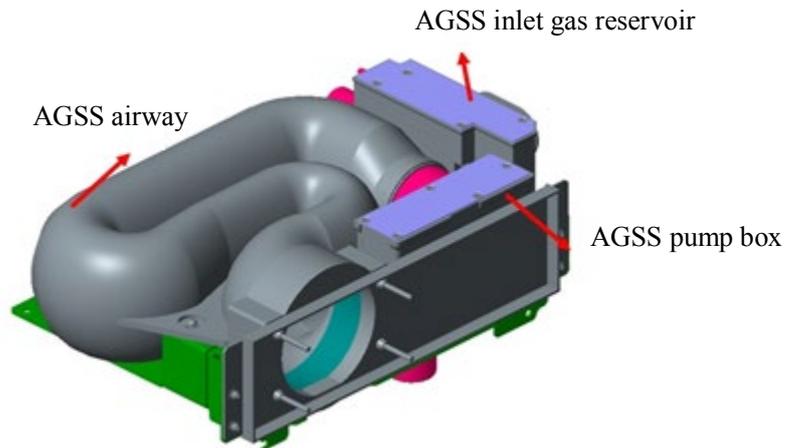


Figure 40 Structural diagram of the active AGSS gas reservoir assembly  
 The passive AGSS gas reservoir assembly consists of three parts: AGSS inlet gas reservoir, AGSS pump box, and AGSS passive plug. The AGSS pump box is connected to the pneumatic block through a silicone tube. After the waste gas enters the gas reservoir, it is pumped to the AGSS pneumatic block assembly under the action of the gas reservoir and then directly exhausted to air. The structural diagram of the passive AGSS gas reservoir assembly is shown below.

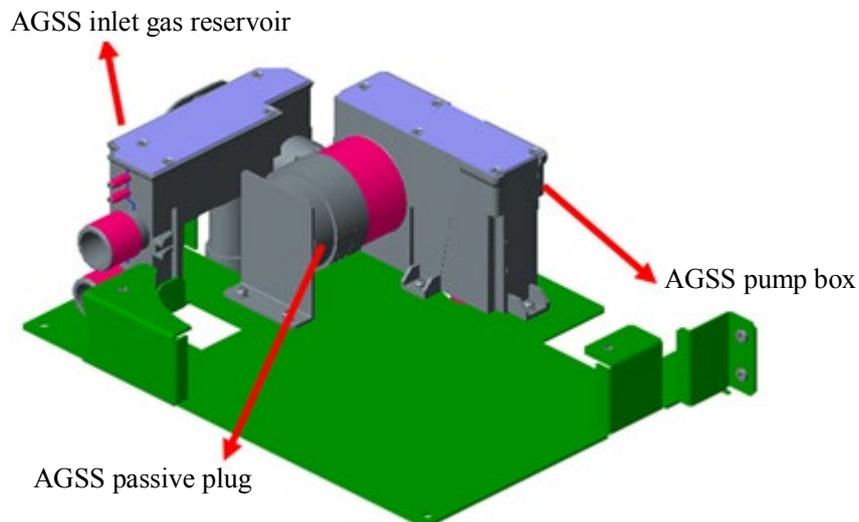


Figure 41 Structural diagram of the passive AGSS gas reservoir assembly

### 6.3.7.2 AGSS Pneumatic Block Assembly

As a residual gas scavenging part of the anesthesia machine, the AGSS pneumatic block assembly is connected to the gas reservoir and the hospital's negative pressure suction system. The active AGSS pneumatic block assembly is used to turn on/off the negative pressure source, and adjust and monitor the pump flow. The related adjustment functions and information are displayed on the screen through an electronic system, allowing you to control the functions on the screen.

The passive AGSS pneumatic block assembly mainly acts as the airway pipeline for connecting the passive AGSS gas reservoir to the outside air to achieve passive scavenging of waste gas.

The active AGSS pneumatic block assembly consists of three parts: adapter block assembly, flow regulator assembly, and ACGO waste gas inlet. The adapter block assembly connects the gas reservoir to the flow regulator assembly and integrates the ACGO waste gas inlet pipeline. The flow regulator assembly consists of a differential pressure gauge and a large-diameter switch valve to implement a series of AGSS functions. The structural diagram of the active AGSS pneumatic block assembly is shown below.

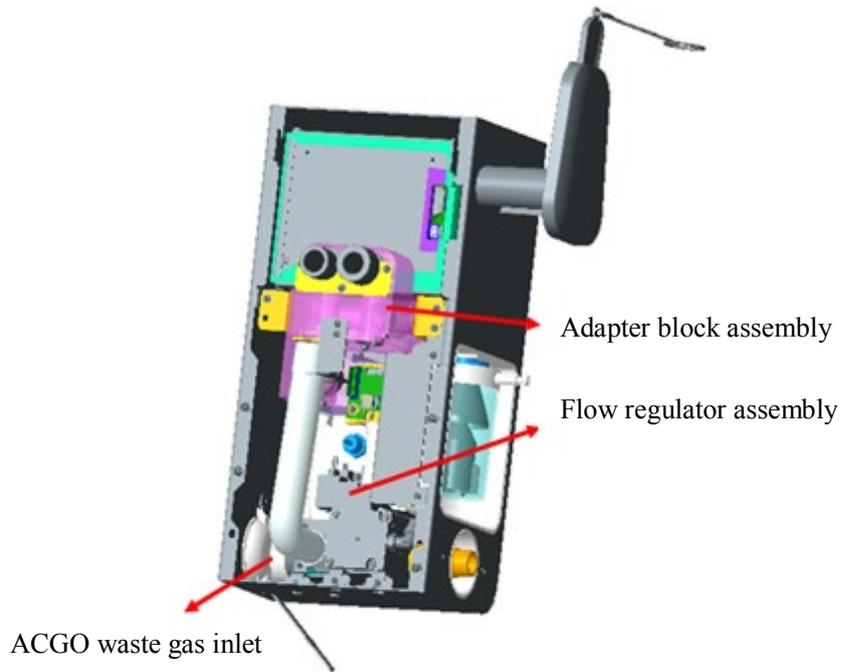


Figure 42 Structural diagram of the active AGSS pneumatic block assembly  
 The passive AGSS pneumatic block assembly consists of three parts: adapter block assembly, waste gas scavenging pipeline, and ACGO waste gas inlet. The adapter block assembly connects the gas reservoir to the atmospheric pipeline and integrates the ACGO waste gas inlet pipeline. The waste gas scavenging pipeline is connected to the atmospheric pipeline.

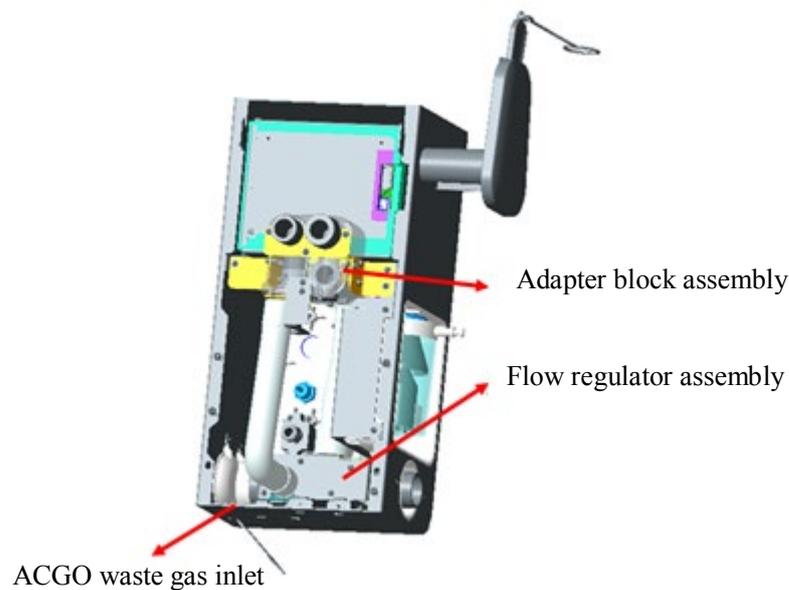


Figure 43 Structural diagram of the passive AGSS pneumatic block assembly

### 6.3.8 Negative Pressure Suction Subsystem

The negative pressure suction subsystem controls negative pressure and delivers negative pressure to the patient side. The negative pressure suction subsystem has two configurations: Venturi negative pressure suction and continuous negative pressure suction, which are different in the way of obtaining negative pressure. The Venturi negative pressure suction subsystem provides the drive gas (positive pressure, air) through the gas inlet assembly and generates negative pressure according to the Venturi principle. The continuous negative pressure suction subsystem is directly connected to an external negative pressure source (the external pressure is negative pressure) through the negative pressure inlet assembly, and

provides only the negative pressure (flow) regulating function. The two configurations are mutually exclusive, and you can choose either configuration based on your actual needs. The pneumatic diagrams of the two configurations are shown below.

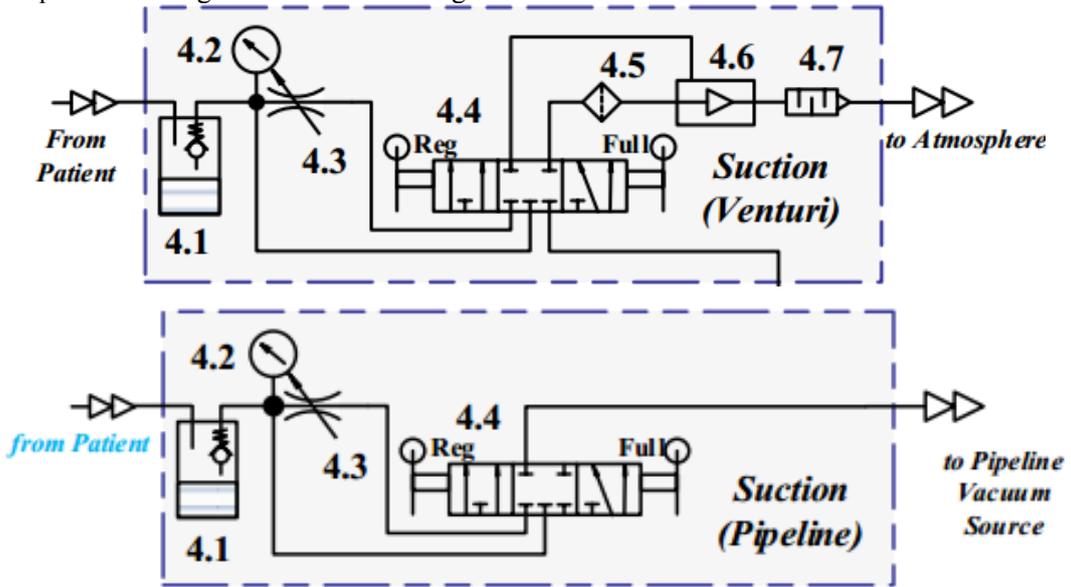


Figure 44 Pneumatic diagrams of Venturi and continuous negative pressure suction subsystems

The Venturi and continuous negative pressure suction subsystems consist of the negative pressure control panel assembly, Venturi negative pressure generator assembly, and pipeline negative pressure inlet assembly. Both configurations use the same negative pressure generator assembly. The difference lies in the pipeline connection between the assemblies (as shown in the above pneumatic diagrams). The structural diagrams of the assemblies are shown below.

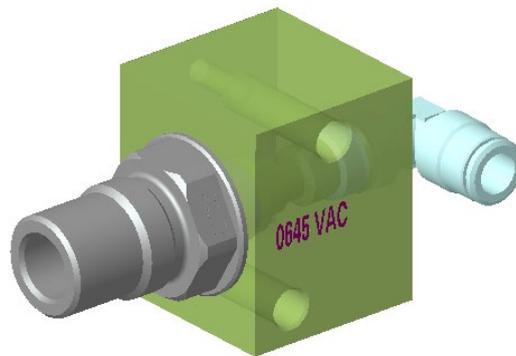


Figure 45 Structural diagram of the pipeline negative pressure inlet assembly

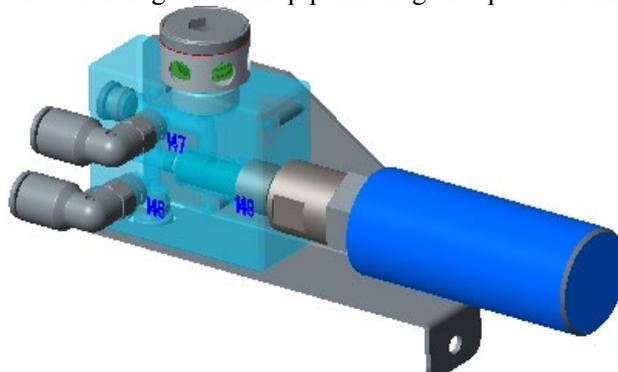
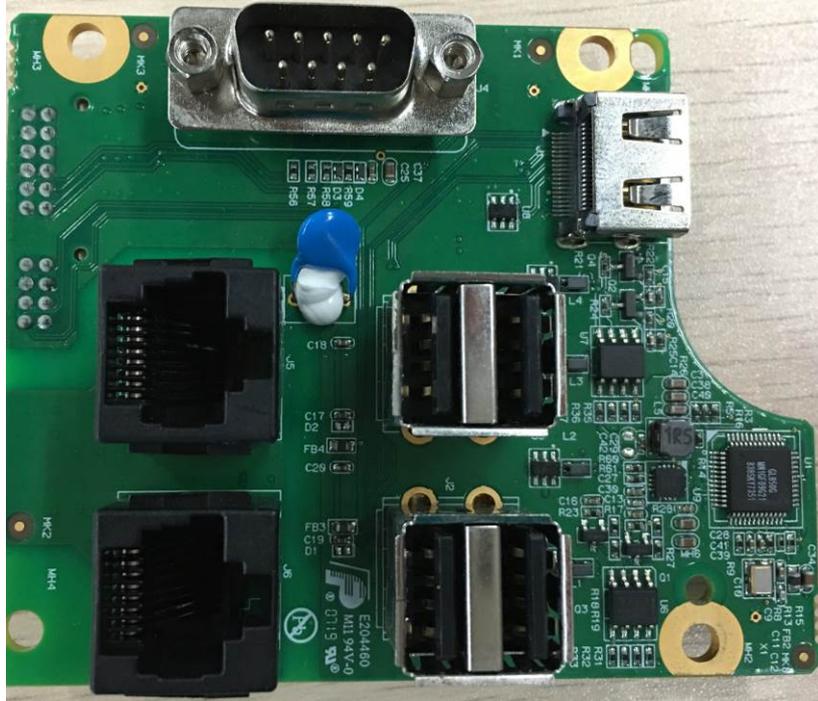


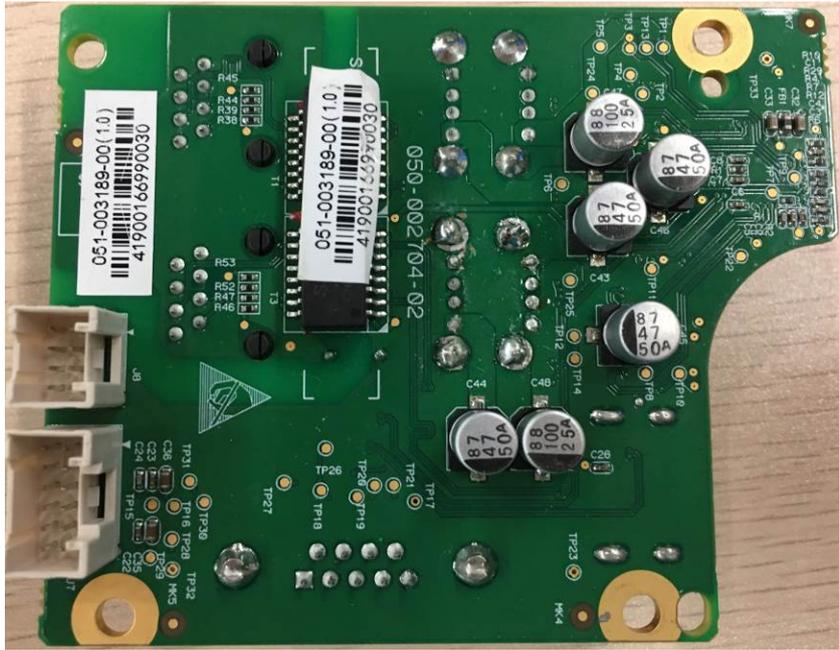
Figure 46 Structural diagram of the Venturi negative pressure generator assembly



Figure 47 Structural diagram of the negative pressure control panel assembly



External I/O interface board (top view)



External I/O interface board (bottom view)

# 7 Testing

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## NOTE

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- **A ventilation test can be performed only when the anesthesia system is powered on (using AC mains instead of batteries).**
- 

## 7.1 Power-on Self-Test

When the system is powered on, it performs a self-test to ensure that its alarm system (including the alarm LED indicators, speaker, and buzzer) and hardware (flowmeter board, VCM, VPM, power board, CPU board, etc.) are properly functioning.

### 7.1.1 Performing the Power-on Self-Test

1. Turn the power switch on the front panel to the ON position. The equipment powers up and begins its power-on self-test.

The power-on self-test is mandatory and cannot be skipped. If the power-on self-test succeeds, the system check screen is displayed to guide the follow-up tests. If the power-on self-test fails, the system displays error messages and cannot jump from the current self-test item to other self-test items.

Possible alarm messages are described in 7.1.2 Power-on Self-Test Alarm Messages.

2. Continue to operate or troubleshoot the equipment based on the self-test results.

### 7.1.2 Power-on Self-Test Alarm Messages

## NOTE

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- **Power-on self-test alarms are not reported in audible or visual form**
  - **Power-on self-test alarm priorities are displayed only in the alarm logs.**
  - **In case of a failure, the self-test result column indicates the result when a power-on self-test alarm is triggered, which may be All, Manual Only, or Non-Functional.**
- 

If a power-on self-test alarm is triggered, take service measures according to the suggestions in section 4.3.1.

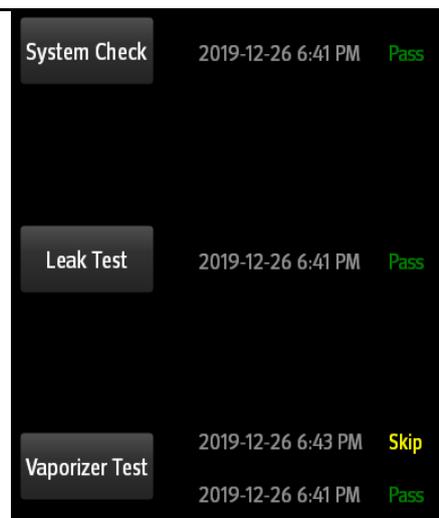
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## 7.2 System Check

Three system check modes are available: power-on self-test, leak test, and vaporizer test (for A9).

### NOTE

- 
- **Both the leak test and vaporizer test are used to check for leakage in the backend circuit of the flowmeter. The difference lies in whether the anesthesia machine is equipped with a vaporizer. During the system check, the anesthesia machine automatically performs detection and selection. You can also manually select the corresponding test on the standby screen. If you select the vaporizer test but no electronic vaporizer is loaded, the test may fail.**
- 



System Check	2019-12-26 6:41 PM	Pass
Leak Test	2019-12-26 6:41 PM	Pass
Vaporizer Test	2019-12-26 6:43 PM	Skip
	2019-12-26 6:41 PM	Pass

- The system check contains the power-on self-test, leak test, or vaporizer test.
- The leak test is used to check for leakage in the pneumatic circuit in manual or mechanical ventilation mode when the anesthesia machine is not equipped with a vaporizer. The test involves volume exchangers, drive gas circuits, APL valves, CO2 absorber canisters, patient pipelines, flow sensors, and flow sensor connectors.
- The vaporizer test is used to check for leakage in the pneumatic circuit in manual or mechanical ventilation mode when the anesthesia machine is equipped with an electronic vaporizer. The test involves volume exchangers, drive gas circuits, APL valves, CO2 absorber canisters, patient pipelines, vaporizers, flow sensors, and flow sensor connectors.

### NOTE

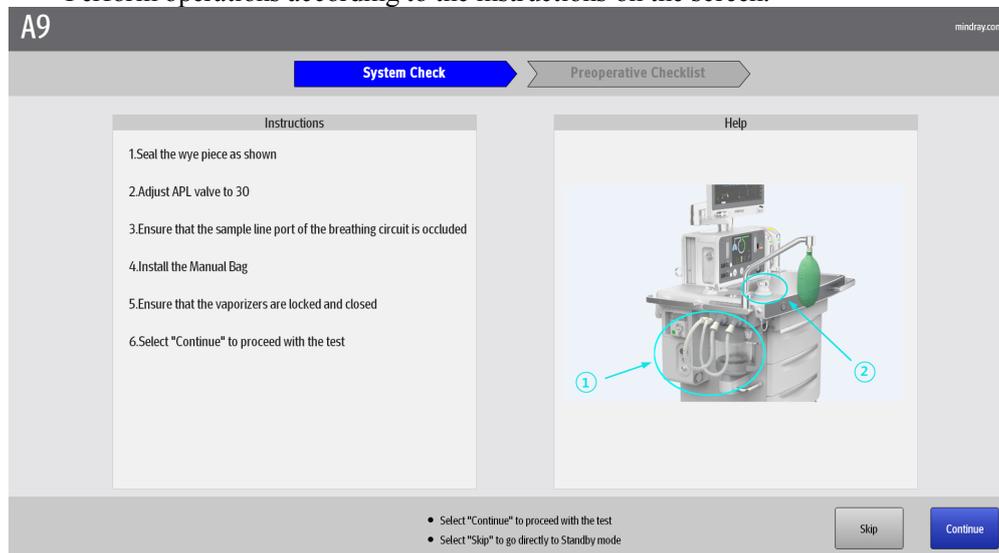
- 
- **Perform the system check after you service the anesthesia machine, replace parts, or reconnect pipelines.**
-

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## 7.2.1 System Check

You can start the system check in either of the following ways:

1. The system check automatically starts after power-on.
2. Access the standby screen from the main screen and choose  > System Check. Perform operations according to the instructions on the screen.



## 7.2.2 Leak Test

You can start the leak test in either of the following ways:

1. The leak test screen is automatically displayed after the power-on self-test is completed.
2. Access the standby screen from the main screen and choose  > Leak Test. Perform operations according to the instructions on the screen.

## 7.2.3 Electronic Vaporizer Test (for A9)

You can start the vaporizer test in either of the following ways:

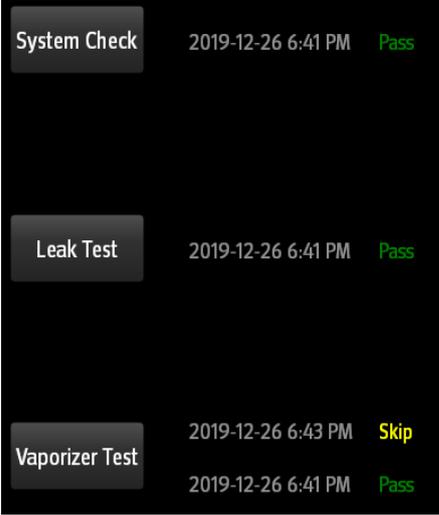
1. The leak test screen is automatically displayed after the power-on self-test is completed. (If the machine is equipped with an electronic vaporizer, the vaporizer test automatically starts.)
2. Access the standby screen from the main screen and choose  > Vaporizer Test. Perform operations according to the instructions on the screen.

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## NOTE

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- In standby mode, you can click  to show the status of the previous two system checks, including whether the test is passed, failed, or skipped.

A screenshot of a system check results screen. It displays three rows of test results. Each row has a test name in a grey box, a timestamp, and a status. The first row is 'System Check' at '2019-12-26 6:41 PM' with a 'Pass' status. The second row is 'Leak Test' at '2019-12-26 6:41 PM' with a 'Pass' status. The third row is 'Vaporizer Test' at '2019-12-26 6:43 PM' with a 'Skip' status. Below the 'Vaporizer Test' row, there is another entry for '2019-12-26 6:41 PM' with a 'Pass' status.

System Check	2019-12-26 6:41 PM	Pass
Leak Test	2019-12-26 6:41 PM	Pass
Vaporizer Test	2019-12-26 6:43 PM	Skip
	2019-12-26 6:41 PM	Pass

- The system check results are also recorded in the service logs. To obtain the information, access the main screen and choose Setup > Service > Information > Logs.
- 

## 7.3 Gas Supply Tests

### 7.3.1 O2 Supply Test

#### NOTE

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- Remove the O2 cylinder from the yoke before performing this test.
- 

1. Connect the machine to the O2 supply connector on the wall via O2 supply hose.
2. Check that the O2 supply pressure gauge reads 280–600 kPa.
3. Turn on the system switch.
4. Open the BFCS door to let the machine enter the BFCS work mode.
5. Fully open the O2 needle valve.
6. Observe the float of the total flowmeter, which should be at the top of the flowmeter.
7. Disconnect the O2 pipeline supply.
8. Ensure that the alarms of **O2 Supply Failure** and **Drive Gas Pressure Low** occur with the decrease of O2 pressure.
9. Check that the O2 supply pressure gauge decreases to zero.

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### 7.3.2 N2O Supply Test

#### NOTE

- 
- **Remove the N2O cylinder from the yoke before performing this test.**
- 

1. Connect the machine to the O2 and N2O supply connectors on the wall via O2 and N2O supply hoses.
2. Check that the O2 and N2O supply pressure gauges read 280–600 kPa.
3. Turn on the system switch.
4. Open the BFCS door to let the machine enter the BFCS work mode.
5. Set the balance gas to N2O. Set the ventilation mode to the manual mode.
6. Adjust the N2O flow to 1 L/min.
7. Disconnect the N2O pipeline supply.
8. Ensure that the N2O supply pressure gauge decreases to zero.

### 7.3.3 Air Supply Test

#### NOTE

- 
- **Remove the air cylinder from the yoke before performing this test.**
- 

1. Connect the machine to the air supply connector on the wall via air supply hose.
2. Check that the air supply pressure gauge reads 280–600 kPa.
3. Turn on the system switch.
4. Enable the BFCS to let the machine enter the BFCS work mode.
5. Fully open the air needle valve.
6. Observe the float of the total flowmeter, which should be at the top of the flowmeter.
7. Disconnect the air pipeline supply.
8. Ensure that the air supply pressure gauge decreases to zero.

Note: Gas supply pressure gauges include mechanical pressure gauges and electronic pressure gauges.

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## 7.4 Cylinder Supply Tests

### 7.4.1 N2O Cylinder Supply Test

1. Remove the N2O supply hose from the gas inlet assembly. Ensure that O2 supply is available.
2. Mount the backup cylinder full of N2O on the backup cylinder yoke.
3. Observe the reading on the N2O high pressure gauge for the entire system. Ensure that the difference between the pressure displayed on the N2O high pressure gauge and the pressure displayed on the cylinder pressure gauge does not exceed 1 MPa.
4. In the EFCS state, set the balance gas to N2O and enable the direct flow control mode. Set the ventilation mode to the manual mode.
5. Adjust the N2O flow to 6 L/min. The O2 flow increases to 2 L/min accordingly.
6. Set the N2O flow to 0. Turn off the N2O cylinder.
7. Ensure that the pressure value displayed on the N2O high pressure gauge decreases by less than 10% within one minute.
8. Set the N2O flow to 6 L/min.
9. Ensure that the **N2O Supply Failure** alarm occurs with the decrease of N2O pressure.
10. Ensure that the N2O high pressure gauge decreases to zero.

### 7.4.2 O2 Cylinder Supply Test

1. Remove the O2 supply hose from the gas inlet assembly.
2. Mount the backup cylinder full of O2 on the backup cylinder yoke.
3. Observe the reading on the O2 high pressure gauge for the entire system. Ensure that the difference between the pressure displayed on the O2 high pressure gauge and the pressure displayed on the cylinder pressure gauge does not exceed 1.25 MPa.
4. In the EFCS state, set the balance gas to None and enable the direct flow control mode. Set the ventilation mode to the manual mode.
5. Adjust the O2 flow gradually. The total flowmeter fluctuates along with the set EFCS flow.
6. Enable the BFCS. The system has about 1 L/min basal flow. Adjust the O2 needle valve. The value on the total flowmeter fluctuates accordingly.
7. Turn off the O2 needle valve and switch the system to the EFCS state. Enter the standby state and turn off the O2 cylinder.
8. Ensure that the pressure value displayed on the O2 high pressure gauge decreases by less than 10% within one minute.
9. Exit the standby state and set the O2 flow to 6 L/min.
10. Ensure that the alarms of **O2 Supply Failure** and **Drive Gas Pressure Low** occur with the decrease of O2 pressure.
11. Ensure that the O2 high pressure gauge decreases to zero.

### 7.4.3 Air Cylinder Supply Test

1. Remove the air supply hose from the gas inlet assembly.
2. Mount the backup cylinder full of air on the backup cylinder yoke.
3. Observe the reading on the air high pressure gauge for the entire system. Ensure that the difference between the pressure displayed on the air high pressure gauge and the pressure displayed on the cylinder pressure gauge does not exceed 1.25 MPa.
4. In the EFCS state, set the balance gas to air and enable the direct flow control mode. Set the ventilation mode to the manual mode.
5. Adjust the air flow gradually. The total flowmeter fluctuates along with the set EFCS flow.
6. Enable the BFCS. The system has about 1 L/min basal flow. Adjust the air needle valve. The value on the total flowmeter fluctuates accordingly.
7. Turn off the air needle valve and switch the system to the EFCS state. Enter the standby state and turn off the air cylinder.
8. Ensure that the pressure value displayed on the air high pressure gauge decreases by less than 10% within one minute.
9. Exit the standby state and set the air flow to 6 L/min.
10. Ensure that the **Air Supply Failure** alarm occurs with the decrease of air pressure.
11. Ensure that the air high pressure gauge decreases to zero.

### 7.5 EFCS Accuracy Test

Switch the system to the manual mode, exit the standby mode, and expose the bag arm port to ambient air. Adjust the fresh gas flow according to the table below and observe whether the flow displayed on the on-screen electronic flowmeter meets the acceptance criteria.

Test Item	Test Method	Acceptance Criterion
Direct flow control mode		
Accuracy of the O2 electronic flowmeter (Balance gas setting: none)	Adjust the O2 flow knob to set the flow to 0.2 L/min.	0.15–0.25 L/min
	Adjust the O2 flow knob to set the flow to 1 L/min.	0.95–1.05 L/min
	Adjust the O2 flow knob to set the flow to 10 L/min.	9.50–10.50 L/min
	Adjust the O2 flow knob to set the flow to 15 L/min.	14.25–15.75 L/min
Accuracy of the air electronic flowmeter (Balance gas setting: air)	Adjust the air flow knob to set the flow to 15 L/min.	14.25–15.75 L/min
	Adjust the air flow knob to set the flow to 10 L/min.	9.50–10.50 L/min
	Adjust the air flow knob to set the flow to 3 L/min.	2.85–3.15 L/min
	Adjust the air flow knob to set the flow to 1 L/min.	0.95–1.05 L/min

---

## 7.6 BFCS Function Tests

### 7.6.1 Checking Switchover Between the EFCS and BFCS

1. When the system is powered on, open the BFCS door in the EFCS state. The **Backup Flow Control is enabled** alarm is generated. The backlight of the total flowmeter is on.
2. Click **Disable Backup Flow Control** in the lower left corner of the screen. Close the BFCS door when the needle valve is turned off, to disable the BFCS. The backlight of the total flowmeter is off after the BFCS door is closed.

### 7.6.2 Checking Needle Valve Correspondence

Perform the following operations in the BFCS state:

1. Verify that the flow on the glass tube flowmeter and the main screen is about 1 L/min.
2. Turn the O<sub>2</sub> needle valve and verify that the flow on the total flowmeter increases to about 15 L/min accordingly.
3. Turn off the O<sub>2</sub> needle valve. The flow should decrease to about 1 L/min (that is, only the basal flow is reserved).
4. Turn the air needle valve and verify that the flow on the total flowmeter increases to about 15 L/min accordingly.
5. Turn off the air needle valve. The flow should decrease to about 1 L/min (that is, only the basal flow is reserved).

### 7.6.3 Checking the Needle Valve Sensitive Switch

1. After the BFCS door is open, turn on the O<sub>2</sub> needle valve by turning it about 1/2 rings and click **Disable Backup Flow Control**. A prompt message **Close manual valves prior to disabling Backup Flow Control** is displayed, and the BFCS door automatically opens again. Turn off the O<sub>2</sub> needle valve. The prompt message disappears, and the BFCS door can be normally closed.
2. After the BFCS door is open, turn on the air needle valve by turning it about 1/2 rings and click **Disable Backup Flow Control**. A prompt message **Close manual valves prior to disabling Backup Flow Control** is displayed, and the BFCS door automatically opens again. Turn off the air needle valve. The prompt message disappears, and the BFCS door can be normally closed.

---

### 7.6.4 Basal Flow Test in the BFCS State

1. Connect the O2 pipeline supply or open the backup O2 cylinder.
2. Enable the BFCS.
3. Verify that the float of the total flowmeter is in the vicinity of 1 L/min.

#### NOTE

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- The gas to be tested must be O2, and the O2 needle valve must be adjusted to the minimum value.
- 

### 7.6.5 Accuracy Confirmation Test

1. Connect the O2 supply.
2. Adjust the auto/manual switch to Manual and APL valve to SP.
3. Connect the Y-piece in the breathing circuit to the leak test port, and the other two ends to the expiratory and inspiratory ports of the circuit.
4. Open the BFCS door and turn on the backup flowmeter.
5. Adjust the O2 knob of the backup flowmeter according to the table below. Ensure that the readings of the backup total flowmeter and the glass tube flowmeter on the left of the screen meet the following requirements:

Adjust the backup flowmeter.	Reading on the glass tube flowmeter	Flow displayed on the left of the screen
Adjust the O2 knob of the backup flowmeter. Set the gas to O2.	2 L/min	1.8–2.2 L/min
	15 L/min	13.5–16.5 L/min

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## 7.7 Electronic Vaporizer Test (for A9)

### 7.7.1 Vaporizer Monitoring Function Test

Monitoring the heating foil temperature:

1. Before the test, ensure that the vaporizer has been powered off for at least 2 hours, and install the vaporizer in canister position 1 of the vaporizer manifold.



2. Choose **Setup > Service > Diagnostic Tests > Vaporizer 1 Tests** to access the vaporizer test screen.
3. Verify that the difference between the displayed values of **Heating Temp Sensor 1** and **Heating Temp Sensor 2** does not exceed 1°C.
4. Verify that the difference between the displayed value of Heating Temp Sensor and the ambient temperature is within  $\pm 3^{\circ}\text{C}$ .
5. Set **Heating Foil** to **On**. Verify that the displayed values of **Heating Temp Sensor 1** and **Heating Temp Sensor 2** gradually increase, and are held at fixed values after about one minute. The hold value of a sevoflurane or isoflurane vaporizer is  $47\pm 3^{\circ}\text{C}$ . The hold value of a desflurane vaporizer is  $37\pm 3^{\circ}\text{C}$ .

Monitoring the drive gas pressure:

1. Connect the O<sub>2</sub> supply and ensure that the gas supply pressure is 280–600 kPa.
2. Install the vaporizer in canister position 1 of the vaporizer manifold.
3. Choose **Setup > Service > Diagnostic Tests > Vaporizer 1 Tests** to access the vaporizer test screen.
4. Verify that all valves on this screen are turned off and **Drive Gas Pressure** is  $0\pm 5$  kPa. Set **Drive Gas Valve Status** to **On** and verify that the displayed value of **Drive Gas Pressure** is  $150\pm 5$  kPa.
5. Open the cover of the vaporizer and verify that **Drive Gas Pressure** decreases to  $0\pm 5$  kPa.
6. Close the cover of the vaporizer and set **Drive Gas Valve Status** to **Off**.
7. Install the vaporizer on the right vaporizer manifold and repeat steps 2 to 5.
8. If there are other vaporizers, repeat steps 2 to 6 to verify the status of each vaporizer.

---

Monitoring the liquid level:

1. Connect the O<sub>2</sub> supply and ensure that the gas supply pressure is 280–600 kPa.
2. Install the vaporizer in canister position 1 of the vaporizer manifold. Identify the vaporizer type corresponding to position 1 on the status display and main display. Verify that the vaporizer type is consistent with the vaporizer.
3. Check the liquid level displayed on the status display and verify that it is consistent with the actual liquid level.
4. Install the vaporizer on the right vaporizer manifold. Identify the vaporizer type corresponding to position 2 on the status display and main display. Verify that the vaporizer type is consistent with the vaporizer.
5. Check the liquid level displayed on the status display and verify that it is consistent with the actual liquid level.
6. If there are other vaporizers, repeat steps 2 to 5 to verify the status of each vaporizer.

### **7.7.2 Vaporizer Self-Locking Test**

1. Install the vaporizer in canister position 1 of the vaporizer manifold. Press the unlock button and verify that the vaporizer can be unlocked and pulled out.
2. Enter the ventilation mode, set the vaporizer output concentration to 0.2%, press the unlock button, and verify that the vaporizer cannot be pulled out.
3. Install the vaporizer in canister position 2 of the vaporizer manifold and repeat steps 1 and 2.

### **7.7.3 Vaporizer Interlock Test**

1. Attach two vaporizers to the vaporizer manifold.
2. Enter the ventilation mode.
3. Set the output concentration of the vaporizer in position 1 to 0.2% on the main display and verify that the vaporizer in position 1 operates properly.
4. In this case, set the output concentration of the vaporizer in position 2 to the minimum value. Verify that the backlight of the vaporizer in position 1 is off, the corresponding vaporizer status on the status display is gray (indicating that the vaporizer in position 1 stops operating), and the vaporizer in position 2 operates properly.
5. Then set the output concentration of the vaporizer in position 1 to the minimum value. Verify that the backlight of the vaporizer in position 2 is off, the corresponding vaporizer status on the status display is gray (indicating that the vaporizer in position 2 stops operating), and the vaporizer in position 1 operates properly.
6. Turn off the vaporizer in position 1.

---

## 7.7.4 Vaporizer Accuracy Test

1. Adjust the APL valve to SP.
2. Adjust the auto/manual switch to Manual.
3. Connect the inspiratory port to the expiratory port through a breathing hose. Connect a manual bag to the bag arm port.
4. Connect the sampling tube of the AG module to the inspiratory port of the anesthesia machine, as shown in the figure.



5. Ensure that the scavenging system is connected to the wall and the float is between the minimum and maximum scales.
6. Install a vaporizer and add anesthetic agent (if necessary).
7. Turn on the anesthesia machine, exit the standby mode, and enable the anesthesia machine to operate in manual mode.
8. Set the fresh gas flow to 2 L/min.
9. Adjust the output concentration of the vaporizer as follows: 0, 0.2%, 0.5%, 1%, and 3% (isoflurane and sevoflurane); 5% and 8% (sevoflurane); 12% (desflurane); 18% (desflurane). Observe the monitored value of the AG module on the anesthesia machine to check whether its accuracy meets the requirement.
10. Test each vaporizer in sequence.

Test record tables

Test Sample	Test Flow	Set Concentration (%)	Test Result (%)	Acceptance Criterion (%)	Pass/Fail
Isoflurane	2 L/min	0		≤ 0.05	
		0.2		0–0.45	
		1.0		0.75–1.25	
		3.0		2.55–3.45	
		5.0		4.25–5.75	

Test Sample	Test Flow	Set Concentration (%)	Test Result (%)	Acceptance Criterion (%)	Pass/Fail
Sevoflurane	2 L/min	0		≤ 0.05	
		0.2		0–0.6	
		1.0		0.6–1.4	
		3.0		2.55–3.45	
		5.0		4.25–5.75	
		8.0		6.8–9.2	

Test Sample	Test Flow	Set Concentration (%)	Test Result (%)	Acceptance Criterion (%)	Pass/Fail
Desflurane	2 L/min	0		≤ 0.05	
		0.2		0–1.1	
		1.0		0.1–1.9	
		5.0		4.1–5.9	
		12.0		10.2–13.8	
		18.0		15.3–20.7	

## 7.8 Mechanical Vaporizer Test (for A8)

### 7.8.1 Vaporizer Interlock Test

1. Connect two vaporizers to the vaporizer manifold and lock them in proper places.
2. Rotate either of the vaporizer dial to 3%.
3. Verify that the other vaporizer dial cannot be rotated.
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 0 or T and remove both vaporizers.
8. Verify that the locking spring is intact.
9. Reconnect both vaporizers to the vaporizer manifold.

### 7.8.2 Vaporizer Back Pressure Test

1. Connect the O<sub>2</sub> pipeline supply or turn on the O<sub>2</sub> cylinder valve.
2. Adjust the auto/manual switch to Manual and the APL valve to SP.
3. Connect the Y-piece in the breathing circuit to the leak test port, and the other two ends to the expiratory and inspiratory ports of the circuit.
4. Open the BFCS door to let the machine enter the BFCS work mode.
5. Set the O<sub>2</sub> flow to 6 L/min.

- 
6. Ensure that the O<sub>2</sub> flow stays constant.
  7. Adjust the vaporizer concentration from 0 to 1%. Ensure that the O<sub>2</sub> flow does not decrease more than 1 L/min through the full range. Otherwise, repeat this step on another vaporizer. If the problem persists, the anesthesia system malfunctions. Do not use this system.
  8. Test each vaporizer according to the steps above.

## NOTE

- 
- **Do not perform this test on the vaporizer when the concentration control is between "OFF" and the first graduation above "0" as the output amount of anesthetic agent is very small within this range.**
- 

### 7.8.3 Vaporizer Accuracy Test

1. Adjust the APL valve to SP.
2. Adjust the auto/manual switch to Manual.
3. Connect the inspiratory port to the expiratory port through a breathing hose. Connect a manual bag to the bag arm port.
4. Connect the sampling tube of the AG module to the inspiratory port of the anesthesia machine, as shown in the figure.



5. Ensure that the scavenging system is connected to the wall and the float is between the minimum and maximum scales.
6. Install a vaporizer and add anesthetic agent (if necessary).

## NOTE

- 
- **Ensure that the anesthetic agent does not exceed the highest liquid level indicator line on the vaporizer.**
-

- 
7. Turn on the anesthesia machine, exit the standby mode, and enable the anesthesia machine to operate in manual mode. Observe the displayed value of the AG module on the anesthesia machine.
  8. Test the vaporizer accuracy according to the manufacturer's instructions.
  9. Test each vaporizer in sequence.

#### 7.8.4 Vaporizer Leak Test

1. Adjust the Auto/Manual switch to Manual.
2. Set ACGO to the patient circuit (if the machine is configured with the ACGO function).
3. Adjust the APL valve to SP.
4. Connect a manual bag to the bag arm port.
5. Connect the Y-piece in the breathing circuit to the leak test port, and the other two ends to the expiratory and inspiratory ports of the circuit.

#### NOTE

- 
- **When the AG module is configured, ensure that both the sampling tube and exhaust tube of the module are connected or not connected to the Y-piece sampling port. If neither tubes are connected, ensure that the Y-piece sampling port is blocked.**
- 



6. Mount and lock the vaporizer onto the vaporizer mount. (The vaporizer must be set to at least 1%.)
7. Set the fresh gas flow to 0.2 L/min.
8. Adjust the APL valve to 70 cmH<sub>2</sub>O.
9. Push the O<sub>2</sub> flush button until the airway pressure gauge value increases to about 30 cmH<sub>2</sub>O.
10. Release the flush button. Ensure that there is no pressure decrease on the airway pressure gauge.
11. Turn off the vaporizer.
12. Repeat steps 6 to 11 for the other vaporizer.

---

## 7.9 Other Functional Tests

### 7.9.1 Auxiliary Flowmeter Test

1. Provide O<sub>2</sub> and air supply for the anesthesia machine.
2. Press the auxiliary flowmeter switch to turn on the auxiliary flowmeter.
3. Verify that the initial flow is 0, the initial O<sub>2</sub> concentration is 100%, and the glass tube float is at the bottom.
4. Set the O<sub>2</sub> concentration to 100%. Verify that the flow can be adjusted to a maximum of 15 L/min and the flow indication of the glass tube is 15±1.5 L/min.
5. Adjust the O<sub>2</sub> concentration to 21%. Verify that the flow can be adjusted to a maximum of 15 L/min and the flow indication of the glass tube is 15±2 L/min.
6. Press and hold the auxiliary flowmeter switch for a few seconds and then release it. Verify that the auxiliary flowmeter is turned off and the glass tube float is at the bottom.

### 7.9.2 High-Flow O<sub>2</sub> Supply Test

1. Provide O<sub>2</sub> and air supply for the anesthesia machine.
2. Press the high-flow O<sub>2</sub> supply switch to enable high-flow O<sub>2</sub> supply.
3. Verify that the initial flow is 0, the initial O<sub>2</sub> concentration is 100%, and the glass tube float is at the bottom.
4. Set the O<sub>2</sub> concentration to 100%. Verify that the flow can be adjusted to a maximum of 60 L/min and the flow indication of the glass tube is about 60 L/min (with a deviation not exceeding 10 L/min).
5. Press and hold the high-flow O<sub>2</sub> supply switch for a few seconds and then release it. Verify that high-flow O<sub>2</sub> supply is disabled and the glass tube float is at the bottom.

### 7.9.3 High-Pressure O<sub>2</sub> Output Test

1. When O<sub>2</sub> is supplied at the O<sub>2</sub> inlet, press the high-pressure O<sub>2</sub> output check valve with your finger and verify that there is high-pressure gas output.



2. Release the check valve at the high-pressure O<sub>2</sub> inlet and verify that there is no gas output at the high-pressure O<sub>2</sub> inlet.

---

### 7.9.4 O<sub>2</sub> Flush Test

1. Connect the O<sub>2</sub> pipeline supply or open the O<sub>2</sub> cylinder.
2. Adjust the Auto/Manual switch to Manual.
3. Make the anesthesia machine enter the standby state.
4. Occlude the patient connection port with a leak test plug.
5. Connect a 3 L or 1 L bag to the bag arm port.
6. Set ACGO to Off.
7. Adjust the APL valve to 75 cmH<sub>2</sub>O.
8. Press and hold O<sub>2</sub> flush button **O<sub>2</sub>+**. Measure the time for bellows to be fully inflated.
9. Repeat the above steps at least twice.
10. Check that the time for bellows to be fully inflated is:
  - ◆ For the 3 L bag: 3s to 6s;
  - ◆ For the 1 L bag: 1s to 3s.

### 7.9.5 Mechanical ACGO Function Test

1. Set the fresh gas flow to 1 L/min, the mode to VCV, and Patient Size to Adult. Retain default values for other parameters. Connect the patient pipeline to the test lung. Run the equipment for three to five cycles in normal ventilation mode.
2. Turn the ACGO switch to the ACGO mode and verify that "VCV" in the display area in system ventilation mode is replaced with "ACGO".
3. Block the ACGO outlet (for example, with a leak test plug). The PAW waveform obviously fluctuates on the screen.
4. Turn the ACGO switch to the non-ACGO mode and verify that the system switches to the VCV mode and the ventilation is normal.
5. Set the fresh gas flow to 0.2 L/min.
6. Turn the ACGO switch to the ACGO mode and verify that the reading on the airway pressure gauge increases to above 30 cmH<sub>2</sub>O within one minute.

### 7.9.6 Internal AG Module Test

1. Connect the O<sub>2</sub> pipeline supply or open the backup O<sub>2</sub> cylinder.
2. Connect the AGSS to the hospital's waste gas scavenging system.
3. Adjust the auto/manual switch to Manual and the APL valve to SP.
4. Connect the pipelines according to 7.8.4 and make the anesthesia machine exit the standby mode. Turn on the vaporizer and set the concentration to 1%.
5. Choose Setup > Service > Data Monitors > AG to access the Data Monitors screen.
5. Check the extraction flow of the internal AG module and verify that it is stable at 150±5 mL/min.
6. Check the anesthetic agent type and concentration monitored by the internal AG module. Verify that the anesthetic agent type is consistent with the vaporizer type and the concentration is 0.8%–1.2%.

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## 7.10 Circuit Function Tests

### 7.10.1 O<sub>2</sub> Concentration Test

NOTE

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- **When performing this test in the EFCS state, air must be set as the balance gas and the direct flow control mode must be set. The system must be connected to O<sub>2</sub> and air supplies.**
- 

1. Set ventilator control parameters as follows:

Ventilator Control Parameter	Ventilator Setting
Patient Size	Adult
Ventilation Mode	VCV
V <sub>t</sub>	1000
Rate	10
I:E	1:2
T <sub>p</sub>	Off
PEEP	6

2. Adjust the O<sub>2</sub> and air flow to 3 L/min. Wait for one minute until the O<sub>2</sub> concentration is stable. The concentration displayed on the screen is 60±3%. Verify that the concentration for external standard equipment is 60±3%.
3. Turn off all flow regulators.

### 7.10.2 APL Valve Test

1. Adjust the Auto/Manual switch to Manual.
2. Ensure that the ring light of the APL valve is on.
3. Connect a manual bag to the bag arm port.
4. Connect the Y-piece in the breathing circuit to the leak test port.
5. Turn the APL valve control knob to 30 cmH<sub>2</sub>O.
6. Push the O<sub>2</sub> flush button to inflate the manual bag.
7. Ensure that the value displayed on the PAW gauge ranges from 20 to 40 cmH<sub>2</sub>O.
8. Pull the APL valve and observe the reading on the airway pressure gauge to verify that the pressure immediately decreases to 0±2 cmH<sub>2</sub>O.
9. Turn the APL valve control knob to SP (minimum).
10. Set the O<sub>2</sub> flow to 3 L/min. Turn any other gases off.
11. Ensure that the value displayed on the PAW gauge is smaller than 5 cmH<sub>2</sub>O.
12. Push the O<sub>2</sub> flush button continuously. Ensure that the value displayed on the PAW gauge does not exceed 10 cmH<sub>2</sub>O.
13. Release the O<sub>2</sub> flush button and turn the O<sub>2</sub> flow control knob to the minimum flow position. Ensure that the value displayed on the PAW gauge does not decrease below 0 cmH<sub>2</sub>O.

---

### 7.10.3 Auto/Manual Switch Test

1. Make the machine exit the standby mode.
2. Adjust the Auto/Manual switch to Manual. Verify that the ring light of the APL valve is on and the current mode displayed on the screen is the manual mode.
3. Adjust the Auto/Manual switch to Auto. Verify that the ring light of the APL valve is off and the current mode displayed on the screen is the auto mode.

### 7.10.4 Patient Circuit Heating Test

1. Ensure that the system is AC powered and standby, the patient circuit remains in place, and the heating module has been working for more than 10 minutes.
2. Choose **Setup > Service > Data Monitors > Power System** to access the Data Monitors screen.
3. Verify that the actual values displayed for **Heating Probe T1 Temp** and **Heating Probe T2 Temp** range from 50°C to 70°C.

### 7.10.5 Sample Gas Return Test

#### 7.10.5.1 Checking the Sample Gas Exhaust Port

Press the leaf spring above the snap hook on the sample gas exhaust port and verify that the snap hook supports self locking. In this state, the quick connector can be normally connected.

#### 7.10.5.2 Leak Test in Sample Gas Return Mode

Connect a quick connector to the sample gas return port at the rear end of the trolley on condition that the rear-end rubber hose is blocked. Set the system to perform an automatic leak test. Follow instructions on the screen for the test and verify that the leak test is passed.

#### 7.10.5.3 Tidal Volume Test in Sample Gas Return Mode

1. When the module rack is installed with the AG module and the module has been warmed up, connect the exhaust port of the AG module to the rubber hose of the quick connector and connect the quick connector to the sample gas return port. Set the O<sub>2</sub> flow to about 1 L/min and set system parameters as follows:

VCV Adult Test 2 Setting	
V <sub>t</sub>	500
Rate	8
T <sub>p</sub>	30
I:E	1:2
PEEP	5

2. Connect the test lung for ventilation. After 10-waveform running in ventilation mode, ensure that the displayed V<sub>t</sub> value is 455–545 mL.

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## 7.11 Active AGSS Check

1. Connect the vacuum hose to the EVAC port or vacuum port of the healthcare facility and turn on the waste gas disposal system.
2. Exit the standby mode. Choose **Setup > Service > Data Monitors > VPM > AGSS Pump Rate** to view the hospital's AGSS pump rate. Verify that the pump rate meets the manufacturer's requirement: 75–105 L/min at high flow and 25–50 L/min at low flow.
3. Check whether the AGSS flow on the status display is between the MIN and MAX lines.
4. If the flow does not meet the requirement, verify the status of the hospital's disposal system or adjust the position of the float to be between the MIN and MAX lines by turning its flow regulating knob (counter-clockwise to increase the flow and clockwise to decrease the flow).

If the float cannot rise, or the AGSS pump rate in diagnostic mode is quite small and cannot be changed with the knob, the possible causes are as follows:

1. The AGSS flow sensor is damaged, or the cable is disconnected.
2. The AGSS flow valve is faulty and cannot be turned on, resulting in occlusion of the AGSS limb.
3. The waste gas disposal system is not working, or the pump rate is less than the flow required for proper operating of the AGSS. Check the waste gas disposal system.

## 7.12 Negative Pressure Suction Tests

### 7.12.1 Pipeline Negative Pressure Suction Test

1. Check that the suction tubes between the overflow protection cup, filter, and liquid collection bottle are correctly connected.
2. Connect the external negative pressure source and the negative pressure gas supply inlet assembly of the anesthesia machine via negative pressure gas supply hose.
3. Fold the patient connection of the suction tube. Set the negative pressure regulator to FULL and check if the negative pressure gauge displays the maximum negative pressure value.
4. Set the negative pressure regulator to OFF and check if the pointer on the negative pressure gauge returns to zero gradually.
5. Set the negative pressure regulator to REG and turn the negative pressure regulating knob slowly. When you turn the knob clockwise, the pressure value displayed on the negative pressure gauge decreases gradually until returning to zero. When you turn the knob counterclockwise, the pressure value displayed on the negative pressure gauge increases gradually until reaching the maximum value.
6. Set the negative pressure regulator to OFF again. Loosen the folded negative pressure suction tube.
7. Disconnect the negative pressure gas supply hose.

If there is no reading on the negative pressure gauge, the possible causes are as follows:

1. The external negative pressure source has no negative pressure output.
2. The negative pressure suction tubes inside the anesthesia machine are not correctly connected.
3. The negative pressure suction tubes are not correctly connected.
4. The overflow protection cup, filter, and liquid collection bottle are not correctly installed.

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## 7.12.2 Venturi Negative Pressure Suction Test

1. Check that the suction tubes between the overfill protection cup, filter, and liquid collection bottle are correctly connected.
2. Connect the external air source and the air supply inlet assembly of the anesthesia machine via air supply hose.
3. Fold the patient connection of the suction tube. Set the negative pressure regulator to FULL and check if the negative pressure gauge displays the maximum negative pressure value.
4. Set the negative pressure regulator to OFF and check if the pointer on the negative pressure gauge returns to zero gradually.
5. Set the negative pressure regulator to REG and turn the negative pressure regulating knob slowly. When you turn the knob clockwise, the pressure value displayed on the negative pressure gauge decreases gradually until returning to zero. When you turn the knob counterclockwise, the pressure value displayed on the negative pressure gauge increases gradually until reaching the maximum value.
6. Set the negative pressure regulator to OFF again. Loosen the folded negative pressure suction tube.
7. Disconnect the air supply hose.

### NOTE

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- **Do not occlude the exhaust port of the muffler when checking.**
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If there is no reading on the negative pressure gauge, the possible causes are as follows:

1. The external air source has no air output, or the pressure is less than 280 kPa.
2. The negative pressure suction tubes inside the anesthesia machine are not correctly connected.
3. The Venturi generator inside the anesthesia machine is occluded or faulty.
4. The negative pressure suction tubes are not correctly connected.
5. The overfill protection cup, filter, and liquid collection bottle are not correctly installed.

## 7.13 Alarm Tests

### 7.13.1 Power Failure Alarm Test

1. Set the system switch to the **On** position.
2. Disconnect the AC mains.
3. Ensure that the AC power indicator and battery charge indicator are off. An audible alarm should sound, and the prompt message **Battery in Use** should be displayed on the main screen.
4. Reconnect the AC mains.
5. Ensure that an audible alarm sounds and the AC power indicator and battery charge indicator are on. The prompt message **Battery in Use** should not be displayed on the main screen.
6. Set the system switch to the **Off** position.

### NOTE

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- **When the battery is full, the battery charge indicator is off.**
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### 7.13.2 Breathing Circuit Not Installed Alarm Test

Remove the patient circuit. An alarm **Breathing System Not Mounted** should occur. Reconnect the patient circuit. The alarm disappears.

### 7.13.3 Volume Exchanger Not Installed Alarm Test

Remove the patient circuit and the volume exchanger. An alarm **Volume Exchanger Not Mounted** should occur. Install the volume exchanger. The alarm disappears.

### 7.13.4 Absorber Canister Alarm Test

Open the handle of the absorber canister (the L-type arm handle is vertically downward). An alarm **CO2 Absorber Canister Not Locked** should occur. Close the handle of the absorbent canister (the L-type alarm handle is horizontally towards the right). Verify that the alarm disappears.

### 7.13.5 O2 Supply Failure and Balance Gas Branch Flow Not Achieved Alarm Tests

Ensure that the O2, air, and N2O (optional) supply input pressure is not lower than 300 kPa. Set the ventilation mode to Manual and start ventilation.

Note: If the hospital has no N2O supply, N2O tests can be skipped.

#### 7.13.5.1 O2 Supply Failure Alarm Test

1. Under the BFCS state, adjust the O2 needle valve to ensure that the reading on the total flowmeter is about 1 L/min.
2. Disconnect the O2 supply. When the pressure drops until the **O2 Supply Failure** alarm occurs on the anesthesia machine, observe the gas supply pressure gauge to verify that the input pressure is  $220\pm 34$  kPa.
3. Re-connect the O2 supply. Verify that when the **O2 Supply Failure** alarm disappears, the input pressure is  $220\pm 34$  kPa.

#### 7.13.5.2 Balance Gas Supply Failure Alarm Test

For models equipped with gas cylinders and without electronic gas supply pressure monitoring in the cylinder limbs, perform a test in the following method:

1. Connect the O2 supply, disconnect other gas supplies, set the balance gas to air, adjust the air flow to 5 L/min, and verify that the anesthesia machine generates the **Balance Gas Branch Flow Not Achieved** alarm.
2. Connect the O2 supply, disconnect other gas supplies, set the balance gas to N2O, adjust the N2O flow to 5 L/min, and verify that the anesthesia machine generates the **Balance Gas Branch Flow Not Achieved** alarm.

For models equipped with electronic cylinder gas supply pressure monitoring or without gas cylinders, perform a test in the following method:

1. Connect the O2 and N2O supplies and adjust the O2 flow so that the reading on the flowmeter is 2 L/min. Set the balance gas to N2O, adjust the N2O flow to 5 L/min, and adjust the N2O supply input pressure. When the pressure drops until the **N2O Supply Failure** alarm occurs on the anesthesia machine, verify that the N2O supply input pressure is  $220\pm 34$  kPa. Gradually increase the N2O supply input. When the **N2O Supply Failure** alarm disappears, verify that the gas supply input pressure is  $220\pm 34$  kPa.

- 
2. Connect the O<sub>2</sub> and air supplies, set the balance gas to air, and adjust the air flow so that the reading on the flowmeter is 5 L/min. Adjust the air supply input pressure. When the pressure drops until the **Air Supply Failure** alarm occurs on the anesthesia machine, verify that the air supply input pressure is 220±34 kPa. Gradually increase the air supply input. When the **Air Supply Failure** alarm disappears, verify that the air supply input pressure is 220±34 kPa.

### 7.13.5.3 Drive Gas Pressure Low Alarm Test

Disconnect the pipeline supply of the drive gas. Verify that the **Drive Gas Pressure Low** alarm occurs after a period of time. Restore drive gas supply. Verify that the **Drive Gas Pressure Low** alarm disappears.

## 7.13.6 Ventilator-Related Alarm Tests

### 7.13.6.1 Setup

1. Ensure that the gas pressure for O<sub>2</sub>, N<sub>2</sub>O, and air is within the specified range.
2. Power on the anesthesia system.
3. Perform the power-on tests according to the instructions on the screen. Ensure that the tests succeed.
4. Attach a breathing circuit and a manual bag.

### NOTE

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- **For testing purposes, always use a reusable breathing circuit.**
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5. Attach an adult test lung to the Y-piece of the breathing circuit.
6. Set the O<sub>2</sub> flow to 2 L/min and disable the N<sub>2</sub>O and air flows.
7. Set breathing parameters.

Parameter	Setting
Patient Size	Adult
Ventilation Mode	VCV
V <sub>t</sub>	600
Rate	8
I:E	1:2
T <sub>pause</sub>	10
PEEP	Off
P <sub>limit</sub>	50

8. Start ventilation.

---

### 7.13.6.2 FiO2 Too Low Alarm Test

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

### 7.13.6.3 FiO2 Too High Alarm Test

1. Set the FiO2 high alarm limit to 50%.
2. Set the O2 flow control valve to 5 L/min.
3. Disable the air flow.
4. Verify that the following FiO2 high alarm signals activate:
  - ◆ The **FiO2 Too High** message appears on the screen.
  - ◆ An alarm tone sounds.
5. Set the FiO2 high alarm limit to the maximum value.
6. Verify that the alarm signals cease.

### 7.13.6.4 Paw Alarm Test

1. Set the peak low alarm limit to the lowest value.
2. Adjust the peak high alarm limit setting to a value about 5 to 8 cmH2O lower than the peak pressure displayed on the screen.
3. Verify that the following (high) pressure alarms activate:
  - a. The **Paw Too High** message appears on the screen.
  - b. An alarm tone sounds.
  - c. Inspiration ends and expiration begins when the pressure meets the high alarm limit.
4. Set the peak high alarm limit to 65 (cmH2O).
5. Verify that the alarm signals cease.
6. Set the peak low alarm limit to 50 (cmH2O).
7. Verify that the following (low) pressure alarms activate:
  - a. The **Paw Too Low** message appears on the screen.
  - b. An alarm tone sounds.
8. Set the PAW low alarm limit to 1 (cmH2O).
9. Verify that the alarm signals cease.

---

### 7.13.6.5 Minute Ventilation Alarm Test

1. Set the MV high and low alarm limits to the highest values.
2. Verify that the following alarms activate:
  - ◆ The **MV Too Low** message appears on the screen.
  - ◆ An alarm tone sounds.
3. Set the MV low alarm limit to the lowest value.
4. Verify that the alarm signals cease.
5. Set the MV high alarm limit to the lowest value.
6. Verify that the following alarms activate:
  - ◆ The **MV Too High** message appears on the screen.
  - ◆ An alarm tone sounds.
7. Set the MV high alarm limit to the highest value.
8. Verify that the alarm signals cease.

### 7.13.6.6 Apnea Alarm Test

1. Run the anesthesia machine in VCV mode for a period of time to ensure that more than six breathing cycles appear on the screen.
2. Remove the test lung and wait at least 30s to ensure that an apnea alarm occurs.
3. Reconnect the test lung and ensure that the apnea alarm disappears.

### 7.13.6.7 Continuous Airway Pressure Alarm Test

1. Connect a manual bag to the manual bag port.
2. Set the O<sub>2</sub> flow to the minimum value.
3. Turn the APL valve control knob to adjust the APL valve to 30 cmH<sub>2</sub>O.
4. Adjust the ventilation switch to Manual.
5. Push the O<sub>2</sub> flush button for approximately 20s. Ensure that the **Continuous Airway Pressure** alarm occurs.
6. Disconnect the breathing circuit and ensure that the alarm disappears.
7. Reconnect the breathing circuit.

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## 7.14 System Ventilation Performance Tests

### 7.14.1 Manual Mode Ventilation Test

1. Adjust the mechanical auto/manual switch to Manual. Perform operations on the screen to switch the system to the manual mode.
2. Adjust the APL valve to 25 cmH<sub>2</sub>O. Push the O<sub>2</sub> flush button to fill the breathing bag.
3. Set the flow to 1 L/min.
4. Squeeze the breathing bag once every 3s.
5. Verify the inflation and deflation of the test lung.
5. Verify that a PAW waveform and all numeric values appear on the screen during bag compression.
7. Stop squeezing the breathing bag and adjust the APL valve to the open position (SP).

### 7.14.2 VCV Adult Ventilation Mode Test

1. Attach a breathing circuit and a manual bag.

#### NOTE

- 
- For testing purposes, always use a reusable breathing circuit.
- 

2. Attach an adult test lung to the Y-piece of the breathing circuit.
3. Connect a ventilation tester between the expiratory port and the breathing hose.
4. Set the O<sub>2</sub> flow to 2 L/min and disable the N<sub>2</sub>O and air flows.
5. Adjust the auto/manual switch to Auto.
6. Set breathing parameters.

Parameter	Setting
Patient Size	Adult
Ventilation Mode	VCV
V <sub>t</sub>	600
Rate	8
I:E	1:2
T <sub>pause</sub>	10
PEEP	Off
P <sub>limit</sub>	50

7. Start ventilation.
8. Verify that the pressure waveform, respiratory volume, mean or plateau pressure, respiratory rate, and minute ventilation appear on the screen.
9. Verify that the tidal volume displayed on the anesthesia machine is within 7% ( $\pm 42$  mL) of the value displayed on the ventilation tester within approximately the first 1 minute after ventilation starts.
10. Verify that the tidal volume displayed on the anesthesia machine is within 7% ( $\pm 42$  mL) of the setting within approximately the first 1 minute after ventilation starts.

---

### 7.14.3 VCV Child Ventilation Mode Test

1. Attach a breathing circuit and a manual bag.

**NOTE**

- 
- **For testing purposes, always use a reusable breathing circuit.**
- 

2. Attach an adult test lung to the Y-piece of the breathing circuit.

**NOTE**

- 
- **Limit the volume in the test lung to provide sufficient airway pressure to satisfy the Low Peak Pressure alarm. Or set the peak pressure alarm limit to a smaller value to prevent the alarm when an adult test lung is used.**
- 

3. Connect a ventilation tester between the expiratory port and the breathing hose.
4. Set the O<sub>2</sub> flow to 2 L/min and set the N<sub>2</sub>O and air flows to the minimum value.
5. Set breathing parameters.

Parameter	Setting
Patient Size	Child
Ventilation Mode	VCV
V <sub>t</sub>	120
Rate	15
I:E	1:2
T <sub>pause</sub>	10
PEEP	Off
P <sub>limit</sub>	40

6. Start ventilation.
7. Verify that the pressure waveform, respiratory volume, mean or plateau pressure, respiratory rate, and minute ventilation appear on the screen.
8. Verify that the tidal volume displayed on the anesthesia machine is within  $\pm 15$  mL of the value displayed on the ventilation tester within approximately the first 1 minute after ventilation starts.
9. Verify that the tidal volume displayed on the anesthesia machine is within  $\pm 15$  mL of the setting within approximately the first 1 minute after ventilation starts.

---

### 7.14.4 PCV Adult Ventilation Mode Test

1. Attach a breathing circuit and a manual bag.

#### NOTE

- 
- For testing purposes, always use a reusable breathing circuit.
- 

2. Attach an adult test lung to the Y-piece of the breathing circuit.
3. Connect a ventilation tester between the expiratory port and the breathing hose.
4. Set the O<sub>2</sub> flow to 3 L/min and disable the N<sub>2</sub>O and air flows.
5. Set breathing parameters.

Parameter	Setting
Patient Size	Adult
Ventilation Mode	PCV
VtG	Off
P <sub>insp</sub>	15
Rate	8
I:E	1:2
PEEP	Off
T <sub>slope</sub>	0.2
PlimVG	NA

6. Start ventilation.
7. Verify that the peak pressure reading on the display is within the set P<sub>insp</sub> ± 2 cmH<sub>2</sub>O.
8. Verify that the pressure waveform, respiratory volume, respiratory rate, and minute ventilation appear on the screen.
9. Verify that the peak value measured by the ventilation tester reaches 15±2.5 cmH<sub>2</sub>O within the first five breathing cycles after ventilation starts.

### 7.15 Sensor Zero Point Check

To check the sensor zero point, perform the following operations:

1. Disconnect the tubes from the inspiratory and expiratory ports.
2. Ensure that the system is in standby mode.
3. Choose **Setup > Service > Data Monitors > Zero Sensors** to access the zero display screen. The second column is the zero point of the current sensor and the third column is the zero point in case of factory calibration.

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

Sensor	Normal Range of Zero Point (AD Counts)
PAW sensor	[1068, 1765]
PEEP sensor	[1068, 1765]
Inspiratory flow sensor	[289, 632]
Expiratory flow sensor	[289, 632]
Esophageal pressure sensor	[1068, 1765]

Balance gas flow sensor (EFCS)	[0, 200]
O2 flow sensor (EFCS)	[0, 200]
Total flow sensor (EFCS)	[0, 200]

If the current zero point exceeds the specified normal range and the actual value is greater than 1, calibrate the zero point again. If the actual value is less than 1 and the zero point of the PAW sensor, PEEP sensor, or inspiratory/expiratory flow sensor is beyond the range, replace the VCM. If the zero point of the balance gas flow sensor, O2 flow sensor, or total flow sensor is beyond the range, replace the flow sensor or its interface board.

**NOTE**

- **If the zero point of the pressure sensor is inaccurate in case of ventilation, the baseline of the PAW waveform is not at the zero point and a great deviation exists between pressure control and measurement.**
- **If the zero point of the inspiratory/expiratory sensor is inaccurate in case of ventilation, the baseline of the PAW waveform is not at the zero point and a great deviation exists between TV control and measurement.**
- **If the zero point A/D value of any sensor runs out of the normal range, it cannot be corrected. Instead, the monitoring signal test board must be replaced.**

## 7.16 Constant Flow Test (Checking the Flow Sensor Accuracy)

To check the measurement accuracy of flow sensors, perform the following operations:

1. Remove the water collection cup.
2. Use a pipe to connect the inspiratory port and expiratory port of the anesthesia machine, as shown in the following figure.



3. Choose **Setup > Service > Data Monitors > Valves** to access the flow test screen.
4. Set **Safety Valve** to **On**.
5. Set **PEEP Valve Pressure** to 50 cmH2O, and **Auto/Manual Valve** to **Auto**.
6. Set **Insp Valve Flow** to the following values: 3L/min, 10L/min, 20L/min, 30L/min, and 60L/min.

- 
7. Check the values displayed on the inspiratory flow sensor and expiratory flow sensor. The deviations between these values and the measured values of the flow sensors on the anesthesia machine do not exceed 1 L/min or 5% of the measured values of the flow sensors on the anesthesia machine, whichever is greater. Otherwise, perform flow calibration again.
  8. After calibration is completed, reinstall the water collection cup.

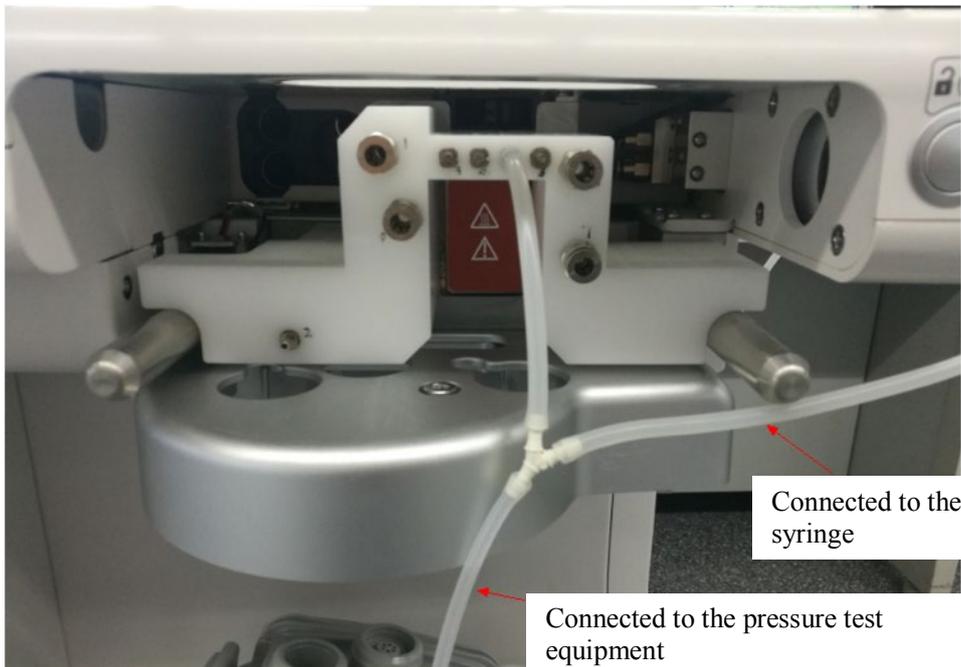
## 7.17 Constant Flow Test (Checking the Pressure Sensor Accuracy)

### NOTE

- 
- Generally, measurement deviations seldom occur on pressure sensors. However, in case that the monitoring signal test board, solenoid valve assembly, or expiratory valve assembly needs to be replaced, you must perform pressure calibration and check the pressure sensor accuracy to confirm the effectiveness of calibration.
  - You can use any flowmeter with the accuracy of at least  $\pm 2\%$  for the accuracy measurement of the pressure sensors.
- 

To check the measurement accuracy of pressure sensors, perform the following operations:

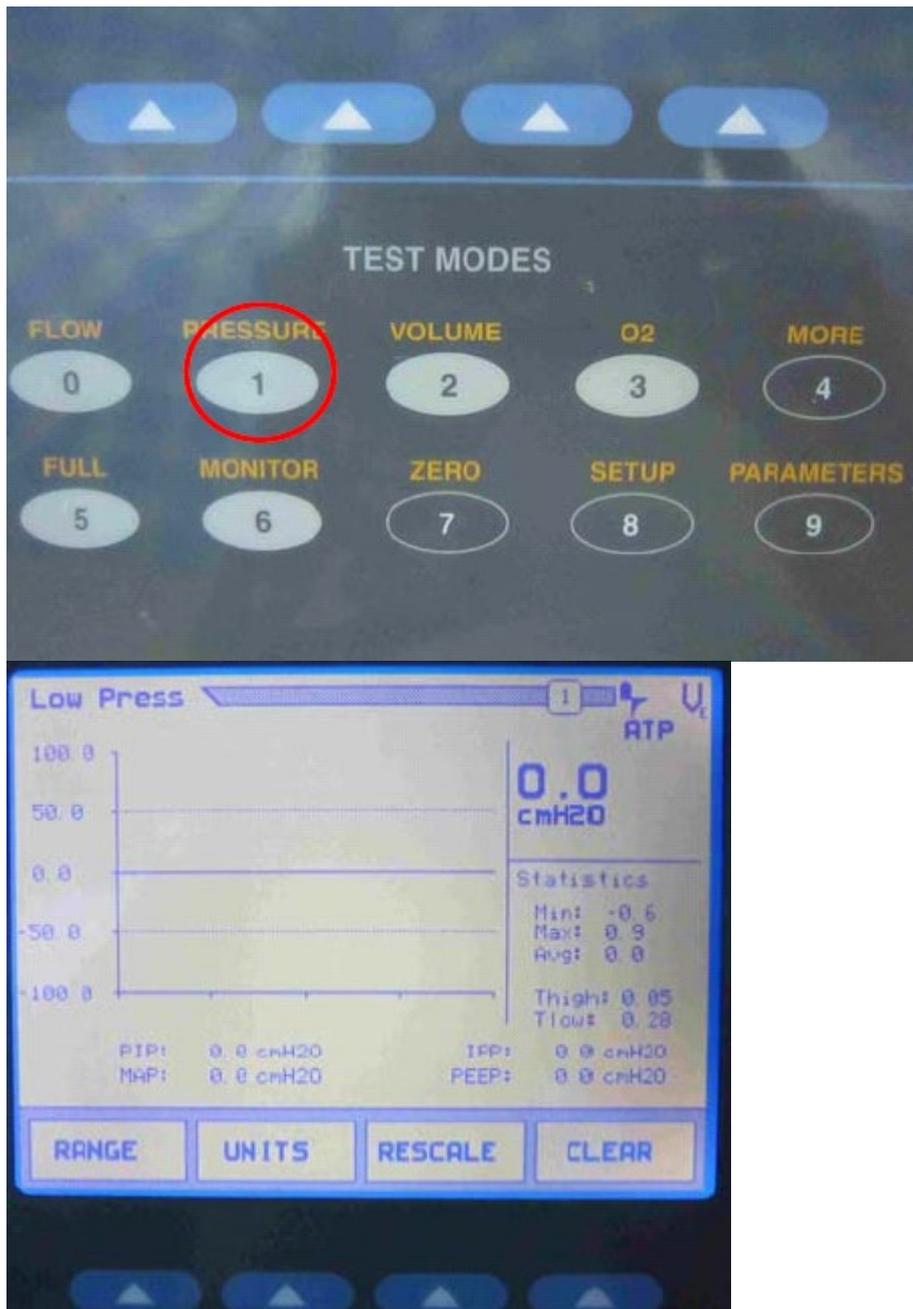
1. Make the machine enter the standby mode, remove the patient circuit, and mount the pressure calibration test fixture to the circuit adapter block in place.
2. Connect the syringe and the pressure sampling port of the pressure test equipment by using a three-way silicon tube.



3. Set the calibration device as described below.

To set the VT-Plus, perform the following operations:

- a. Pressure settings: Press the **PRESSURE** button on the front calibration control panel. Select **Range** and then set it to **Low Press**.



4. Choose **Setup** > **Service** > **Data Monitors** > **VCM** and find the actual airway pressure values.
5. Adjust the pressure by using the syringe so that the pressure test equipment displays  $(5 \pm 1)$  cmH<sub>2</sub>O,  $(20 \pm 1)$  cmH<sub>2</sub>O,  $(50 \pm 1)$  cmH<sub>2</sub>O,  $(70 \pm 2)$  cmH<sub>2</sub>O, and  $(90 \pm 2)$  cmH<sub>2</sub>O in sequence.
6. Ensure that the deviation between the measured value of the PAW sensor displayed on the machine and that of the pressure test equipment does not exceed 1 cmH<sub>2</sub>O or 2% of the measured value of the calibration device, whichever is greater. Otherwise, perform pressure calibration again.

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## 7.18 Electrical Tests

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### WARNING

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- **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.**
- 

### 7.18.1 Auxiliary Power Receptacle Test

Verify that AC voltage always exists on all auxiliary output receptacles, regardless of whether the anesthesia system is enabled or disabled. Use a multimeter to test the voltage and grounding performance of auxiliary output receptacles.

### 7.18.2 Work Light Test

1. Press the work light switch on the right of the primary display once to turn on the work light.
2. Verify that all LED lamps are turned on.
3. Press the switch again (for the second time) and verify that the work light is at high brightness.
4. Press the switch again (for the third time) and verify that the work light is off.

### 7.18.3 Electrical Safety Inspection Test

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#### CAUTION

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- **The electrical safety inspection should be performed once a year.**
1. Perform the protective earth resistance test:
    - a. Plug the earth resistance probes of the safety analyzer into the protective earth terminal and equipotential terminal of the AC power cord.
    - b. Test the earth resistance with a current of 25 A.
    - c. Verify that the resistance is less than 0.1 ohms (100 mohms).
    - d. Plug the earth resistance probes of the safety 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 greater than 0.1 ohms (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 terminal of the AC 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 that the maximum leakage current does not exceed 500  $\mu\text{A}$  (0.5 mA) in the first two tests. While for the last two tests, verify that the maximum leakage current does not exceed 1000  $\mu\text{A}$  (1 mA).
  4. If the BIS and NMT modules are configured, perform the following patient leakage current tests:
    - ◆ Normal polarity;
    - ◆ Reverse polarity;
    - ◆ Normal polarity with open neutral;
    - ◆ Reverse polarity with open neutral;
    - ◆ Normal polarity with open earth;
    - ◆ Reverse polarity with open earth;
    - ◆ Normal polarity with mains on AP; and
    - ◆ Reverse polarity with mains on AP.
  5. Verify that the maximum leakage current does not exceed 100  $\mu\text{A}$  (0.1 mA) in the first two tests. For the next four tests, verify that the maximum leakage current does not exceed 500  $\mu\text{A}$  (0.5 mA). And for the last two tests, verify that the maximum leakage current does not exceed 5000  $\mu\text{A}$  (5 mA).
  6. If the BIS and NMT modules are configured, perform the following patient auxiliary current tests between each electrode and the others by turns:
    - ◆ Normal polarity;
    - ◆ Reverse polarity;
    - ◆ Normal polarity with open neutral;
    - ◆ Reverse polarity with open neutral;
    - ◆ Normal polarity with open earth;
    - ◆ Reverse polarity with open earth;
  7. Verify that the maximum leakage current does not exceed 100  $\mu\text{A}$  (0.1 mA) in the first two tests. While for the last two tests, verify that the maximum leakage current does not exceed 500  $\mu\text{A}$  (0.5 mA).

## NOTE

- Ensure the safety analyzer is authorized by certificate organizations (UL, CSA, AAMI, etc.). Follow the instructions of the analyzer manufacturer. Fluke ESA620 is used as an example.

Electrical safety inspection form

<b>Location:</b>			<b>Technician:</b>	
<b>Equipment:</b>			<b>Control Number:</b>	
<b>Manufacturer:</b>		<b>Model:</b>		<b>SN:</b>
<b>Measurement Equipment/SN:</b>			<b>Date of Calibration:</b>	
<b>Inspection and Testing</b>			<b>Pass/Fail</b>	<b>Limit</b>
1	Auxiliary mains output voltage			
2	Earth resistance	$\Omega$		Max 0.1 $\Omega$
3	Earth leakage current	Normal condition	___ $\mu$ A	Max: Normal condition: 500 $\mu$ A Single fault condition: 1000 $\mu$ A
		Single fault condition	___ $\mu$ A	
4	Patient leakage current	Normal condition	___ $\mu$ A	Max: Normal condition: 100 $\mu$ A Single fault condition: 500 $\mu$ A
		Single fault condition	___ $\mu$ A	
5	Mains on applied part		___ $\mu$ A	Max: 5000 $\mu$ A
6	Patient auxiliary current	Normal condition	___ $\mu$ A	Max: Normal condition: 100 $\mu$ A Single fault condition: 500 $\mu$ A
		Single fault condition	___ $\mu$ A	

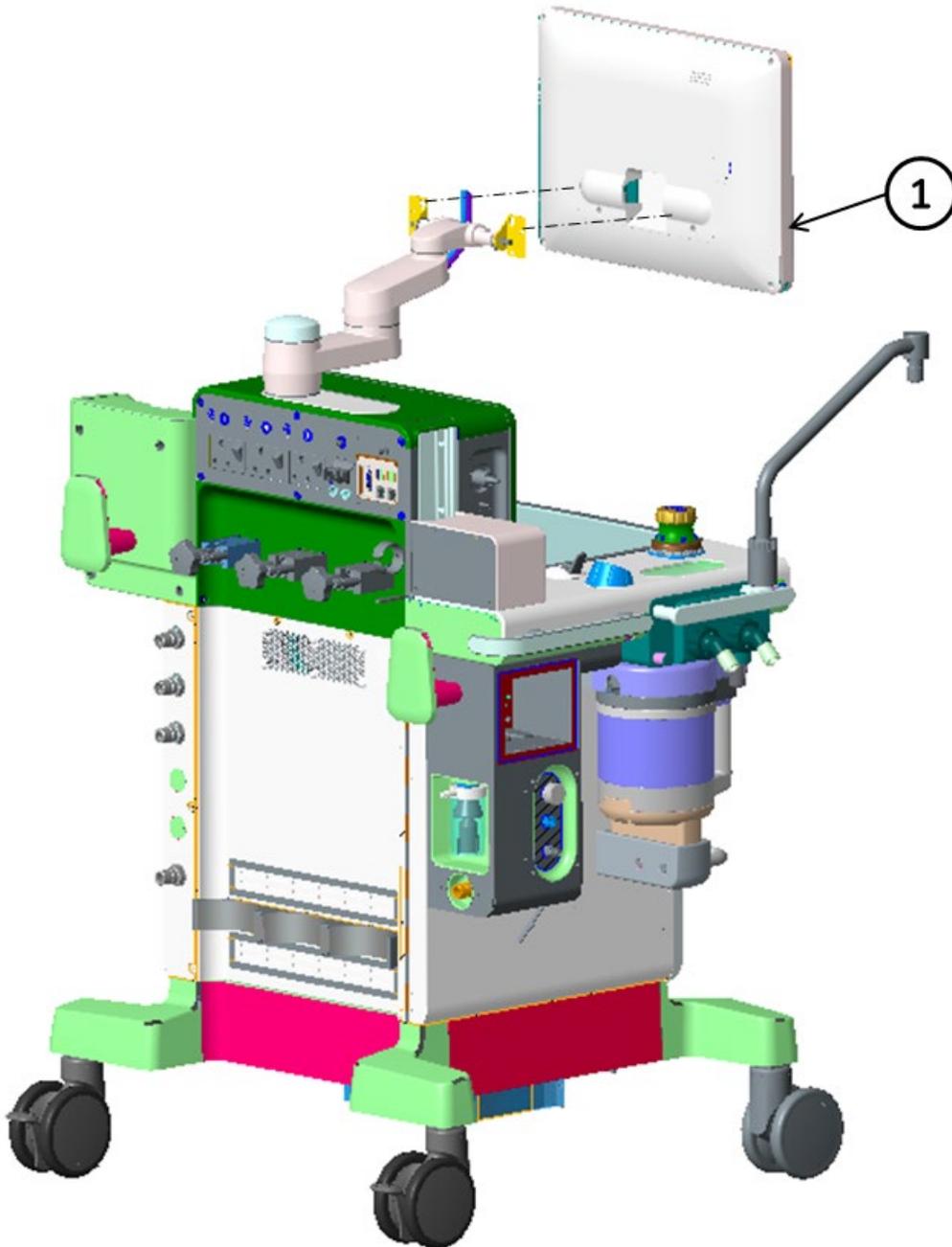
In routine maintenance, all the test items included in the electrical safety inspection form shall be performed. The following table specifies test items to be performed after the equipment is repaired with the main unit disassembled.

When none of the power board, transformer, and patient circuit board is repaired or replaced	Test items: 1 and 2
When the power board or transformer is repaired or replaced	Test items: 1, 2, and 3
When the patient circuit board is repaired or replaced	Test items: 1, 2, 4, 5, and 6
When all of the power board, transformer, and patient circuit board are repaired or replaced	Test items: 1, 2, 3, 4, 5, and 6

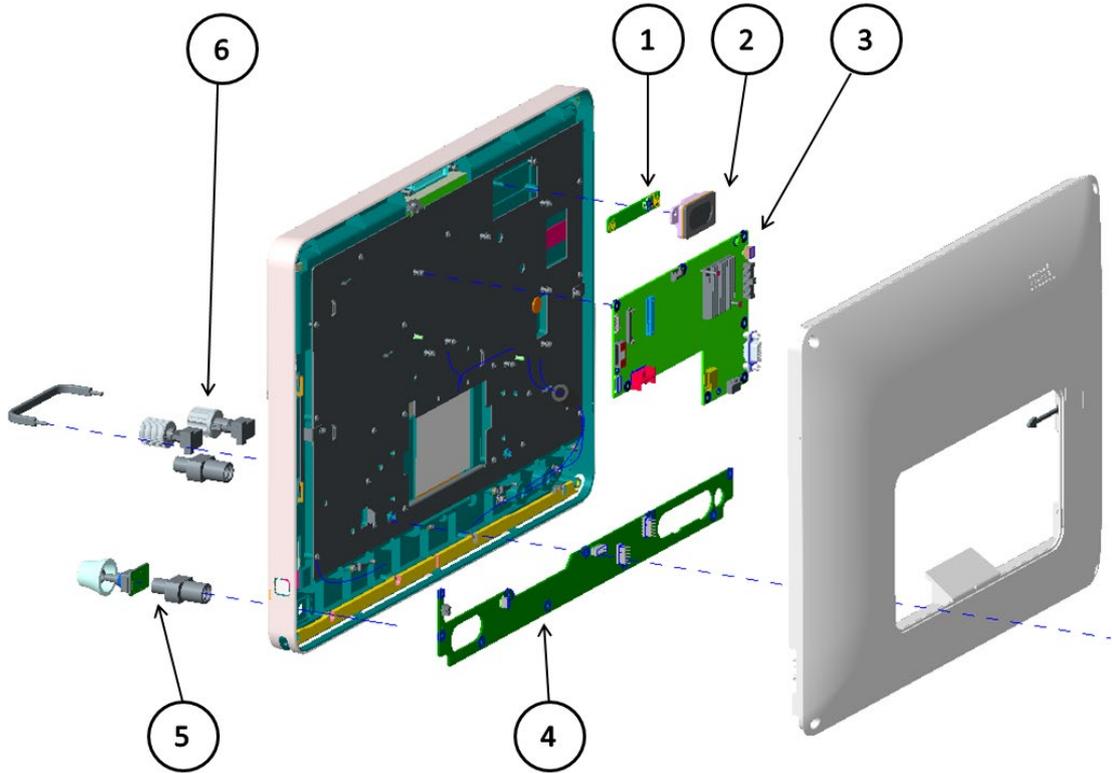
# 8 FRUs

## 8.1 Mechanical Subsystem

### 8.1.1 Display Assembly

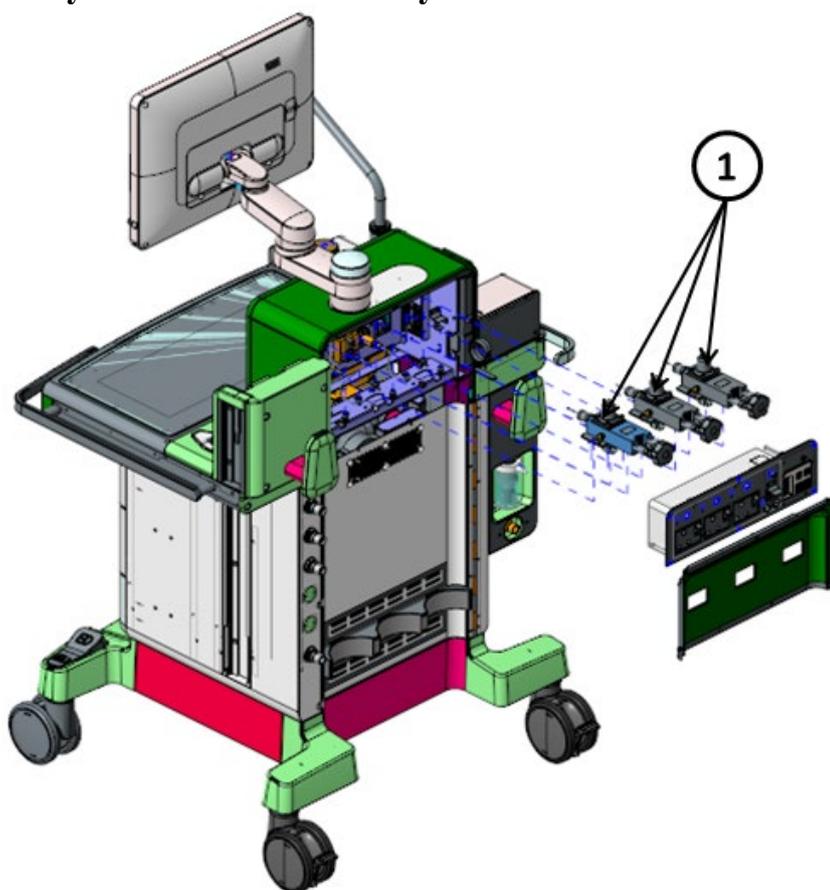


No.	Name	P/N	Test Item After Replacement	Remarks
1	Display service kit (American standard)	115-066858-00	7.1 Power-on self-test. Check the touchscreen and encoder functions.	The CPU board PCBA is excluded.
	Display service kit (European standard)	115-066859-00	7.1 Power-on self-test. Check the touchscreen and encoder functions.	The CPU board PCBA is excluded.



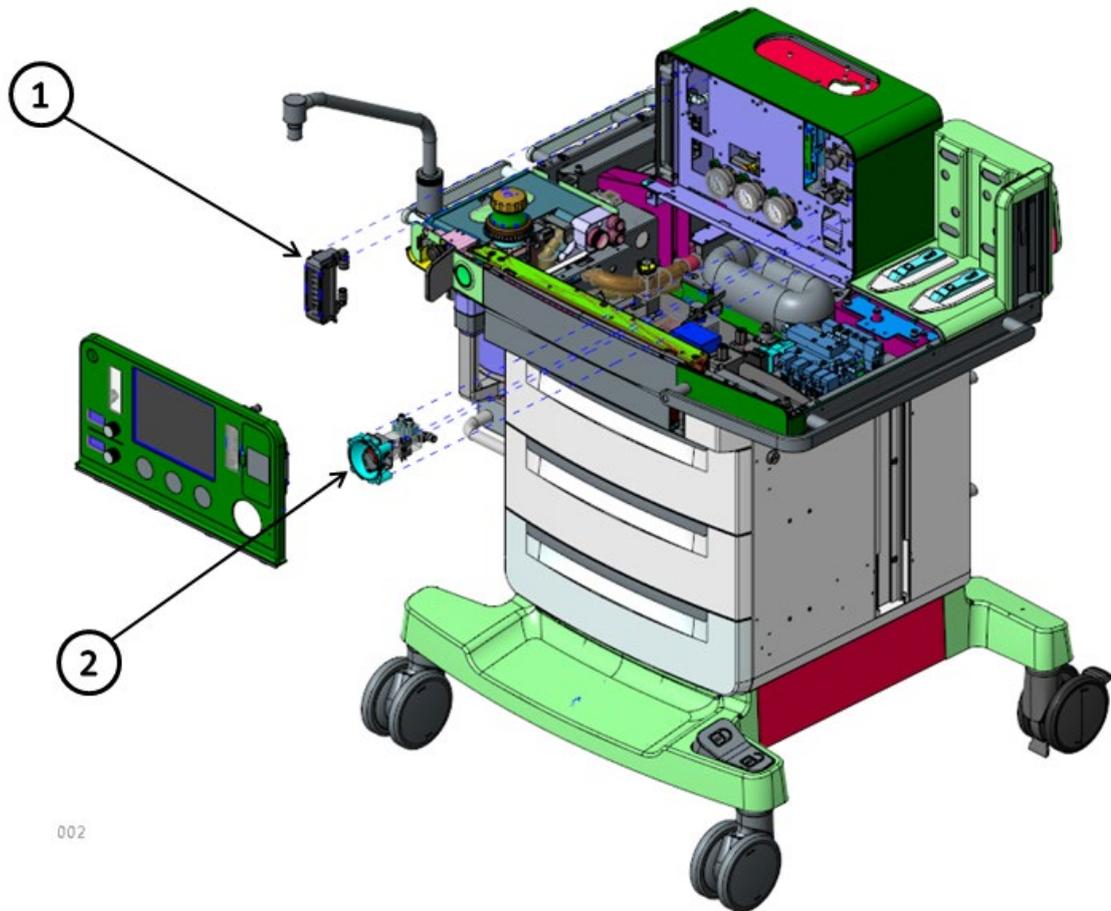
No.	Name	P/N	Test Item After Replacement	Remarks
1	Alarm lamp board PCBA (0645)	051-003208-00	7.1 Power-on self-test. Check whether the lamp is turned on in red, yellow, and blue in turn.	/
2	Speaker assembly (0645)	115-065029-00	7.1 Power-on self-test	/
3	CPU board PCBA (0645)	051-002985-00	7.1 Power-on self-test	/
4	Key lighting board PCBA (0645)	051-003105-00	7.1 Power-on self-test	/
5	Encoder knob service kit (strawhat-shaped)	115-066849-00	7.1 Power-on self-test. Rotate and push the encoder to check its functions.	/
6	Encoder knob service kit	115-066848-00	7.1 Power-on self-test. Rotate encoder to check its functions.	/

## 8.1.2 Cylinder Yoke Assembly



No.	Name	P/N	Test Item After Replacement	Remarks
1	O2 cylinder yoke assembly (mechanical) FRU	115-066817-00	7.4.2 O2 cylinder supply test	/
	N2O cylinder yoke assembly (mechanical) FRU	115-066818-00	7.4.1 N2O cylinder supply test	/
	Air cylinder yoke assembly (mechanical) FRU	115-066819-00	7.4.3 Air cylinder supply test	/
	O2 cylinder yoke assembly (electronic monitoring) FRU	115-066820-00	7.4.2 O2 cylinder supply test. Observe whether the O2 cylinder pressure is displayed on the small display.	/
	N2O cylinder yoke assembly (electronic monitoring) FRU	115-066821-00	7.4.1 N2O cylinder supply test. Observe whether the N2O cylinder pressure is displayed on the small display.	/
	Air cylinder yoke assembly (electronic monitoring) FRU	115-066822-00	7.4.3 Air cylinder supply test. Observe whether the air cylinder pressure is displayed on the small display.	/

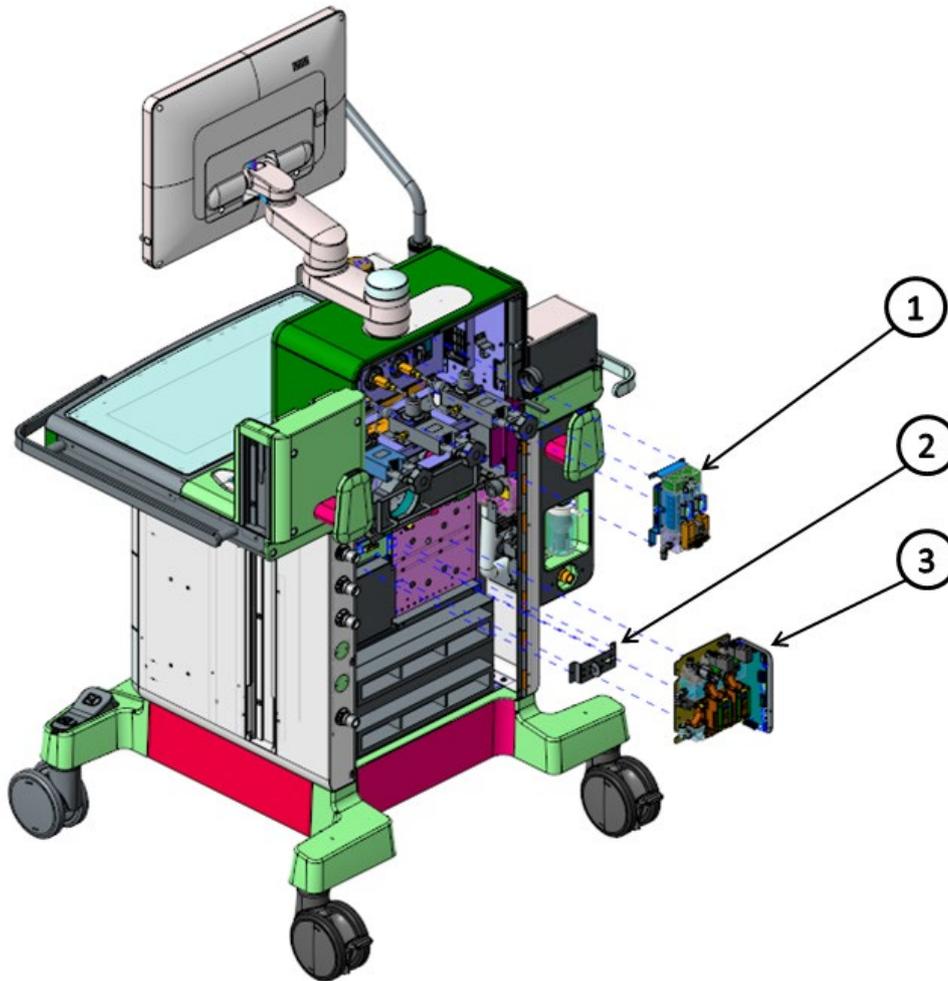
### 8.1.3 Auxiliary Output Flowmeter Assembly, High-Flow O2 Therapy Flowmeter Assembly, and System Switch Assembly



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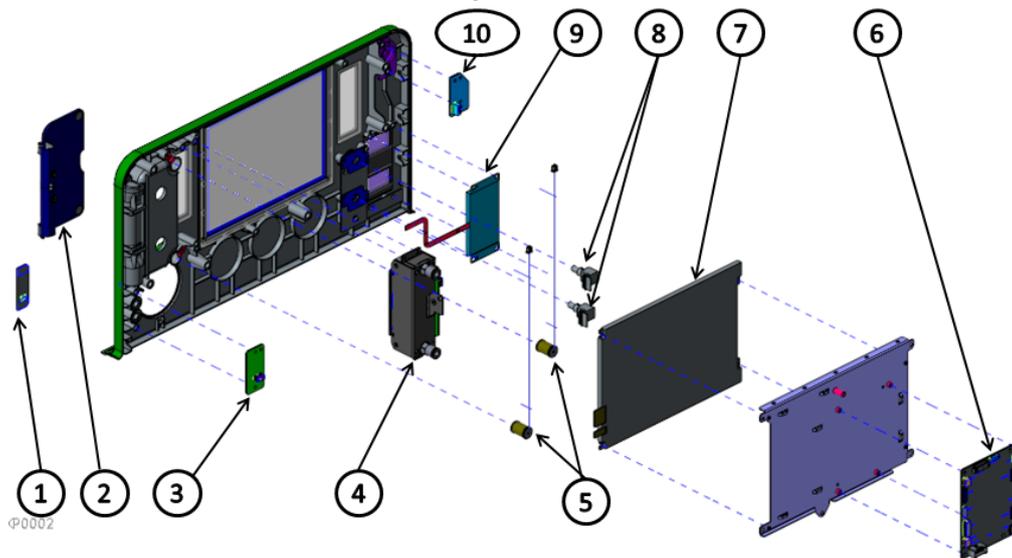
No.	Name	P/N	Test Item After Replacement	Remarks
1	Auxiliary output flowmeter assembly (0645)	115-065007-00	7.9.1 Auxiliary flowmeter test	/
	High-flow O2 therapy flowmeter assembly (0645)	115-065008-00	7.9.2 High-flow O2 supply test	/
2	System switch assembly (0645)	115-064077-00	7.2.1 System check	/

### 8.1.4 Auxiliary O2/Air Assembly, High-Flow O2 Supply Assembly, Anesthesia Calculation Inlet Pipeline Assembly, and EFCS Flowmeter Service Part



No.	Name	P/N	Test Item After Replacement	Remarks
1	Auxiliary O2/Air Assembly	115-064056-00	7.9.1 Auxiliary flowmeter test	/
	High-Flow O2 Supply Assembly	115-064118-00	7.9.2 High-flow O2 supply test	
2	Anesthesia calculation inlet pipeline assembly (0645)	115-065016-00	7.9.6 Internal AG module test	/
3	EFCS flowmeter FRU (O2/N2O/air)	115-066823-00	7.5 EFCS accuracy test 7.6 BFCS function test	/

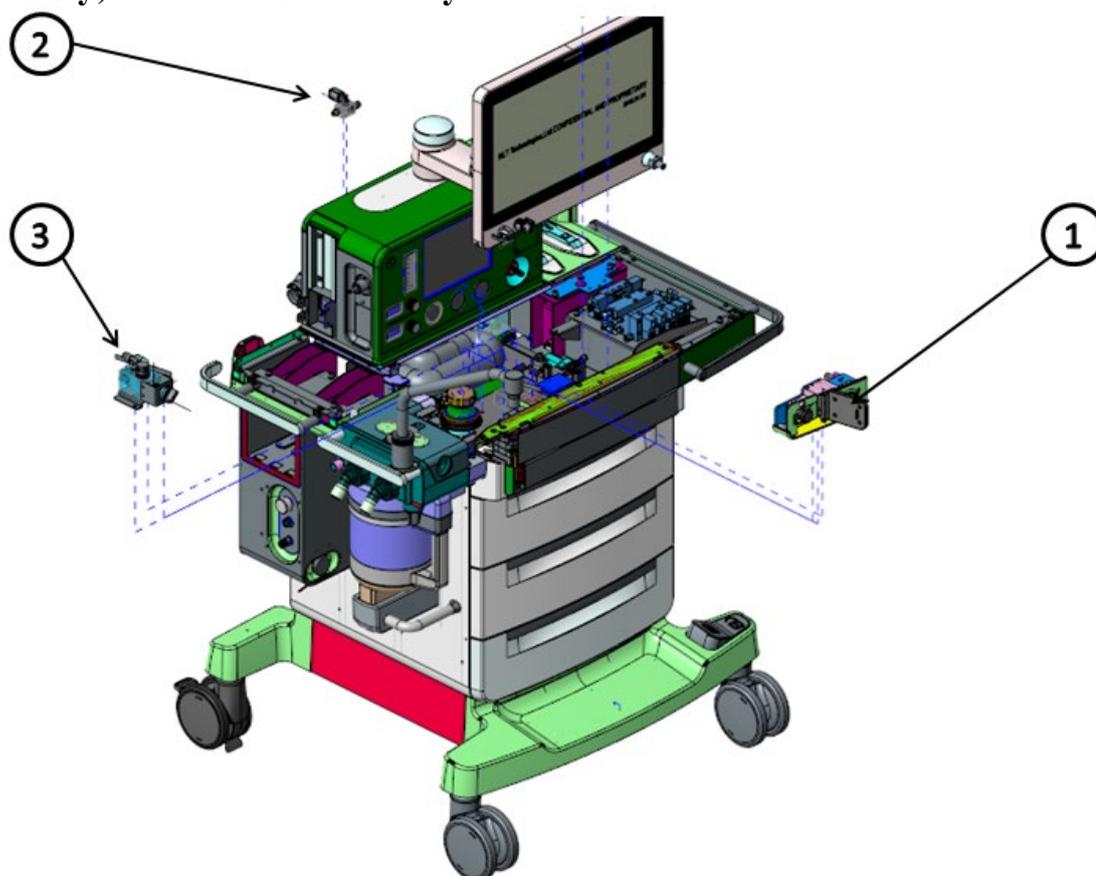
## 8.1.5 Instrument Panel Assembly



No.	Name	P/N	Test Item After Replacement	Remarks
1	BFCS switch control board PCBA (0645)	051-003212-00	7.6 BFCS function test	/
2	BFCS door service kit	115-066824-00	7.6 BFCS function test	Two springs are included.
3	Indicator light board PCBA (0625)	051-001934-00	7.1 Power-on self-test. Connect and disconnect the AC power supply in turn, and observe the status of the AC indicator and battery indicator.	/
4	Spare flowmeter assembly (0645)	115-065006-00	7.6.4 Basal flow test in the BFCS state 7.6.5 Accuracy confirmation test	/
5	Electromagnet	024-001089-00	7.6 BFCS function test	/
6	Display board PCBA (0645)	051-002986-00	7.1 Power-on self-test	/
7	Small-display service part	115-066860-00	7.1 Power-on self-test	/
8	Optical Encoder 24detent 5 VDC Cable	010-000257-00	7.1 Power-on self-test. Verify the functions of the rotary encoder.	The knob is included.
9	Segment LCD, I2C interface, 10-pin FPC	021-000481-00	Turn on the auxiliary O2/air module or high-flow O2 therapy module to check whether the segment LCD is on.	/
10	Spare flowmeter keyboard PCBA (0627)	051-002581-00	Turn on the auxiliary O2/air	/

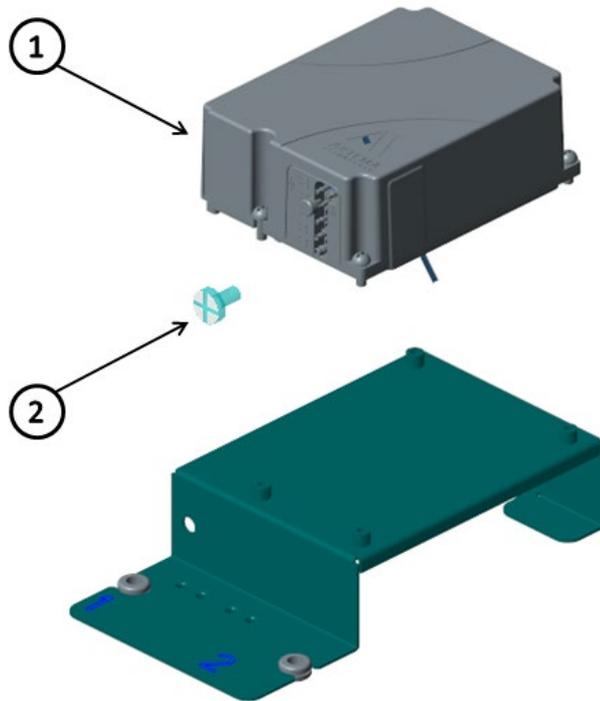
No.	Name	P/N	Test Item After Replacement	Remarks
			module or high-flow O2 therapy module to check whether the segment LCD is on.	

### 8.1.6 O2 Cell Door Cover Assembly, O2 Cell Calibration Valve Assembly, and ACGO Assembly



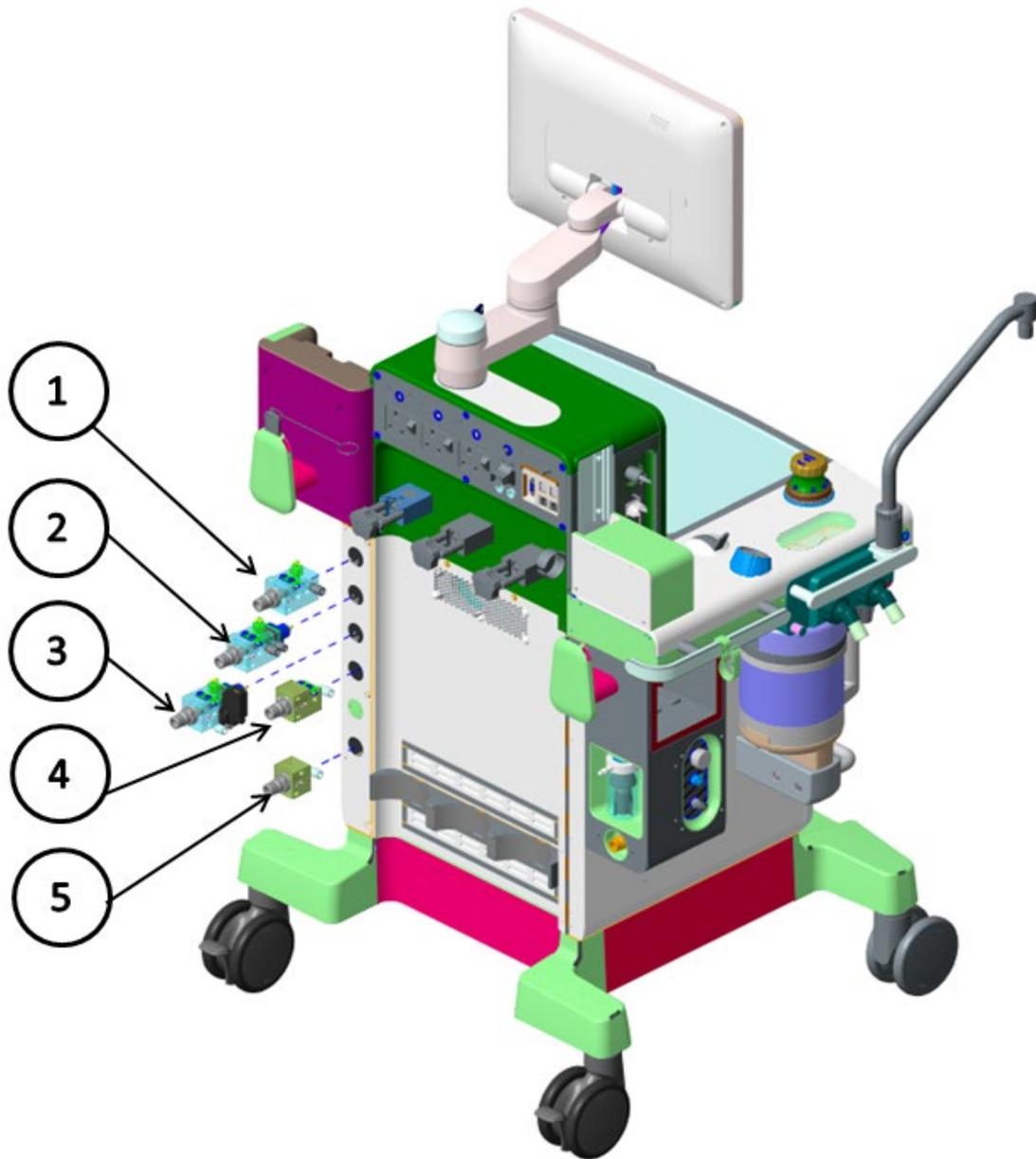
No.	Name	P/N	Test Item After Replacement	Remarks
1	O2 cell door cover assembly (0645, American standard) (The door can be opened.)	115-064805-00	/	/
	O2 cell door cover assembly (0645, European standard) (The door can be opened.)	115-064804-00	/	/
2	O2 Cell Calibration Valve Assembly	115-064094-00	7.2.1 System check	Install the O2 cell
3	ACGO assembly (0645)	115-064074-00	7.9.5 Mechanical ACGO function test	/

### 8.1.7 Built-in AG Assembly



No.	Name	P/N	Test Item After Replacement	Remarks
1	AION Argentum AG module (M01C)	115-039361-00	7.9.6 Internal AG module test	/
2	Air filter, filtering accuracy $\mu\text{m}$ , filtering efficiency $\geq 95\%$ , in compliance with GB8368	3001-10-07054	7.9.6 Internal AG module test	/

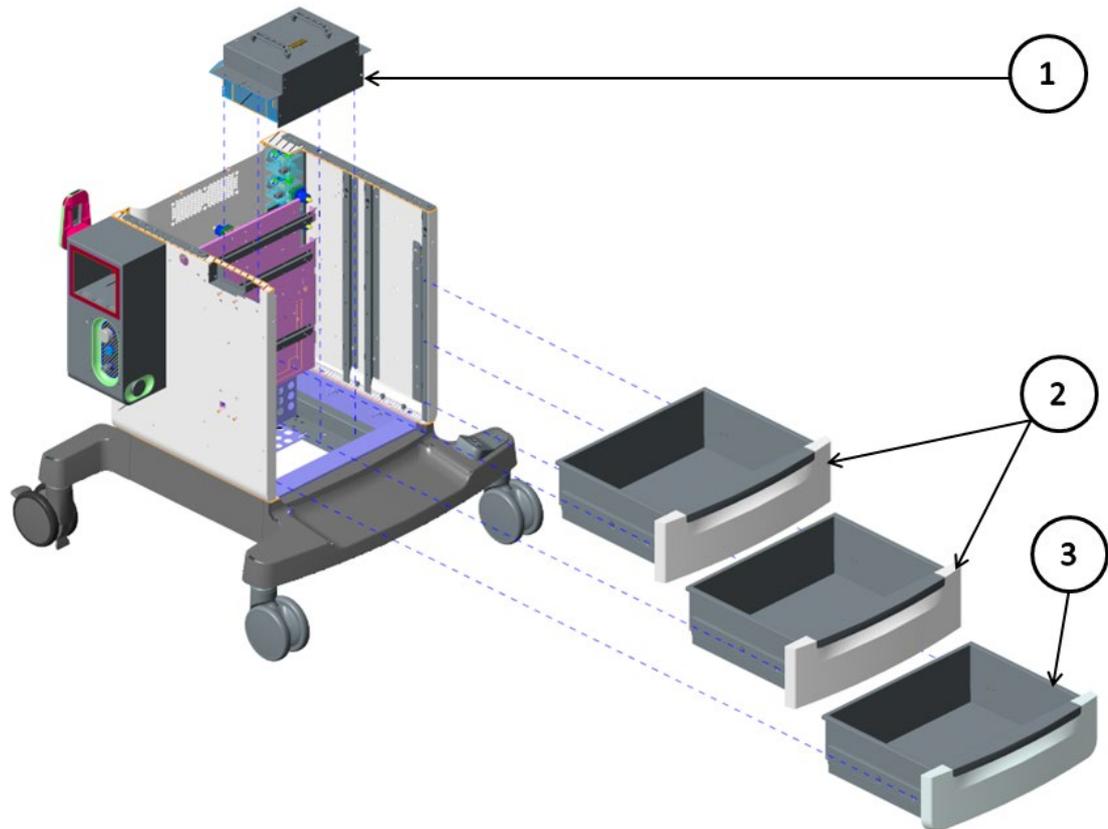
### 8.1.8 Gas Inlet Assembly



No.	Name	P/N	Test Item After Replacement	Remarks
1	N2O inlet assembly (0645/NIST)	115-064068-00	7.3.2 N2O supply test. Check whether the N2O pressure is displayed on the small display.	/
	N2O inlet assembly (0645/DISS)	115-064065-00	7.3.2 N2O supply test. Check whether the N2O pressure is displayed on the small display.	/
2	Air inlet assembly (0645/NIST)	115-064064-00	7.3.3 Air supply test.	/

No.	Name	P/N	Test Item After Replacement	Remarks
			Check whether the air pressure is displayed on the small display.	
	Air inlet assembly (0645/DISS)	115-064069-00	7.3.3 Air supply test. Check whether the air pressure is displayed on the small display.	/
3	O2 inlet assembly (0645/NIST)	115-064066-00	7.3.1 O2 supply test. Check whether the O2 pressure is displayed on the small display.	/
	O2 inlet assembly (0645/DISS)	115-064067-00	7.3.1 O2 supply test. Check whether the O2 pressure is displayed on the small display.	
4	Spare O2 supply assembly (DISS/electronic pressure monitoring)	115-064070-00	7.3.1 O2 supply test	/
	Spare O2 supply assembly (NIST/electronic pressure monitoring)	115-064071-00	7.3.1 O2 supply test	/
5	Pipeline negative pressure inlet assembly (0645/DISS)	115-064073-00	7.12.1 Pipeline negative pressure suction test	/
	Pipeline negative pressure inlet assembly (0645/NIST)	115-064072-00	7.12.1 Pipeline negative pressure suction test	/

## 8.1.9 Drawer and Battery Box Assemblies

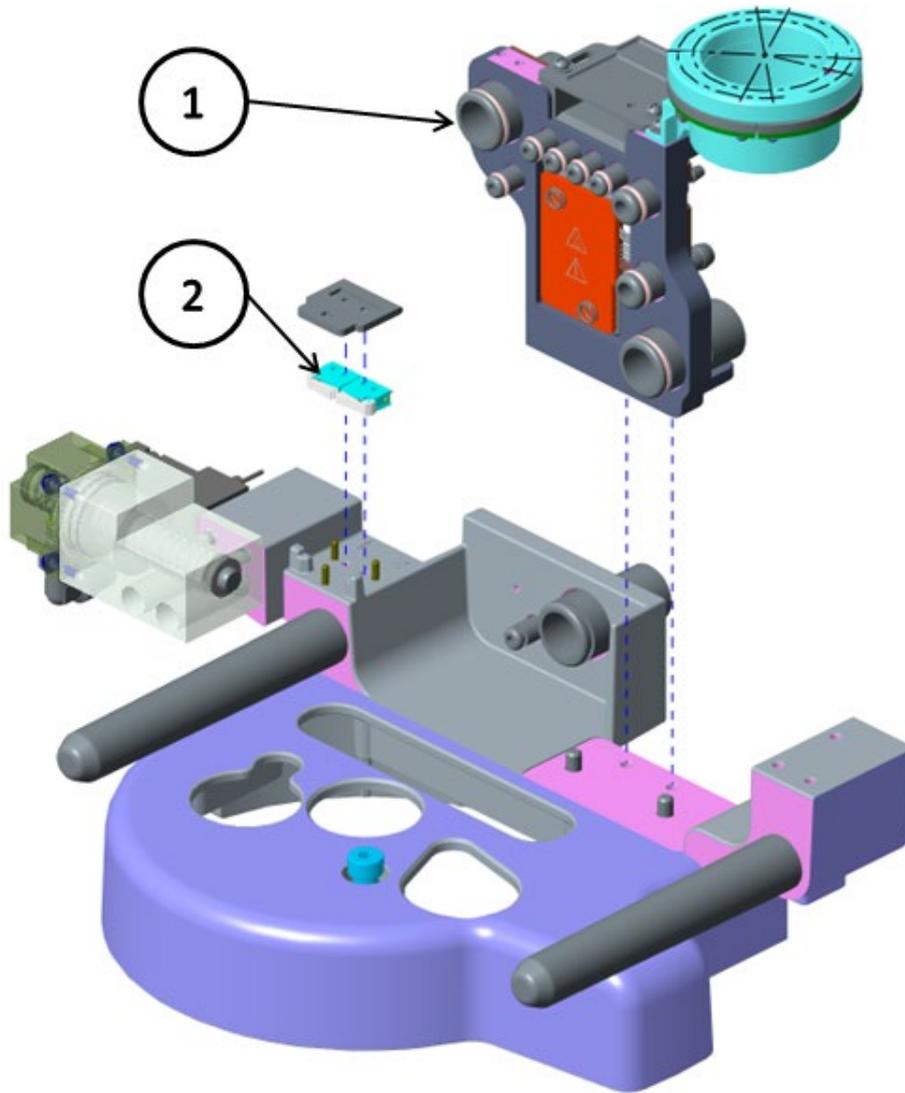


No.	Name	P/N	Test Item After Replacement	Remarks
1	Battery box assembly (two batteries)	115-066846-00	Power on the machine, access the diagnostic maintenance screen, choose <b>Data Monitors &gt; Power System</b> , and check the battery quantity and voltage.	/
	Battery box assembly (one battery)	115-066847-00	Power on the machine, access the diagnostic maintenance screen, choose <b>Data Monitors &gt; Power System</b> , and check the battery quantity and voltage.	/
2	Upper-middle drawer assembly service part	115-066841-00	/	The drawer assembly and the left and right rails on the cart are included.
3	Lower drawer assembly service part	115-066842-00	/	The drawer assembly and

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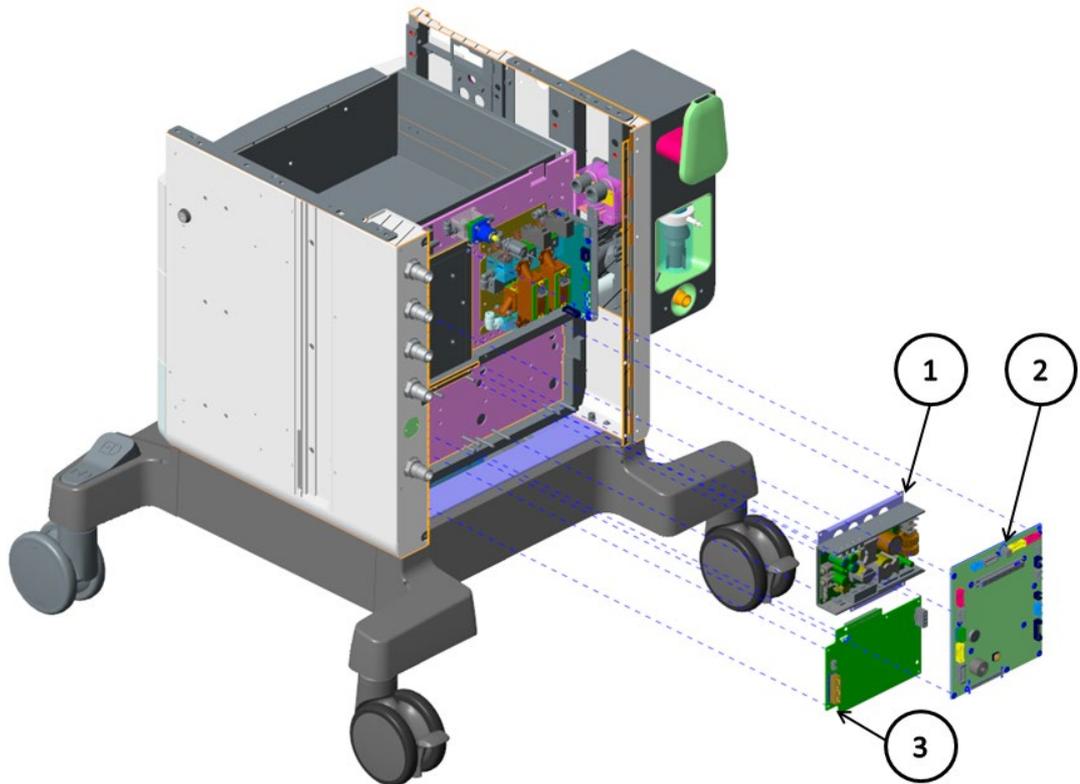
				the left and right rails on the cart are included.
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### 8.1.10 Circuit Adapter Block Assembly



No.	Name	P/N	Test Item After Replacement	Remarks
1	Circuit adapter block assembly (circuit connector adapter assembly)	115-066856-00	7.2.2 Leak test	
2	Auto/manual position detection switch	009-008835-00	7.10.3 Auto/manual switch test	Cables are included.

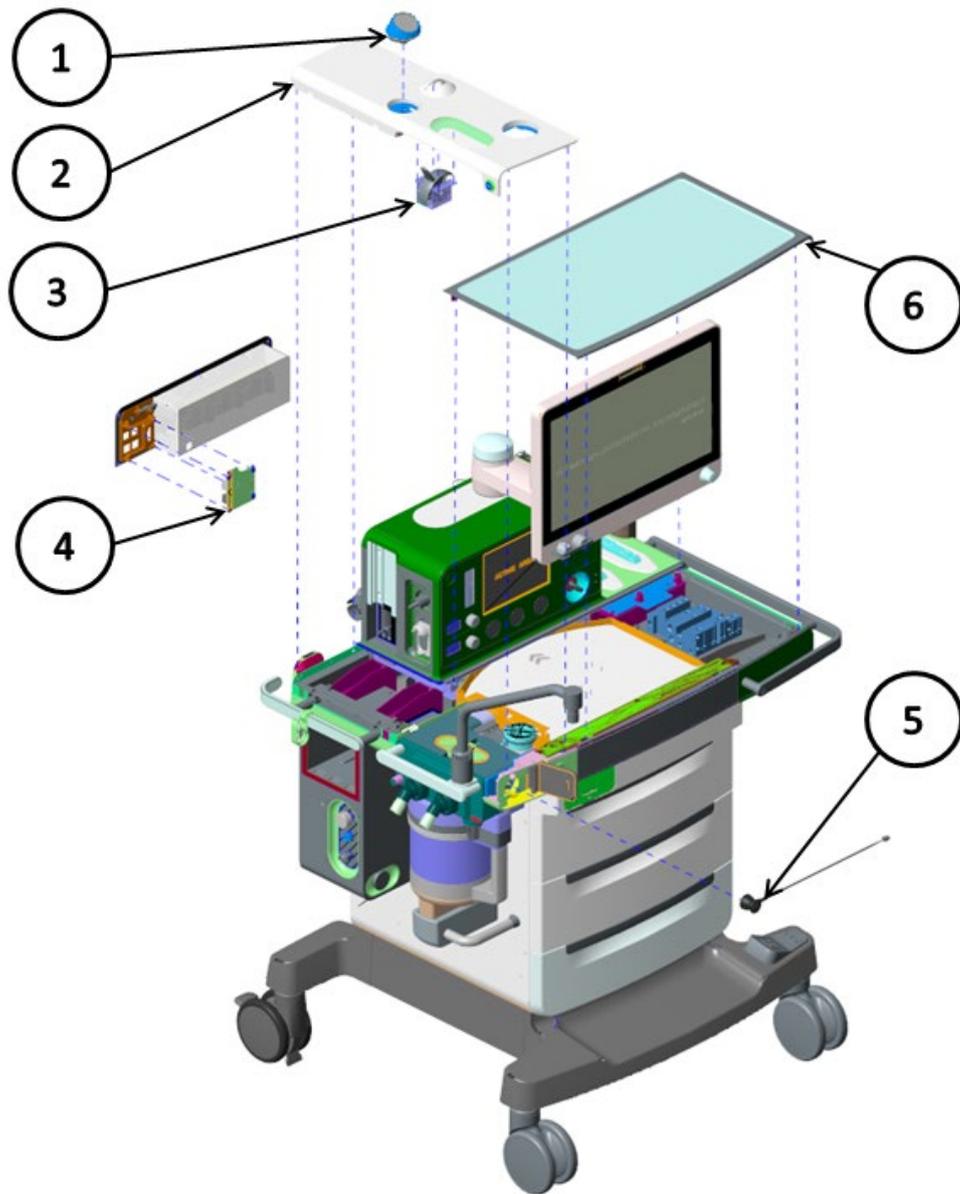
### 8.1.11 Boards



No.	Name	P/N	Test Item After Replacement	Remarks
1	AC-DC board (0645) (A8)	115-066844-00	7.1Power-on self-test	The cable from the AC-DC board to the DC-DC board is included.
	AC-DC board (0645) (A9)	115-066845-00	7.1Power-on self-test	The cable from the AC-DC board to the DC-DC board is included.
2	Motherboard service part	051-003203-00	7.1Power-on self-test	/
3	DC-DC board (0645) (A8)	051-003642-00	7.1Power-on self-test	/
	DC-DC board (0645) (A9)	051-003643-00	7.1Power-on self-test	/

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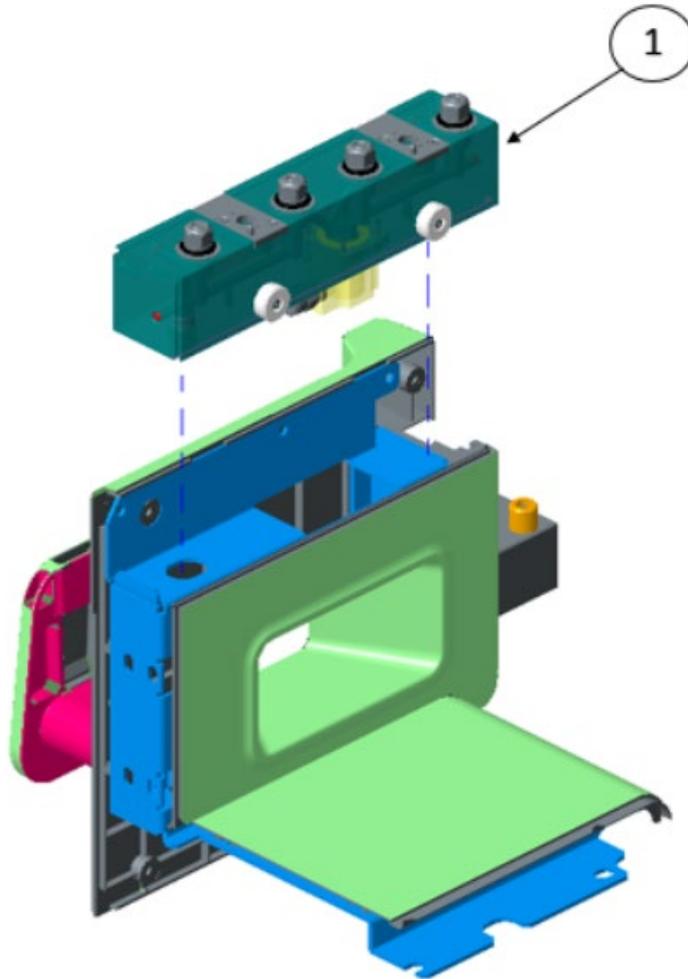
### 8.1.12 Work Surface and Left Cover Plate



No.	Name	P/N	Test Item After Replacement	Remarks
1	Airway pressure gauge	082-003308-00	7.2.2 Leak test	/
2	Upper-left cover plate FRU	115-066828-00	/	The pressure gauge is removed from the left cover plate, and there is no auto/manual switch.
3	Auto/manual switch assembly (0645)	115-064076-00	7.2.2 Leak test	/
4	I/O interface board	051-003189-00	Check whether the network, USB, and DB9 ports are available.	/
5	O2 cell cable (0645)	009-009627-00	Check whether the O2 cell is properly connected.	/
6	Work surface cover plate FRU	115-066843-00	/	Two waterproof seals are included.

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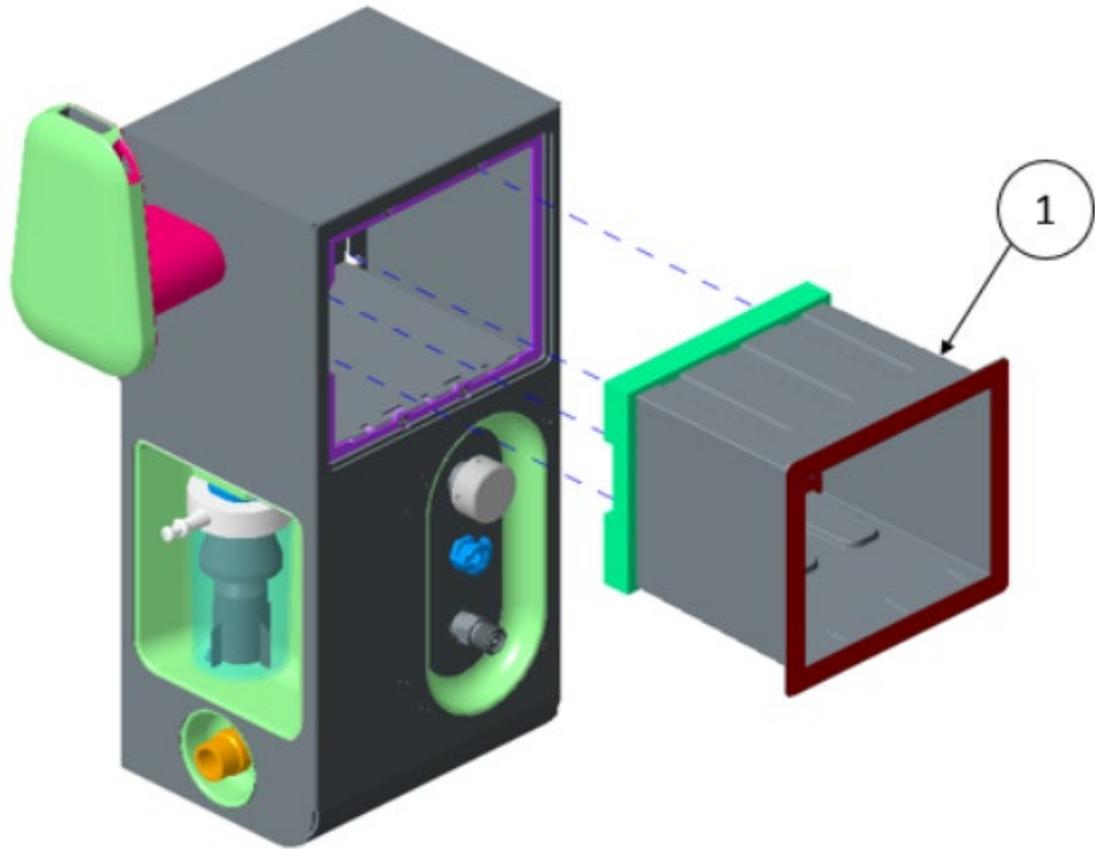
### 8.1.13 Mechanical Vaporizer Subsystem



No.	Name	P/N	Test Item After Replacement	Remarks
1	Vaporizer manifold assembly (0645/mechanical)	115-064121-00	7.8.1 Vaporizer interlock assembly 7.8.4 Vaporizer leak test	/

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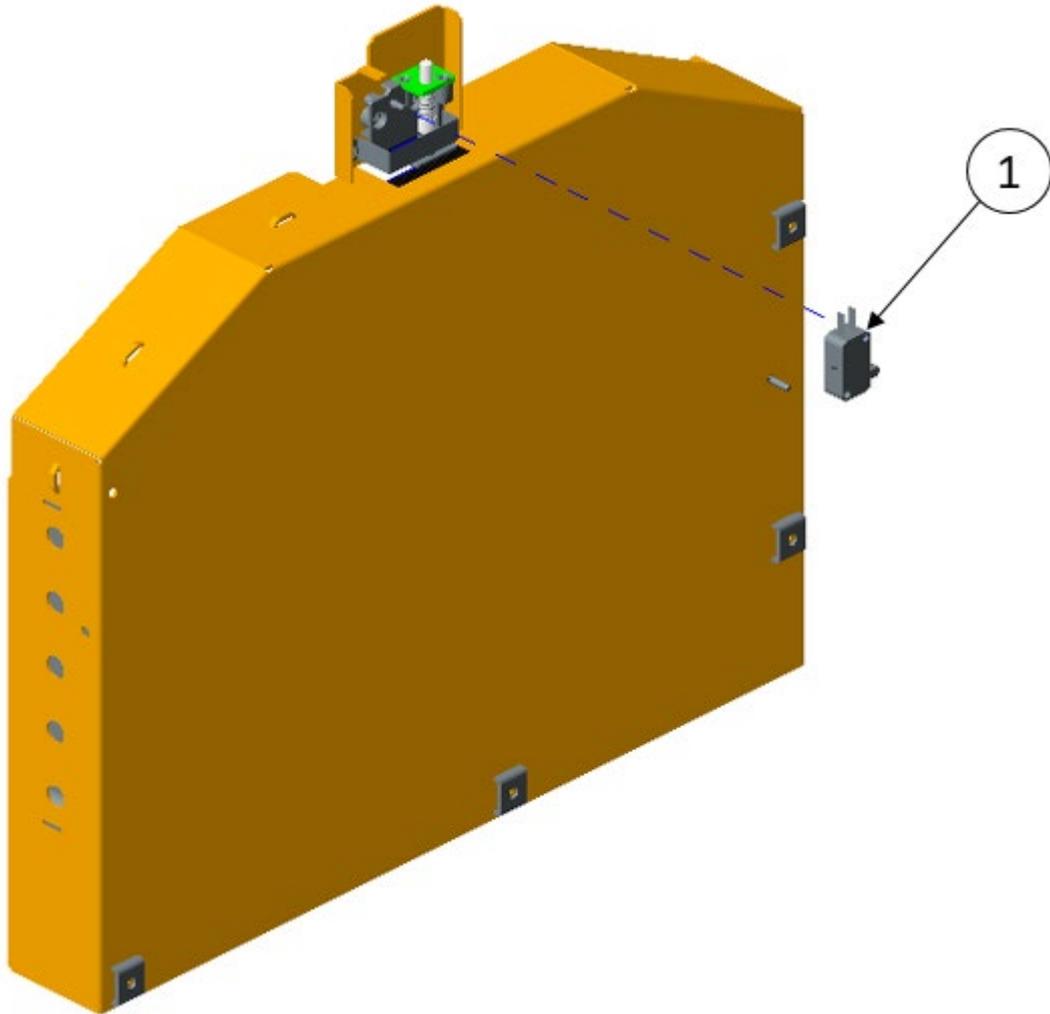
### 8.1.14 AGSS Assembly



No.	Name	P/N	Test Item After Replacement	Remarks
1	Module rack assembly (0645)	115-065010-00	Connect gas modules to the three slots to check whether the gas modules work properly.	The infrared communication board is included.

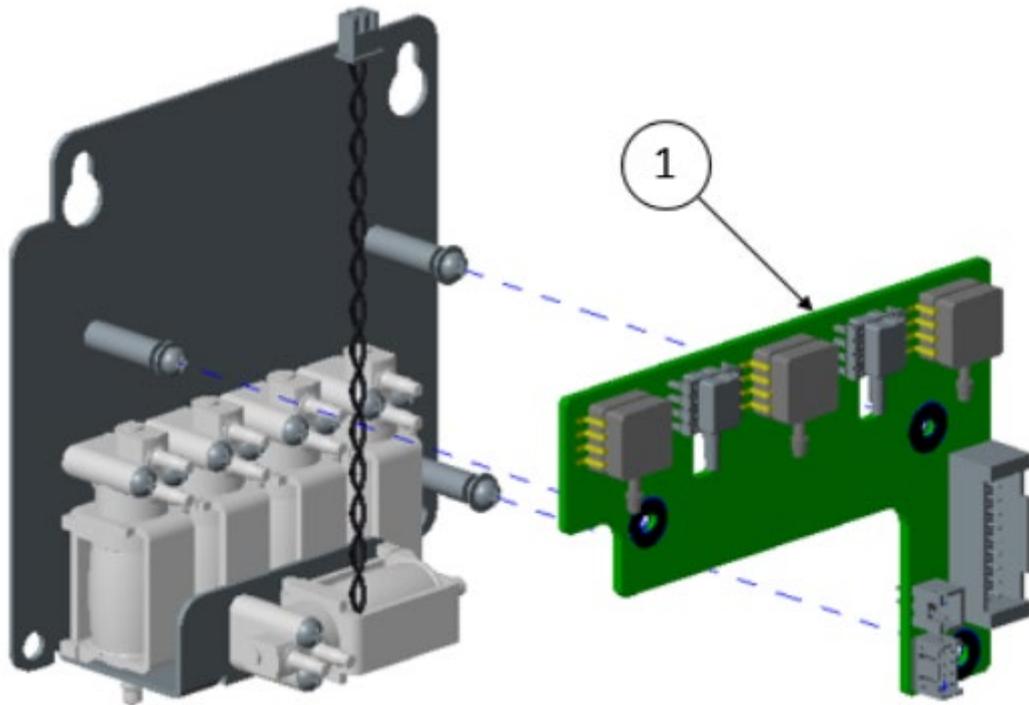
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### 8.1.15 VE Mounting Box Assembly

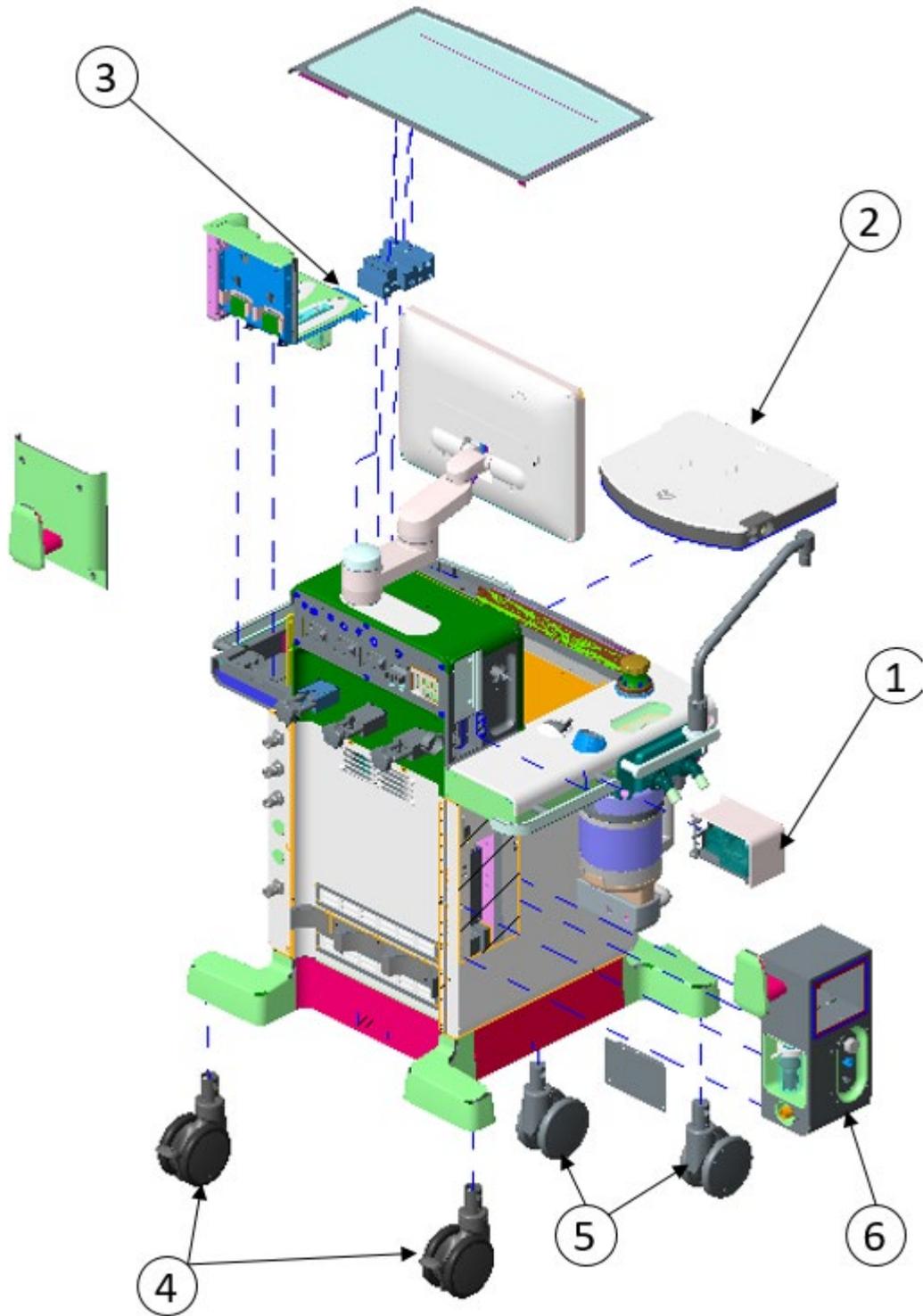


No.	Name	P/N	Test Item After Replacement	Remarks
1	SWITCH, small-stroke, caster-type, 200 gf	M07-00010S-00	7.13.3 "Volume Exchanger Not Installed" alarm test	VE mounting box in-position switch

### 8.1.16 Sensor Adapter Board PCBA (0645)



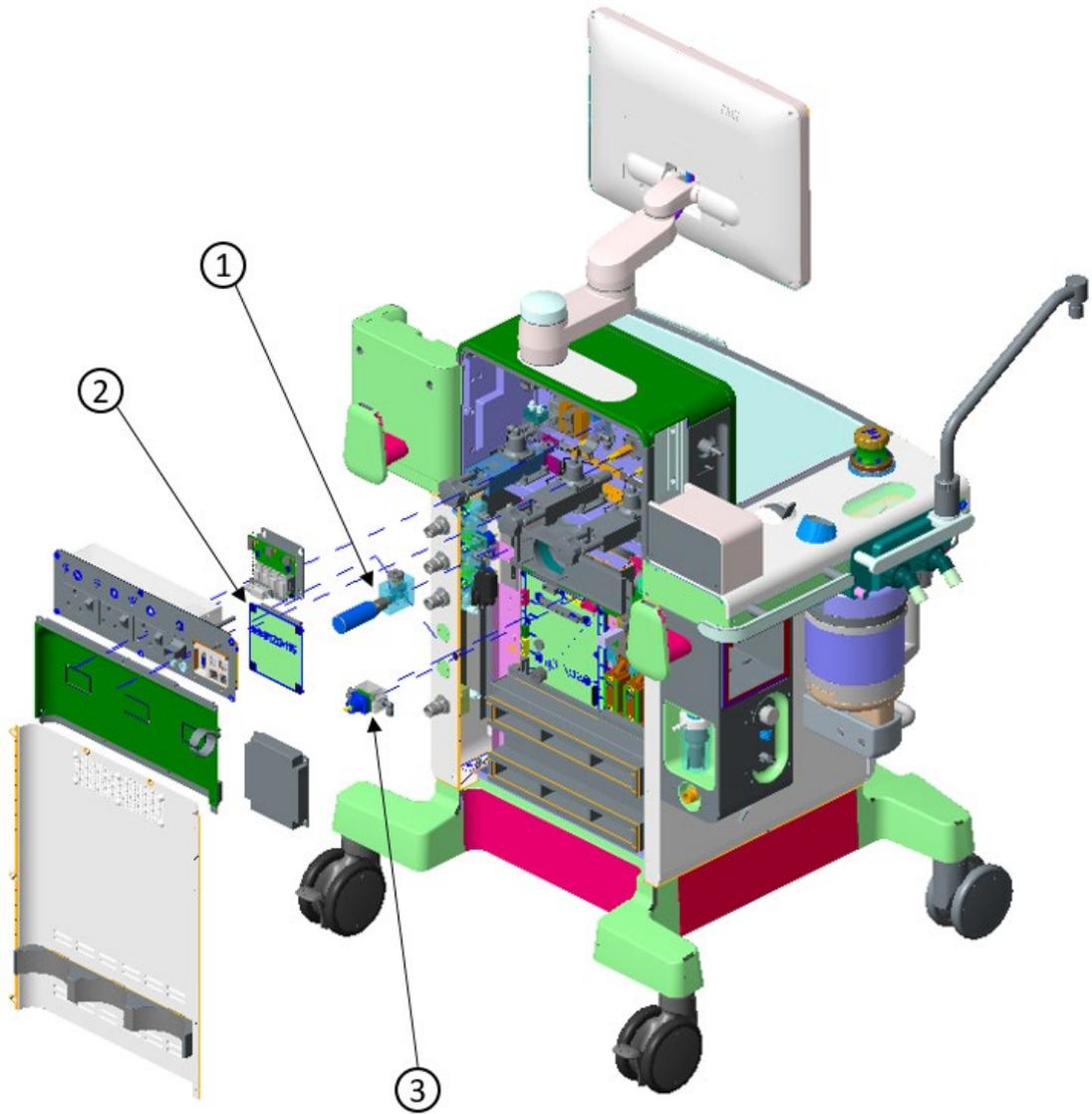
No.	Name	P/N	Test Item After Replacement	Remarks
1	Sensor adapter board PCBA (0645)	051-003214-00	Perform 10.3.1 flow calibration and 10.3.6 pressure calibration first. 7.14 System ventilation performance test 7.15 Sensor zero point check	/
	Sensor adapter board PCBA (0645) (without intrapulmonary pressure)	051-003775-00	Perform 10.3.1 flow calibration and 10.3.6 pressure calibration first. 7.14 System ventilation performance test 7.15 Sensor zero point check	/



No.	Name	P/N	Test Item After Replacement	Remarks
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1	Negative pressure control panel assembly (0645/pipeline/English)	115-064062-00	7.12.1 Pipeline negative pressure suction test	/
	Negative pressure control panel assembly (0645/Venturi/English)	115-065013-00	7.12.2 Venturi negative pressure suction test	/
2	Volume exchanger assembly FRU	115-066855-00	7.2.2 Leak test	/
3	Electronic vaporizer base assembly FRU	115-066850-00	7.2.2 Leak test	/
4	STEINCO 5-inch standalone brake caster	034-000670-00	Check the braking function of the caster, and try to move the device	/
5	STEINCO 5-inch central control caster	034-000669-00	Check the braking function of the caster, and try to move the device	/
6	Active AGSS assembly (low flow/without high-pressure O2/with negative pressure)	115-066829-00	7.11 Active AGSS check	/
	Active AGSS assembly (low flow/without high-pressure O2/without negative pressure)	115-066830-00	7.11 Active AGSS check	/
	Active AGSS assembly (high flow/without high-pressure O2/with negative pressure)	115-066831-00	7.11 Active AGSS check	/
	Active AGSS assembly (high flow/without high-pressure O2/without negative pressure)	115-066832-00	7.11 Active AGSS check	/
	Passive AGSS assembly (without high-pressure O2/with negative pressure)	115-066833-00	/	/
	Passive AGSS assembly (without high-pressure O2/without negative pressure)	115-066834-00	/	/
	Active AGSS assembly (low flow/with high-pressure O2/with negative pressure)	115-066835-00	7.11 Active AGSS check	/
	Active AGSS assembly (low flow/with high-pressure O2/without negative pressure)	115-066836-00	7.11 Active AGSS check	/
	Active AGSS assembly (high flow/with high-pressure O2/with negative pressure)	115-066837-00	7.11 Active AGSS check	/
	Active AGSS assembly (high flow/with high-pressure O2/without negative pressure)	115-066838-00	7.11 Active AGSS check	/

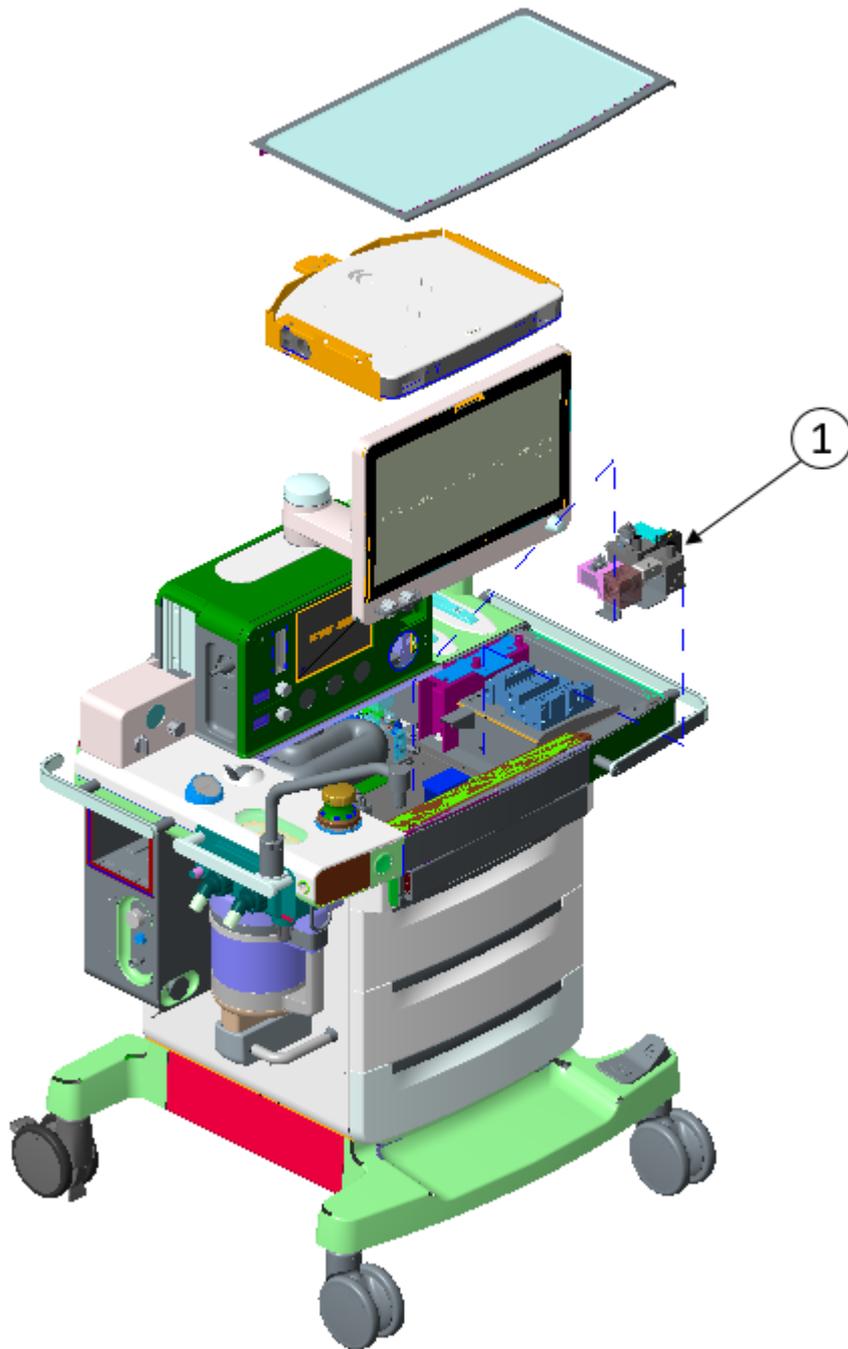
Passive AGSS assembly (with high-pressure O2/with negative pressure)	115-066861-00	/	
Passive AGSS assembly (with high-pressure O2/without negative pressure)	115-066862-00	/	



No.	Name	P/N	Test Item After Replacement	Remarks
1	Negative pressure generator (0645/Venturi)	115-064120-00	7.12.2 Venturi negative pressure suction test	/
2	VCM FRU (with ACGO/with auxiliary pressure)	115-066826-00	10.3.1 Flow calibration 10.3.6 Pressure calibration 10.3.2 O2 sensor calibration 7.2 System check 7.11 Active AGSS check 7.14 System ventilation Performance	/
	VCM FRU (with ACGO/without auxiliary pressure)	115-066827-00	10.3.1 Flow calibration 10.3.6 Pressure calibration 10.3.2 O2 sensor calibration 7.2 System check 7.11 Active AGSS check 7.14 System ventilation Performance	/
3	Pressure regulator assembly (0645)	115-064092-00	7.7.1 Vaporizer monitoring function test	This assembly is applicable to A9. It is used to monitor the drive gas pressure.

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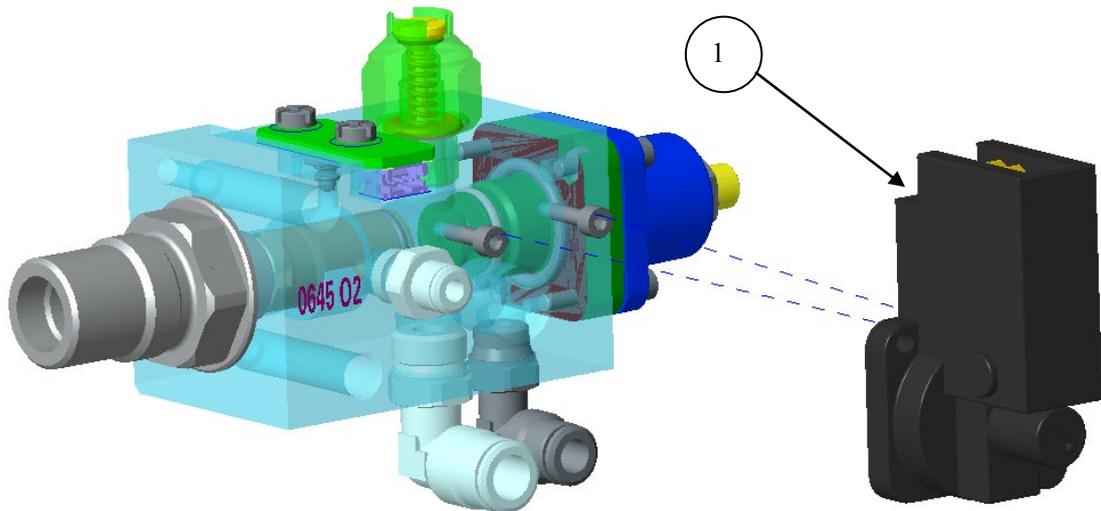
### 8.1.17 Inspiratory Valve Assembly



No.	Name	P/N	Test Item After Replacement	Remarks
1	Inspiratory valve assembly FRU	115-066825-00	10.3.6 Pressure calculation 7.2.1 System check 7.2.2 Leak test 7.14.2 VCV adult ventilation mode test 7.14.3 VCV child ventilation mode test 7.14.4 PCV adult ventilation mode test	/

## 8.2 Gas Supply Subsystem

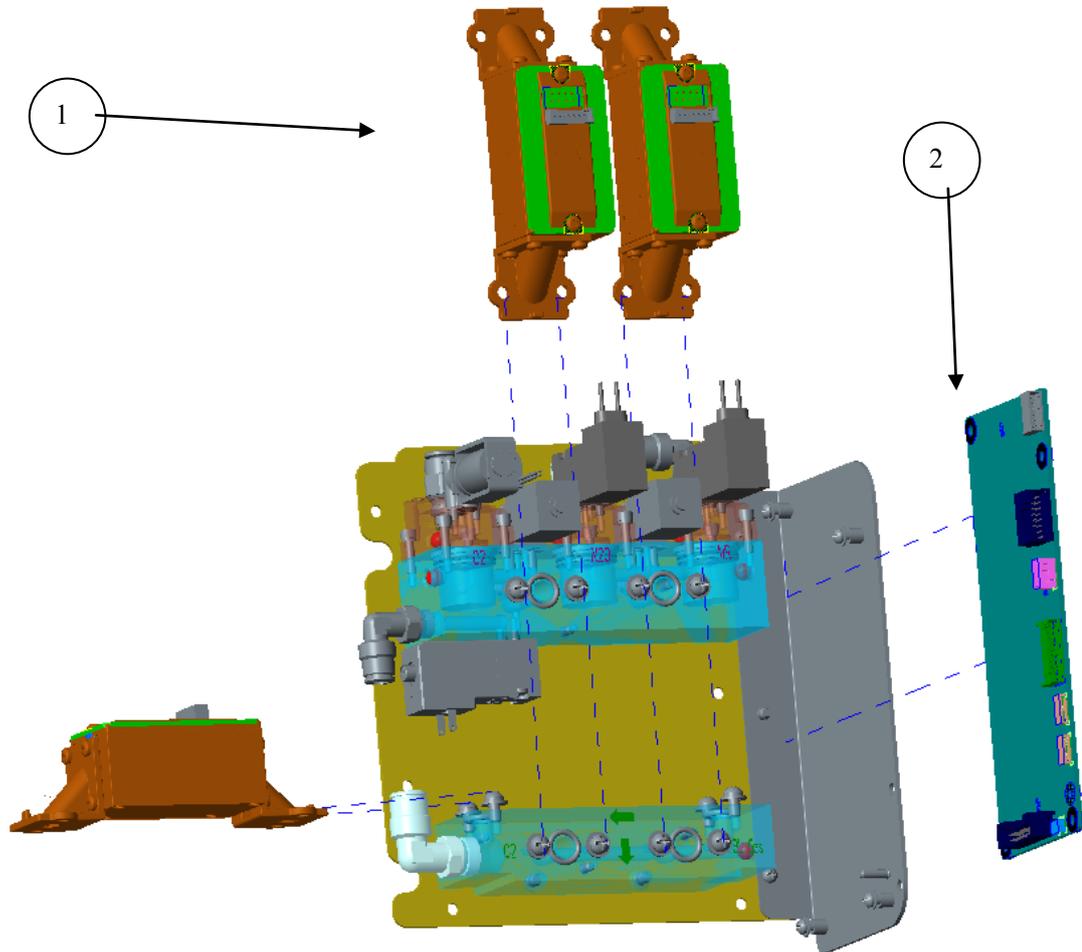
### 8.2.1 O2 Inlet Assembly



No.	Name	P/N	Test Item After Replacement	Remarks
1	Pressure switch (gas inlet)	M07-00126S	7.3.1 O2 supply test	/

## 8.3 Flowmeter Subsystem

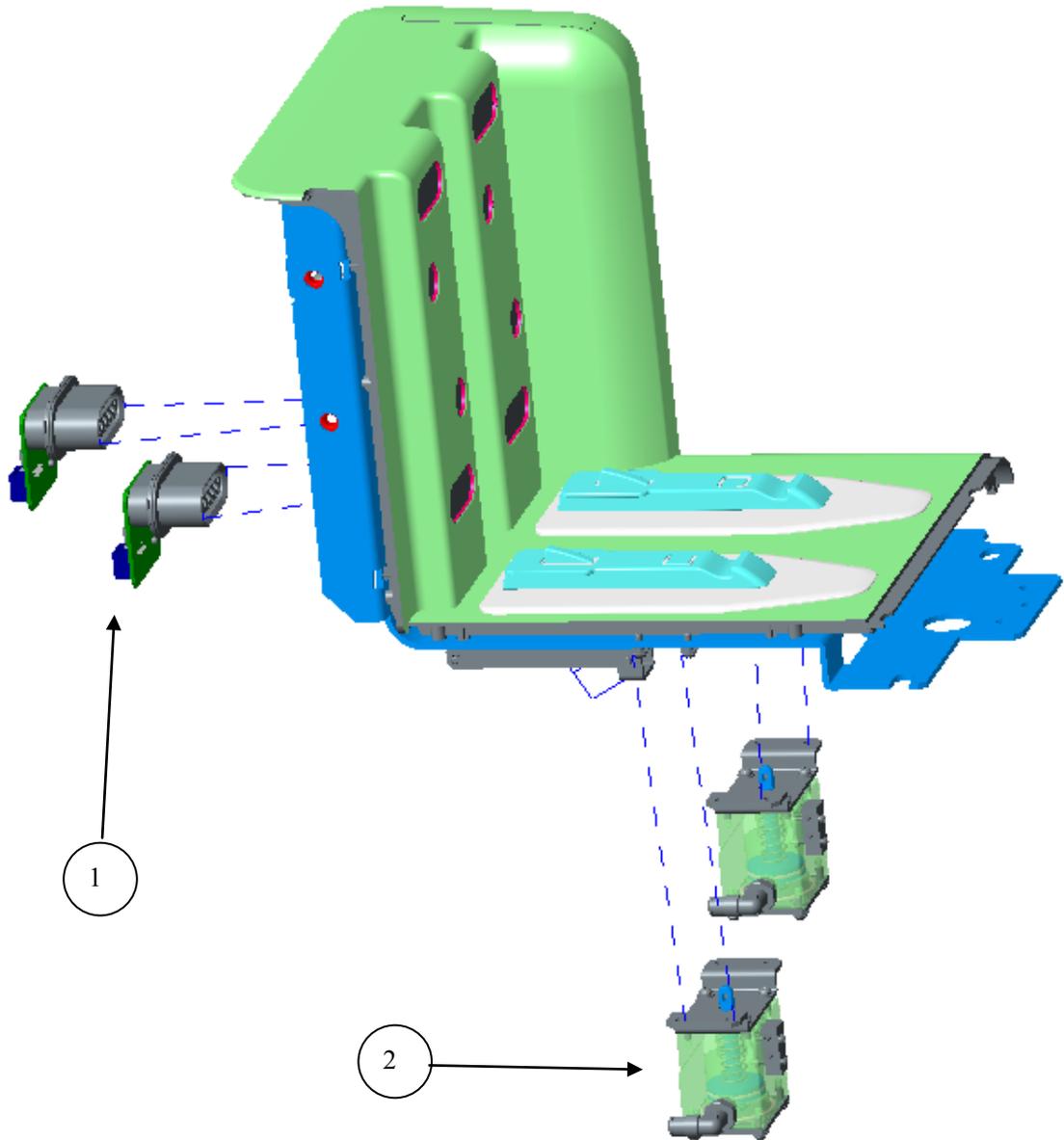
### 8.3.1 EFCS Assembly



No.	Name	P/N	Test Item After Replacement	Remarks
1	EFCS flowmeter flow sensor	051-002721-00	10.3.9 Total flow sensor calibration 7.5 EFCS accuracy test	/
2	EFCS flowmeter monitoring board PCBA (0645)	051-003204-00	10.3.9 Total flow sensor calibration test 7.5 EFCS accuracy test 7.6 BFCS function test	/

## 8.4 Vaporizer Subsystem

### 8.4.1 Electronic Vaporizer Base

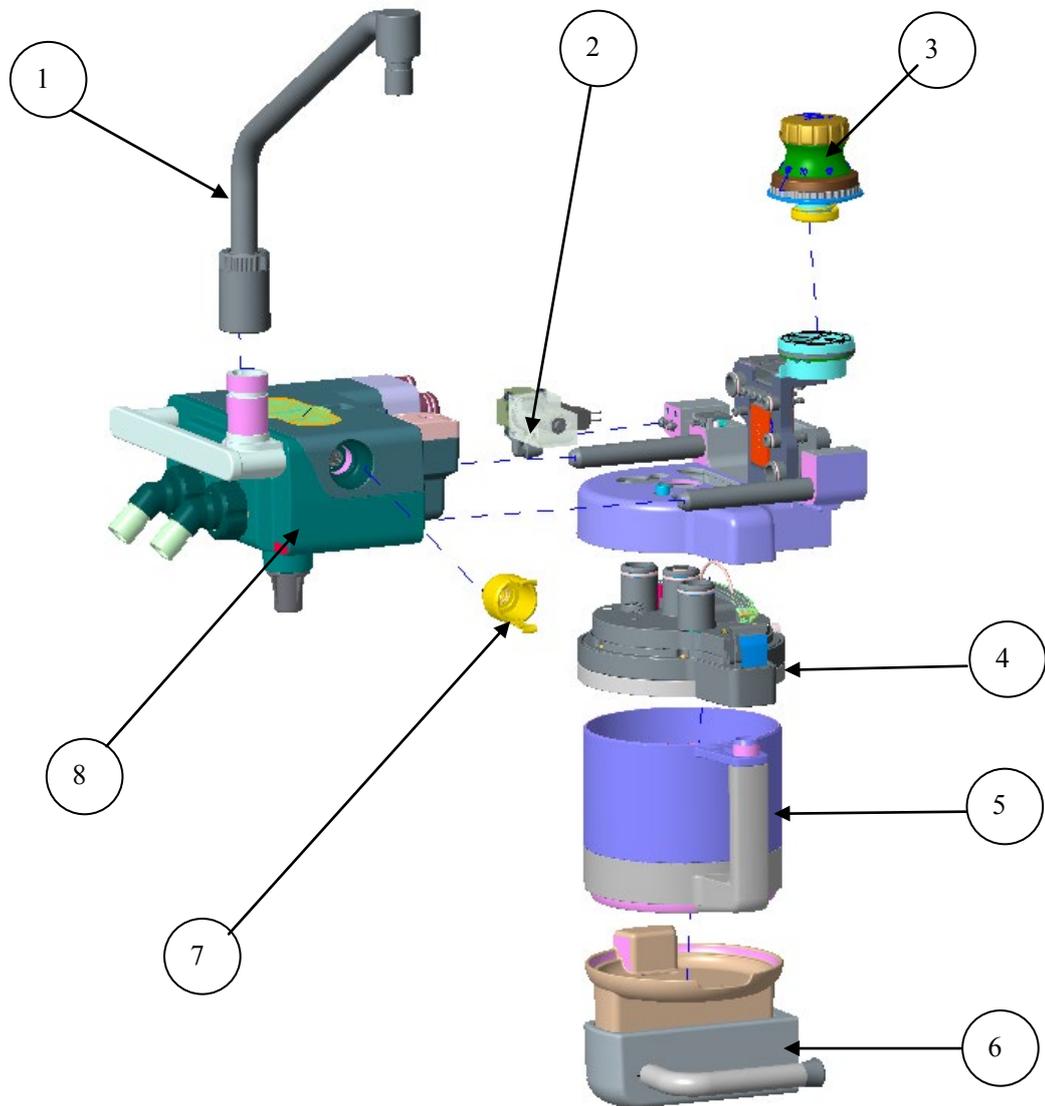


No.	Name	P/N	Test Item After Replacement	Remarks
1	Electronic vaporizer base interface board PCBA (0645)	051-003280-00	7.7 Electronic vaporizer test	/
2	Pneumatically-controlled lock assembly	115-064346-00	7.7.2 Vaporizer self-locking test	/

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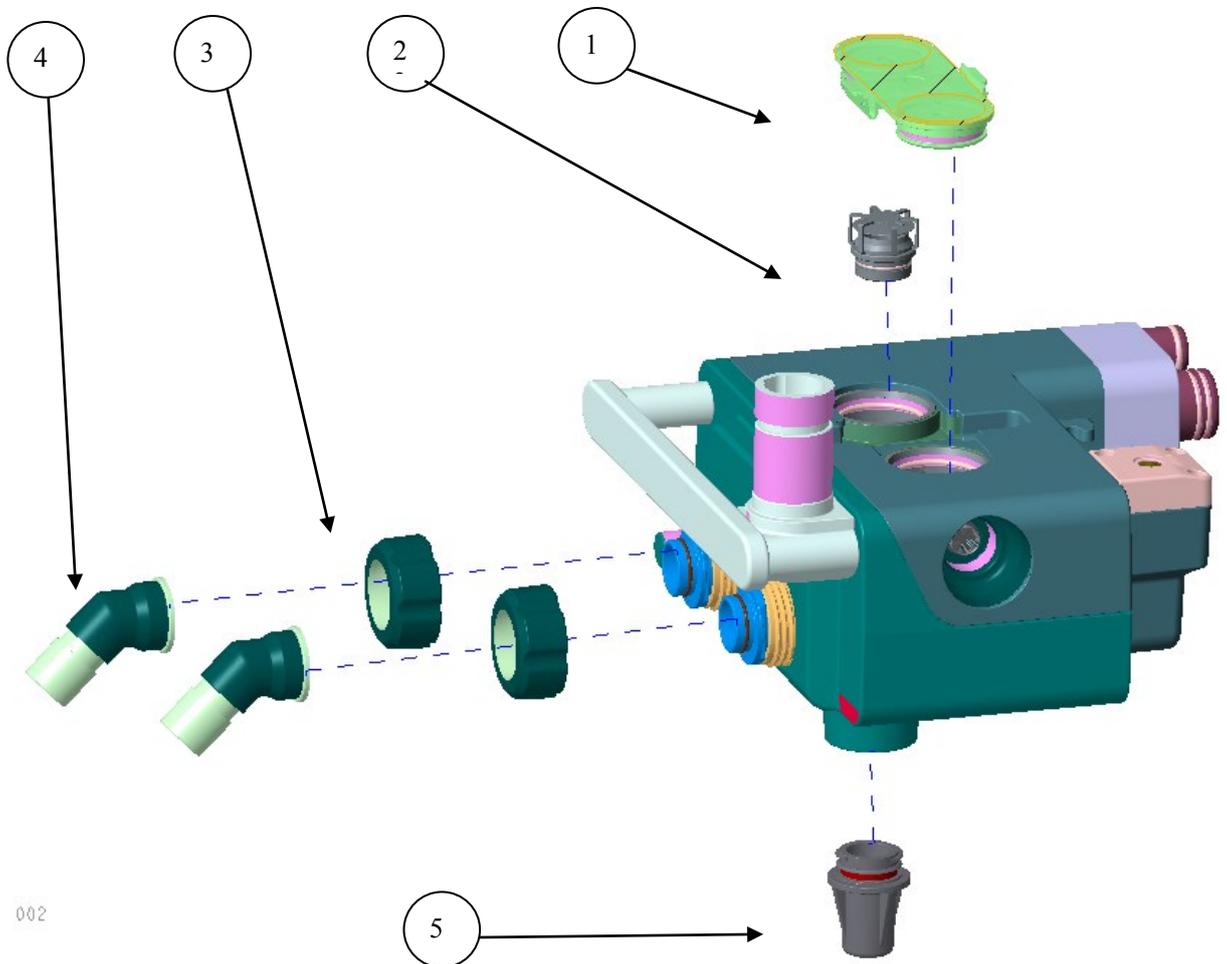
## 8.5 Breathing Circuit Subsystem

### 8.5.1 Patient Circuit Material Package



No.	Name	P/N	Test Item After Replacement	Remarks
1	Bag arm assembly (new silkscreen)	115-047846-00	7.2.2 Leak test	/
2	Auto/manual valve	115-064186-00	7.2.2 Leak test	/
3	APL valve assembly (0645)	115-064061-00	7.10.2 APL valve test 7.2.2 Leak test	/
4	Bypass assembly (0645)	115-064182-00	7.2.2 Leak test	/
5	Sodalime absorber canister assembly (0645)	115-064183-00	7.2.2 Leak test	/
6	Poppet device assembly	115-064184-00	7.13.4 Absorber canister alarm test	/
7	O2 cell holder assembly	115-064181-00	7.2.2 Leak test	/
8	Patient circuit assembly (0645)	115-064177-00	7.2.2 Leak test	/

### 8.5.2 Patient circuit assembly

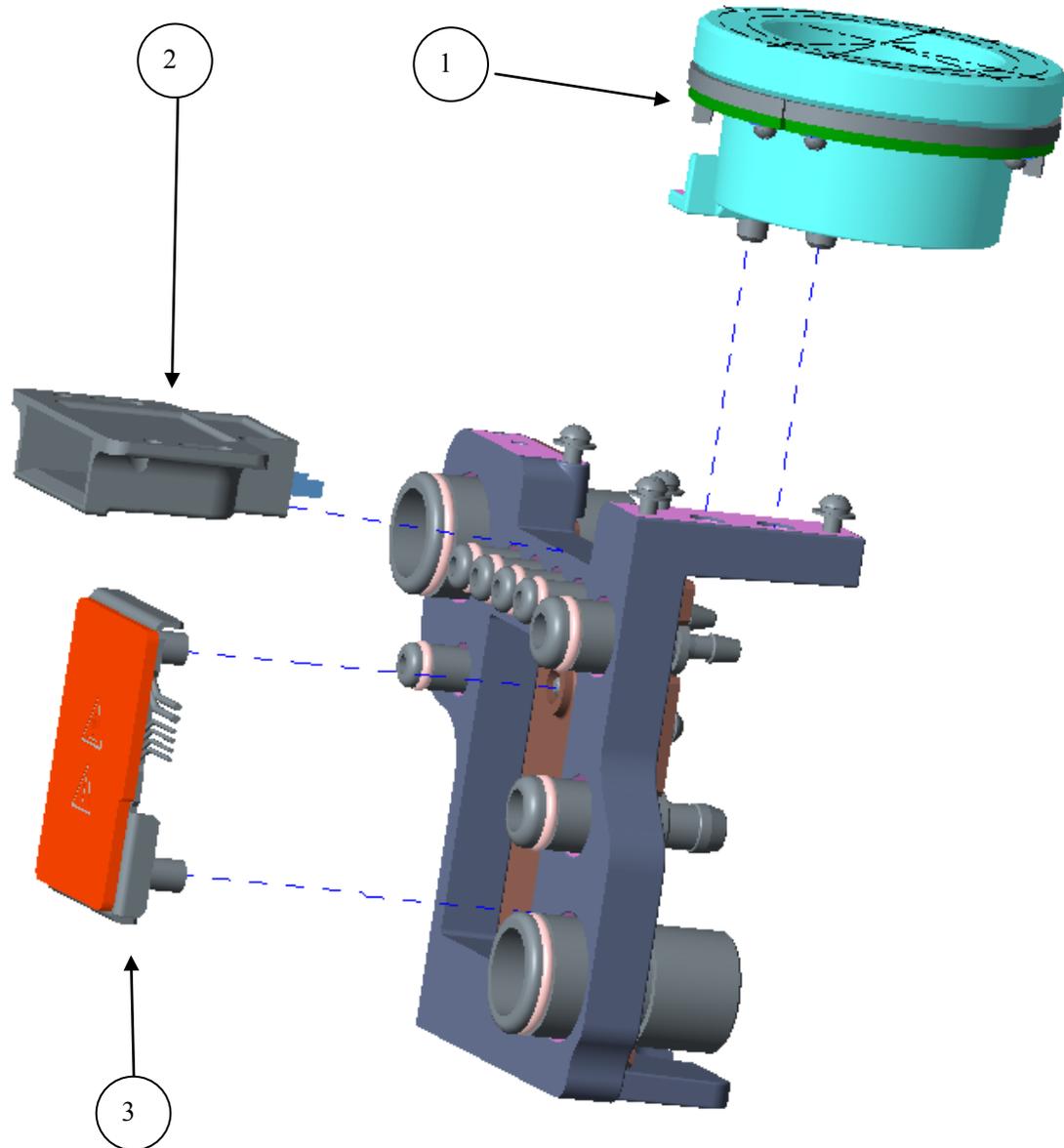


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No.	Name	P/N	Test Item After Replacement	Remarks
1	Valve cover	043-009522-00	7.2.2 Leak test	/
2	Check valve service part	115-066435-00	7.2.2 Leak test	/
3	Locking nuts of the inspiration and expiration connectors (0631)	043-001261-00	7.2.2 Leak test	/
4	Inspiration and expiration	043-001287-00	7.2.2 Leak test	/

	connectors			
5	Water collection cup	043-001281-00	7.2.2 Leak test	/

### 8.5.3 Circuit Connector Adapter Assembly



No.	Name	P/N	Test Item After Replacement	Remarks
1	APL valve mounting base assembly	115-064187-00	7.10.2 APL valve test	/
2	Circuit switch (hook lock)	115-066435-00	7.13.2 "Breathing Circuit Not Installed" alarm test	/
3	Circuit heater service part (0634)	024-001100-00	7.10.4 Patient circuit heating test	/

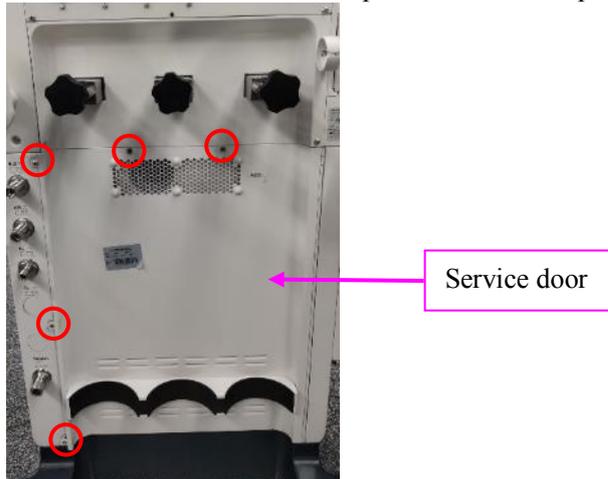
# 9 Repair and Disassembly

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## 9.1 Pre-disassembly (Disassemble Housings and Some System Parts)

### 9.1.1 Open the Service Door

Remove the five screws from the service door with the Phillips screwdriver to open the door.



### 9.1.2 Remove the Auxiliary Output Assembly

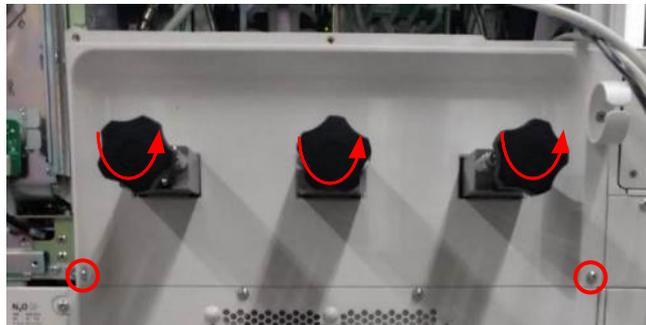
Remove the six screws from the auxiliary output assembly with the Phillips screwdriver to remove the assembly.



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### 9.1.3 Remove the Rear Cover Plate of the Work Surface

1. Turn the three pentagonal knobs on the cylinder yoke assembly counterclockwise to remove the knobs (if there is a cylinder yoke).
2. Remove the two screws from the rear cover plate of the work surface with the Phillips screwdriver to remove the rear cover plate.



### 9.1.4 Remove the Work Surface Cover Plate FRU

Loosen the four captive screws with the Phillips screwdriver, remove the two screws, and remove the work surface cover plate.



Work surface cover plate



One captive screw on the rear



Three captive screws on the bottom right



Open the front VE door and remove the two screws

### 9.1.5 Remove the Instrument Panel Assembly

1. Remove the five screws (marked by  $\circ$  in Figure A) from the instrument panel assembly and loosen the two captive screws (marked by  $\Delta$  in Figure A) with the Phillips screwdriver.
2. Open the BFCS door, remove the set screws fastening the air needle valve knob and O2 needle valve knob with the M3 hexagon screw spanner, and take out of the knobs, as shown in Figure B.
3. Disconnect the cables and pipelines from the instrument panel assembly and remove the assembly.

Figure A

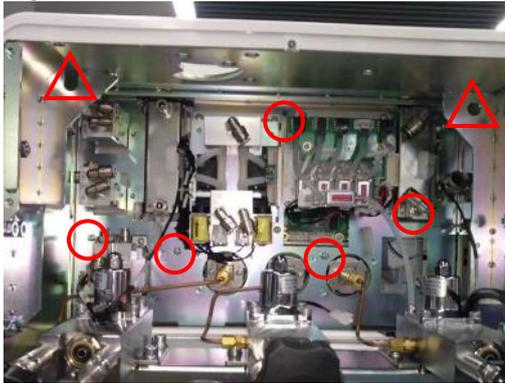


Figure B



Instrument panel assembly

BFCs door

### 9.1.6 Remove the Upper-Left Cover Plate

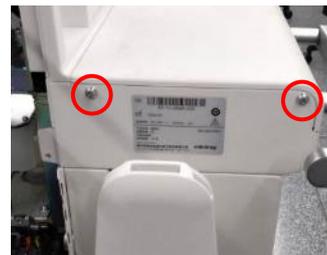
1. Remove the five screws from the upper-left cover plate with the Phillips screwdriver.
2. Disconnect the cables and pipelines from the upper-left cover plate assembly of the work surface and remove the assembly.



Two screws near the patient circuit



One screw under the O2 cell door



Two screws on the rear

### 9.1.7 Remove the Display Assembly

1. Remove the six screws (marked by  $\circ$  in Figure A) with the Phillips screwdriver to remove the rear cover plate of the display assembly.
2. Remove the four screws (marked by  $\circ$  in Figure B) fastening the cable with the Phillips screwdriver to remove the cable.
3. Pre-loosen the two screws (marked by  $\Delta$  in Figure B) with the Phillips screwdriver and turn them counterclockwise three or four rounds. Then remove the four screws (marked by  $\square$  in Figure B). Finally, vertically lift the display assembly up to remove it.

Figure A

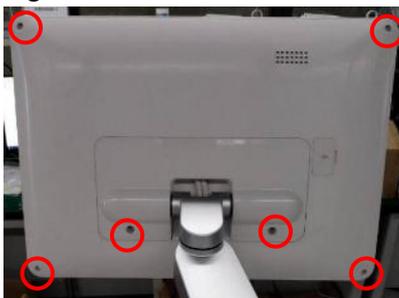
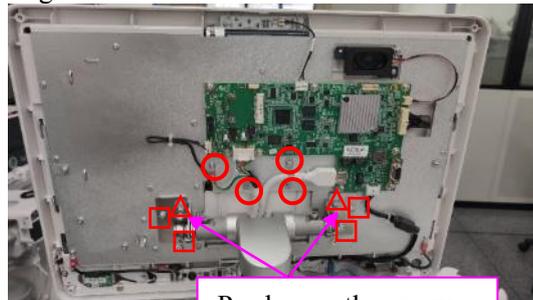


Figure B



Pre-loosen the screws

---

## 9.2 Disassemble the N2O, Air, and O2 Inlet Assemblies

### 9.2.1 Prepare for Disassembly

#### 9.2.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- M4 hexagon screw spanner
- Phillips screwdriver

#### 9.2.1.2 Preparations

Before disassembly,

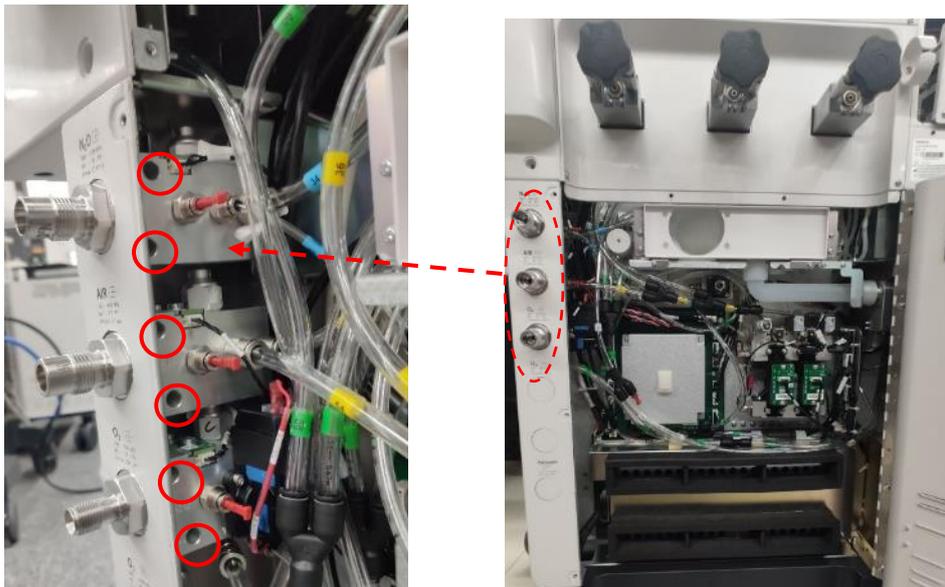
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.2.1.3 Pre-disassembly

Refer to *9.1.1 Open the Service Door* to open the service door.

### 9.2.2 Remove the N2O, Air, and O2 Inlet Assemblies

1. Remove the two screws fastening the corresponding gas inlet assembly with the M4 hexagon screw spanner (due to the space limitation, remove the N2O inlet assembly first during the disassembly).
2. Remove the corresponding gas inlet assembly.
3. Disconnect all pipelines and cables from the corresponding gas inlet assembly.



---

## 9.3 Disassemble the Spare O2 Supply Assembly

### 9.3.1 Prepare for Disassembly

#### 9.3.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- M4 hexagon screw spanner
- Phillips screwdriver

#### 9.3.1.2 Preparations

Before disassembly,

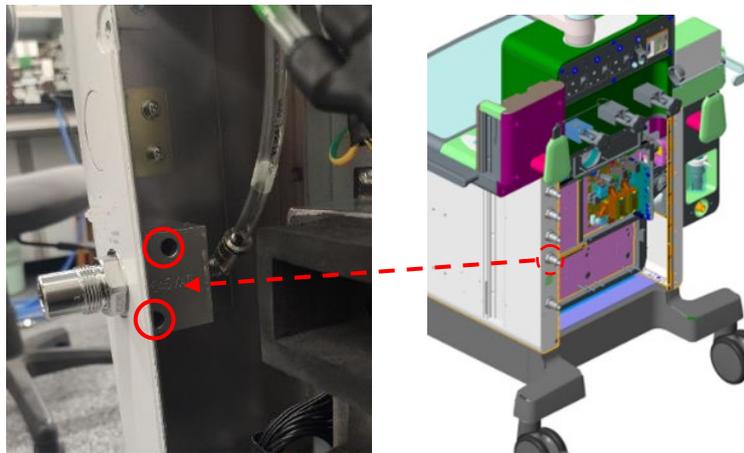
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.3.1.3 Pre-disassembly

Refer to *9.1.1 Open the Service Door* to open the service door.

### 9.3.2 Remove the Spare O2 Supply Assembly

1. Disconnect the pipeline from the spare O2 supply assembly.
2. Remove the two screws fastening the gas inlet assembly with the M4 hexagon screw spanner to remove the assembly.



---

## 9.4 Disassemble the Pipeline Negative Pressure Inlet Assembly

### 9.4.1 Prepare for Disassembly

#### 9.4.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- M4 hexagon screw spanner
- Phillips screwdriver

#### 9.4.1.2 Preparations

Before disassembly,

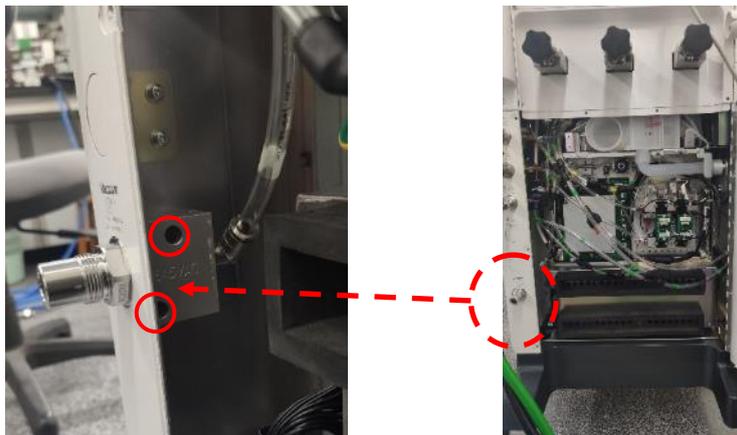
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.4.1.3 Pre-disassembly

Refer to *9.1.1 Open the Service Door* to open the service door.

### 9.4.2 Remove the Pipeline Negative Pressure Inlet Assembly

1. Disconnect the hose from the pipeline negative pressure inlet assembly.
2. Remove the two screws fastening the gas inlet assembly with the M4 hexagon screw spanner to remove the assembly.



---

## 9.5 Disassemble the Pressure Switch (Gas Inlet)

### 9.5.1 Prepare for Disassembly

#### 9.5.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- M3 and M4 hexagon screw spanners
- Phillips screwdriver

#### 9.5.1.2 Preparations

Before disassembly,

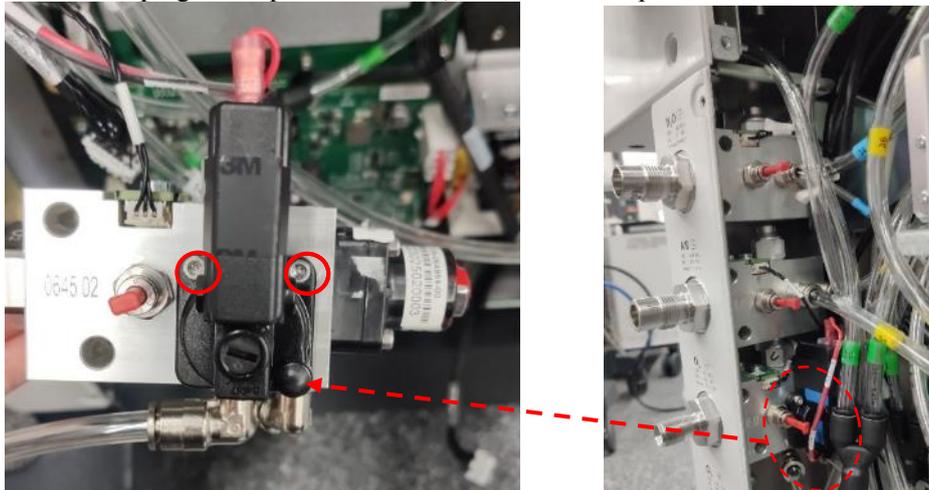
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.5.1.3 Pre-disassembly

1. Refer to *9.1.10 Open the Service Door* to open the service door.
2. Remove the gas inlet assembly corresponding to the pressure switch. Refer to steps 1 and 2 in section 9.2.2.

### 9.5.2 Remove the Pressure Switch (Gas Inlet)

Remove the two screws fastening the switch pressure with the M3 hexagon screw spanner, disconnect the plug of the pressure switch, and remove the pressure switch.



---

## 9.6 Disassemble the I/O Interface Board

### 9.6.1 Prepare for Disassembly

#### 9.6.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- M4 hexagon screw spanner
- Phillips screwdriver

#### 9.6.1.2 Preparations

Before disassembly,

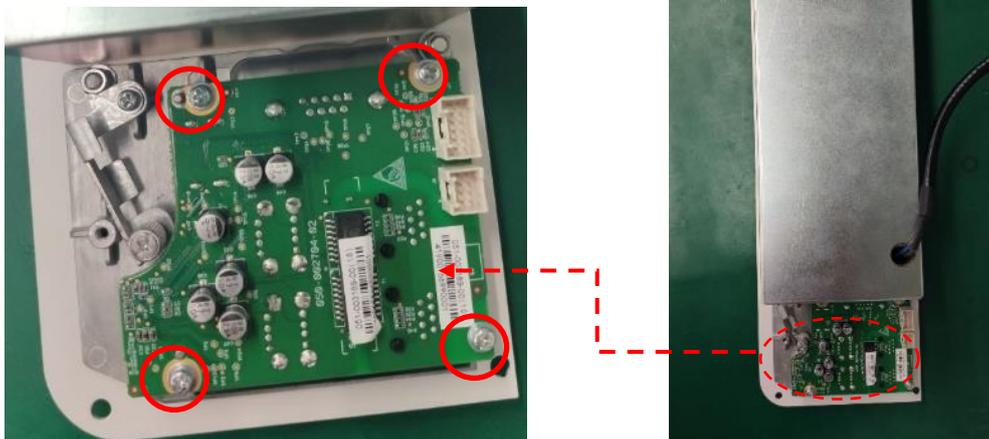
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.6.1.3 Pre-disassembly

Refer to *9.1.2 Remove the Auxiliary Output Assembly* to remove the auxiliary output assembly.

### 9.6.2 Remove the I/O Interface Board

Remove the four screws from the I/O interface board with the Phillips screwdriver to remove the board.



---

## 9.7 Disassemble the Monitoring Board

### 9.7.1 Prepare for Disassembly

#### 9.7.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.7.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.7.1.3 Pre-disassembly

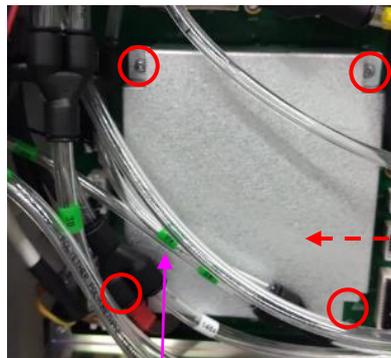
Refer to *9.1.10 Open the Service Door* to open the service door.

### 9.7.2 Remove the Monitoring Board

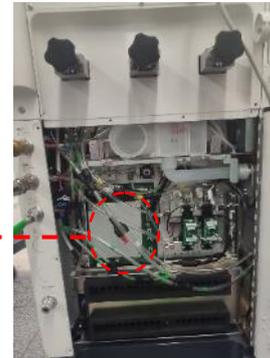
1. Remove the four screws from the protection cap of the monitoring board with the Phillips screwdriver to remove the protection cap.
2. Horizontally and gently pull out the monitoring board.



Monitoring board



Protection cap of the monitoring board



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## 9.8 Disassemble the AC-DC Board

### 9.8.1 Prepare for Disassembly

#### 9.8.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.8.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.8.1.3 Pre-disassembly

Refer to *9.1.10 Open the Service Door* to open the service door.

### 9.8.2 Remove the AC-DC Board

1. Remove the six screws from the sealing cover of the power board with the Phillips screwdriver to remove the sealing cover, as shown in Figure A.
2. Pull out the 0645 AC-DC connection line (24 V) (marked by □ in Figure B) and disconnect the 0645 AC input connection line (marked by ◇ in Figure B).
3. Remove the four screws (marked by △ in Figure B) fastening the AC-DC board with the Phillips screwdriver to remove the AC-DC board.

Figure A

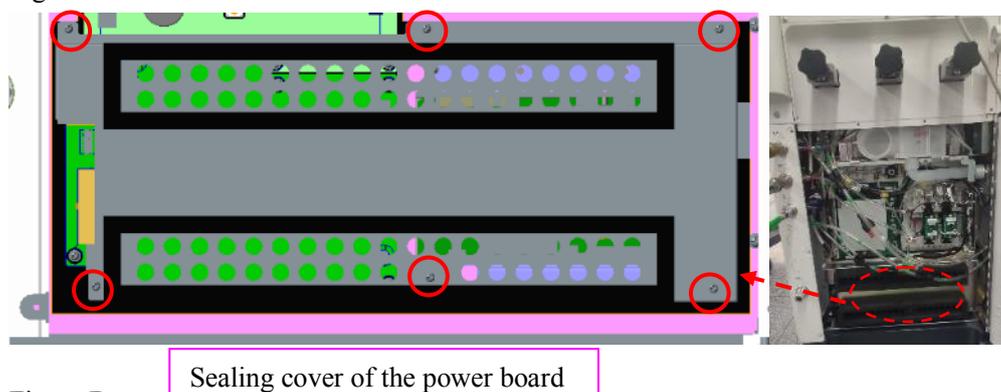
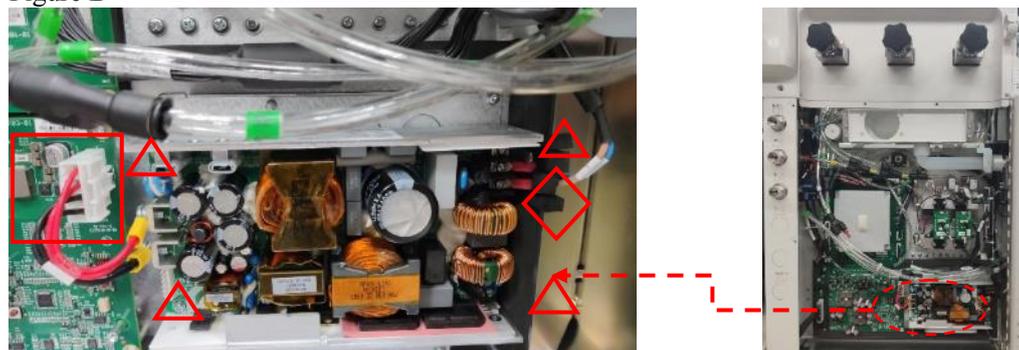


Figure B



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## 9.9 Disassemble the DC-DC Board

### 9.9.1 Prepare for Disassembly

#### 9.9.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.9.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

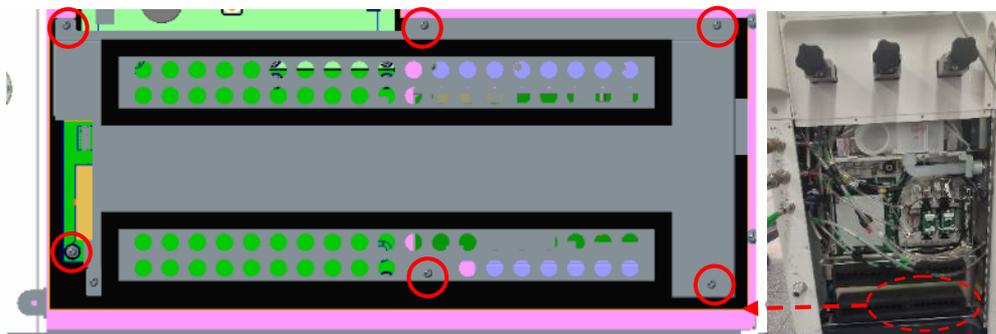
#### 9.9.1.3 Pre-disassembly

Refer to *9.1.1 Open the Service Door* to open the service door.

### 9.9.2 Remove the DC-DC Board

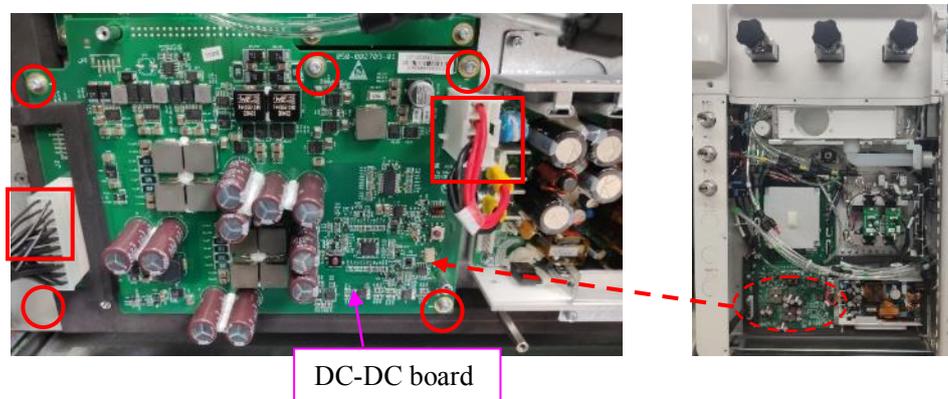
1. Remove the six screws from the sealing cover of the power board with the Phillips screwdriver to remove the sealing cover, as shown in Figure A.
2. Disconnect the two connection lines (marked by □ in Figure B)
3. Remove the five screws fastening the DC-DC board with the Phillips screwdriver to remove the DC-DC board, as shown in Figure B.

Figure A



Sealing cover of the power board

Figure B



DC-DC board

---

## 9.10 Disassemble the Motherboard

### 9.10.1 Prepare for Disassembly

#### 9.10.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.10.1.2 Preparations

Before disassembly,

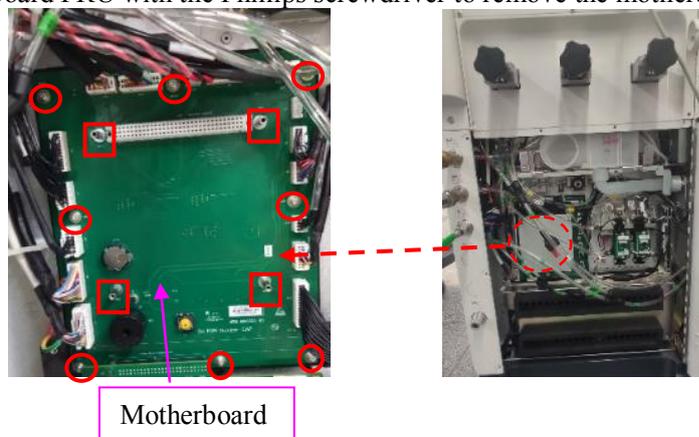
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.10.2 Pre-disassembly

1. Refer to *9.1.1 Open the Service Door* to open the service door.
2. Refer to *9.7 Disassemble the Monitoring Board* to remove the monitoring board assembly.
3. Refer to *9.9 Disassemble the DC-DC Board* to remove the DC-DC board assembly.

## 1.9.2 Remove the Motherboard FRU

Disconnect the connection lines from the motherboard. Then remove the eight screws (marked by ○ in the figure) and four stud screws (marked by □ in the figure) from the motherboard FRU with the Phillips screwdriver to remove the motherboard.



## 9.11 Disassemble the Pressure Regulator Assembly (0645)

### 9.11.1 Prepare for Disassembly

#### 9.11.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.11.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

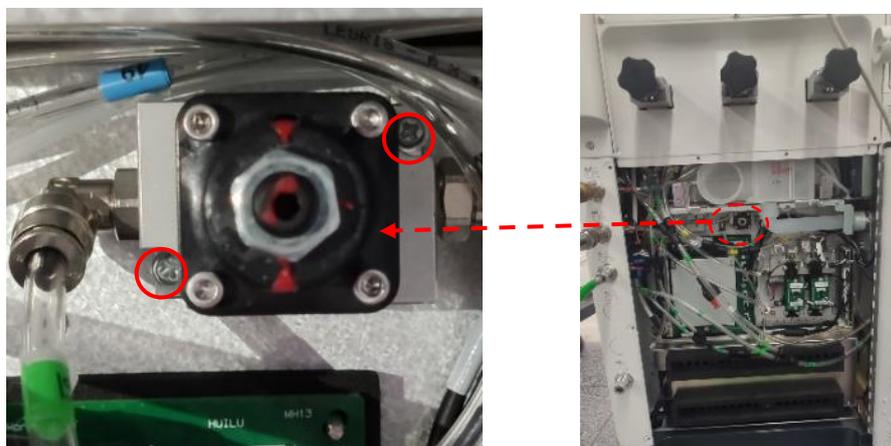
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### 9.11.1.3 Pre-disassembly

Refer to *9.1.1 Open the Service Door* to open the service door.

### 9.11.2 Remove the Pressure Regulator Assembly (0645)

1. Disconnect the hose from the pressure regulator assembly (0645).
2. Remove the two screws from the pressure regulator assembly (0645) with the Phillips screwdriver to remove the pressure regulator assembly (0645).



## 9.12 Disassemble the EFCS Flowmeter Monitoring Board

### 9.12.1 Prepare for Disassembly

#### 9.12.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.12.1.2 Preparations

Before disassembly,

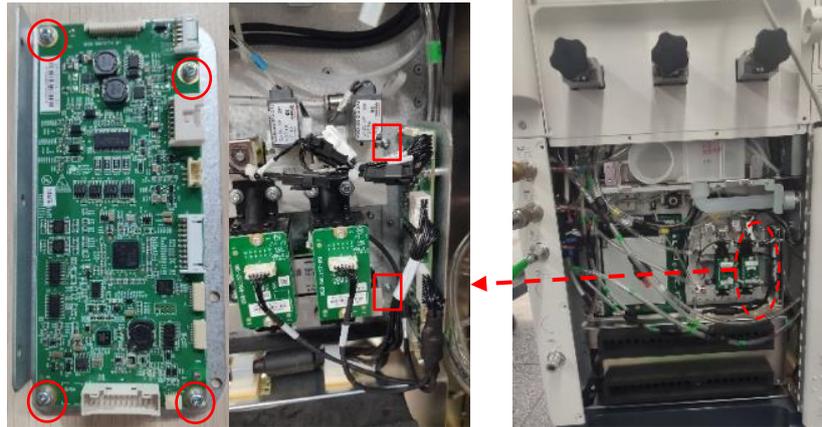
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.12.1.3 Pre-disassembly

Refer to *9.1.1 Open the Service Door* to open the service door.

### 9.12.2 Remove the EFCS Flowmeter Monitoring Board

1. Disconnect the cable plugs from the EFCS flowmeter monitoring board.
2. Remove the two screws (marked by □ in the figure) from the monitoring board assembly with the Phillips screwdriver to remove the assembly.
3. Remove the four screws (marked by ○ in the figure) from the monitoring board with the Phillips screwdriver to remove the monitoring board.



## 9.13 Disassemble the EFCS Flowmeter FRU (O2/N2O/Air)

### 9.13.1 Prepare for Disassembly

#### 9.13.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.13.1.2 Preparations

Before disassembly,

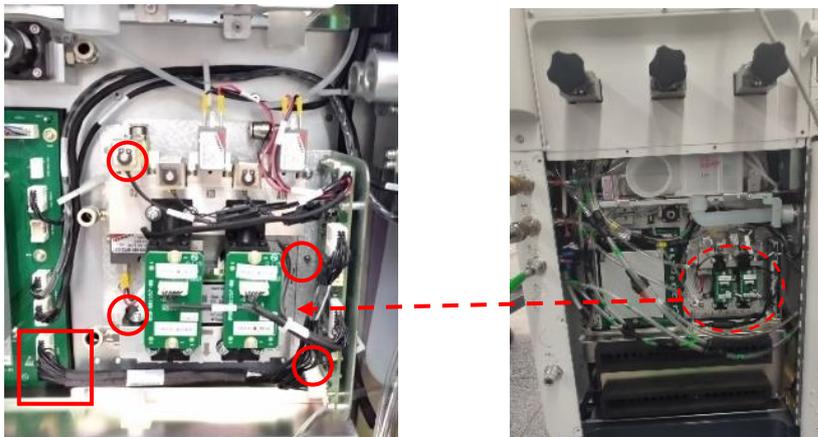
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.13.1.3 Pre-disassembly

Refer to *9.1.1 Open the Service Door* to open the service door.

### 9.13.2 Remove the EFCS Flowmeter FRU (O2/N2O/Air)

1. Disconnect the pipelines from the EFCS flowmeter module and the cables (marked by □ in the figure) from the motherboard.
2. Remove the four screws (marked by ○ in the figure) from the EFCS flowmeter module with the Phillips screwdriver to remove the module.



---

## 9.14 Disassemble the EFCS Flowmeter Flow Sensors

### 9.14.1 Prepare for Disassembly

#### 9.14.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.14.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.14.1.3 Pre-disassembly

1. Refer to *9.1.10 Open the Service Door* to open the service door.
2. Refer to *9.13 Disassemble the EFCS Flowmeter FRU (O2/N2O/Air)* to remove the EFCS flowmeter FRU (O2/N2O/air).

### 9.14.2 Remove the EFCS Flowmeter Flow Sensors

1. Disconnect the cable plugs from the EFCS flowmeter flow sensors.
2. Remove the eight screws with the Phillips screwdriver to remove the two flow sensors in the front, as shown in Figure A.
3. Remove the three screws from the rear of the FRU with the Phillips screwdriver to remove the corresponding assembly, as shown in Figure B.
4. Remove the four screws with the Phillips screwdriver to remove the flow sensor on the side, as shown in Figure C.

Figure A

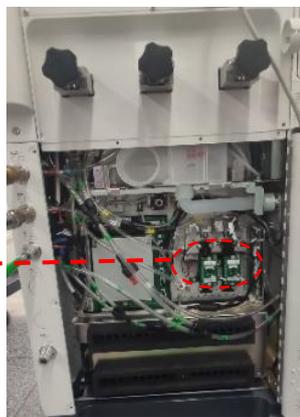
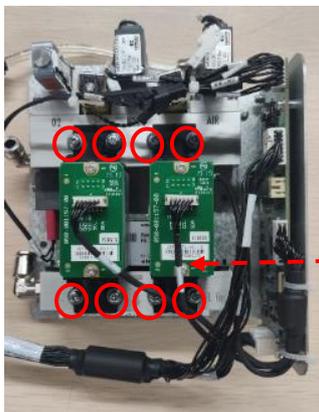


Figure B

Figure C



---

## 9.15 Disassemble the N2O, Air, and O2 Cylinder Yoke Assemblies

### 9.15.1 Prepare for Disassembly

#### 9.15.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver
- 220 mm torque wrench
- M6 hexagon screw spanner

#### 9.15.1.2 Preparations

Before disassembly,

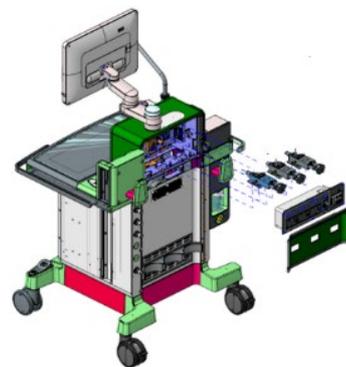
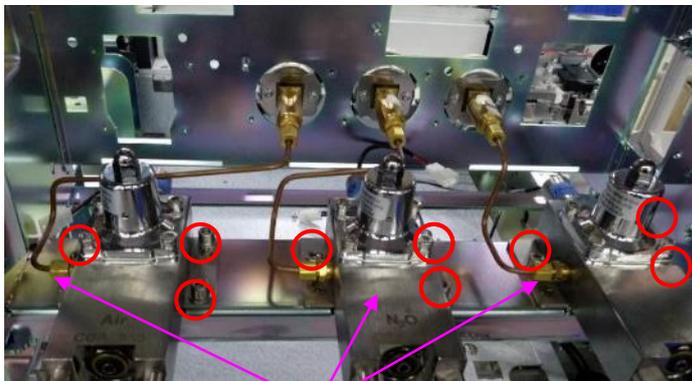
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.15.1.3 Pre-disassembly

1. Refer to **9.1.1 Open the Service Door** to open the service door.
2. Refer to **9.1.2 Remove the Auxiliary Output Assembly** to remove the auxiliary output assembly.
3. Refer to **9.1.3 Remove the Rear Cover Plate of the Work Surface** to remove the rear cover plate of the work surface.

### 9.15.2 Remove the N2O, Air, and O2 Cylinder Yoke Assemblies

1. Disconnect the cable plug on the rear of the cylinder yoke and the hose at the bottom of the cylinder yoke.
2. Remove the nut from the corresponding cylinder yoke.
3. Remove the three screws from the corresponding cylinder yoke assembly (there are three screws for each assembly) with the M6 hexagon screw spanner to remove the assembly.



Turn the nuts counterclockwise to remove them from the connectors

---

## 9.16 Disassemble the Sensor Adapter Board PCBA

### 9.16.1 Prepare for Disassembly

#### 9.16.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.16.1.2 Preparations

Before disassembly,

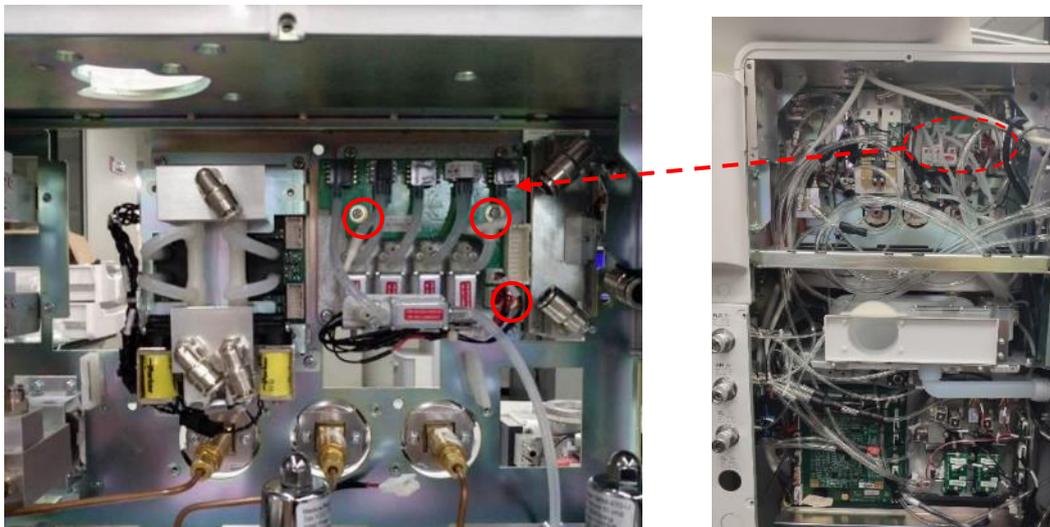
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.16.1.3 Pre-disassembly

1. Refer to **9.1.1** *Open the Service Door* to open the service door.
2. Refer to **9.1.2** *Remove the Auxiliary Output Assembly* to remove the auxiliary output assembly.
3. Refer to **9.1.3** *Remove the Rear Cover Plate of the Work Surface* to remove the rear cover plate of the work surface.

### 9.16.2 Remove the Sensor Adapter Board PCBA

1. Disconnect the pipelines from the sensor adapter board PCBA.
2. Remove the three screws from the sensor adapter board PCBA with the Phillips screwdriver to remove the PCBA.



## 9.17 Disassemble the High-Flow O2 Supply Assembly or Auxiliary O2/Air Assembly

### 9.17.1 Prepare for Disassembly

#### 9.17.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

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### 9.17.1.2 Preparations

Before disassembly,

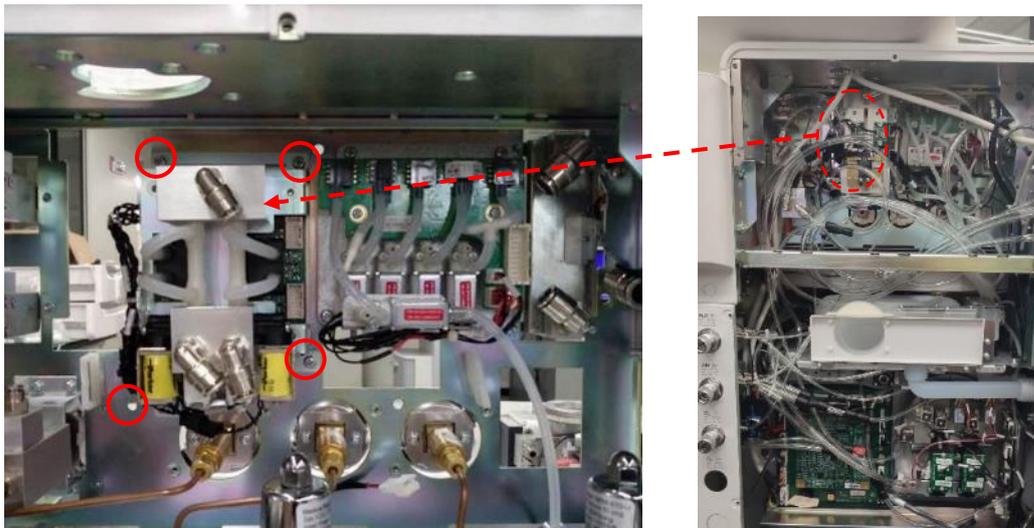
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.17.1.3 Pre-disassembly

1. Refer to **9.1.1 Open the Service Door** to open the service door.
2. Refer to **9.1.2 Remove the Auxiliary Output Assembly** to remove the auxiliary output assembly.
3. Refer to **9.1.3 Remove the Rear Cover Plate of the Work Surface** to remove the rear cover plate of the work surface.

## 9.17.2 Remove the High-Flow O2 Supply Assembly or Auxiliary O2/Air Assembly

1. Disconnect the cables and pipelines from the high-flow O2 supply assembly or auxiliary O2/air assembly.
2. Remove the four screws from the high-flow O2 supply assembly or auxiliary O2/air assembly with the Phillips screwdriver to remove the assembly.



## 9.18 Disassemble the System Switch Assembly

### 9.18.1 Prepare for Disassembly

#### 9.18.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.18.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.

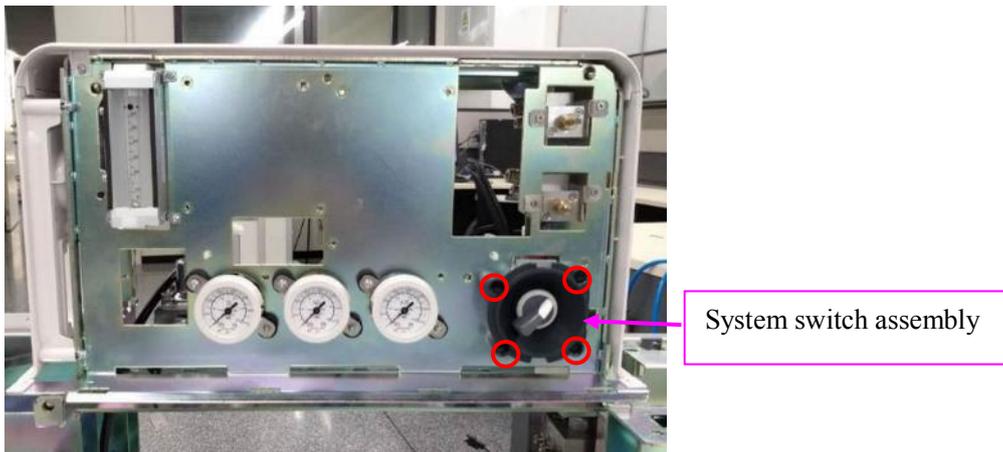
- 
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
  - Disconnect all pipelines and cylinder gas supplies.
  - Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.18.1.3 Pre-disassembly

1. Refer to **9.1.1 Open the Service Door** to open the service door.
2. Refer to **9.1.2 Remove the Auxiliary Output Assembly** to remove the auxiliary output assembly.
3. Refer to **9.1.3 Remove the Rear Cover Plate of the Work Surface** to remove the rear cover plate of the work surface.
4. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
5. Refer to **9.1.5 Remove the Instrument Panel Assembly** to remove the instrument panel assembly.

### 9.18.2 Remove the System Switch Assembly

1. Disconnect the hose and cable from the system switch assembly.
2. Remove the four screws from the system switch assembly with the Phillips screwdriver to remove the assembly.



## 9.19 Disassemble the High-Flow O<sub>2</sub> Therapy Flowmeter or Auxiliary Output Flowmeter Assembly

### 9.19.1 Prepare for Disassembly

#### 9.19.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.19.1.2 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

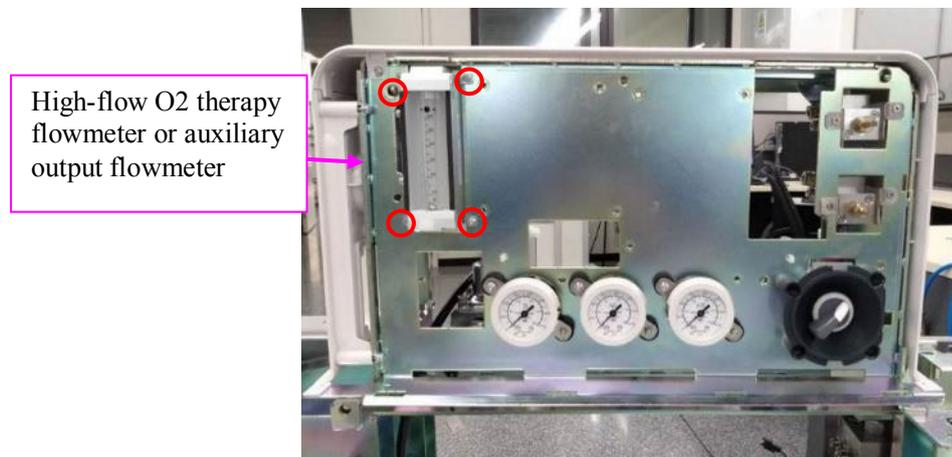
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### 9.19.1.3 Pre-disassembly

1. Refer to **9.1.1** *Open the Service Door* to open the service door.
2. Refer to **9.1.2** *Remove the Auxiliary Output Assembly* to remove the auxiliary output assembly.
3. Refer to **9.1.3** *Remove the Rear Cover Plate of the Work Surface* to remove the rear cover plate of the work surface.
4. Refer to **9.1.4** *Remove the Work Surface Cover Plate FRU* to remove the work surface cover plate.
5. Refer to **9.1.5** *Remove the Instrument Panel Assembly* to remove the instrument panel assembly.

### 9.19.2 Remove the High-Flow O2 Therapy Flowmeter or Auxiliary Output Flowmeter Assembly

1. Disconnect the hose and cable from the high-flow O2 therapy flowmeter or auxiliary output flowmeter assembly.
2. Remove the four screws from the high-flow O2 therapy flowmeter or auxiliary output flowmeter assembly with the Phillips screwdriver to remove the assembly.



## 9.20 Disassemble the Venturi Negative Pressure Control Panel Assembly

### 9.20.1 Prepare for Disassembly

#### 9.20.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.20.1.2 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.20.1.3 Pre-disassembly

1. Refer to **9.1.1** *Open the Service Door* to open the service door.

2. Refer to **9.1.2 Remove the Auxiliary Output Assembly** to remove the auxiliary output assembly.
3. Refer to **9.1.3 Remove the Rear Cover Plate of the Work Surface** to remove the rear cover plate of the work surface.

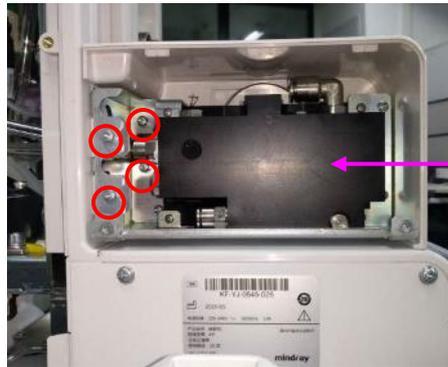
## 9.20.2 Remove the Venturi Negative Pressure Control Panel Assembly

1. Remove the two screws from the rear of the control panel assembly with the Phillips screwdriver to remove the rear panel, as shown in Figure A.
2. Remove the four screws from the negative pressure suction assembly with the Phillips screwdriver, as shown in Figure B.
3. To facilitate operations, disconnect the hose at the other end of the control panel assembly, as shown in Figure C. Remove the control panel assembly.

Figure A

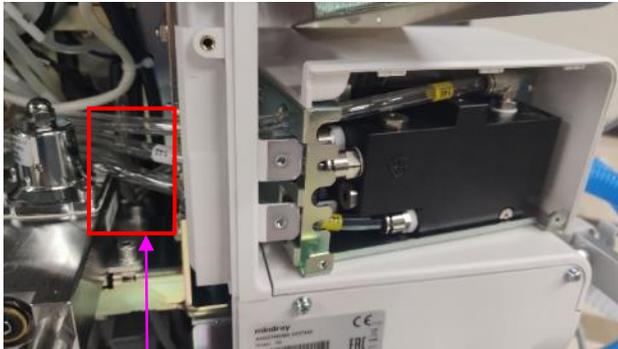


Figure B



Negative pressure suction assembly

Figure C



Pull out the hose plug at the other end along the pipeline

---

## 9.21 Disassemble the O2 Cell Holder Assembly

### 9.21.1 Prepare for Disassembly

#### 9.21.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

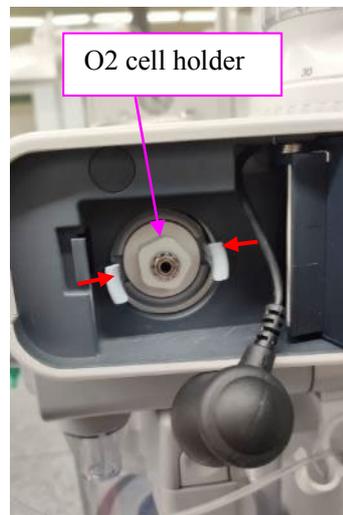
#### 9.21.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.21.2 Remove the O2 Cell Holder Assembly

1. Press the button of the O2 cell door to open the door.
2. Press the two protrusions and gently pull out the O2 cell holder assembly.



## 9.22 Disassemble the Sodalime Absorber Canister Assembly

### 9.22.1 Prepare for Disassembly

#### 9.22.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

#### 9.22.1.2 Preparations

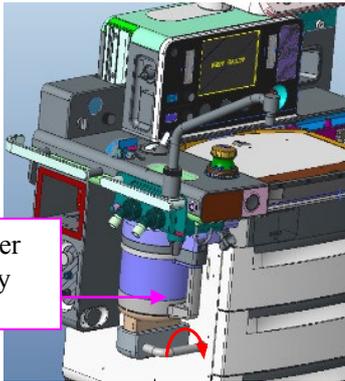
Before disassembly,

- 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.22.2 Remove the Sodalime Absorber Canister Assembly

1. Hold the rotary handle and turn it clockwise 90 degrees.

- 
2. Remove the sodalime absorber canister assembly.



## 9.23 Disassemble the Bypass Assembly

### 9.23.1 Prepare for Disassembly

#### 9.23.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

#### 9.23.1.2 Preparations

Before disassembly,

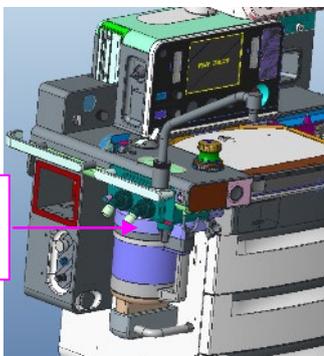
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.23.1.3 Pre-disassembly

Refer to *9.22 Disassemble the Sodalime Absorber Canister Assembly* to remove the sodalime absorber canister assembly.

### 9.23.2 Remove the Bypass Assembly

Press the button inward with your left hand while holding and pulling down the bypass assembly with your right hand to take it out.



---

## 9.24 Disassemble the Bag Arm Assembly

### 9.24.1 Prepare for Disassembly

#### 9.24.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

#### 9.24.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.24.2 Remove the Bag Arm Assembly

1. Remove the locking nut counterclockwise and pull out the nut vertically.
2. Lift and remove the bag arm assembly.



## 9.25 Disassemble the Patient Circuit Assembly

### 9.25.1 Prepare for Disassembly

#### 9.25.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

#### 9.25.1.2 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

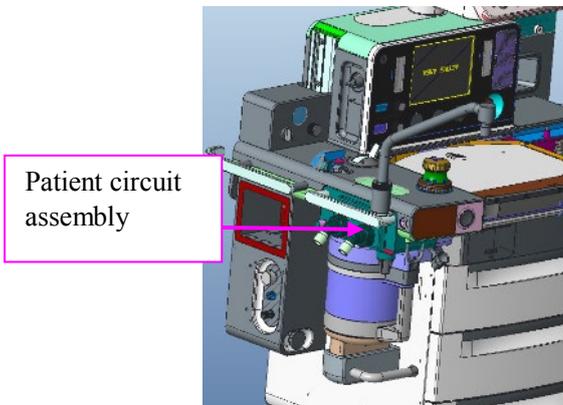
#### 9.25.1.3 Pre-disassembly

1. Refer to **9.21 Disassemble the O2 Cell Holder Assembly** to remove the O2 cell holder assembly.
2. Refer to **9.22 Disassemble the Sodalime Absorber Canister Assembly** to remove the sodalime absorber canister assembly.
3. Refer to **9.23 Disassemble the Bypass Assembly** to remove the bypass assembly.

---

## 9.25.2 Remove the Patient Circuit Assembly

1. Pull the patient circuit assembly away from the circuit adaptation block assembly.
2. Refer to **9.24Disassemble** the Bag Arm Assembly to remove the bag arm assembly.



## 9.26 Disassemble the APL Valve Assembly

### 9.26.1 Prepare for Disassembly

#### 9.26.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

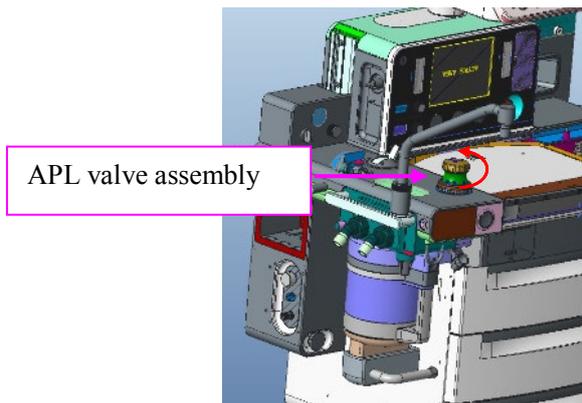
#### 9.26.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.26.2 Remove the APL Valve Assembly

Turn the locking nut counterclockwise and pull the APL valve assembly straight up to remove it.



---

## 9.27 Disassemble the Locking Nuts of the Inspiration and Expiration Connectors

### 9.27.1 Prepare for Disassembly

#### 9.27.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

#### 9.27.1.2 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.27.2 Remove the Locking Nuts of the Inspiration and Expiration Connectors

Turn the locking nuts of the inspiration and expiration connectors counterclockwise and pull out them horizontally.



## 9.28 Disassemble the Inspiration and Expiration Connectors

### 9.28.1 Prepare for Disassembly

#### 9.28.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

#### 9.28.1.2 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.28.2 Remove the Inspiration and Expiration Connectors

Turn the locking nuts of the inspiration and expiration connectors counterclockwise. Pull out the inspiration and expiration connectors together with their locking nuts. Then remove the inspiration and expiration connectors.



## 9.29 Disassemble the Water Collection Cup

### 9.29.1 Prepare for Disassembly

#### 9.29.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

#### 9.29.1.2 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.29.2 Remove the Water Collection Cup

Turn the water collection cup counterclockwise to remove it.



## 9.30 Disassemble the Volume Exchanger Assembly

### 9.30.1 Prepare for Disassembly

#### 9.30.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

#### 9.30.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.30.1.3 Pre-disassembly

Refer to step 1 in *9.25.2 Remove the Patient Circuit Assembly* to remove the patient circuit.

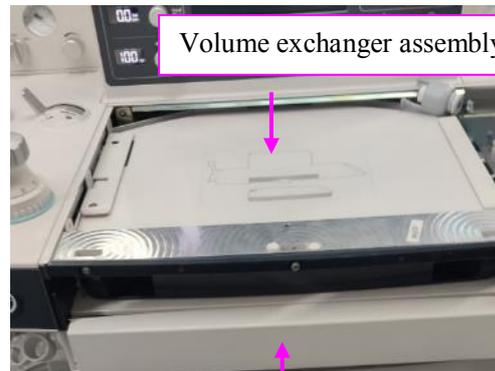
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## 9.30.2 Remove the Volume Exchanger Assembly

Press the VE door switch to open the VE door. Then horizontally pull out the volume exchanger assembly.



Press the switch



Volume exchanger assembly

Open the VE door

## 9.31 Disassemble the VE Box Assembly

### 9.31.1 Prepare for Disassembly

#### 9.31.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.31.1.2 Preparations

Before disassembly,

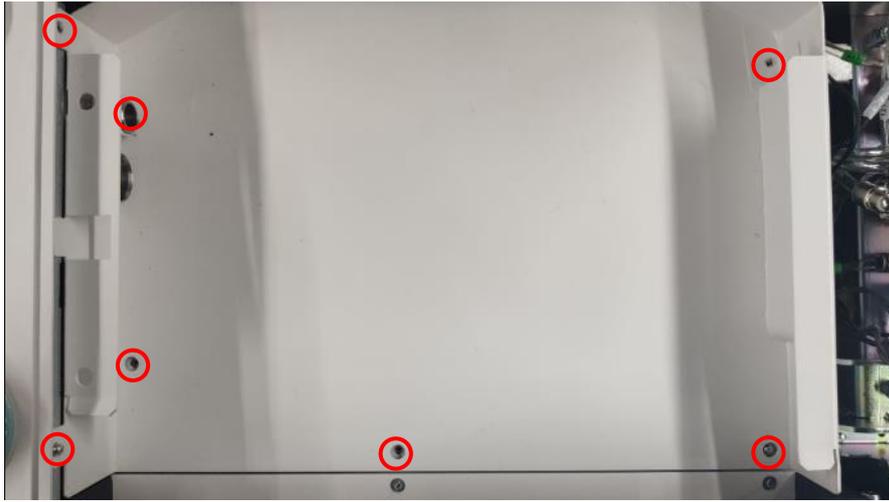
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.31.1.3 Pre-disassembly

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.

### 9.31.2 Remove the VE Box Assembly

Remove the seven screws with the Phillips screwdriver, lift the VE box assembly, disconnect the cables, and remove the VE box assembly.



## 9.32 Disassemble the VE Mounting Box In-Position Switch

### 9.32.1 Prepare for Disassembly

#### 9.32.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.32.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.32.1.3 Pre-disassembly

Refer to *9.31 Disassemble the VE Box Assembly* to remove the VE box assembly.

### 9.32.2 Remove the VE Mounting Box In-Position Switch

Remove the two screws with the Phillips screwdriver, remove the protection cap, disconnect the plug, and then pull out the in-position switch.



## 9.33 Disassemble the Upper-Half Drawer Assembly

### 9.33.1 Prepare for Disassembly

#### 9.33.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

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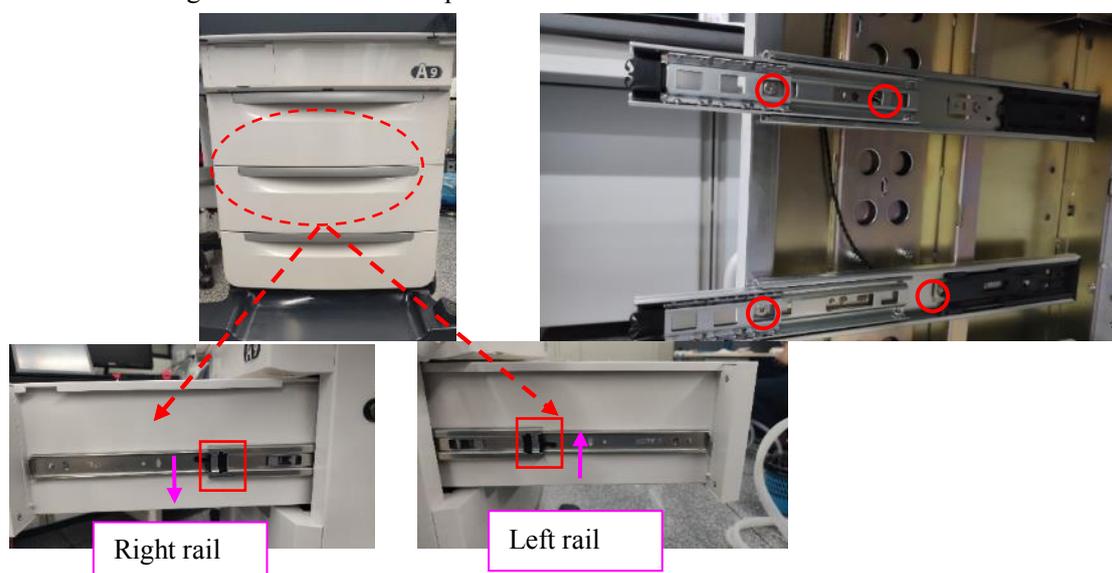
### 9.33.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.33.2 Remove the Upper-Middle Drawer Assembly

1. Pull out the drawer until the black locking pieces (marked by □ in the figure) on the rails can be seen.
2. Lift the locking piece on the left rail of the drawer while pressing down on the locking piece on the right rail.
3. Take out the drawer.
4. Move the slides to the specific positions. Remove the four screws from each of the left and right rails with the Phillips screwdriver to remove the rails.



### 9.34 Disassemble the Lower Drawer Assembly

#### 9.34.1 Prepare for Disassembly

##### 9.34.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

##### 9.34.1.2 Preparations

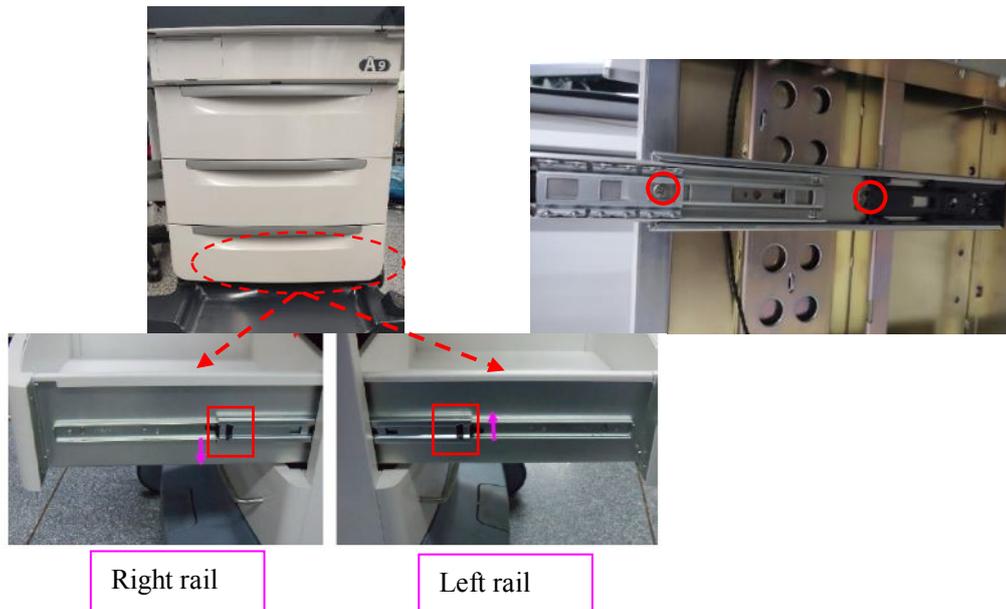
Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.34.2 Remove the Lower Drawer Assembly

1. Pull out the drawer until the black locking pieces (marked by □ in the figure) on the rails can be seen. (Note: The corners on both sides of the drawer are round.)
2. Lift the locking piece on the left rail of the drawer while pressing down on the locking piece on the right rail.
3. Take out the drawer.

- 
4. Remove the two screws from each of the left and right rails with the Phillips screwdriver to remove the rails.



## 9.35 Disassemble the Poppet Device Assembly

### 9.35.1 Prepare for Disassembly

#### 9.35.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- M5 hexagon screw spanner
- Scissors

#### 9.35.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

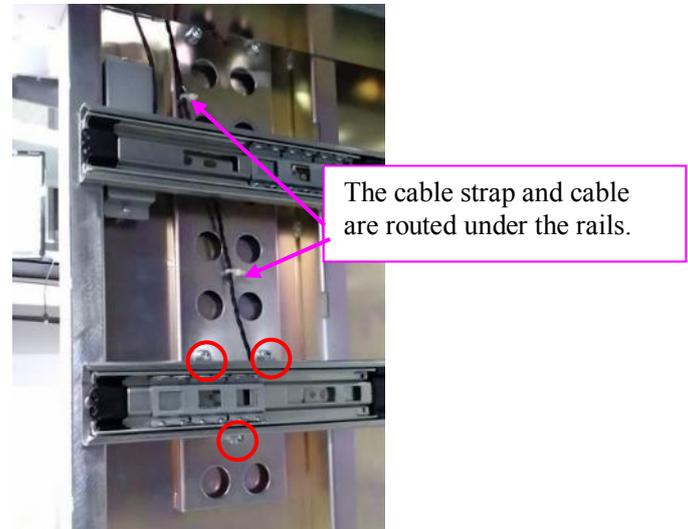
#### 9.35.1.3 Pre-disassembly

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
4. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.
5. Refer to **9.33 Disassemble the Upper-Half Drawer Assembly** and **9.34 Disassemble the Lower Drawer Assembly** to remove the upper, middle, and lower drawers.

---

## 9.35.2 Remove the Poppet Device Assembly

1. Cut the cable strap with the scissors and disconnect the plug from the poppet device assembly (at the bottom of the VE box).
2. Remove the three screws with the M5 hexagon screw spanner to remove the poppet device assembly.



## 9.36 Disassemble the AGSS Assembly

### 9.36.1 Prepare for Disassembly

#### 9.36.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.36.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

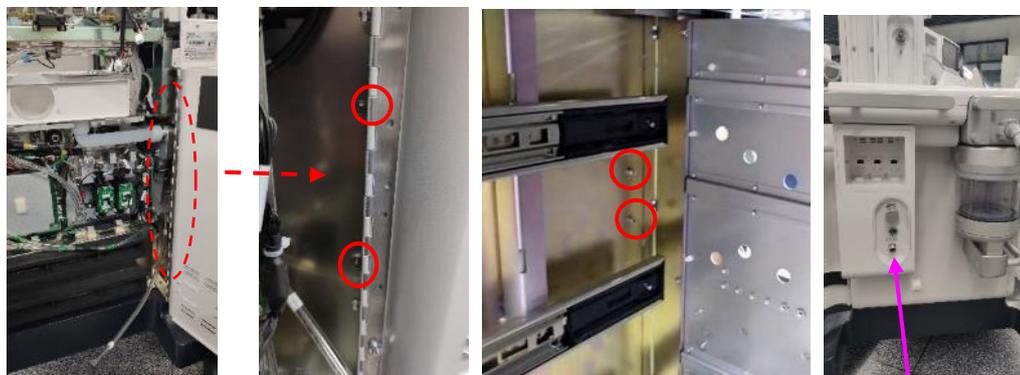
#### 9.36.1.3 Pre-disassembly

1. Refer to **9.1.1 Open the Service Door** to open the service door.
2. Refer to **9.33 Disassemble the Upper-Half Drawer Assembly** and **9.34 Disassemble the Lower Drawer Assembly** to remove the upper, middle, and lower drawers.

---

## 9.36.2 Remove the AGSS Assembly

1. Remove the four screws with the Phillips screwdriver.
2. Disconnect the pipelines and cables from the AGSS assembly and remove the AGSS assembly.



Two screws on the rear of the cart

Two screws inside the drawer mounting position

AGSS assembly

## 9.37 Disassemble the Module Rack Assembly

### 9.37.1 Prepare for Disassembly

#### 9.37.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

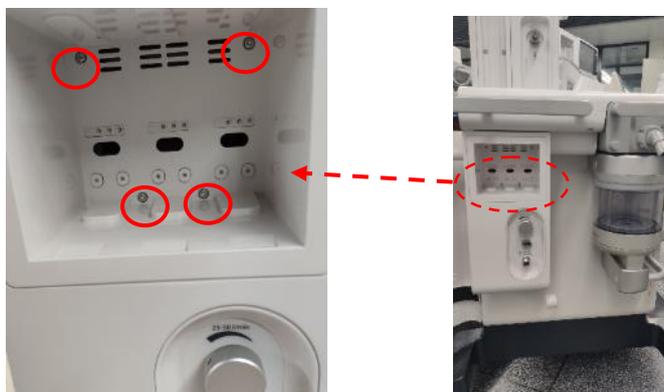
#### 9.37.1.2 Preparations

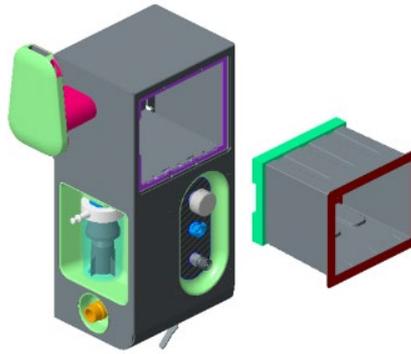
Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.37.2 Remove the Module Rack Assembly

1. Remove the four screws from the module rack assembly with the Phillips screwdriver.
2. Gently pull out the module rack assembly, disconnect the cables (marked by □ in the figure), and remove the assembly.





## 9.38 Disassemble the Battery Box Assembly

### 9.38.1 Prepare for Disassembly

#### 9.38.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.38.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.

#### 9.38.1.3 Pre-disassembly

1. Refer to *9.1.1 Open the Service Door* to open the service door.
2. Refer to *9.33 Disassemble the Upper-Half Drawer Assembly* and *9.34 Disassemble the Lower Drawer Assembly* to remove the upper, middle, and lower drawers.

### 9.38.2 Remove the Battery Box Assembly

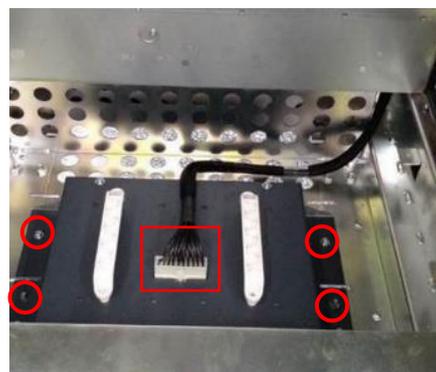
1. Remove the four screws from the battery box cover plate with the Phillips screwdriver to remove the cover plate, as shown in Figure A.
2. Disconnect the cable (marked by □ in Figure B) from the battery box assembly.
3. Remove the four screws (marked by ○ in Figure B) with the Phillips screwdriver to remove the battery box assembly.

Figure A



Battery box cover plate

Figure B



---

## 9.39 Disassemble the Anesthesia Calculation Pipeline Assembly

### 9.39.1 Prepare for Disassembly

#### 9.39.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver
- Scissors

#### 9.39.1.2 Preparations

Before disassembly,

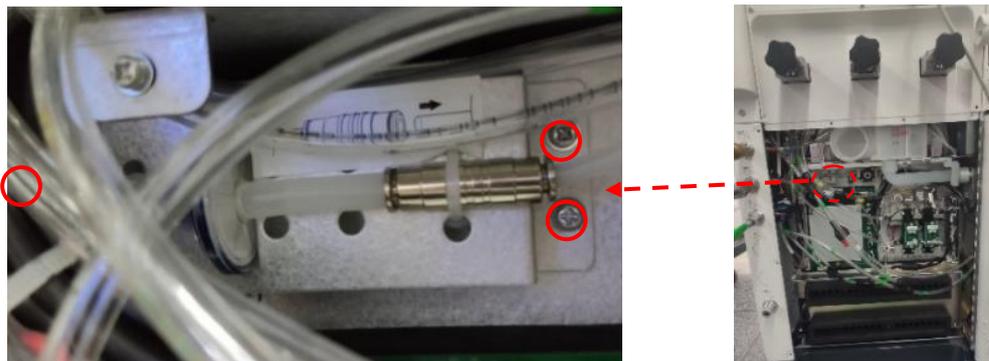
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.39.1.3 Pre-disassembly

1. Refer to **9.1.1** *Open the Service Door* to open the service door.
2. Refer to **9.1.4** *Remove the Work Surface Cover Plate FRU* to remove the work surface cover plate.
3. Refer to step 1 in **9.25.2** *Remove the Patient Circuit Assembly* to remove the patient circuit.
4. Refer to **9.30** *Disassemble the Volume Exchanger Assembly* to remove the volume exchanger assembly.
5. Refer to **9.31** *Disassemble the VE Box Assembly* to remove the VE box assembly.

### 9.39.2 Remove the Anesthesia Calculation Pipeline Assembly

1. Remove the three screws from the anesthesia calculation pipeline assembly with the Phillips screwdriver to remove the assembly.
2. Cut the cable strap with the scissors and disconnect the hose from the anesthesia calculation pipeline assembly.



## 9.40 Disassemble the Inspiratory Valve Assembly

### 9.40.1 Prepare for Disassembly

#### 9.40.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.40.1.2 Preparations

Before disassembly,

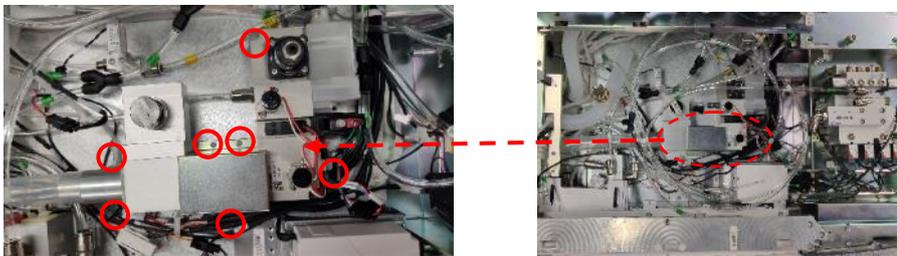
- 
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
  - Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.40.1.3 Pre-disassembly

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
4. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.

## 9.40.2 Remove the Inspiratory Valve Assembly

1. Remove the seven screws with the Phillips screwdriver.
2. Disconnect the hose and cable from the inspiratory valve assembly and remove the assembly.



## 9.41 Disassemble the ACGO Assembly

### 9.41.1 Prepare for Disassembly

#### 9.41.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.41.1.2 Preparations

Before disassembly,

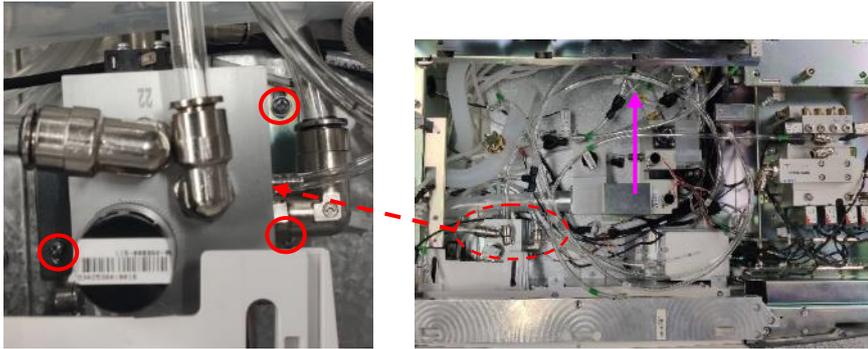
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.41.1.3 Pre-disassembly

Remove the inspiratory valve assembly (without disconnecting the hose or cable). Refer to step 1 in section 9.40.2.

### 9.41.2 Remove the ACGO Assembly

1. Disconnect the hose from the ACGO assembly and remove the three screws with the Phillips screwdriver.
2. Move the inspiratory valve assembly forward along the arrow direction, to reserve sufficient space for removing the ACGO assembly.
3. Remove the ACGO assembly.



## 9.42 Disassemble the O2 Cell Calibration Valve Assembly

### 9.42.1 Prepare for Disassembly

#### 9.42.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.42.1.2 Preparations

Before disassembly,

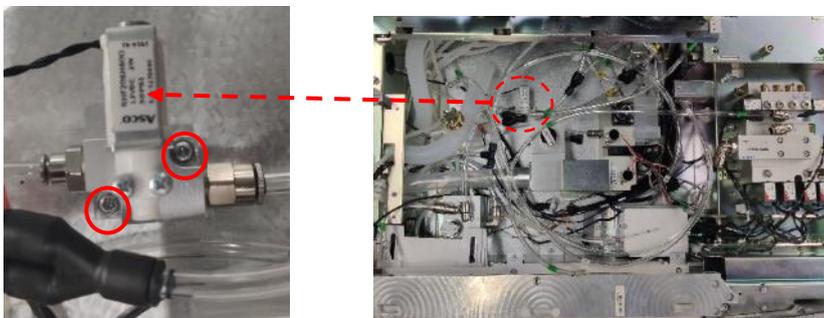
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.42.1.3 Pre-disassembly

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
4. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.

### 9.42.2 Remove the O2 Cell Calibration Valve Assembly

1. Disconnect the hose and cable from the O2 cell calibration valve assembly.
2. Remove the two screws with the Phillips screwdriver to remove the O2 cell calibration valve assembly.



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## 9.43 Disassemble the Air Filter

### 9.43.1 Prepare for Disassembly

#### 9.43.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.43.1.2 Preparations

Before disassembly,

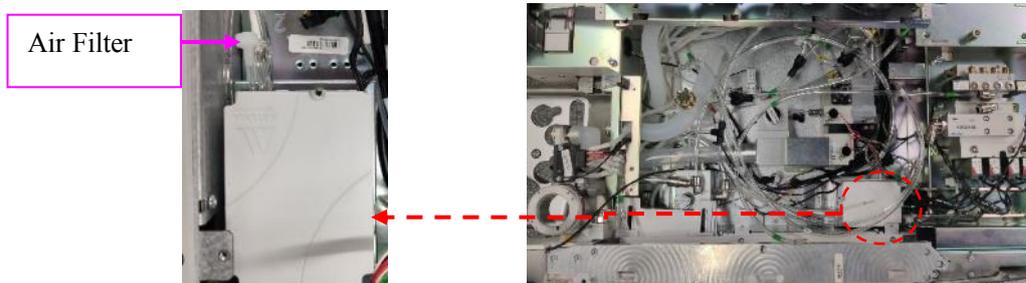
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.43.1.3 Pre-disassembly

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
4. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.

### 9.43.2 Remove the Air Filter

Pull out the air filter.



## 9.44 Disassemble the AG Module

### 9.44.1 Prepare for Disassembly

#### 9.44.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.44.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

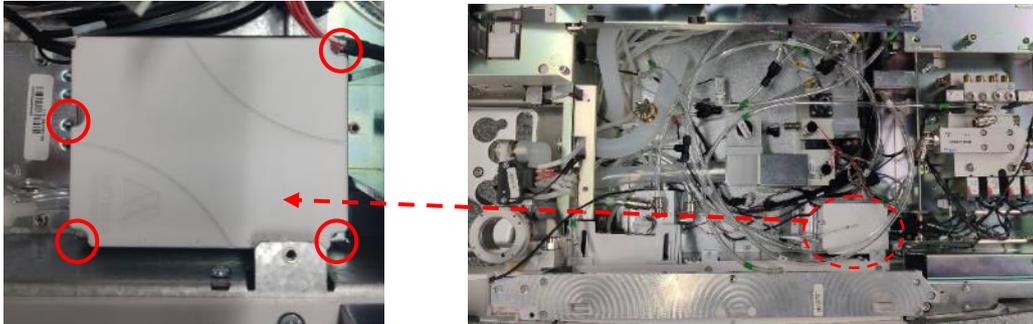
#### 9.44.1.3 Pre-disassembly

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.

3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
4. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.

## 9.44.2 Remove the AG Module

1. Disconnect the hose and cable from the AG module.
2. Remove the four screws with the Phillips screwdriver to remove the AG module.



## 9.45 Disassemble the Negative Pressure Generator

### 9.45.1 Prepare for Disassembly

#### 9.45.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.45.1.2 Preparations

Before disassembly,

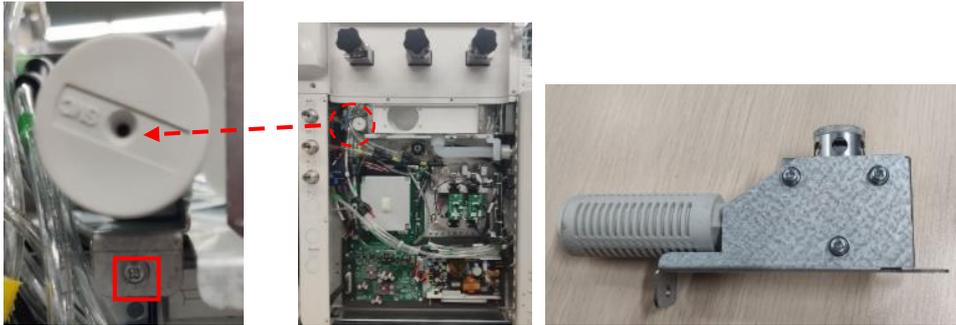
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.45.1.3 Pre-disassembly

1. Refer to **9.1.1 Open the Service Door** to open the service door.
2. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
3. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
4. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
5. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.

## 9.45.2 Remove the Negative Pressure Generator

1. Remove the screw (marked by □ in the figure) from the negative pressure generator with the Phillips screwdriver.
2. Disconnect the hose from the negative pressure generator and remove the negative pressure generator.



## 9.46 Disassemble the Valve Cover

### 9.46.1 Prepare for Disassembly

#### 9.46.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

#### 9.46.1.2 Preparations

Before disassembly,

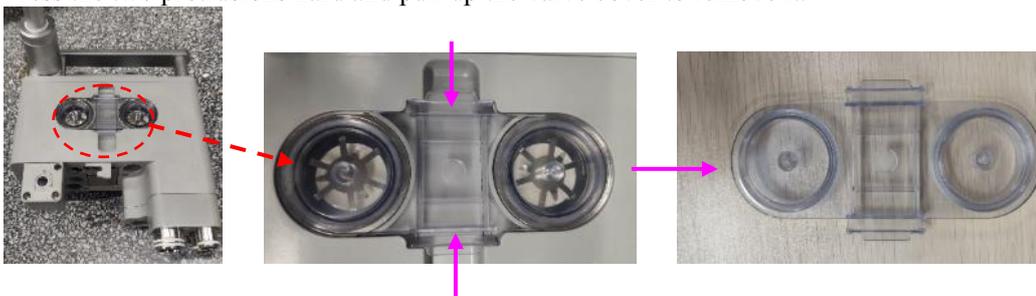
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.46.1.3 Pre-disassembly

Refer to step 1 in **9.25.2 Remove** the Patient Circuit Assembly to remove the patient circuit.

### 9.46.2 Remove the Valve Cover Assembly

Press the two protrusions hard and pull up the valve cover to remove it.



## 9.47 Disassemble the One-Way Valve

### 9.47.1 Prepare for Disassembly

#### 9.47.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

#### 9.47.1.2 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.47.1.3 Pre-disassembly

Refer to **9.46 Disassemble the Valve Cover** to remove the valve cover.

## 9.47.2 Remove the One-Way Valve

Pull the one-way valve assembly straight up to remove it.



## 9.48 Disassemble the Vaporizer Manifold Assembly

### 9.48.1 Prepare for Disassembly

#### 9.48.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver
- M4 and M5 hexagon screw spanners

#### 9.48.1.2 Preparations

Before disassembly,

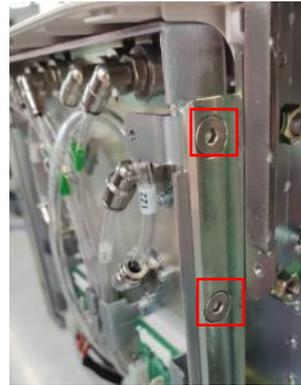
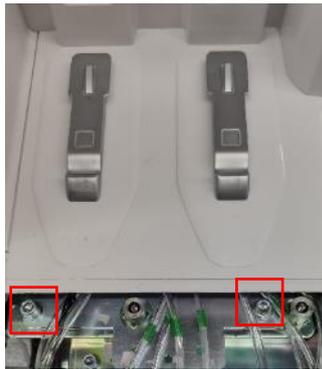
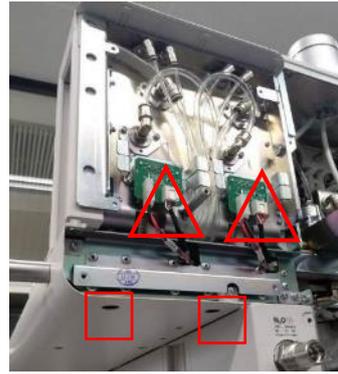
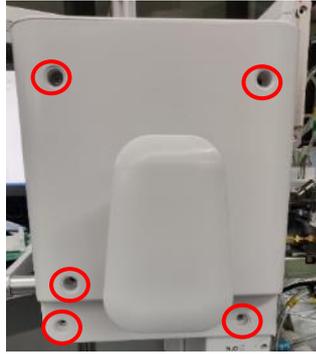
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.48.1.3 Pre-disassembly

1. Refer to **9.1.1 Open the Service Door** to open the service door.
2. Refer to **9.1.2 Remove the Auxiliary Output Assembly** to remove the auxiliary output assembly.
3. Refer to **9.1.3 Remove the Rear Cover Plate of the Work Surface** to remove the rear cover plate of the work surface.
4. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.

### 9.48.2 Remove the Vaporizer Manifold Assembly

1. Remove the five screws (marked by ○ in the figure) with the Phillips screwdriver to remove the rear cover plate.
2. Remove the six screws (marked by □ in the figure) fastening the vaporizer manifold assembly with the M4 and M5 hexagon screw spanners.
3. Disconnect the hose and cable (marked by Δ in the figure) from the vaporizer manifold assembly and remove the assembly.



## 9.49 Disassemble the Electronic Vaporizer Base Interface Board PCBA

### 9.49.1 Prepare for Disassembly

#### 9.49.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.49.1.2 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.49.1.3 Pre-disassembly

None.

### 9.49.2 Remove the Electronic Vaporizer Base Interface Board PCBA

1. Remove the five screws with the Phillips screwdriver to remove the rear cover plate, as shown in Figure A.
2. Disconnect the cables (marked by □ in Figure B) from the electronic vaporizer base interface board PCBA.
3. Remove the eight screws (marked by ○ in Figure B) with the Phillips screwdriver to remove the interface board PCBA.

---

Figure A

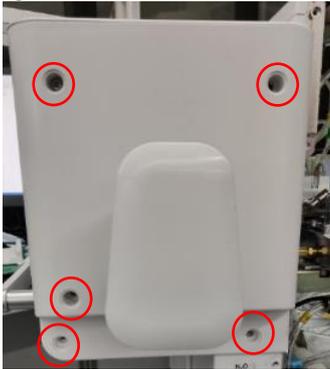
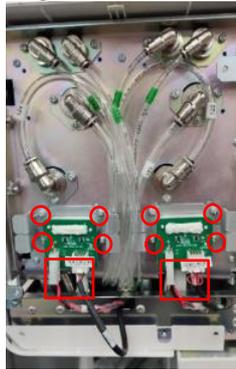


Figure B



## 9.50 Disassemble the Pneumatically-Controlled Lock Assemblies

### 9.50.1 Prepare for Disassembly

#### 9.50.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver
- M4 and M5 hexagon screw spanners

#### 9.50.1.2 Preparations

Before disassembly,

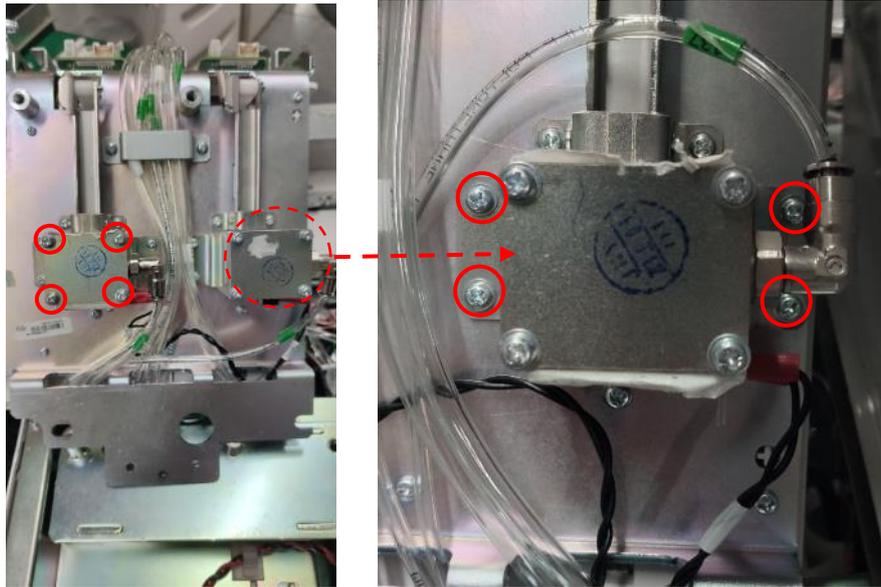
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.50.1.3 Pre-disassembly

Refer to *9.48 Disassemble the Vaporizer Manifold Assembly* to remove the vaporizer manifold assembly (disconnect the cable but not the hose).

### 9.50.2 Remove the Pneumatically-Controlled Lock Assemblies

1. Lift the vaporizer manifold assembly and turn it over forward in position.
2. Disconnect the hoses and cables from the pneumatically-controlled lock assemblies.
3. Remove the eight screws (there are four screws for each pneumatically-controlled lock assembly) with the Phillips screwdriver to remove the two pneumatically-controlled lock assemblies.



## **9.51 Disassemble the Small-Screen CPU Board (Without the Display Cable)**

### **9.51.1 Prepare for Disassembly**

#### **9.51.1.1 Tools**

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### **9.51.1.2 Preparations**

Before disassembly,

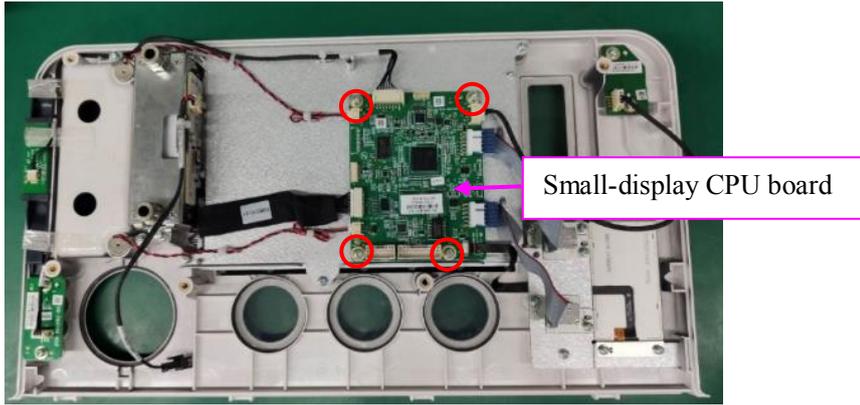
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.

#### **9.51.1.3 Pre-disassembly**

1. Refer to **9.1.1 Open the Service Door** to open the service door.
2. Refer to **9.1.2 Remove the Auxiliary Output Assembly** to remove the auxiliary output assembly.
3. Refer to **9.1.3 Remove the Rear Cover Plate of the Work Surface** to remove the rear cover plate of the work surface.
4. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
5. Refer to **9.1.5 Remove the Instrument Panel Assembly** to remove the instrument panel assembly.

### **9.51.2 Remove the Small-Display CPU Board Assembly (Without the Display Cable)**

1. Disconnect the cables from the small-display CPU board assembly (without the display cable).
2. Remove the four screws from the small-display CPU board assembly (without the display cable) with the Phillips screwdriver to remove the CPU board.



## 9.52 Disassemble the Small Display

### 9.52.1 Prepare for Disassembly

#### 9.52.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.52.1.2 Preparations

Before disassembly,

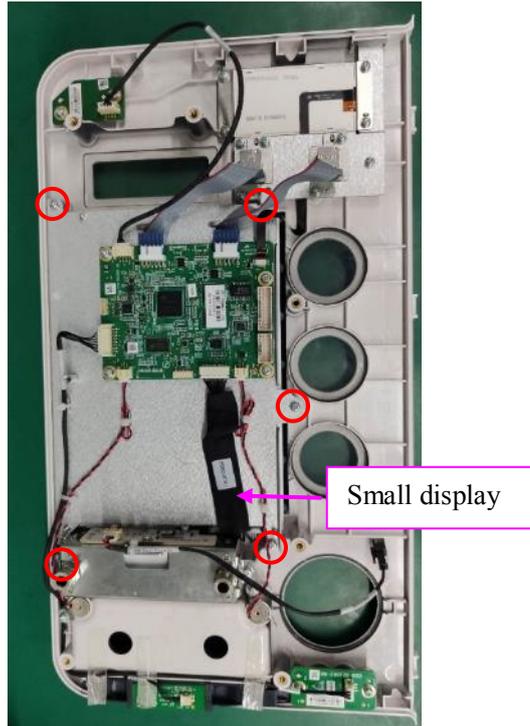
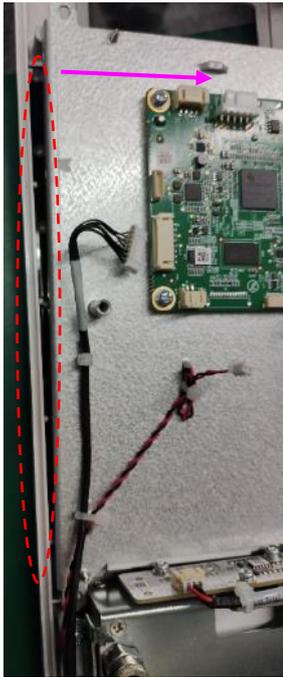
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.52.1.3 Pre-disassembly

1. Refer to **9.1.1***Open the Service Door* to open the service door.
2. Refer to **9.1.2***Remove the Auxiliary Output Assembly* to remove the auxiliary output assembly.
3. Refer to **9.1.3***Remove the Rear Cover Plate of the Work Surface* to remove the rear cover plate of the work surface.
4. Refer to **9.1.4***Remove the Work Surface Cover Plate FRU* to remove the work surface cover plate.
5. Refer to **9.1.5***Remove the Instrument Panel Assembly* to remove the instrument panel assembly.
6. Refer to **9.51***Disassemble the Small-Screen CPU Board (Without the Display Cable)* to remove the small-display CPU board assembly (without the display cable).

### 9.52.2 Remove the Small Display Assembly

1. Disconnect the cables from the small display assembly.
2. Remove the five screws from the small display assembly with the Phillips screwdriver.
3. There is a groove between the small display assembly and the instrument panel. When you remove the small display assembly, horizontally pull it out and then take it out.



## 9.53 Disassemble the Spare Flowmeter Assembly

### 9.53.1 Prepare for Disassembly

#### 9.53.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.53.1.2 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

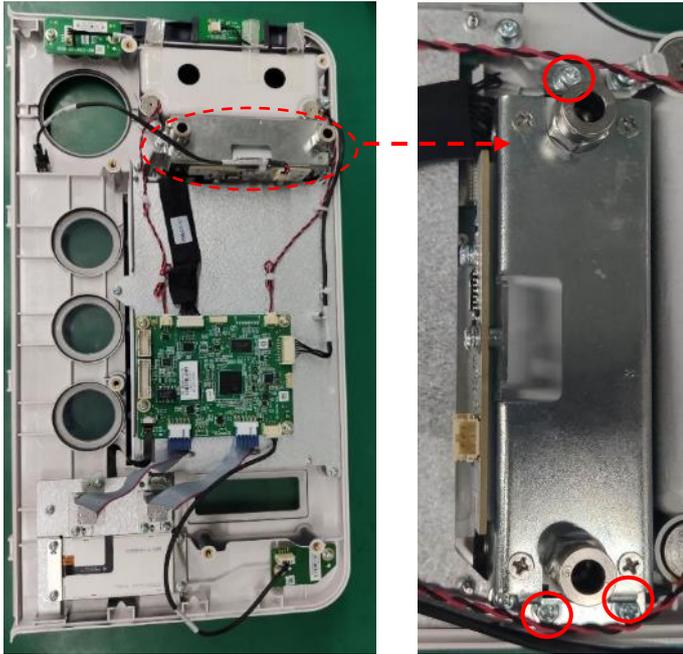
#### 9.53.1.3 Pre-disassembly

1. Refer to **9.1.1 Open the Service Door** to open the service door.
2. Refer to **9.1.2 Remove the Auxiliary Output Assembly** to remove the auxiliary output assembly.
3. Refer to **9.1.3 Remove the Rear Cover Plate of the Work Surface** to remove the rear cover plate of the work surface.
4. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
5. Refer to **9.1.5 Remove the Instrument Panel Assembly** to remove the instrument panel assembly.

### 9.53.2 Remove the Spare Flowmeter Assembly

1. Disconnect the cable from the spare flowmeter assembly.

2. Remove the three screws from the spare flowmeter assembly with the Phillips screwdriver to remove the assembly.



## 9.54 Disassemble the Spare Flowmeter Door Electromagnet

### 9.54.1 Prepare for Disassembly

#### 9.54.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.54.1.2 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

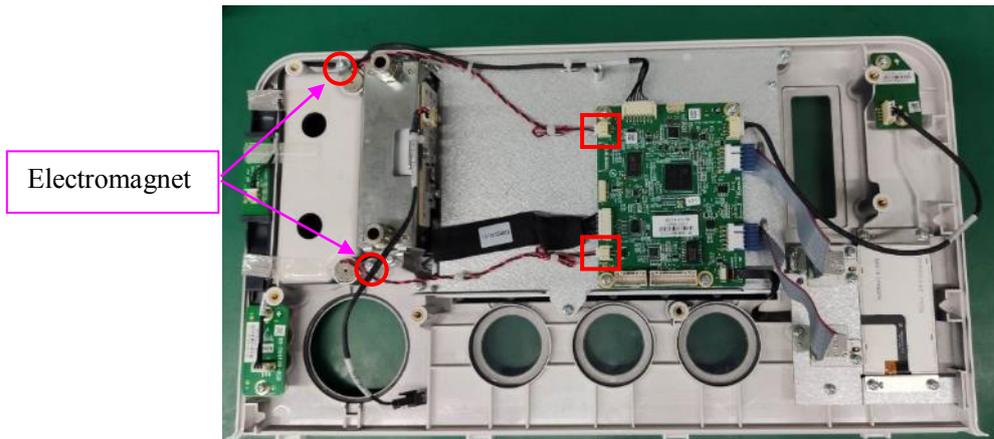
#### 9.54.1.3 Pre-disassembly

1. Refer to **9.1.1 Open the Service Door** to open the service door.
2. Refer to **9.1.2 Remove the Auxiliary Output Assembly** to remove the auxiliary output assembly.
3. Refer to **9.1.3 Remove the Rear Cover Plate of the Work Surface** to remove the rear cover plate of the work surface.
4. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
5. Refer to **9.1.5 Remove the Instrument Panel Assembly** to remove the instrument panel assembly.

### 9.54.2 Remove the Spare Flowmeter Door Electromagnet

1. Disconnect the cables (marked by □ in the figure) from the spare flowmeter door electromagnet.

2. Remove the two screws from the spare flowmeter door electromagnet with the Phillips screwdriver to remove the electromagnet.



## 9.55 Disassemble the Indicator Light Board

### 9.55.1 Prepare for Disassembly

#### 9.55.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.55.1.2 Preparations

Before disassembly,

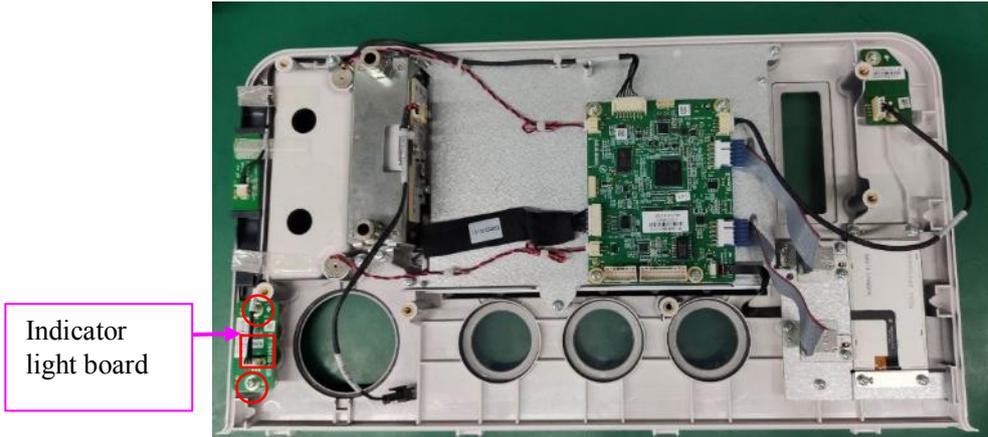
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.

#### 9.55.1.3 Pre-disassembly

1. Refer to **9.1.1 Open the Service Door** to open the service door.
2. Refer to **9.1.2 Remove the Auxiliary Output Assembly** to remove the auxiliary output assembly.
3. Refer to **9.1.3 Remove the Rear Cover Plate of the Work Surface** to remove the rear cover plate of the work surface.
4. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
5. Refer to **9.1.5 Remove the Instrument Panel Assembly** to remove the instrument panel assembly.

### 9.55.2 Remove the Indicator Light Board

1. Disconnect the cable (marked by □ in the figure) from the indicator light board.
2. Remove the two screws from the indicator light board with the Phillips screwdriver to remove the indicator light board.



## 9.56 Disassemble the Segment Display

### 9.56.1 Prepare for Disassembly

#### 9.56.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.56.1.2 Preparations

Before disassembly,

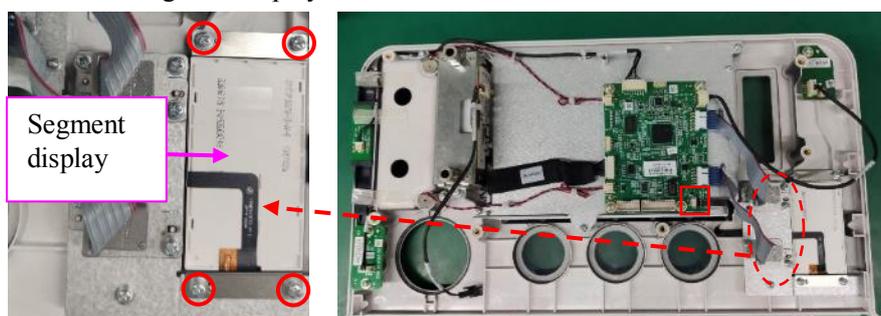
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.56.1.3 Pre-disassembly

1. Refer to **9.1.1 Open the Service Door** to open the service door.
2. Refer to **9.1.2 Remove the Auxiliary Output Assembly** to remove the auxiliary output assembly.
3. Refer to **9.1.3 Remove the Rear Cover Plate of the Work Surface** to remove the rear cover plate of the work surface.
4. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
5. Refer to **9.1.5 Remove the Instrument Panel Assembly** to remove the instrument panel assembly.

### 9.56.2 Remove the Segment Display

1. Disconnect the cable (marked by □ in the figure) from the segment display.
2. Remove the four screws from the segment display with the Phillips screwdriver to remove the segment display.



---

## **9.57 Disassemble the Encoder Beside the Segment Display**

### **9.57.1 Prepare for Disassembly**

#### **9.57.1.1 Tools**

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver
- 220 mm torque wrench

#### **9.57.1.2 Preparations**

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.

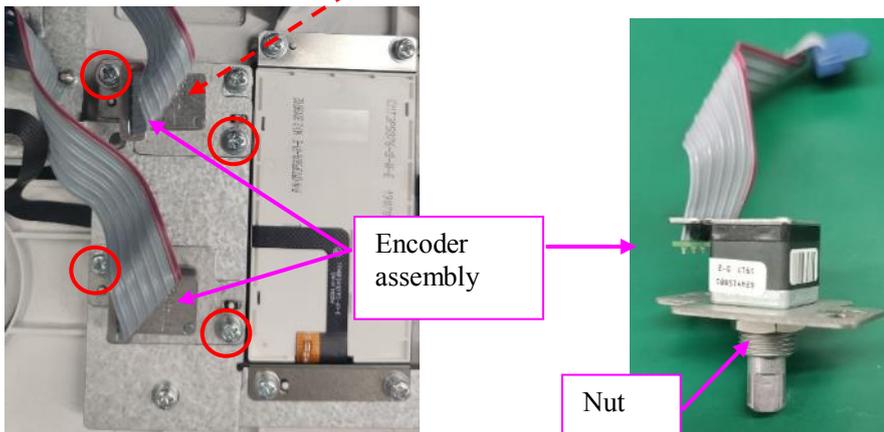
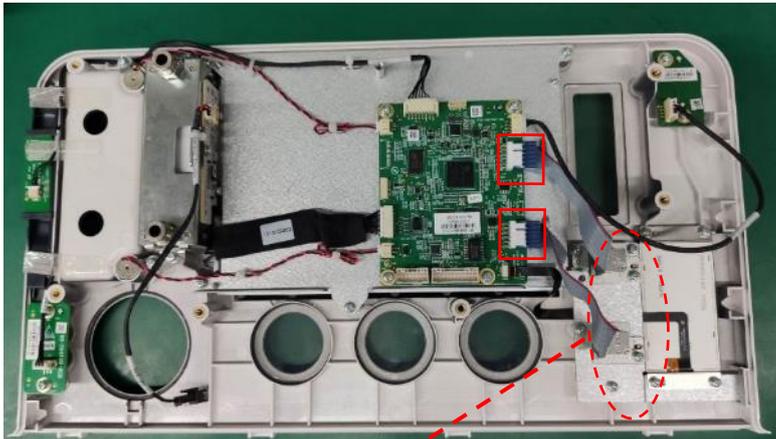
#### **9.57.1.3 Pre-disassembly**

1. Refer to **9.1.1***Open the Service Door* to open the service door.
2. Refer to **9.1.2***Remove the Auxiliary Output Assembly* to remove the auxiliary output assembly.
3. Refer to **9.1.3***Remove the Rear Cover Plate of the Work Surface* to remove the rear cover plate of the work surface.
4. Refer to **9.1.4***Remove the Work Surface Cover Plate FRU* to remove the work surface cover plate.
5. Refer to **9.1.5***Remove the Instrument Panel Assembly* to remove the instrument panel assembly.

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## 9.57.2 Remove the Encoder Beside the Segment Display

1. Disconnect the cables (marked by □ in the figure) from the encoder beside the segment display.
2. Remove the four screws from the encoder with the Phillips screwdriver and pull the encoder assembly straight up to remove it.
3. Remove the nut from the encoder assembly with the 220 mm torque wrench, remove the metal sheet, and take out the encoder.



## 9.58 Disassemble the BFCS Switch Control Board

### 9.58.1 Prepare for Disassembly

#### 9.58.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.58.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

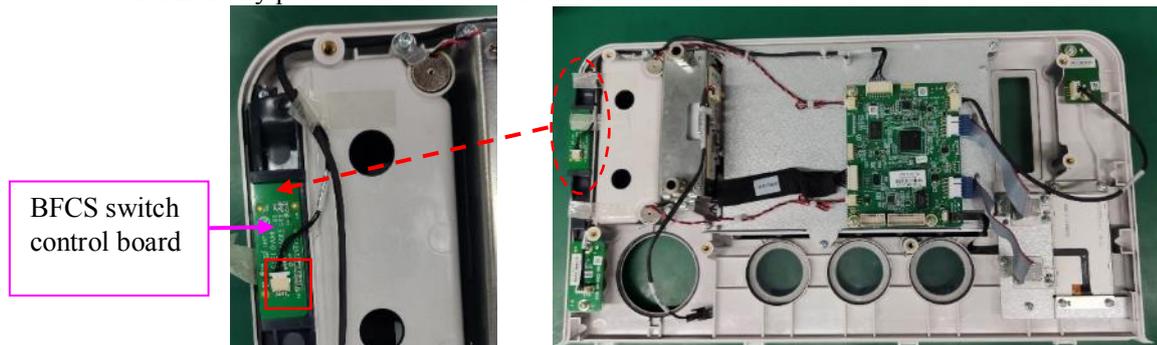
#### 9.58.1.3 Pre-disassembly

1. Refer to *9.1.1 Open the Service Door* to open the service door.

2. Refer to **9.1.2 Remove the Auxiliary Output Assembly** to remove the auxiliary output assembly.
3. Refer to **9.1.3 Remove the Rear Cover Plate of the Work Surface** to remove the rear cover plate of the work surface.
4. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
5. Refer to **9.1.5 Remove the Instrument Panel Assembly** to remove the instrument panel assembly.

## 9.58.2 Remove the BFCS Switch Control Board

Disconnect the cable (marked by □ in the figure) from the BFCS switch control board and horizontally pull out the BFCS switch control board.



## 9.59 Disassemble the BFCS Door Assembly

### 9.59.1 Prepare for Disassembly

#### 9.59.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.59.1.2 Preparations

Before disassembly,

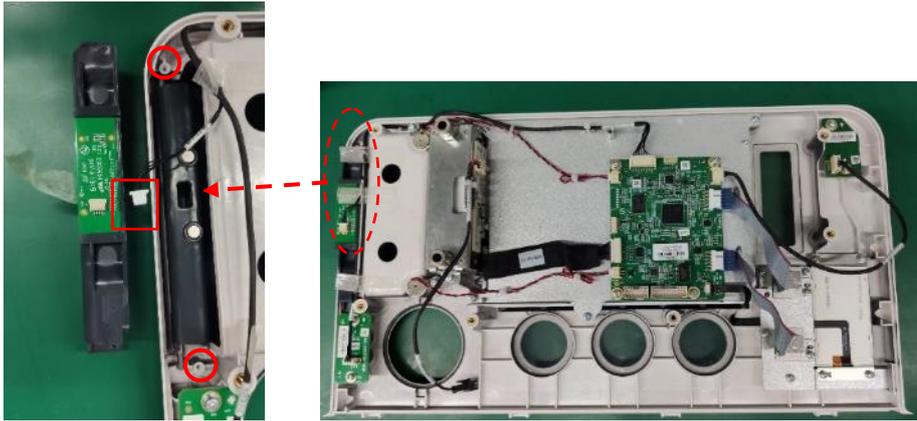
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.59.1.3 Pre-disassembly

1. Refer to **9.1.1 Open the Service Door** to open the service door.
2. Refer to **9.1.2 Remove the Auxiliary Output Assembly** to remove the auxiliary output assembly.
3. Refer to **9.1.3 Remove the Rear Cover Plate of the Work Surface** to remove the rear cover plate of the work surface.
4. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
5. Refer to **9.1.5 Remove the Instrument Panel Assembly** to remove the instrument panel assembly.

### 9.59.2 Remove the BFCS Door Assembly

1. Disconnect the cable (marked by □ in the figure) from the BFCS switch control board.
2. Remove the two screws from the BFCS door assembly with the Phillips screwdriver, take out the upper cover plate, and gently remove the BFCS door assembly. Note that there is a torsion spring.



## 9.60 Disassemble the Spare Flowmeter Keyboard

### 9.60.1 Prepare for Disassembly

#### 9.60.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.60.1.2 Preparations

Before disassembly,

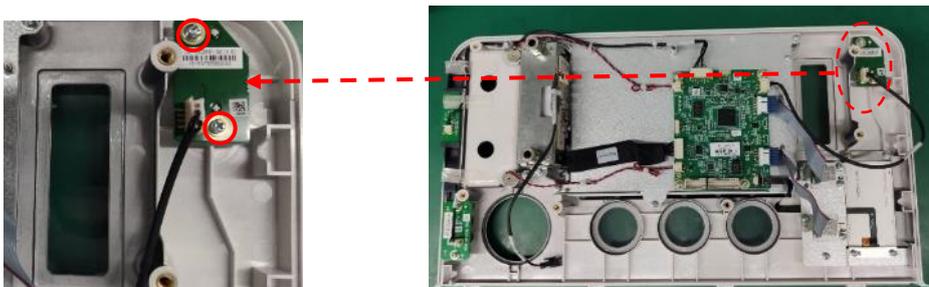
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.60.1.3 Pre-disassembly

1. Refer to *9.1.1 Open the Service Door* to open the service door.
2. Refer to *9.1.2 Remove the Auxiliary Output Assembly* to remove the auxiliary output assembly.
3. Refer to *9.1.3 Remove the Rear Cover Plate of the Work Surface* to remove the rear cover plate of the work surface.
4. Refer to *9.1.4 Remove the Work Surface Cover Plate FRU* to remove the work surface cover plate.
5. Refer to *9.1.5 Remove the Instrument Panel Assembly* to remove the instrument panel assembly.

### 9.60.2 Remove the Spare Flowmeter Keyboard

1. Disconnect the cable from the spare flowmeter keyboard.
2. Remove the two screws with the Phillips screwdriver and take out the spare flowmeter keyboard.



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## 9.61 Disassemble the Alarm Lamp Board

### 9.61.1 Prepare for Disassembly

#### 9.61.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.61.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.61.1.3 Pre-disassembly

Refer to step 1 in *9.1.7 Remove the Display Assembly* to remove the display assembly.

### 9.61.2 Removing the Alarm Lamp Board

1. Disconnect the cable from the alarm lamp board.
2. Remove the two screws with the Phillips screwdriver to remove the alarm lamp board.



## 9.62 Disassemble the Speaker

### 9.62.1 Prepare for Disassembly

#### 9.62.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.62.1.2 Preparations

Before disassembly,

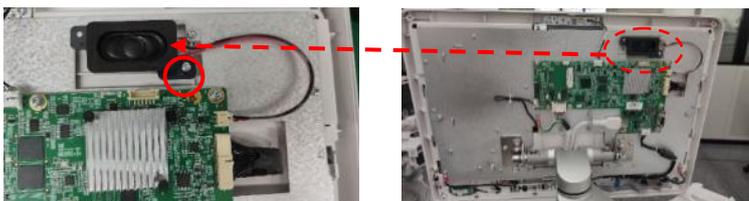
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.62.1.3 Pre-disassembly

Refer to step 1 in *9.1.7 Remove the Display Assembly* to remove the display assembly.

### 9.62.2 Remove the Speaker

1. Disconnect the cable from the speaker.
2. Remove the screw with the Phillips screwdriver to remove the speaker.



---

## 9.63 Disassemble the Display Service Kit

### 9.63.1 Prepare for Disassembly

#### 9.63.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.63.1.2 Preparations

Before disassembly,

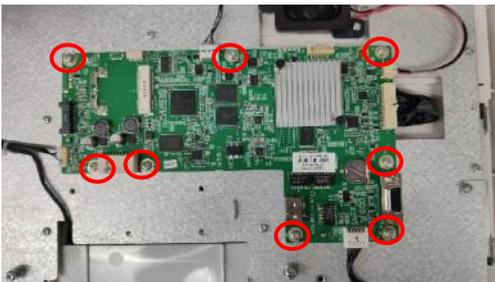
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.63.1.3 Pre-disassembly

Refer to *9.1.7 Remove the Display Assembly* to remove the display assembly.

### 9.63.2 Remove the Display Service Kit

1. Disconnect the cables from the CPU board.
2. Remove the eight screws from the CPU board with the Phillips screwdriver and take out the display service kit.



## 9.64 Disassemble the CPU Board PCBA

### 9.64.1 Prepare for Disassembly

#### 9.64.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.64.1.2 Preparations

Before disassembly,

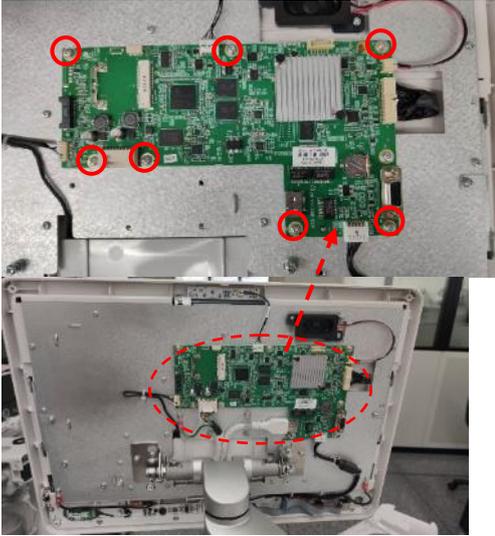
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.64.1.3 Pre-disassembly

Refer to step 1 in *9.1.7 Remove the Display Assembly* to remove the display assembly.

### 9.64.2 Remove the CPU Board PCBA

1. Disconnect the cables from the CPU board PCBA.
2. Remove the eight screws from the CPU board PCBA with the Phillips screwdriver and take out the CPU board PCBA.



## 9.65 Disassemble the Key Lighting Board

### 9.65.1 Prepare for Disassembly

#### 9.65.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.65.1.2 Preparations

Before disassembly,

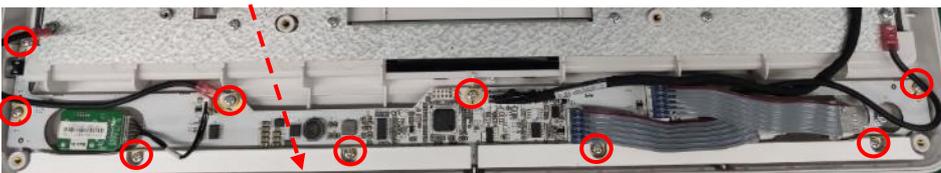
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.65.1.3 Pre-disassembly

Refer to step 1 in *9.1.7 Remove the Display Assembly* to remove the display assembly.

### 9.65.2 Remove the Key Lighting Board

1. Disconnect the cables from the key lighting board.
2. Remove the nine screws from the key lighting board with the Phillips screwdriver and take out the key lighting board.



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## 9.66 Disassemble the Encoder Knob (Strawhat-shaped)

### 9.66.1 Prepare for Disassembly

#### 9.66.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.66.1.2 Preparations

Before disassembly,

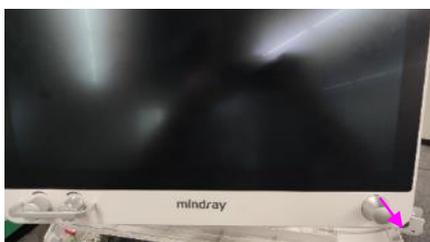
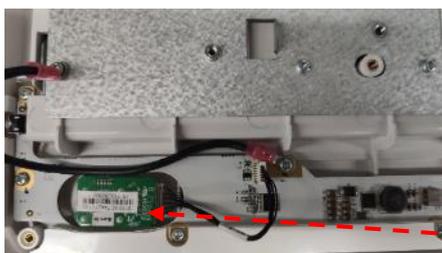
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.66.1.3 Pre-disassembly

Refer to step 1 in *9.1.7 Remove the Display Assembly* to remove the display assembly.

### 9.66.2 Remove the Encoder Knob (Strawhat-shaped)

1. Disconnect the cable from the encoder knob (strawhat-shaped).
2. Pull out the encoder knob (strawhat-shaped), turn the nut counterclockwise with the tool in the service kit to remove it, and take out the encoder.



## 9.67 Disassemble the Flow Regulator Encoder and Two Gas Knobs

### 9.67.1 Prepare for Disassembly

#### 9.67.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver
- Needle-nose pliers

#### 9.67.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

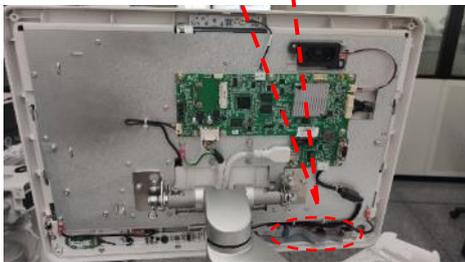
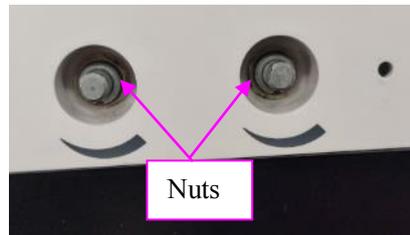
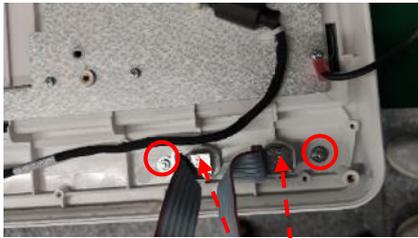
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### 9.67.1.3 Pre-disassembly

Refer to step 1 in **9.1.7 Remove the Display Assembly** to remove the display assembly.

### 9.67.2 Remove the Flow Regulator Encoder and Two Gas Knobs

1. Disconnect the cables from the flow regulator encoder.
2. Remove the two nuts fastening the bracket with the needle-nose pliers.
3. Turn the two nuts counterclockwise with the needle-nose pliers to remove them, and take out the flow regulator encoder.



## 9.68 Disassemble the Airway Pressure Gauge

### 9.68.1 Prepare for Disassembly

#### 9.68.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- None.

#### 9.68.1.2 Preparations

Before disassembly,

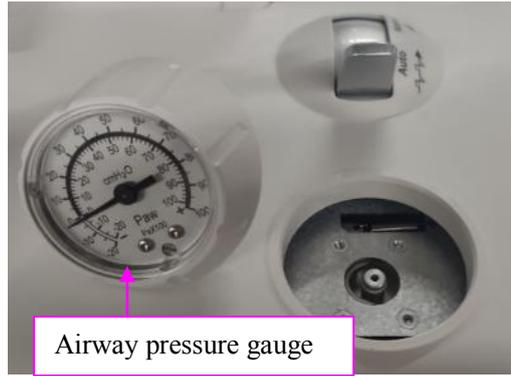
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.68.1.3 Pre-disassembly

Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.

### 9.68.2 Remove the Airway Pressure Gauge

Press the button (marked by ○ in the figure) hard and pull out the airway pressure gauge.



## 9.69 Disassemble the Auto/Manual Switch Assembly

### 9.69.1 Prepare for Disassembly

#### 9.69.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.69.1.2 Preparations

Before disassembly,

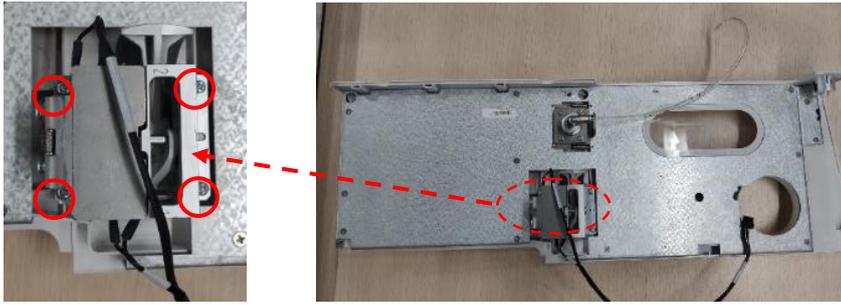
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.69.1.3 Pre-disassembly

1. Refer to **9.1.10 Open the Service Door** to open the service door.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
4. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.
5. Refer to **9.20 Disassemble the Venturi Negative Pressure Control Panel Assembly** to remove the Venturi negative pressure control panel assembly.
6. Refer to **9.26 Disassemble the APL Valve Assembly** to remove the APL valve assembly.
7. Refer to **9.1.6 Remove the Upper-Left Cover Plate** to remove the upper-left cover plate assembly of the work surface.

### 9.69.2 Remove the Auto/Manual Switch Assembly

1. Turn over the upper-left cover plate assembly and disconnect the cable from the auto/manual switch assembly.
2. Remove the four screws with the Phillips screwdriver to remove the auto/manual switch assembly.



## **9.70 Disassemble the Upper-Left Cover Plate FRU**

### **9.70.1 Prepare for Disassembly**

#### **9.70.1.1 Tools**

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### **9.70.1.2 Preparations**

Before disassembly,

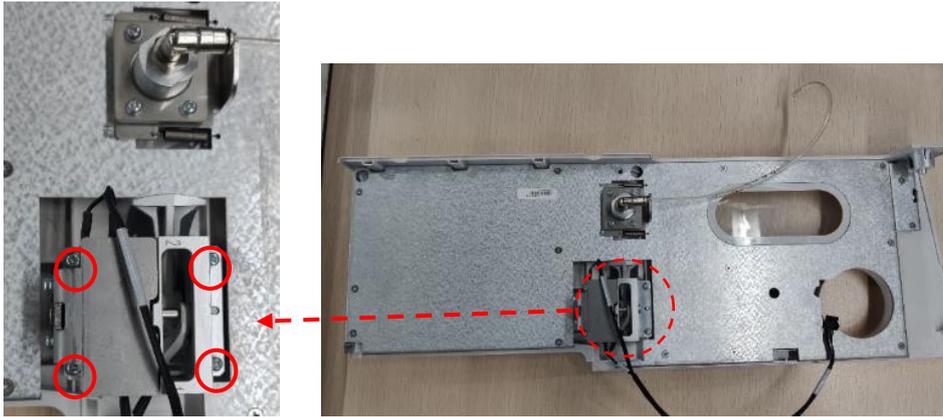
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### **9.70.1.3 Pre-disassembly**

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.68 Disassemble the Airway Pressure Gauge** to remove the airway pressure gauge.
4. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
5. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.
6. Refer to **9.20 Disassemble the Venturi Negative Pressure Control Panel Assembly** to remove the Venturi negative pressure control panel assembly.
7. Refer to **9.26 Disassemble the APL Valve Assembly** to remove the APL valve assembly.
8. Refer to **9.1.6 Remove the Upper-Left Cover Plate** to remove the upper-left cover plate assembly of the work surface.

### **9.70.2 Remove the Upper-Left Cover Plate FRU**

1. Disconnect the hose from the airway pressure gauge and the cable from the auto/manual switch assembly.
2. Remove the eight screws with the Phillips screwdriver to remove the airway pressure gauge and the auto/manual switch assembly.



## 9.71 Disassemble the O2 Cell Door Cover Assembly

### 9.71.1 Prepare for Disassembly

#### 9.71.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver
- M4 hexagon screw spanner

#### 9.71.1.2 Preparations

Before disassembly,

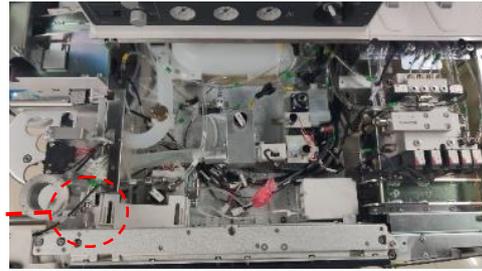
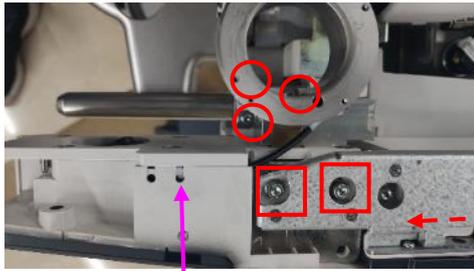
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Bleed down the gas pressure inside the anesthesia machine to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.71.1.3 Pre-disassembly

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
4. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.
5. Refer to **9.20 Disassemble the Venturi Negative Pressure Control Panel Assembly** to remove the Venturi negative pressure control panel assembly.
6. Refer to **9.26 Disassemble the APL Valve Assembly** to remove the APL valve assembly.
7. Refer to **9.1.6 Remove the Upper-Left Cover Plate** to remove the upper-left cover plate assembly of the work surface.

### 9.71.2 Remove the O2 Cell Door Cover Assembly

1. Disconnect the hose and cable from the O2 cell door cover assembly.
2. Remove the three screws (marked by ○ in the figure) with the Phillips screwdriver.
3. Remove the two screws (marked by □ in the figure) with the hexagon screw spanner to remove the O2 cell door cover assembly.



O2 cell door cover

## 9.72 Disassemble the O2 Cell Cable

### 9.72.1 Prepare for Disassembly

#### 9.72.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver
- M3 and M4 hexagon screw spanners
- Scissors

#### 9.72.1.2 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.72.1.3 Pre-disassembly

Refer to *9.71 Disassemble the O2 Cell Door Cover Assembly* to remove the O2 cell door cover assembly.

### 9.72.2 Remove the O2 Cell Cable

1. Remove the two screws (marked by □ in the figure) with the M3 hexagon screw spanner and the six screws (marked by ○ in the figure) with the Phillips screwdriver, and remove the fixing plate.
2. Cut the cable strap with the scissors and remove the O2 cell cable.



## 9.73 Disassemble the Circuit Adapter Block Assembly

### 9.73.1 Prepare for Disassembly

#### 9.73.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

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### 9.73.1.2 Preparations

Before disassembly,

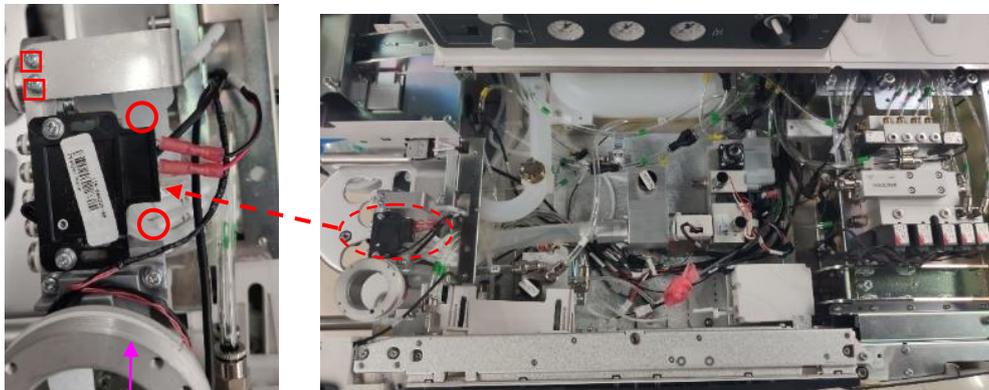
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.73.1.3 Pre-disassembly

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
4. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.
5. Refer to **9.20 Disassemble the Venturi Negative Pressure Control Panel Assembly** to remove the Venturi negative pressure control panel assembly.
6. Refer to **9.26 Disassemble the APL Valve Assembly** to remove the APL valve assembly.
7. Refer to **9.1.6 Remove the Upper-Left Cover Plate** to remove the upper-left cover plate assembly of the work surface.

### 9.73.2 Remove the Circuit Adapter Block Assembly

1. Remove the two screws (marked by □ in the figure) with the Phillips screwdriver to remove the protection cap.
2. Disconnect the hose and cable from the circuit adapter block assembly.
3. Remove the two screws (at the bottom layer under the hose) with the Phillips screwdriver to remove the circuit adapter block assembly.



Circuit adapter block assembly

### 9.74 Disassemble the Circuit Switch (Hook Lock)

#### 9.74.1 Prepare for Disassembly

##### 9.74.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

##### 9.74.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.

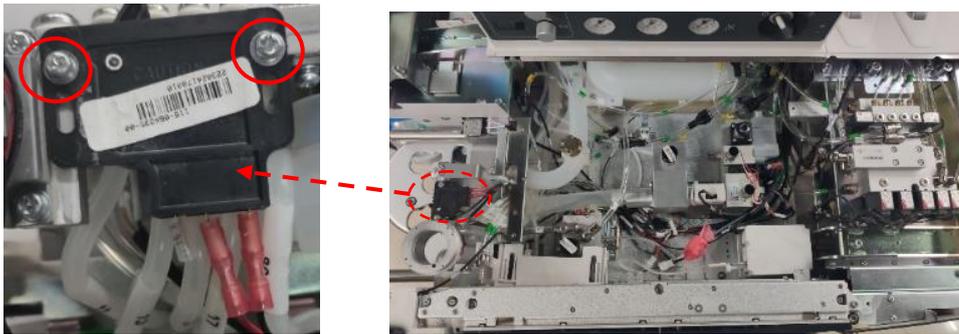
- 
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.74.1.3 Pre-disassembly

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
4. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly..
5. Refer to **9.20 Disassemble the Venturi Negative Pressure Control Panel Assembly** to remove the Venturi negative pressure control panel assembly.
6. Refer to **9.26 Disassemble the APL Valve Assembly** to remove the APL valve assembly.
7. Refer to **9.1.6 Remove the Upper-Left Cover Plate** to remove the upper-left cover plate assembly of the work surface.

### 9.74.2 Remove the Circuit Switch (Hook Lock)

1. Disconnect the plug from the circuit switch (hook lock).
2. Remove the two screws with the Phillips screwdriver and take out the circuit switch (hook lock).



## 9.75 Disassemble the Circuit Heater

### 9.75.1 Prepare for Disassembly

#### 9.75.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.75.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.75.1.3 Pre-disassembly

Refer to **9.73 Disassemble the Circuit Adapter Block Assembly** to remove the circuit adapter block assembly.

### 9.75.2 Remove the Circuit Heater

1. Disconnect the hose and cable from the circuit heater.
2. Hold down the circuit heater, remove the two screws with the Phillips screwdriver, and gently take out the circuit heater. Note that there is a spring.



## 9.76 Disassemble the Auto/Manual Position Detection Switch

### 9.76.1 Prepare for Disassembly

#### 9.76.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.76.1.2 Preparations

Before disassembly,

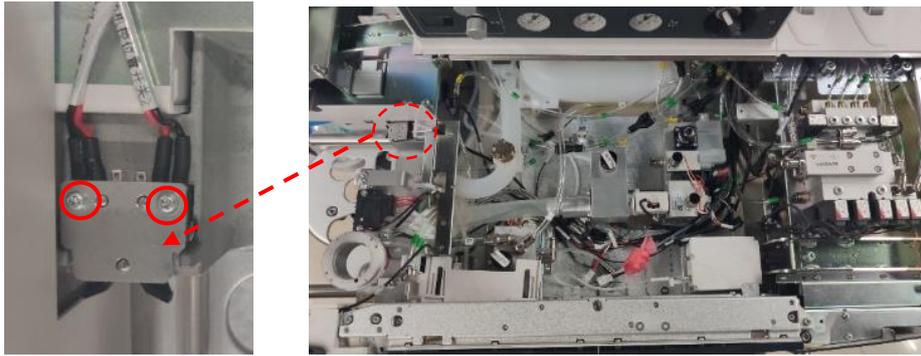
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.76.1.3 Pre-disassembly

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
4. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.
5. Refer to **9.20 Disassemble the Venturi Negative Pressure Control Panel Assembly** to remove the Venturi negative pressure control panel assembly.
6. Refer to **9.26 Disassemble the APL Valve Assembly** to remove the APL valve assembly.
7. Refer to **9.1.6 Remove the Upper-Left Cover Plate** to remove the upper-left cover plate assembly of the work surface.

### 9.76.2 Remove the Auto/Manual Position Detection Switch

1. Disconnect the cable from the auto/manual position detection switch.
2. Remove the two screws with the Phillips screwdriver to remove the auto/manual position detection switch.



## **9.77 Disassemble the APL Valve Mounting Base Assembly**

### **9.77.1 Prepare for Disassembly**

#### **9.77.1.1 Tools**

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### **9.77.1.2 Preparations**

Before disassembly,

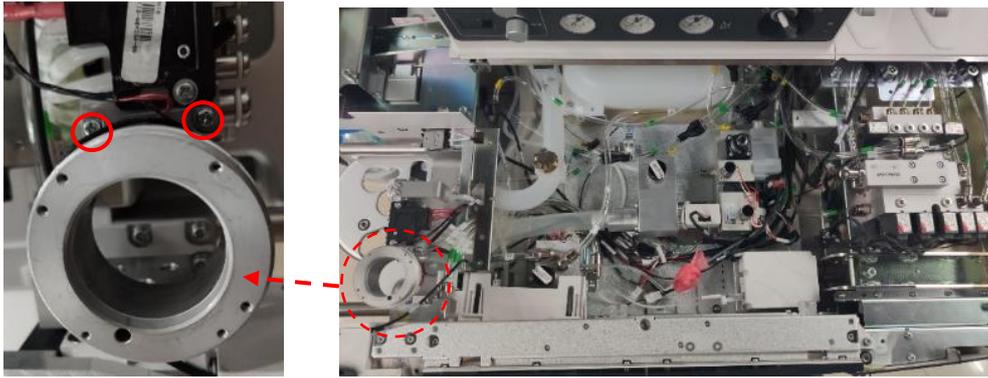
- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### **9.77.1.3 Pre-disassembly**

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
4. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.
5. Refer to **9.20 Disassemble the Venturi Negative Pressure Control Panel Assembly** to remove the Venturi negative pressure control panel assembly.
6. Refer to **9.26 Disassemble the APL Valve Assembly** to remove the APL valve assembly.
7. Refer to **9.1.6 Remove the Upper-Left Cover Plate** to remove the upper-left cover plate assembly of the work surface.

### **9.77.2 Remove the APL Valve Mounting Base Assembly**

1. Disconnect the cable from the APL valve mounting base assembly.
2. Remove the two screws with the Phillips screwdriver to remove the APL valve mounting base assembly.



## 9.78 Disassemble the Auto/Manual Drive Valve Assembly

### 9.78.1 Prepare for Disassembly

#### 9.78.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver

#### 9.78.1.2 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 to avoid personal injury or equipment damage.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

#### 9.78.1.3 Pre-disassembly

1. Refer to **9.1.4 Remove the Work Surface Cover Plate FRU** to remove the work surface cover plate.
2. Refer to step 1 in **9.25.2 Remove the Patient Circuit Assembly** to remove the patient circuit.
3. Refer to **9.30 Disassemble the Volume Exchanger Assembly** to remove the volume exchanger assembly.
4. Refer to **9.31 Disassemble the VE Box Assembly** to remove the VE box assembly.

### 9.78.2 Remove the Auto/Manual Drive Valve Assembly

1. Disconnect the hose and cable from the auto/manual drive valve assembly.
2. Remove the screw with the Phillips screwdriver to remove the cover of the auto/manual drive valve assembly.
3. Remove the two screws with the Phillips screwdriver and vertically pull out the auto/manual drive valve assembly downward.



Cover of the auto/manual drive valve assembly

Auto/manual drive valve assembly

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## 9.79 Disassemble the STEINCO 5-Inch Central Control Caster

### 9.79.1 Prepare for Disassembly

#### 9.79.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver
- M6 and M8 hexagon screw spanners

#### 9.79.1.2 Preparations

Before disassembly,

- Make sure that the anesthesia machine is turned off and disconnected from the A/C power source.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

### 9.79.2 Remove the STEINCO 5-Inch Central Control Caster

1. Refer to *9.1.1 Open the Service Door* to open the service door.
2. Refer to *9.38 Disassemble the Battery Box Assembly* to remove the battery box assembly.
3. Remove the four screws from the left and right rails at the bottom with the Phillips screwdriver to remove the rails.

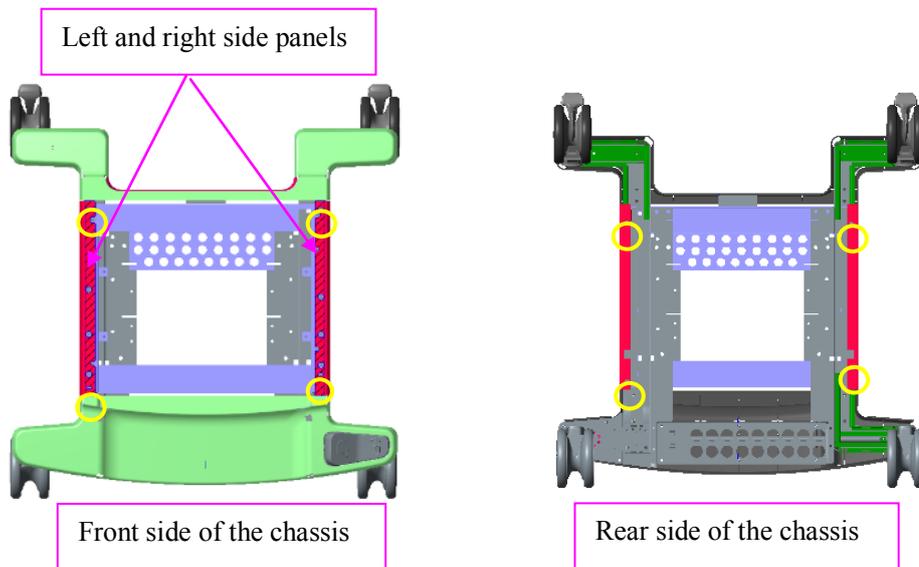


4. Remove the six screws on the left and right fixed cart rails and the two screws on the left and right of the service door with the hexagon screw spanner, and lift the upper half to remove it.

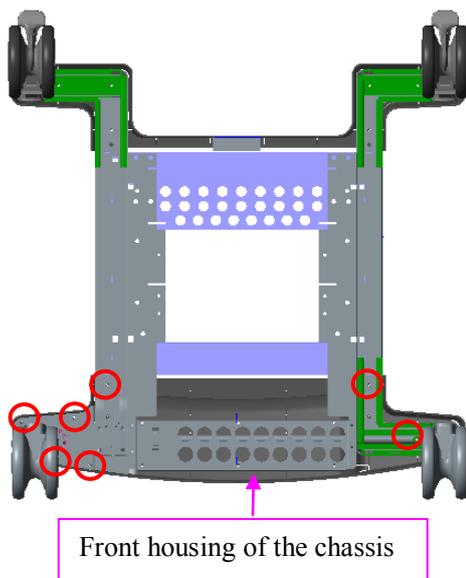




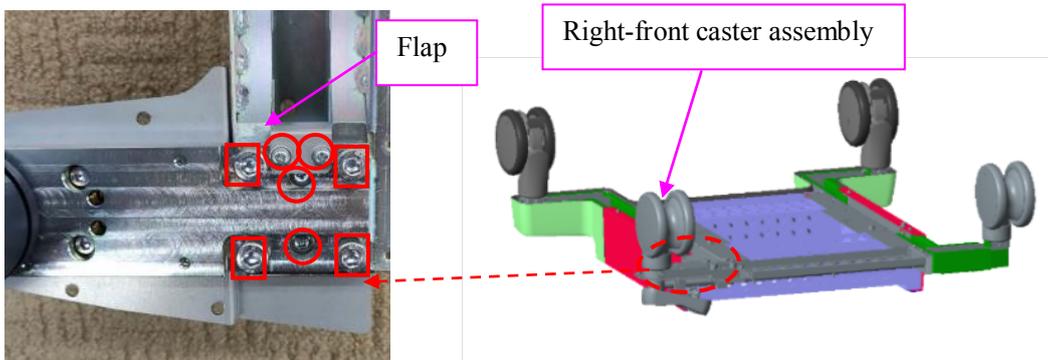
5. Remove the four screws on each of the left and right side panels with the Phillips screwdriver to remove the side panels.



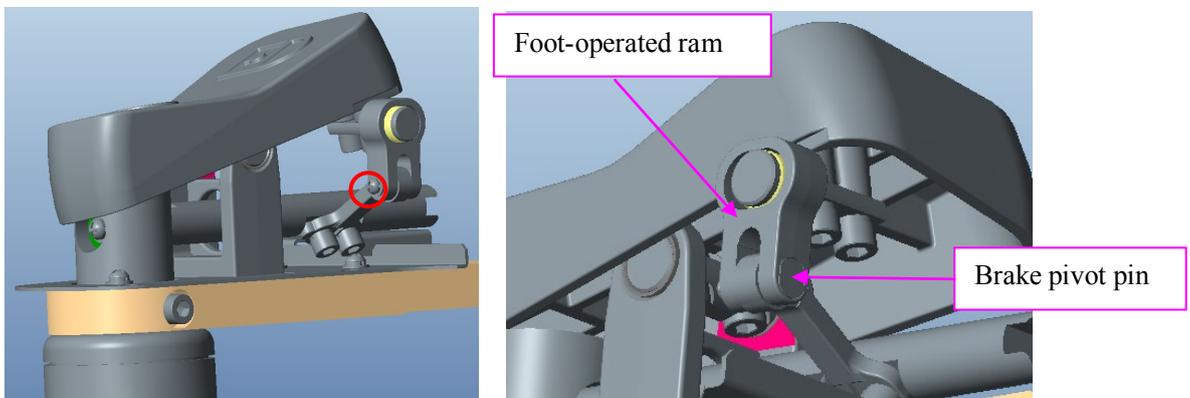
6. Turn over the chassis and remove the seven screws with the Phillips screwdriver to remove the front housing of the chassis.



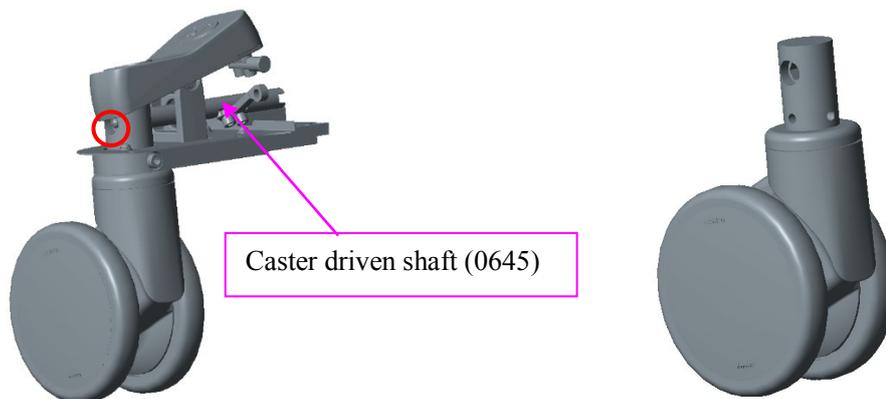
7. Remove the four screws (marked by ○ in the figure) with the Phillips screwdriver to remove the flap. Then remove the four screws (marked by □ in the figure) with the M8 hexagon screw spanner to remove the right-front caster assembly.



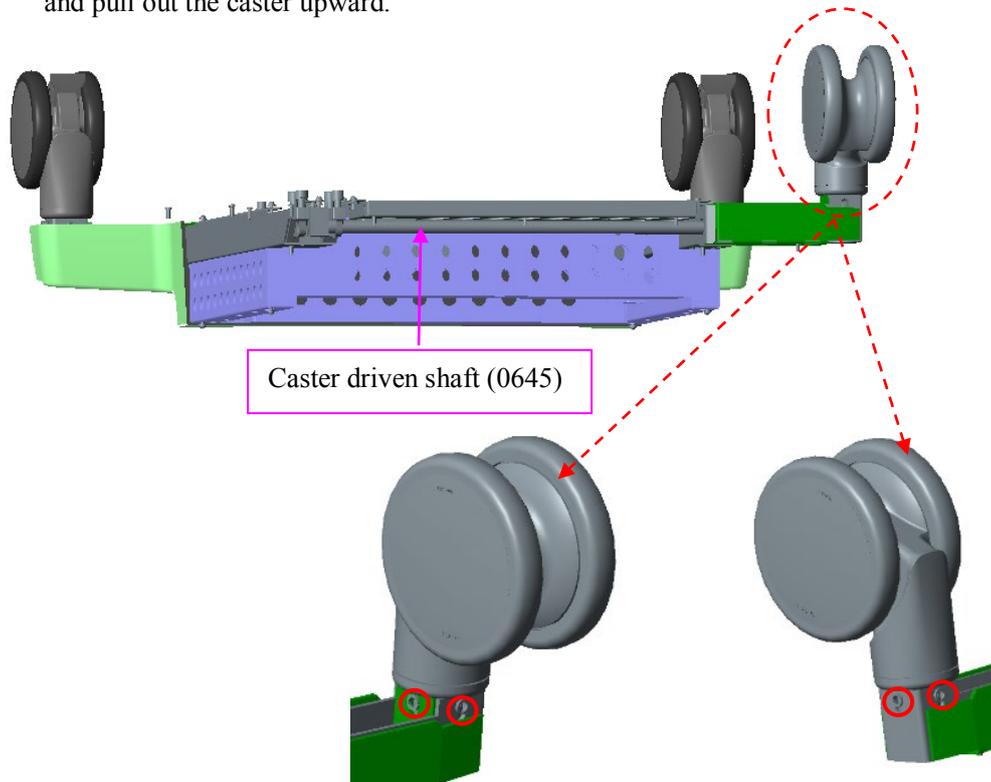
8. Remove the screw (marked by ○ in the figure) with the Phillips screwdriver, pull out the brake pivot pin, and remove the foot-operated ram.



9. Remove the screw (marked by ○ in the figure) with the Phillips screwdriver, pull out the caster driven shaft, and remove the right-front caster.



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10. Pull out the caster driven shaft (0645) for a certain distance, remove the four screws from the STEINCO 5-inch central control caster with the M6 hexagon screw spanner, and pull out the caster upward.



## 9.80 Disassemble the STEINCO 5-Inch Standalone Brake Casters

### 9.80.1 Prepare for Disassembly

#### 9.80.1.1 Tools

During parts disassembly and replacement, the following tools may be required:

- Phillips screwdriver
- M6 hexagon screw spanner

#### 9.80.1.2 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 instructed.
- Disconnect all pipelines and cylinder gas supplies.
- Maneuver the anesthesia machine to an appropriate location and then apply the brake.

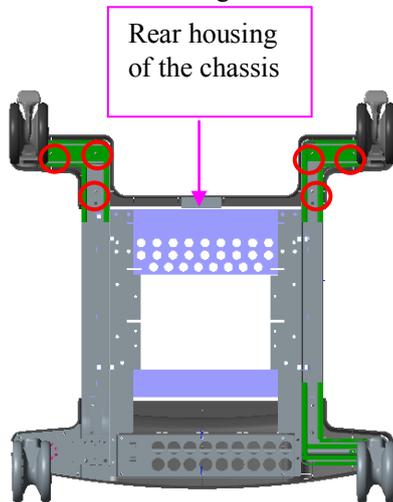
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### 9.80.1.3 Pre-disassembly

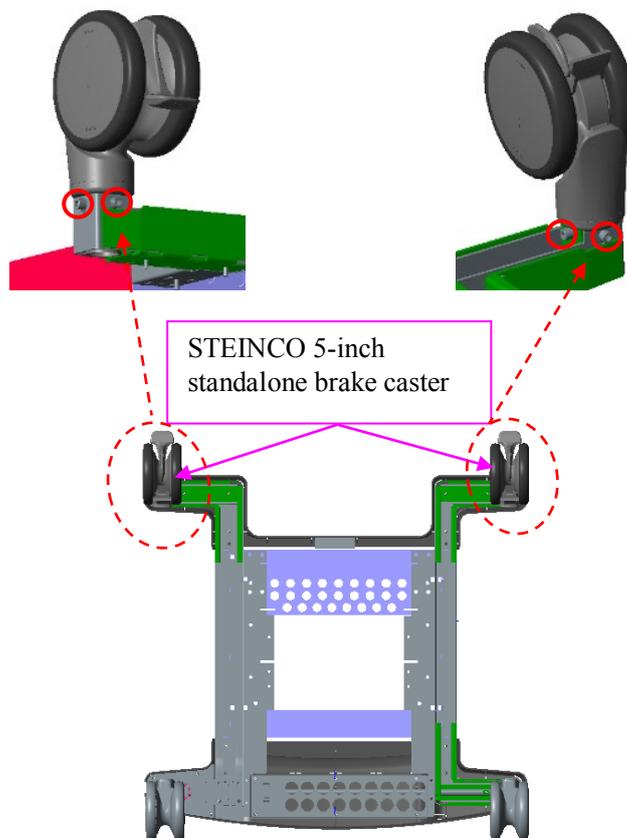
Refer to steps 1 to 5 in **9.79.2 Remove the STEINCO 5-Inch Central Control Caster** to remove the chassis.

### 9.80.2 Remove the STEINCO 5-Inch Standalone Brake Casters

1. Turn over the chassis and remove the six screws with the Phillips screwdriver to remove the rear housing of the chassis.



2. Remove the four screws from each of the left and right casters with the M6 hexagon screw spanner and remove the two STEINCO 5-inch standalone brake casters.



# 10 System Calibration

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## 10.1 Overview

This section elaborates how to test and calibrate the A8/A9 anesthesia machine. Calibration refers to mechanical and electrical adjustments using test devices.

### NOTE

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- **Functional tests must be performed after calibration to verify the calibration result.**
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Ensure that all test materials including the drive gas, breathing circuits, test fixtures, tools, and documents are the latest, available, and calibrated prior to system calibration.

## 10.2 Precautions

### 10.2.1 Warnings

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#### WARNING

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- Use fuses of the specified type and rating to prevent fire.
  - The machine (protection class I) can be connected only to a correctly grounded power supply (including the socket with grounding contact) to prevent electric shocks.
  - Remove all auxiliary devices from the shelf before moving the anesthesia machine on the rough road or any slope. The anesthesia machine with a weight on its top is likely to tip over, causing personal injuries.
  - To avoid the possible explosion hazard, do not operate the machine near flammable anesthetic agents or other flammable substances. Do not use flammable anesthetic agents such as ether or cyclopropane.
  - When high-frequency electric surgery equipment is used, anti-static or electrically conductive breathing tubes may cause burns. Therefore, they are recommended at no time.
  - The electric shock hazard may exist. The machine can be opened only by authorized service personnel.
  - According to IATA and DOT regulations, compressed gases are dangerous. Therefore, the packages or transport packages of dangerous goods must be properly identified, packed, marked, classified, labeled, and documented in accordance with the DOT and IATA regulations. For details, see the International Air Transport Association – Dangerous Goods Regulations and/or Part 171-180 "Transportation" in Title 49 of the Code of Federal Regulations.
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## 10.2.2 Cautions

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### CAUTION

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- Refer to the maintenance period in Chapter 5 "Factory Maintenance Menu" when conducting periodic maintenance.
  - If the pipeline gas supply is in use and the main switch of the system is set to the ON position, ensure that the standby gas cylinder valve is not opened. Otherwise, the cylinder gas supply could be depleted, resulting in an insufficient reserve in the case of a pipeline gas supply failure.
  - Use the cleaning agent sparingly. Excess fluid could enter the machine, causing damage.
  - The machine can be operated only by trained and skilled medical personnel.
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## 10.2.3 Notes

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### NOTE

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- Only a bacterial filter with a low-flow resistance can be connected to the patient module and/or patient pipe.
  - Wear surgical gloves when touching or disassembling valves or other internal components of the breathing system.
  - Ensure that the gas supply of the machine always complies with technical specifications.
  - The markers on the APL valve and PAW gauge are for reference only. The anesthesia machine displays the calibrated airway pressure.
  - If the machine malfunctions during initial calibration or testing, do not use it until the fault is rectified by a professional service technician.
  - After servicing, functional tests, sensor tests, and system tests must be carried out prior to clinical application.
  - The anesthesia machine supports up to two vertical mounting brackets to accommodate additional monitors and other devices. Unauthorized mounting accessories are not recommended.
  - Ensure that all devices on the top plate of the anesthesia machine are secured.
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## 10.3 System Calibration

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### NOTE

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- The drive gas of the anesthesia machine and the drive gas set in the calibration device must be consistent with the actual drive gas configured for the machine.
  - If a test item concerning measurement accuracy fails in the system test, perform relevant calibration.
  - Fluke VT Plus: The zero point (baseline) of pressure measurements may slightly drift with the temperature and time. Users can perform zeroing manually to eliminate zero offset. In general, zeroing needs to be performed if the monitor displays a non-zero reading in the case of no pressure. Perform zeroing on the calibration device before making any measurements.
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## NOTE

- You can use VT Plus to perform automatic calibration on pressure sensors or flow sensors, or use other calibration devices meeting the accuracy requirement to perform manual calibration.
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The anesthesia machine provides the functions of monitoring the volume, pressure, inspiratory O<sub>2</sub> concentration, CO<sub>2</sub> concentration, and gas concentration inside the machine. Great measurement deviations of the monitored values are very likely to result from the offset in measured values of relevant measurement components, and calibration needs to be performed.

In standby mode, choose **Main > Setup** to perform flow calibration (user) and O<sub>2</sub> sensor calibration (user); or choose **Main > System > Calibrate** to perform flowmeter zeroing (user), auxiliary O<sub>2</sub>/air zeroing (user), and high-flow O<sub>2</sub> supply zeroing (user); or choose **Main > Service > Calibrate** to perform pressure calibration (service), expiratory valve calibration (service), pressure and flow zeroing (service), and total flow sensor calibration (service).

The following table lists the possible calibration items and calibration occasions:

No.	Calibration Item	Function Description	Calibration Occasion
1	Flow calibration (user)	Calibrates flow sensors of the breathing system.	<ol style="list-style-type: none"> <li>1. The TV measured value greatly deviates from the settings (with the deviation of more than 9%) after the flow sensors in the patient circuit have been used for a long time.</li> <li>2. The flow sensors in the patient circuit are replaced.</li> <li>3. The sensor adapter board is replaced.</li> <li>4. The VCM is replaced.</li> <li>5. The inspiratory valve assembly is replaced.</li> </ol>
2	O <sub>2</sub> sensor calibration (user)	Calibrates the measurement accuracy of the O <sub>2</sub> sensor at both 21% O <sub>2</sub> and 100% O <sub>2</sub> .	<ol style="list-style-type: none"> <li>1. The measured values of the O<sub>2</sub> sensor present a deviation of greater than 3% in both the atmospheric environment (21%) and pure O<sub>2</sub> environment (100%).</li> <li>2. The O<sub>2</sub> sensor is replaced.</li> <li>3. The VCM is replaced.</li> </ol>
3	Flowmeter zeroing (user)	Calibrates zero offset in the flowmeter.	<p>Zero offset exists in the flowmeter.</p> <ol style="list-style-type: none"> <li>1. The monitored value deviates from the total flow setting by 100 ml or 5%, whichever is larger; or the monitored value deviates from the limb flow setting by 50 ml or 5%, whichever is larger.</li> <li>2. The flowmeter still displays a flow reading after all fresh gases are turned off.</li> </ol>
4	Auxiliary O <sub>2</sub> /air zeroing (user)	Calibrates zero offset in the auxiliary O <sub>2</sub> /air	<ol style="list-style-type: none"> <li>1. Zero offset exists in the auxiliary O<sub>2</sub>/air module (the</li> </ol>

No.	Calibration Item	Function Description	Calibration Occasion
		module.	<p>monitored value deviates from the total flow setting by 100 ml or 10%, whichever is larger).</p> <p>2. The auxiliary O2/air module is replaced.</p>
5	High-flow O2 supply zeroing (user)	Calibrates zero offset in the high-flow O2 supply module.	<p>1. Zero offset exists in the high-flow O2 supply module (the monitored value deviates from the total flow setting by 2 L or 10%, whichever is larger).</p> <p>2. The high-flow O2 supply module is replaced.</p>
6	Pressure calibration (service)	Calibrates the pressure sensor and PEEP valve of the anesthesia machine.	<p>1. The VCM is replaced.</p> <p>2. The expiratory valve assembly is replaced.</p> <p>3. The sensor adapter board is replaced.</p> <p>4. The measured value of the machine's pressure sensor deviates from that of the standard pressure gauge by 5% of the reading or 2 cmH2O, whichever is larger.</p>
7	Expiratory valve calibration (service)	Calibrates the expiratory valve of the anesthesia machine.	<p>1. The VCM is replaced.</p> <p>2. The inspiratory valve assembly is replaced.</p> <p>3. The sensor adapter board is replaced.</p>
8	Pressure and flow zeroing (service)	Calibrates zero offset in the VCM and VPM.	The flow or pressure waveform deviates from the baseline.
9	Total flow sensor calibration (service)	Calibrates the total limb O2 flow sensor of the electronic flowmeter and obtains the N2O factor of the sensor.	<p>1. The N2O factor of the total limb O2 flow sensor is excessively large.</p> <p>2. The flow sensor is replaced.</p> <p>3. The electronic flowmeter board is replaced.</p>

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## 10.3.1 Flow Calibration (User)

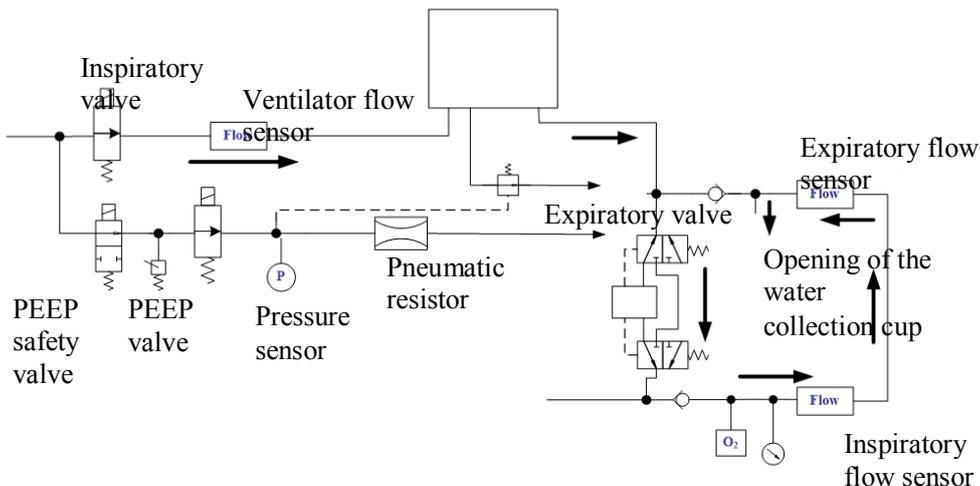
### 10.3.1.1 Principles

#### NOTE

- A new flow sensor must be calibrated.
  - The measurement accuracy of flow sensors may be affected by the operating environment, especially when they have been used for a long time, and the tidal volume control may also experience a great deviation correspondingly. After-sales engineers can call users to help them resolve the deviation problem through calibration.
  - Before calibration, perform the auto circuit leak test and ensure that no leak exists.
  - During calibration, ensure that the drive gas pressure is within the specified range. Otherwise, the calibration may fail.
  - Set the machine to work in EFCS mode for flow calibration.
- 

This calibration item is used to calibrate only the flow sensors and inspiratory valve in the circuit. The built-in flow measurement base source of the machine is utilized to calibrate the inspiratory flow sensor, expiratory flow sensor, and inspiratory valve in the breathing system. The VCM opens the inspiratory valve based on inspiratory valve DA values obtained from service calibration, to inflate the circuit of the breathing system, records the flow of the built-in flow sensor, uses the measured value of the built-in flow sensor as well as AD values collected by the inspiratory flow sensor and expiratory flow sensor as the data of one calibration point for flow sensors, and uses the measured value of the built-in flow sensor as well as the DA value of the inspiratory valve as the data of one calibration point for the inspiratory valve. Change the DA value of the inspiratory valve to obtain calibration data under a series of flows, forming a flow calibration data table. The flow should be in the range from 0 L/min to 120 L/min when the inspiratory valve is opened during flow calibration. If the inspiratory flow sensor and expiratory flow sensor have been used for months, for example, three months after calibration, the measured tidal volume greatly deviates from the settings (with the deviation of more than 9%) due to sensor aging or environmental factors; or a flow sensor is replaced. In this case, the flow sensor needs to be calibrated. The flow calibration (user) can be adopted.

Figure 1 Schematic diagram of flow calibration (user)

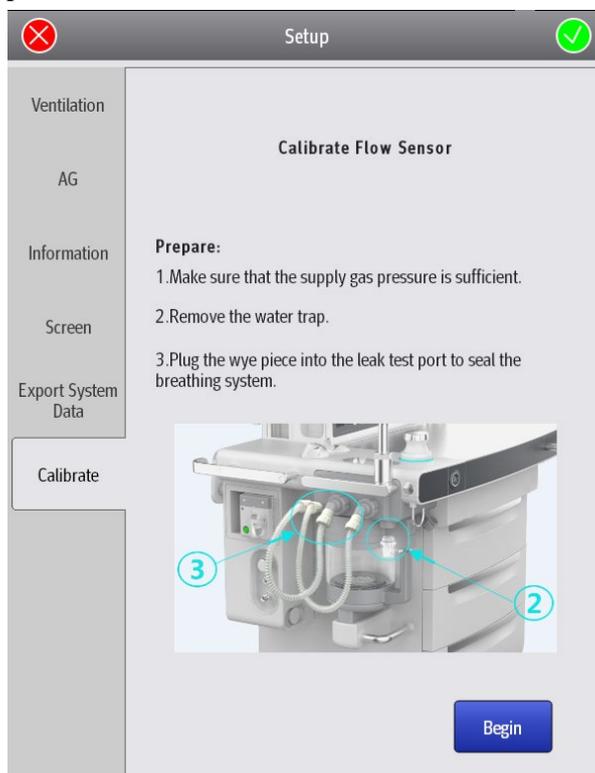


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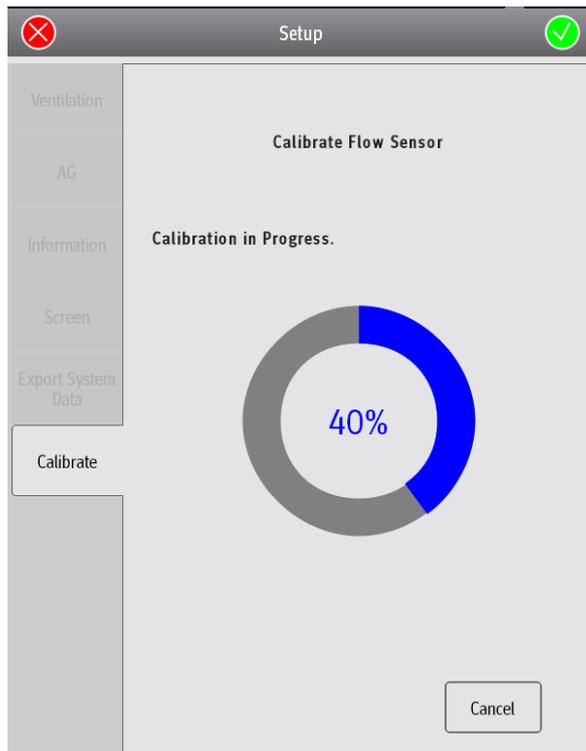
### 10.3.1.2 Calibration Procedure

Perform the following steps to calibrate flow sensors.

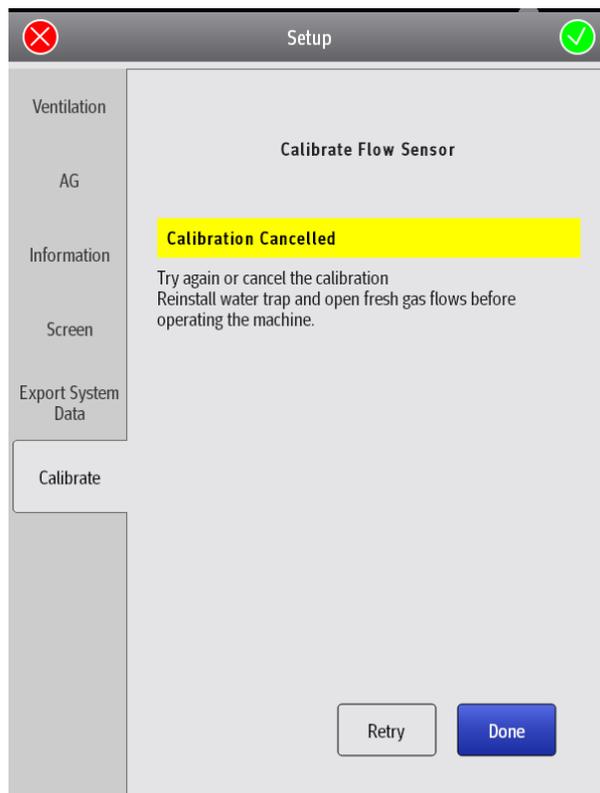
1. Enter the standby mode.
2. Choose **Setup** > **Calibrate** to access the screen shown below.



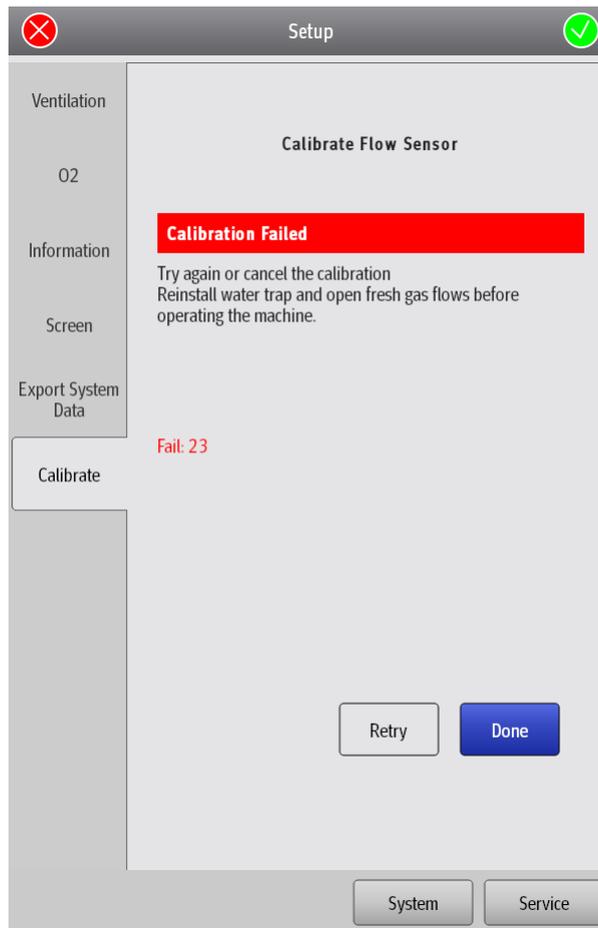
3. Ensure that the drive gas pressure is sufficient.
4. Remove the water collection cup.
5. Insert the three-way Y-piece in the leak test plug to block the breathing circuit.
6. Select **Begin** to start calibration. During calibration, you can select **Cancel** to abort the calibration.



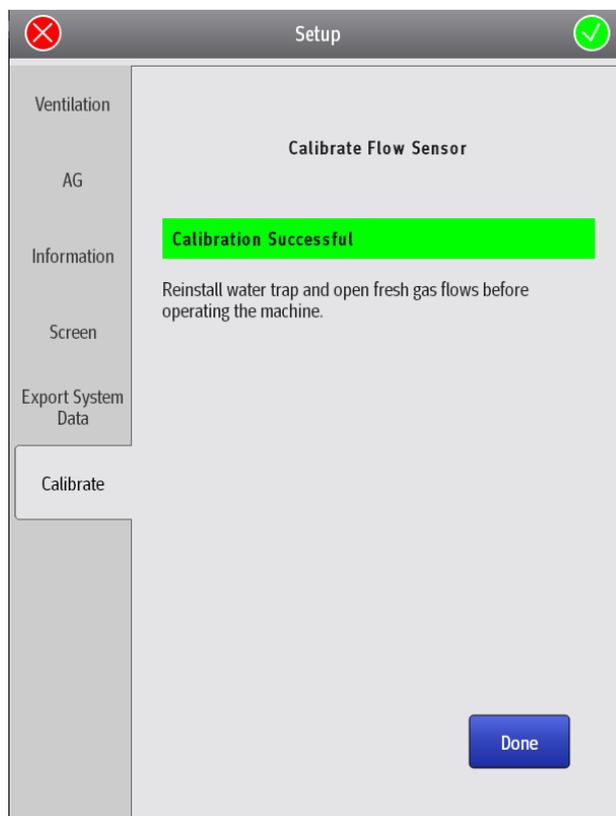
7. The screen shown below is displayed if the ongoing calibration is aborted. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.



8. The screen shown below is displayed if the calibration fails. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.



9. The screen shown below is displayed upon successful calibration. Select **Done** to exit the calibration screen.



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## NOTE

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- **If measurement deviations are not corrected after multiple flow sensor calibrations, it is recommended that a flow sensor in the circuit be replaced and then a calibration be performed for the new flow sensor. If the problem persists, send the machine to the manufacturer for maintenance. After the problem is fixed, perform the calibration and system tests.**
- 

### 10.3.1.3 Common Failures and Recommended Actions

Failure Description	Possible Cause	Recommended Action
Display 1	The valve output flow is insufficient.	<ol style="list-style-type: none"><li>1. Check whether the gas supply is sufficient for the whole calibration process. (The cylinder pressure is not less than 6.9 MPa, and the pipeline gas pressure is not less than 400 kPa.)</li><li>2. Check whether the maximum output flow of the valve is greater than 60 L/min. If not, replace the inspiratory valve.</li></ol>
Display 2	The inspiratory valve is not monotonic.	<ol style="list-style-type: none"><li>1. Replace the inspiratory valve assembly.</li><li>2. Replace the VCM.</li></ol>
Display 3	The flow change is not monotonic.	<ol style="list-style-type: none"><li>1. Check whether the pipeline is connected according to the instructions.</li><li>2. Check whether the gas supply is sufficient for the whole calibration process. (The cylinder pressure is not less than 6.9 MPa, and the pipeline gas pressure is not less than 400 kPa.)</li><li>3. Check whether the calibration device works properly.</li></ol>
Display 4	A zero point error occurs in the expiratory flow sensor.	<ol style="list-style-type: none"><li>1. Check whether the fresh gas is turned off.</li><li>2. Check whether the inspiratory valve can be closed tightly. According to the valve diagnosis tool, after the valve is closed, if the gas supply is disconnected and then connected, the AD values of the ventilator flow sensor basically remain unchanged (the reading change does not exceed 1%), indicating that the valve is closed tightly. If the valve cannot be closed tightly, replace the inspiratory valve assembly.</li><li>3. Check whether the zero point of the sensor is red. If yes, calibrate the sensor again.</li><li>4. Replace the VCM.</li></ol>
Display 5	The expiratory flow sensor is not monotonic.	<ol style="list-style-type: none"><li>1. Check whether the check valve is connected correctly.</li><li>2. Check whether the sampling line is connected correctly.</li></ol>

Failure Description	Possible Cause	Recommended Action
		<ol style="list-style-type: none"> <li>3. Replace the expiratory flow sensor.</li> <li>4. Replace the VCM.</li> </ol>
Display 6	The resolution of the expiratory flow sensor is incorrect.	<ol style="list-style-type: none"> <li>1. Check the connection of the sampling line and the gas tightness.</li> <li>2. Check whether the gas supply pressure ranges from 280 kPa to 600 kPa.</li> <li>3. Check the settings of the calibration device.</li> <li>4. Replace the relevant flow sensor in the circuit.</li> <li>5. Replace the VCM.</li> </ol>
Display 7	The measurement range of the expiratory flow sensor is abnormal.	<ol style="list-style-type: none"> <li>1. Check whether the sampling line is connected correctly.</li> <li>2. Start the valve diagnosis tool in the calibrated pneumatic connection environment, set <b>PEEP Valve Current</b> to 500 mA, close the expiratory valve based on 500 mA, gradually increase the current of the inspiratory valve (<b>Insp Valve Current</b>), and observe the measured value of the calibration device under each valve current. If the collected AD value of the expiratory flow sensor at the time point with the measured value of the calibration device close to (smaller than) 180 L/min is greater than 4050, the measurement range of the expiratory flow sensor is abnormal. Replace the expiratory flow sensor.</li> <li>3. Replace the VCM.</li> </ol>
Display 8	A zero point error occurs on the inspiratory flow sensor.	<ol style="list-style-type: none"> <li>1. Check whether the fresh gas is turned off.</li> <li>2. Check whether the inspiratory valve can be closed tightly. According to the valve diagnosis tool, after the valve is closed, if the gas supply is disconnected and then connected, the AD values of the ventilator flow sensor basically remain unchanged (the reading change does not exceed 1%), indicating that the valve is closed tightly. If the valve cannot be closed tightly, replace the inspiratory valve assembly.</li> <li>3. Check whether the zero point of the sensor is red. If yes, calibrate the sensor again.</li> <li>4. Replace the VCM.</li> </ol>
Display 9	The inspiratory flow sensor is not monotonic.	<ol style="list-style-type: none"> <li>1. Check whether the check valve is connected correctly.</li> <li>2. Check whether the sampling line is connected correctly.</li> <li>3. Replace the inspiratory flow sensor.</li> </ol>

Failure Description	Possible Cause	Recommended Action
		4. Replace the VCM.
Display A	The resolution of the inspiratory flow sensor is incorrect.	<ol style="list-style-type: none"> <li>1. Check the connection of the sampling line and the gas tightness.</li> <li>2. Check whether the gas supply pressure ranges from 280 kPa to 600 kPa.</li> <li>3. Check the settings of the calibration device.</li> <li>4. Replace the relevant flow sensor in the circuit.</li> <li>5. Replace the VCM.</li> </ol>
Display B	The measurement range of the inspiratory flow sensor is abnormal.	<ol style="list-style-type: none"> <li>1. Check whether the sampling line is connected correctly.</li> <li>2. Start the valve diagnosis tool in the calibrated pneumatic connection environment, set <b>PEEP Valve Current</b> to 500 mA, close the expiratory valve based on 500 mA, gradually increase the current of the inspiratory valve (<b>Insp Valve Current</b>), and observe the measured value of the calibration device under each valve current. If the collected AD value of the expiratory flow sensor at the time point with the measured value of the calibration device close to (smaller than) 180 L/min is greater than 4050, the measurement range of the expiratory flow sensor is abnormal. Replace the expiratory flow sensor.</li> <li>3. Replace the VCM.</li> </ol>
Display 34	The drive gas pressure is low.	<ol style="list-style-type: none"> <li>1. Replace or connect a gas supply to keep the gas supply pressure within 280–600 kPa.</li> <li>2. If the gas supply is normal, check the gas supply pressure switch.</li> </ol>
Display 39	The system fails to write data into EEPROM.	<ol style="list-style-type: none"> <li>1. Perform the calibration again.</li> <li>2. Replace the VCM.</li> </ol>
Display 3B	The ACGO switch is in the <b>ON</b> position.	<ol style="list-style-type: none"> <li>1. Check whether the ACGO switch is set to <b>OFF</b>.</li> <li>2. Check the monitoring status of the ACGO switch on the screen of the anesthesia machine.</li> </ol>

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## 10.3.2 O2 Sensor Calibration (User)

### 10.3.2.1 Principles

#### NOTE

- The O2 sensor needs to be calibrated when a great deviation occurs in the O2 monitored value or the O2 sensor or VCM is replaced.
  - Observe whether the O2 sensor displays values on the measure screen before calibration. If not, check whether the O2 measure switch is turned on, check the connection cables of the O2 sensor, or replace the O2 sensor until values are displayed on the screen.
  - The O2 sensor needs to be calibrated at 21% O2 and 100% O2, and corresponding standard gases with the O2 concentration are required.
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### 10.3.2.2 Calibration Procedure

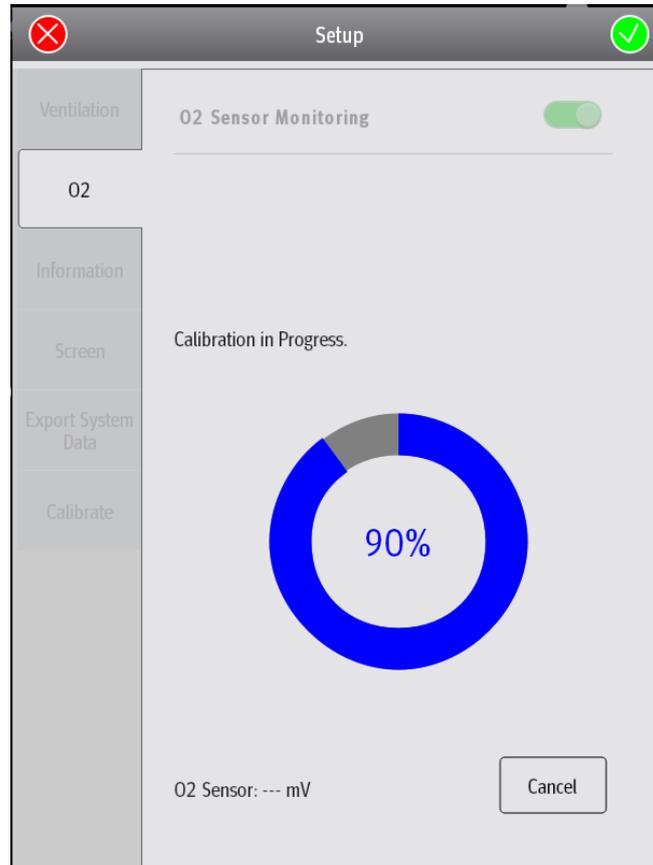
#### Calibration at 21% O2

Perform the following steps to calibrate the O2 sensor at 21% O2.

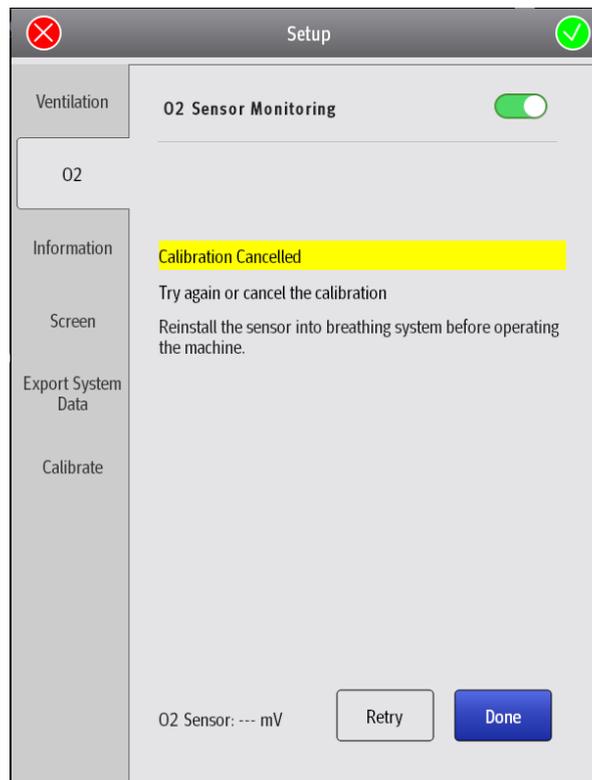
1. Choose **Setup** > **O2** to access the following menu. Follow the instructions on the screen to set the machine. Select **Begin** to start calibration. The normal voltage range of the O2 sensor is 4.44–13.69 mV at 21% O2.



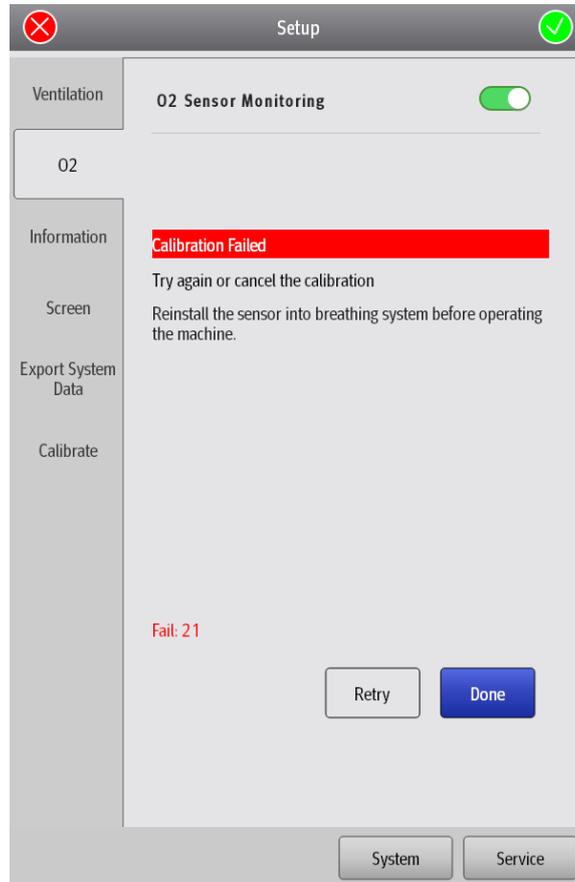
- 
2. The calibration screen shown below is displayed after you select **Begin**. During calibration, you can select **Cancel** to abort the calibration.



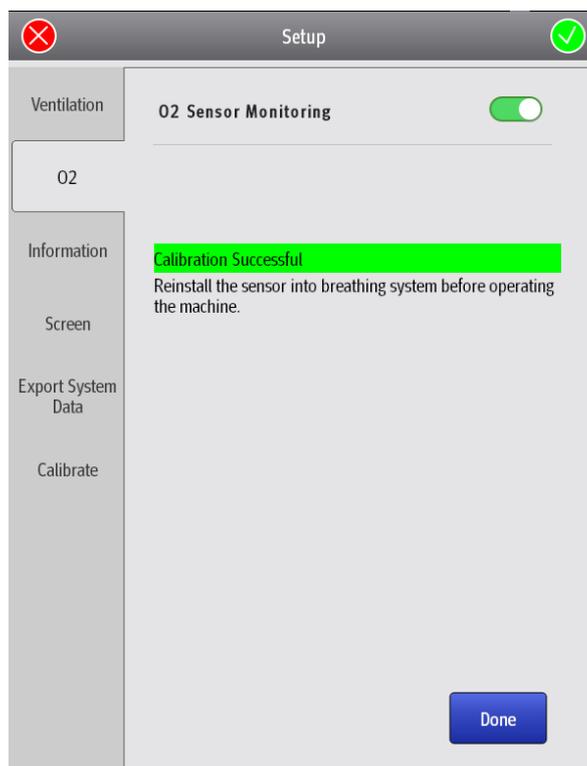
3. The screen shown below is displayed if the ongoing calibration is aborted. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.



- 
4. The screen shown below is displayed if the calibration fails. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.



5. The screen shown below is displayed upon successful calibration (in standby mode). Select **Done** to exit the calibration screen.



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## Calibration at 21% and 100% O<sub>2</sub>

### NOTE

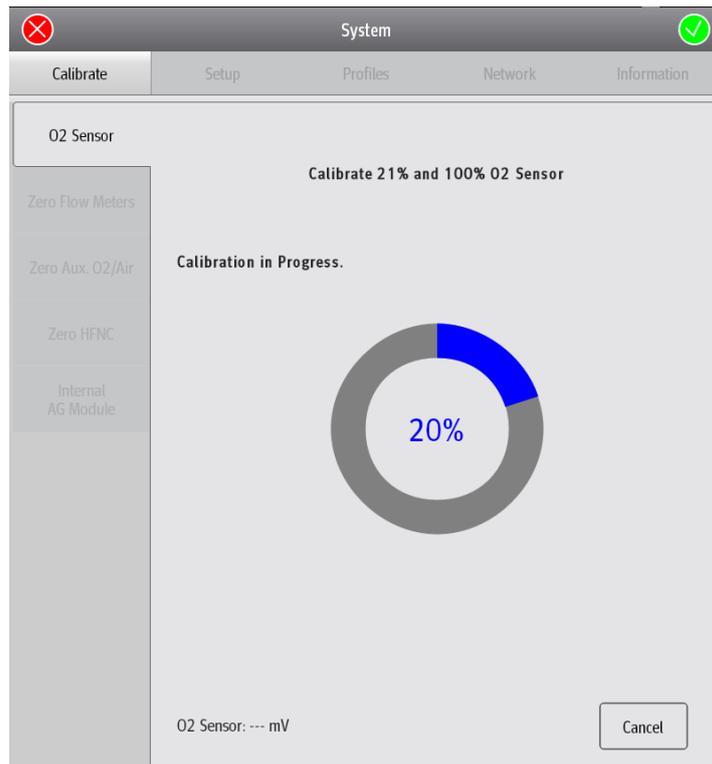
- The calibration at 100% O<sub>2</sub> and that at 21% O<sub>2</sub> are performed together. The first 50% progress indicates the calibration at 21% O<sub>2</sub>, and the last 50% progress indicates the calibration at 100% O<sub>2</sub>.

Perform the following steps to calibrate the O<sub>2</sub> sensor at 21% O<sub>2</sub> and 100% O<sub>2</sub>.

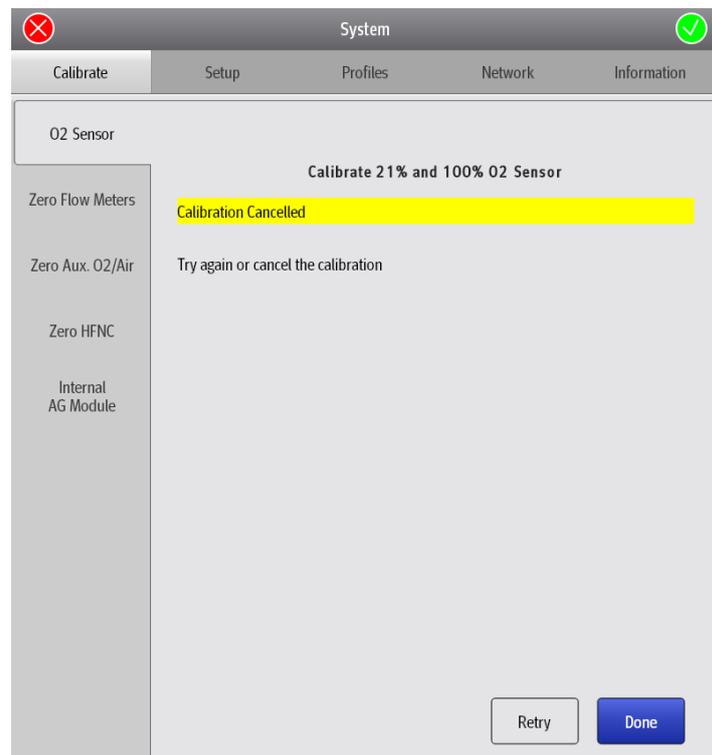
1. Enter the standby mode.
2. Choose **Setup** > **System** > **Calibrate** > **O<sub>2</sub> Sensor**. The calibration screen shown below is displayed. Follow the instructions on the screen to set the machine. Set the auto/manual switch to Auto and select **Begin**.



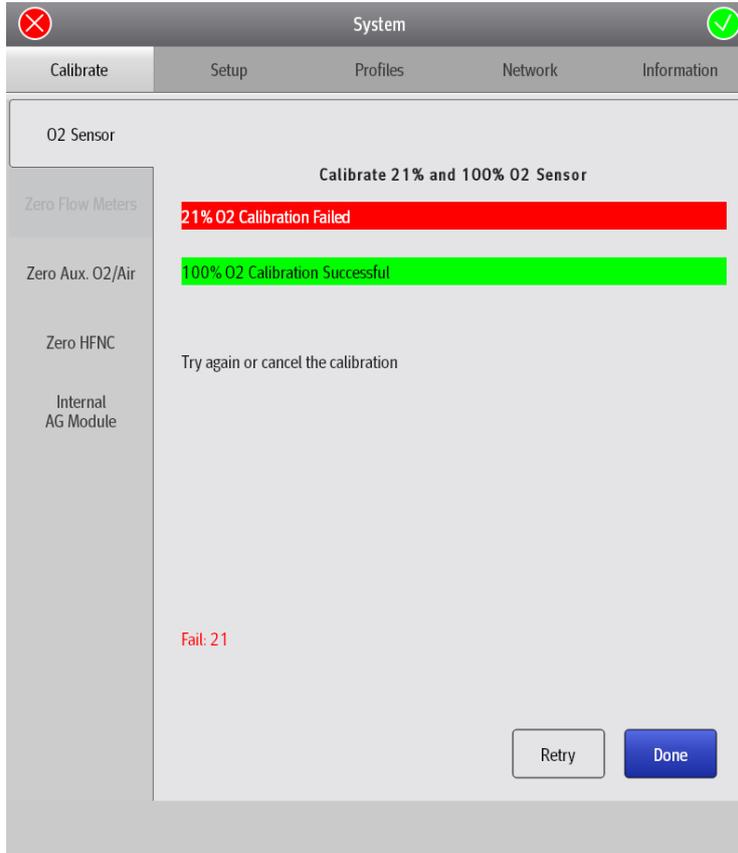
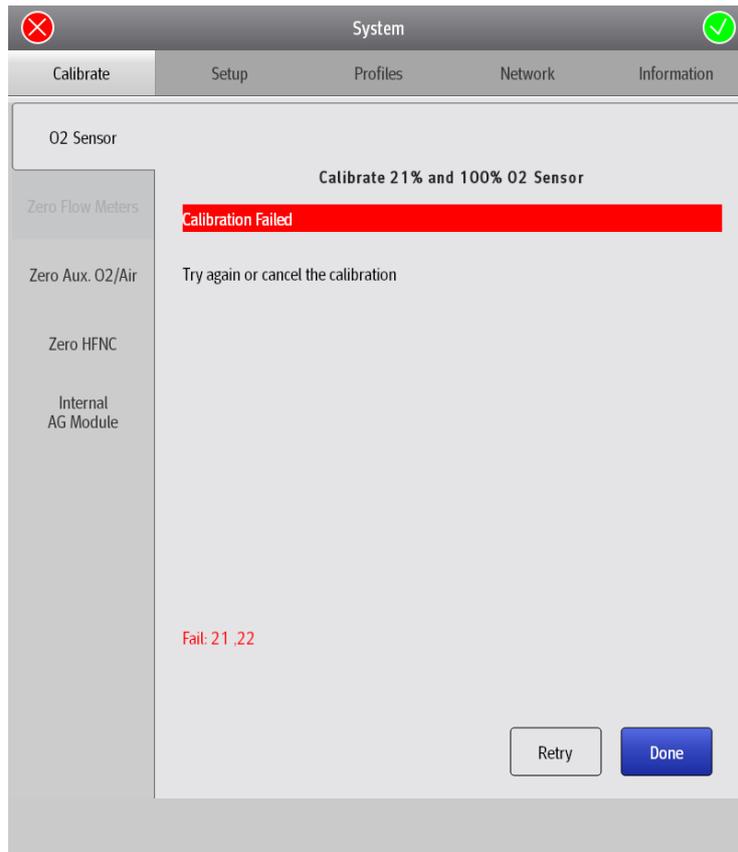
3. The calibration screen shown below is displayed after you select **Begin**. In the first stage, the system turns off N<sub>2</sub>O and O<sub>2</sub> flows automatically, turns on air flow which is greater than 8 L/min automatically, and enters the calibration screen. In the second stage, the system turns off N<sub>2</sub>O and air flows automatically, and turns on O<sub>2</sub> flow which is greater than 8 L/min automatically.

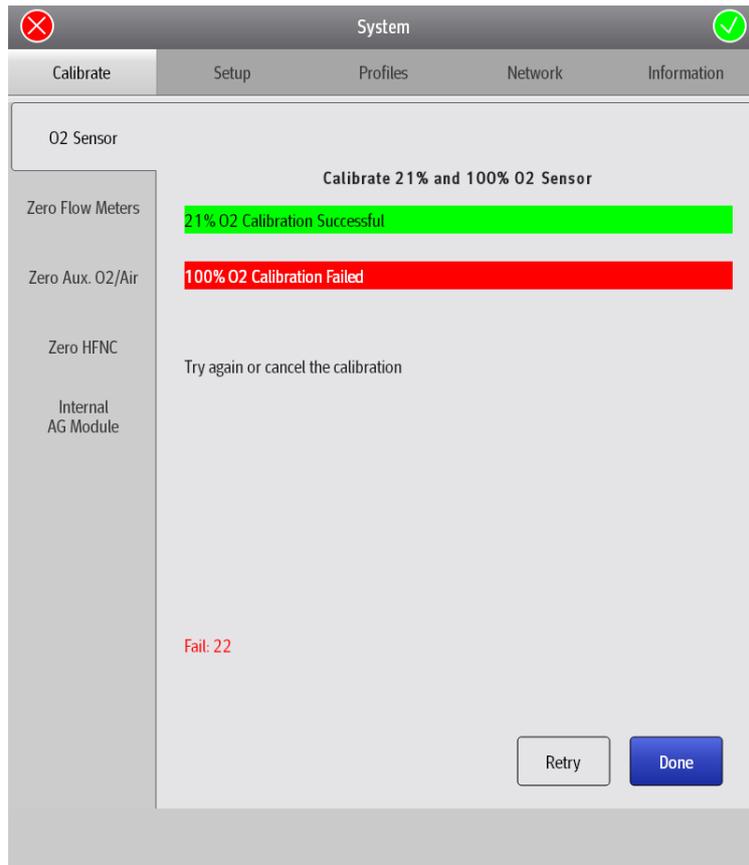


4. The screen shown below is displayed if the ongoing calibration is aborted. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.

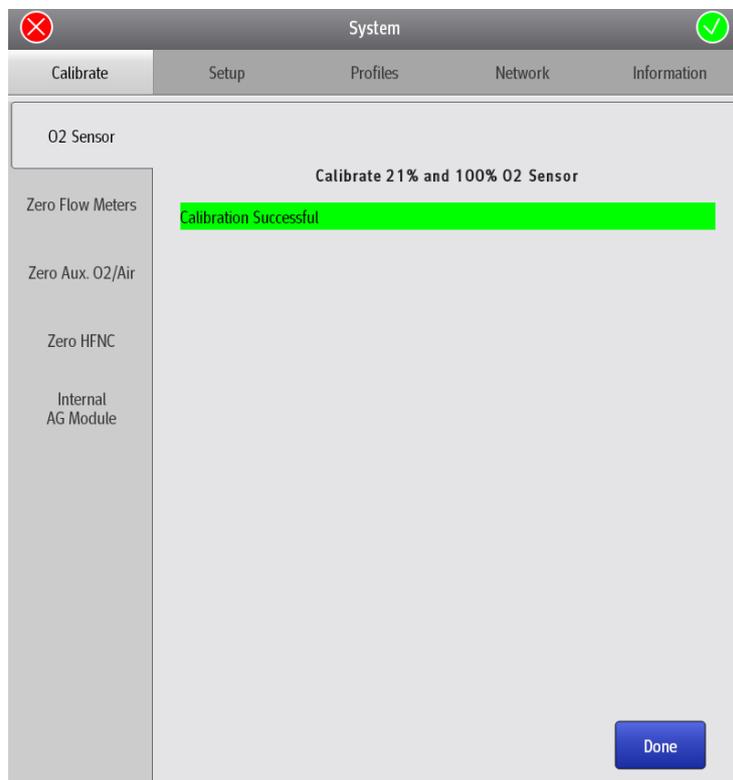


5. The screen shown below is displayed if the calibration fails. There are three cases: (1) the calibration at 21% and 100% O2 fails; (2) the calibration at 21% O2 fails and that at 100% O2 succeeds; (3) the calibration at 21% O2 succeeds and that at 100% O2 fails. The fonts in red indicate the fault code. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.





- The screen shown below is displayed if the calibration at 21% and 100% O2 succeeds. Select **Done** to exit the calibration screen.



### 10.3.2.3 Common Failures and Recommended Actions

Error Code	Description	Recommended Action
Display 1	The calibration value at 21% O2 is too small.	<ol style="list-style-type: none"> <li>1. Reinstall the O2 cell.</li> <li>2. Check whether the O2 sensor is in the 21% O2 environment.</li> <li>3. Check whether the output voltage of the O2 sensor is stable in the calibration menu (that is, the AD value ranges from 150 to 560).</li> <li>4. Replace the O2 sensor.</li> </ol>
Display 2	The calibration value at 21% O2 is too large.	<ol style="list-style-type: none"> <li>1. Reinstall the O2 cell.</li> <li>2. Check whether the O2 sensor is in the 21% O2 environment.</li> <li>3. Check whether the output voltage of the O2 sensor is stable in the calibration menu (that is, the AD value ranges from 150 to 560).</li> <li>4. Replace the O2 sensor.</li> </ol>
Display 3	The calibration value at 100% O2 is too small.	<ol style="list-style-type: none"> <li>1. Reinstall the O2 cell.</li> <li>2. Check whether the O2 sensor is in the 100% O2 environment.</li> <li>3. Check whether the output voltage of the O2 sensor is stable in the calibration menu (that is, the AD value ranges from 523 to 2123).</li> <li>4. Replace the O2 sensor.</li> </ol>
Display 4	The calibration value at 100% O2 is too large.	<ol style="list-style-type: none"> <li>1. Reinstall the O2 cell.</li> <li>2. Check whether the O2 sensor is in the 100% O2 environment.</li> <li>3. Check whether the output voltage of the O2 sensor is stable in the calibration menu (that is, the AD value ranges from 523 to 2123).</li> <li>4. Replace the O2 sensor.</li> </ol>
Display 5	The difference between the calibration value at 21% O2 and that at 100% O2 exceeds the threshold.	Replace the O2 sensor.
Display 6	The calibration value at 21% O2 is used to correct an error at 100% O2.	<ol style="list-style-type: none"> <li>1. Replace the O2 sensor.</li> <li>2. Perform the calibration again.</li> <li>3. Replace the VCM.</li> </ol>
Display 7	The machine is in the BFCS state.	Set the machine to the EFCS state.
Display 33	The O2 supply pressure is low.	<ol style="list-style-type: none"> <li>1. Replace or connect a gas supply.</li> <li>2. If the gas supply is normal, check the gas supply pressure switch.</li> </ol>

Display 35	The air supply pressure is low.	<ol style="list-style-type: none"> <li>1. Replace or connect a gas supply.</li> <li>2. If the gas supply is normal, check the gas supply pressure switch.</li> </ol>
Display 37	The O2 sensor is not connected.	<ol style="list-style-type: none"> <li>1. Check whether the alarm "O2 Sensor Disconnected" is displayed. If yes, check whether the O2 sensor is installed in the O2 sensor holder. Reconnect the cable of the O2 cell.</li> <li>2. Check whether the output voltage of the O2 sensor is stable in the calibration menu (that is, the AD value ranges from 150 to 560 at 21% O2 and ranges from 523 to 2123 at 100% O2).</li> <li>3. Replace the O2 sensor.</li> </ol>
Display 38	The O2 sensor fails.	<ol style="list-style-type: none"> <li>1. Check whether the alarm "Replace O2 Sensor" is displayed. If yes, check whether the O2 sensor is installed in the O2 sensor holder. Reconnect the cable of the O2 cell.</li> <li>2. Check whether the output voltage of the O2 sensor is stable in the calibration menu (that is, the AD value ranges from 150 to 560 at 21% O2 and ranges from 523 to 2123 at 100% O2).</li> <li>3. Replace the O2 sensor.</li> </ol>
Display 39	Table saving fails.	<ol style="list-style-type: none"> <li>1. Perform the calibration again.</li> <li>2. Replace the VCM.</li> </ol>
Display 3B	The ACGO switch is turned on.	Turn off the ACGO switch.

### 10.3.3 Flowmeter Zeroing (User)

#### 10.3.3.1 Principles

After the gas supply is disconnected, zero offset may occur in the sensor of the EFCS flowmeter if the pointer of the pressure gauge returns to zero but the EFCS flowmeter still displays a non-zero flow value. You can zero the flowmeter manually to immediately eliminate measurement deviations caused by zero offset.

The principles are as follows: Close the air, O2, and N2O branch proportional valves when starting zeroing. Switch the three-way valve to the BFCS state. Read the actual flows measured by the Sensirion flow sensors in the three branches and use them as zero points of the three branch flow sensors. Switch the three-way valve to the EFCS state, and the zeroing ends.

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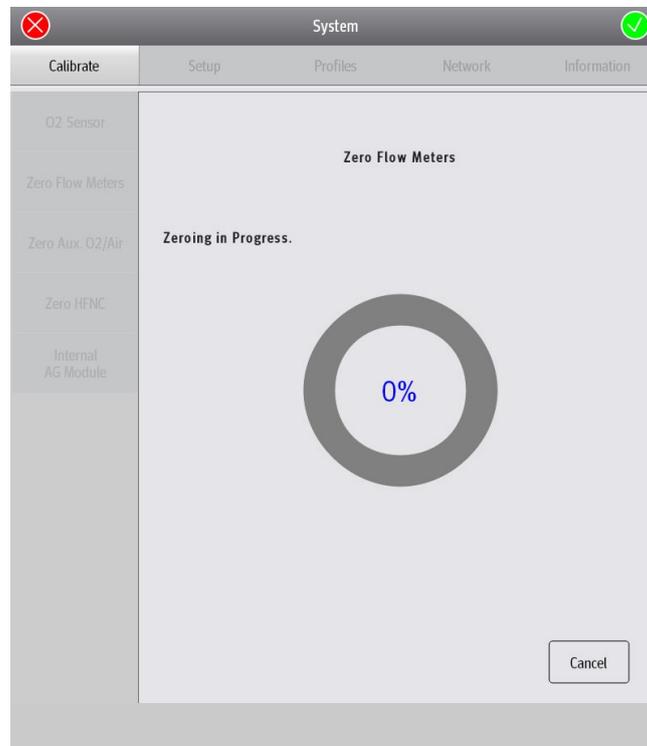
### 10.3.3.2 Zeroing Procedure

Perform the following steps to zero the EFCS.

1. Choose **Setup** > **System** > **Calibrate** > **Zero Flow Meters** to access the screen shown below. Select **Begin** to start zeroing.



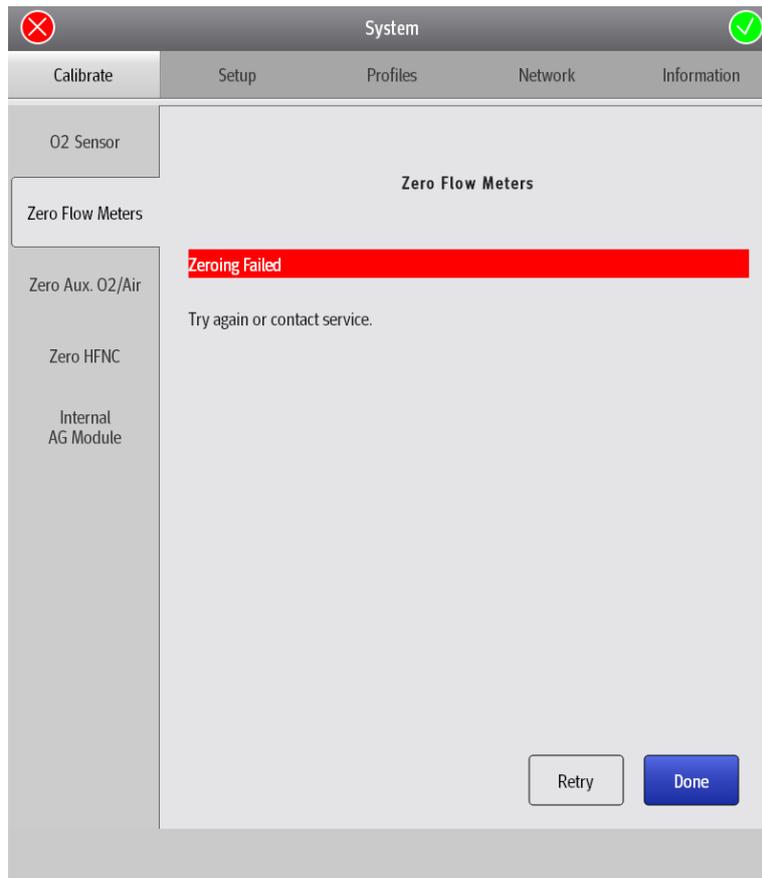
2. The zeroing screen shown below is displayed after you select **Begin**. During zeroing, you can select **Cancel** to abort the zeroing.



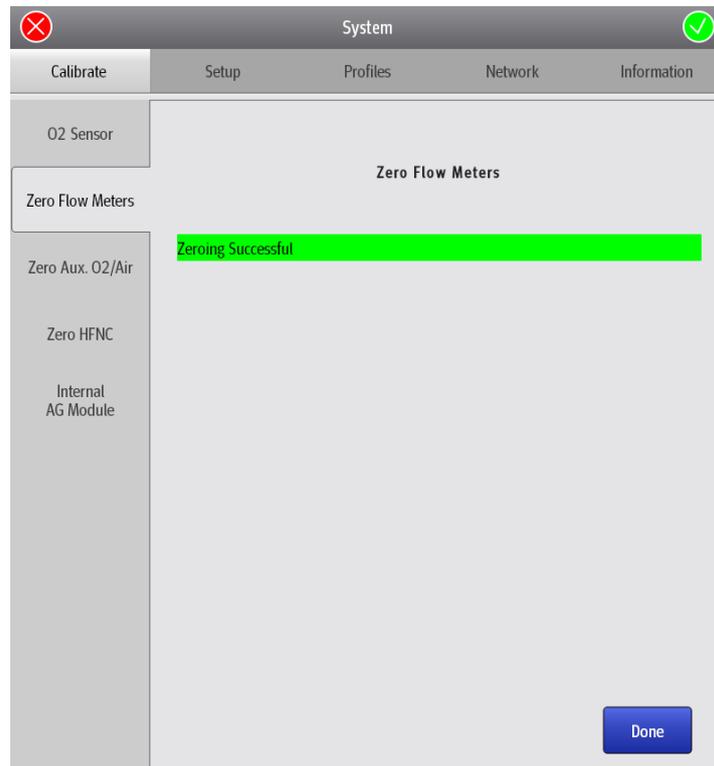
3. The screen shown below is displayed if the ongoing zeroing is aborted. Select **Retry** to do the zeroing again, or select **Done** to exit the zeroing screen.



4. The screen shown below is displayed if the zeroing fails. Select **Retry** to do the zeroing again, or select **Done** to exit the zeroing screen.



- 
5. The screen shown below is displayed upon successful zeroing. Select **Done** to exit the zeroing screen.



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## NOTE

- Other faults may exist in the EFCS if the zeroing fails. You must locate and rectify the faults.
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### 10.3.3.3 Zeroing Failure Troubleshooting

If the zeroing fails, perform the following steps to locate and rectify the fault.

1. Disconnect the gas supplies, 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 a mechanical failure in the three-way valve or faults in the proportional valves. Replace the service parts of the EFCS.
3. If the zeroing still fails, replace the EFCS flowmeter sensor or board.

### 10.3.4 Auxiliary O2/Air Zeroing (User)

#### 10.3.4.1 Principles

The principles are as follows: Close the air and O2 branch switch valves and proportional valves when starting zeroing. Read the AD values measured by the Sensirion differential pressure sensors in the two branches and use them as zero points of the two branch differential pressure sensors.

#### 10.3.4.2 Zeroing Procedure

Perform the following steps to zero the auxiliary O2/air assembly.

1. Enter the standby mode.
2. Choose **Setup > System > Calibrate > Zero Aux. O2/Air** to access the screen shown below.



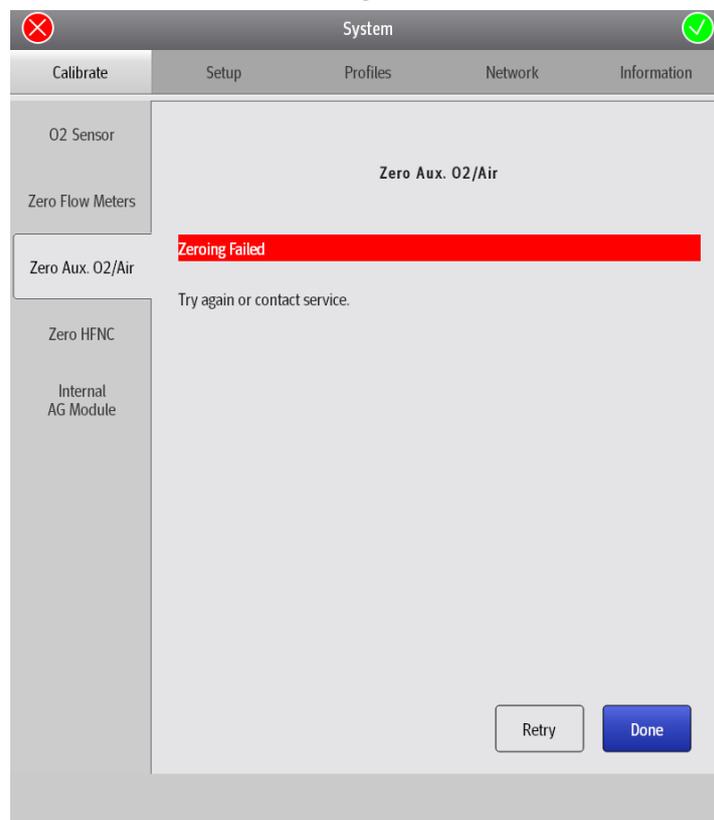
3. Select **Begin** to start zeroing. During zeroing, you can select **Cancel** to abort the zeroing.



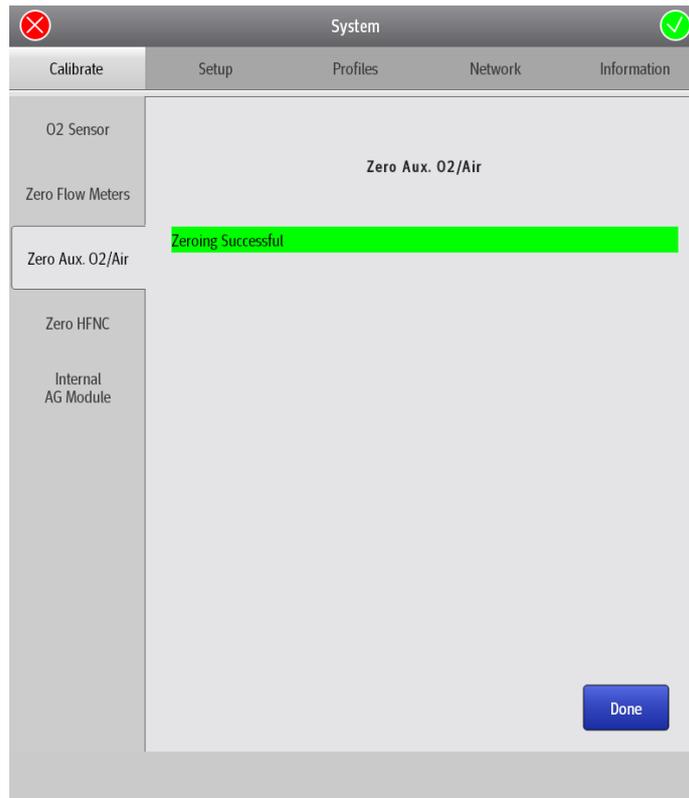
4. The screen shown below is displayed if the ongoing zeroing is aborted. Select **Retry** to do the zeroing again, or select **Done** to exit the zeroing screen.



5. The screen shown below is displayed if the zeroing fails. Select **Retry** to do the zeroing again, or select **Done** to exit the zeroing screen.



6. The screen shown below is displayed upon successful zeroing. Select **Done** to exit the zeroing screen.



#### 10.3.4.3 Zeroing Failure Troubleshooting

If the zeroing fails, perform the following steps to locate and rectify the fault.

1. Disconnect the gas supplies, adjust the flowmeter for the pointer of the pressure gauge to return to zero, and then perform zeroing again.
2. If the zeroing still fails, replace the auxiliary O2/air assembly.

#### 10.3.5 High-flow O2 Supply Zeroing (User)

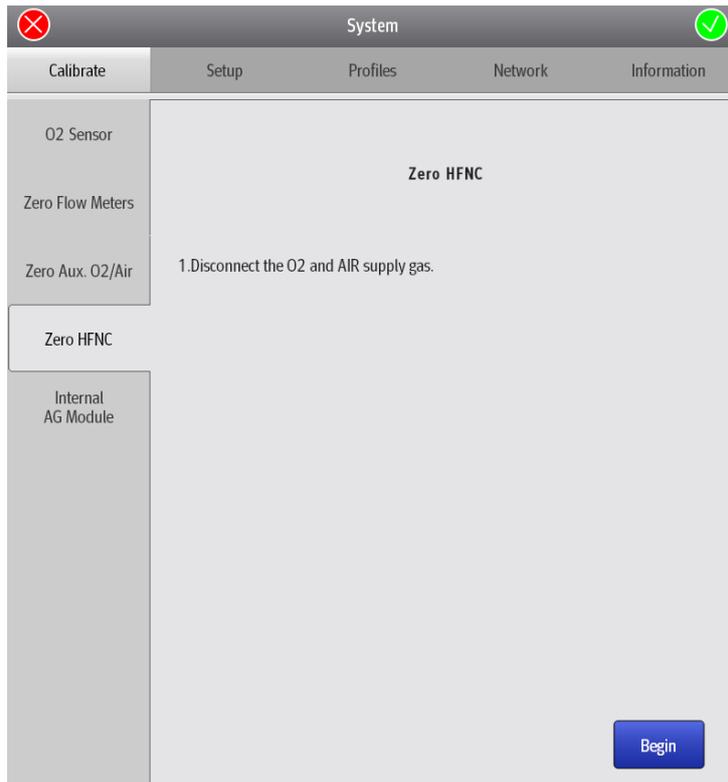
##### 10.3.5.1 Principles

The principles are as follows: Close the pilot valve and the air and O2 branch proportional valves when starting zeroing. Read the AD values measured by the Sensirion differential pressure sensors in the two branches and use them as zero points of the two branch differential pressure sensors.

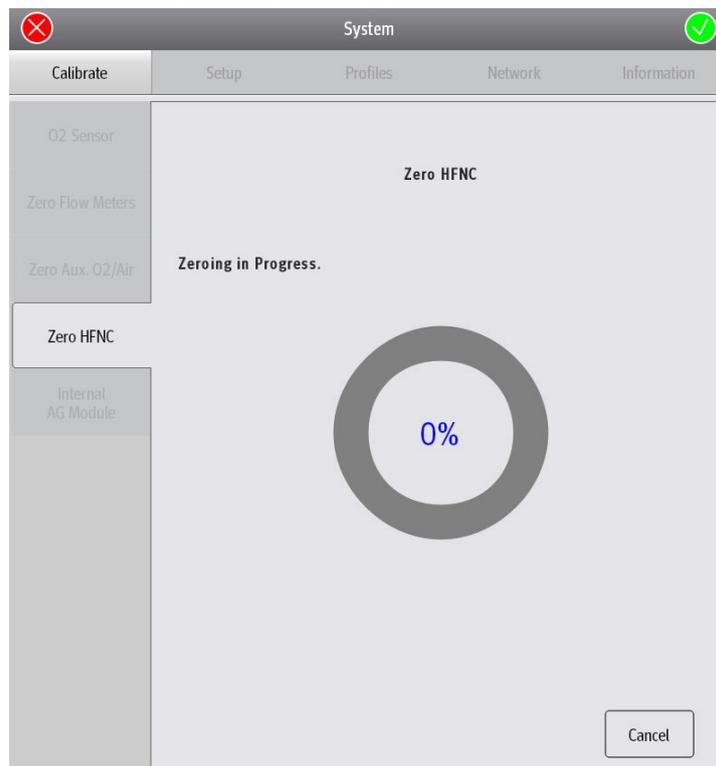
##### 10.3.5.2 Zeroing Procedure

Perform the following steps to zero the high-flow O2 supply assembly.

1. Enter the standby mode.
2. Choose **Setup** > **System** > **Calibrate** > **Zero HFNC** to access the screen shown below.



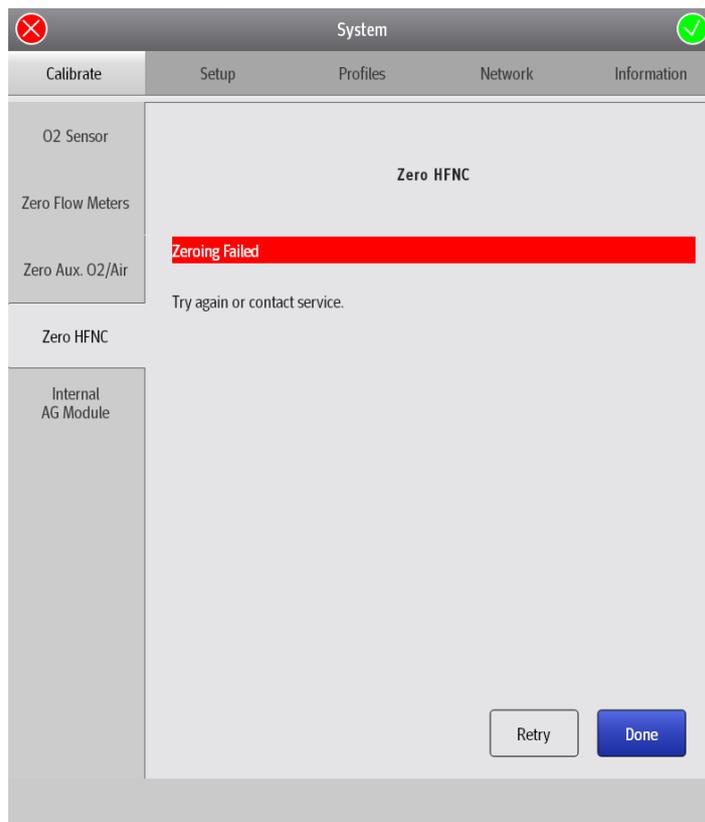
3. Select **Begin** to start zeroing. During zeroing, you can select **Cancel** to abort the zeroing.



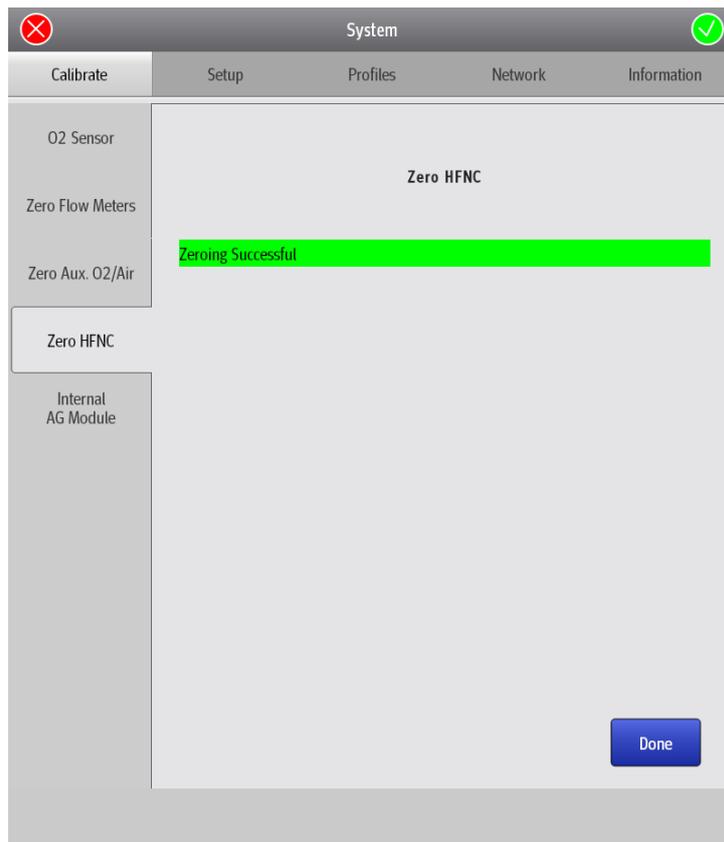
4. The screen shown below is displayed if the ongoing zeroing is aborted. Select **Retry** to do the zeroing again, or select **Done** to exit the zeroing screen.



5. The screen shown below is displayed if the zeroing fails. Select **Retry** to do the zeroing again, or select **Done** to exit the zeroing screen.



6. The screen shown below is displayed upon successful zeroing. Select **Done** to exit the zeroing screen.



### 10.3.5.3 Zeroing Failure Troubleshooting

If the zeroing fails, perform the following steps to locate and rectify the fault.

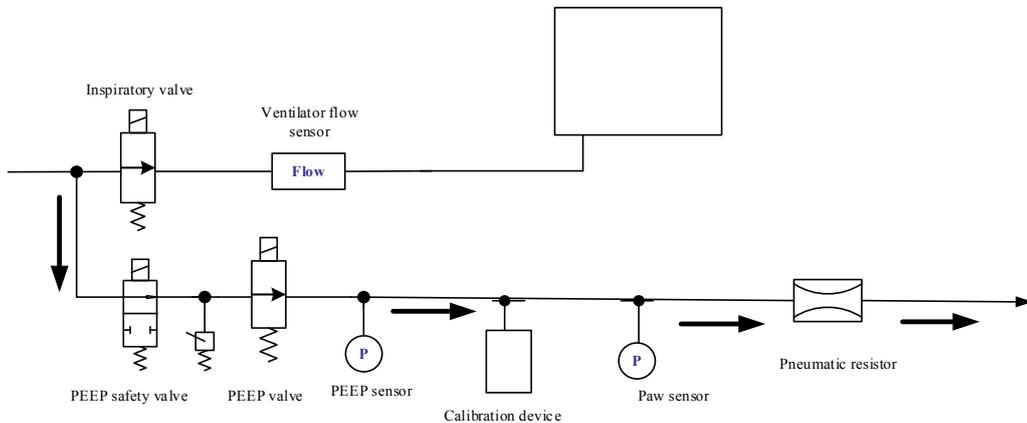
1. Disconnect the gas supplies, exhaust the gas inside the machine, and perform zeroing again.
2. If the zeroing is successful, it is concluded that the previous zeroing failure is caused by a mechanical failure in the pilot valve or faults in the proportional valves. Replace the pilot valve assembly and proportional valve assemblies.
3. If the zeroing still fails, it is concluded that the cause is the fault in the Sensirion differential pressure sensors or the high-flow O2 supply board. Replace the Sensirion differential pressure sensor assemblies and high-flow O2 supply board.

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## 10.3.6 Pressure Calibration (Service)

### 10.3.6.1 Principles

In pressure calibration (service), the anesthesia machine calibration device (for example, VT900, VT650, PF300, and FPM) specified by the manufacturer needs to be used to calibrate the PEEP valve, Paw sensor, and PEEP pressure sensor. The calibration principles are as follows: The anesthesia machine calibration device can communicate with the VCM, which controls the tight closing of the inspiratory valve. The VCM opens the PEEP valve based on a certain DA value to make the circuit pressure reach a certain value. The Paw sensor, PEEP pressure sensor, and anesthesia machine calibration device collect the circuit pressure. The calibration device sends the collected pressure to the VCM. The VCM uses the pressure measured by the calibration device and AD values collected by the pressure sensors as the data of one calibration point for the pressure sensors, and uses the pressure measured by the calibration device and DA value of the PEEP valve as the data of one calibration point for the PEEP valve. The VCM controls the PEEP valve to change the DA value to obtain calibration data under a series of pressures, forming a pressure calibration data table. The gas pressure should be in the range from 0 cmH<sub>2</sub>O to 100 cmH<sub>2</sub>O when the VCM opens the PEEP valve. Figure 1 Schematic diagram of pressure calibration (service)



### 10.3.6.2 Precautions

#### NOTE

- Pressure calibration (service) needs to be performed if the sensor adapter board, VCM, or expiratory valve assembly is replaced.
  - Pressure calibration (service) needs to be performed if the measured value of the built-in pressure sensor deviates from that of the standard pressure measuring device by 5% or 2 cmH<sub>2</sub>O, whichever is larger .
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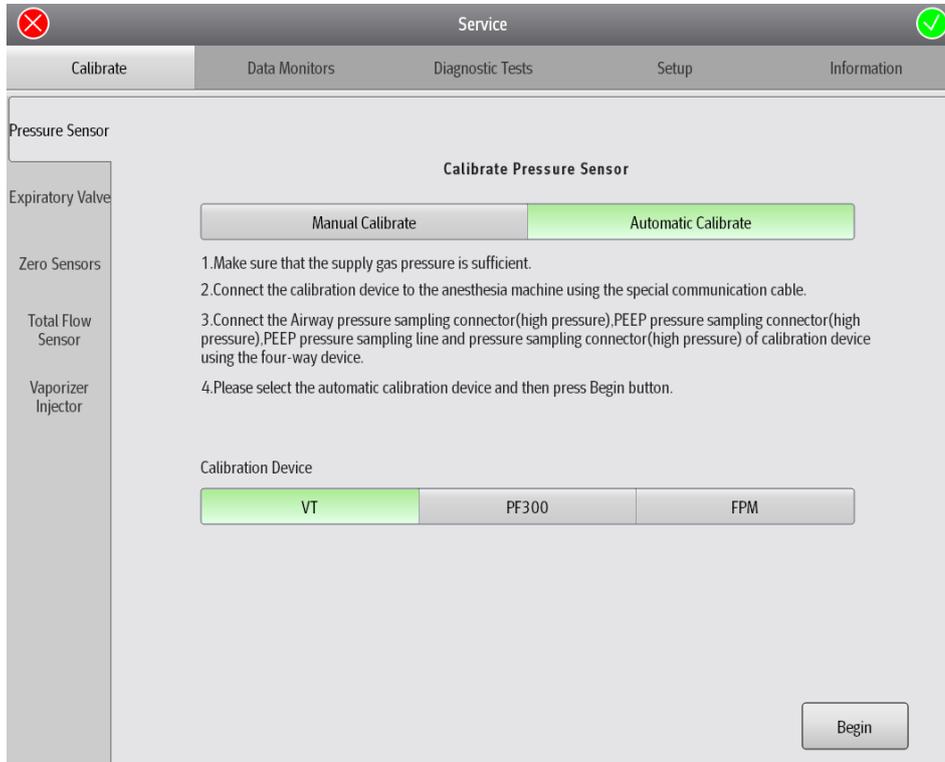
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### 10.3.6.3 Calibration Procedure

#### Automatic Calibration

Perform the following steps to calibrate the pressure sensor and PEEP proportional valve.

1. Ensure that the anesthesia machine is in standby mode.
2. Choose **Setup > Service > Calibrate > Pressure Sensor** and select Automatic Calibrate to access the screen shown below.



3. Use a communication cable to connect the calibration device and the anesthesia machine according to the instructions on the screen. Connect the pressure sampling line to the calibration device according to steps 2 and 4. Details are shown below:

When VT Plus is used as the calibration device, perform the following operations on it (note: verify the correctness of the settings before each calibration):

- 1) **Gas Type:** same as the drive gas type
  - Choose **SETUP > Settings > ENTER > Gas Settings > MODIFY**, and set **Gas Type** to **O<sub>2</sub>** in case of O<sub>2</sub> driving (or **AIR** in case of air driving).
- 2) Zero Mode: Manual
  - Choose **SETUP > Settings > ENTER** and set Zero Mode to Manual.
- 3) Serial Mode: OTIS Ctrl
  - Choose **SETUP > System > ENTER** and select Serial Mode: OTIS Ctrl.
- 4) Correction Mode
  - Choose **SETUP > Settings > ENTER > Correction Mode > MODIFY** and select BTPS.
  - Note: Set Serial Mode before calibration. Exit the Serial Mode setup screen before you access the (flow or pressure) measurement screen. To exit the Serial Mode setup screen, choose **SETUP > System > ENTER** and select Serial Mode: NONE.
  - When VT900 is used as the calibration device, perform the following operations on it (note: verify the correctness of the settings before each calibration):
    - 1) **Gas Type:** same as the drive gas type

- Choose **Menu > Setup > Gas**, select **O<sub>2</sub>** in case of O<sub>2</sub> driving (or **AIR** in case of air driving), and select **OK**.
- 2) Correction Mode
  - Choose **Menu > Setup > Correction Mode**, select **BTPS**, and select **OK**.
- 3) Unit
  - Choose **Menu > Unit > Low Pressure**, select **cmH<sub>2</sub>O**, and select **OK**.
- 4) Zero
  - Remove the two protection caps from the LOW PRESSURE (-) and (+) ports. Choose **Low Pressure > Zero > OK**. The pressure displayed is 0.00 cmH<sub>2</sub>O.
  - Note 1: Zero the pressure of the calibration device before each pressure calibration. Disconnect all pipelines from the calibration device before zeroing.
  - Note 2: When the device is not in use, install protection caps on all ports of the device to prevent dust from entering and damaging the sensors.
- ✧ **Drive gas connection:** The calibration gas is compressed O<sub>2</sub> for O<sub>2</sub>-driven machines, and is compressed air for air-driven machines.
- ✧ **Preparations before calibration:** Enter the standby mode, opened the O<sub>2</sub> cell door, verify that the O<sub>2</sub> cell holder and O<sub>2</sub> cell are removed, set the auto/manual switch to Manual, and then remove the circuit absorber canister, bypass assembly, and patient circuit in turn. Set the auto/manual switch to Auto and turn off all flow regulators.
- ✧ **Calibration communication connection:** If VT900 is used for calibration, connect the UBS port of VT900 to the calibration port of the anesthesia machine through a calibration fixture according to Figure 1; or replace VT900 with VT Plus for calibration as shown in Figure 1; or use VT Plus for calibration as shown in Figure 2.
- ✧ Connect the communication cable as shown in Figure 1 and turn on the calibration fixture. You can switch the calibration device to VT Plus or VT900 through **MODE** on the calibration fixture. When the calibration device is switched to VT Plus or VT900, the corresponding indicator is steady on. When the calibration device is switched to VT900, set the system to the low pressure measurement mode, press **FUN** and switch to **Remote Control**.

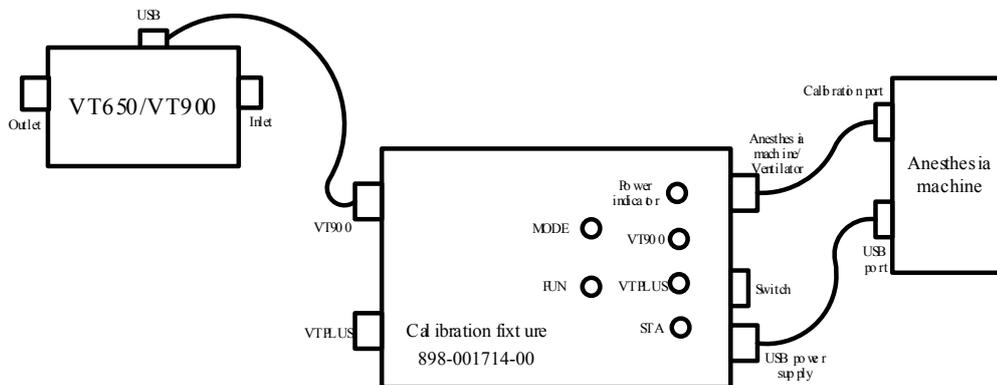


Figure 1 Calibration communication connection of VT900

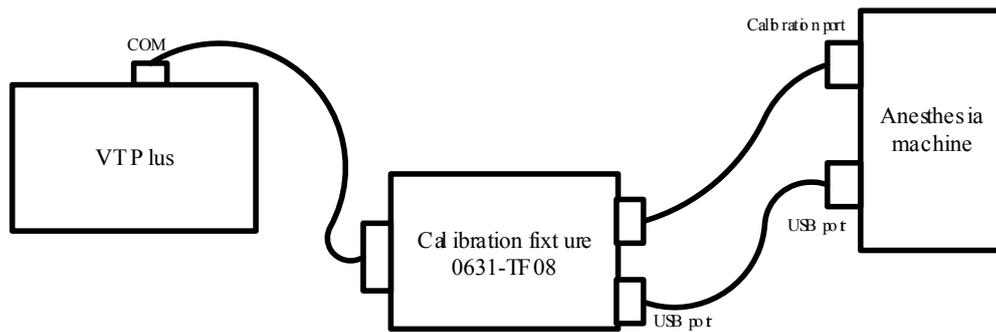


Figure 2 Calibration communication connection of VT Plus

- ✧ **Calibration pipeline connection:** Mount the pressure calibration test fixture to the circuit adapter block in place. For a machine with the auxiliary pressure monitoring function, use a five-way silicone tube to connect the auxiliary pressure monitoring port (Paux) and three ports of the pressure calibration test fixture (as shown in Figure 3). Connect the last connector of the five-way silicone tube to the LOW PRESSURE (+GAS OR FLUID) port of VT Plus or the LOW PRESSURE (+) port of VT900. For a machine without the auxiliary pressure monitoring function, use a four-way silicone tube to connect the three ports of the pressure calibration test fixture (as shown in Figure 3). Connect the last connector of the four-way silicone tube to the LOW PRESSURE (+GAS OR FLUID) port of VT Plus or the LOW PRESSURE (+) port of VT900.

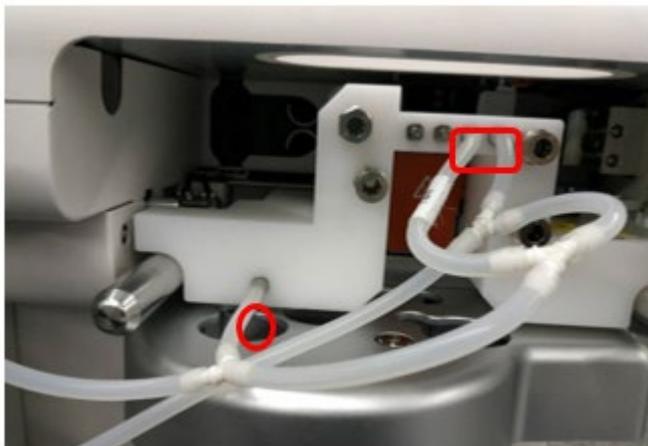
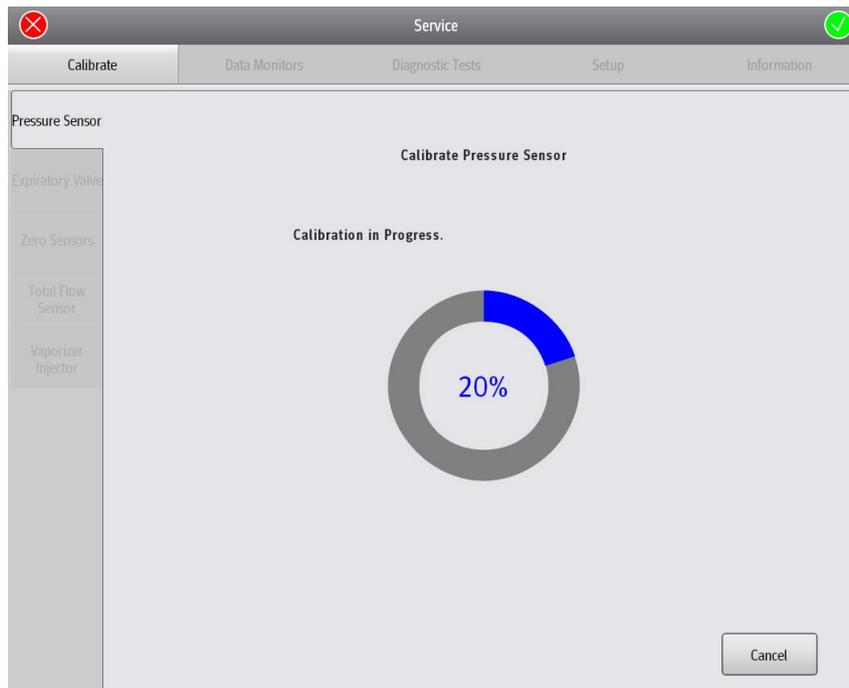
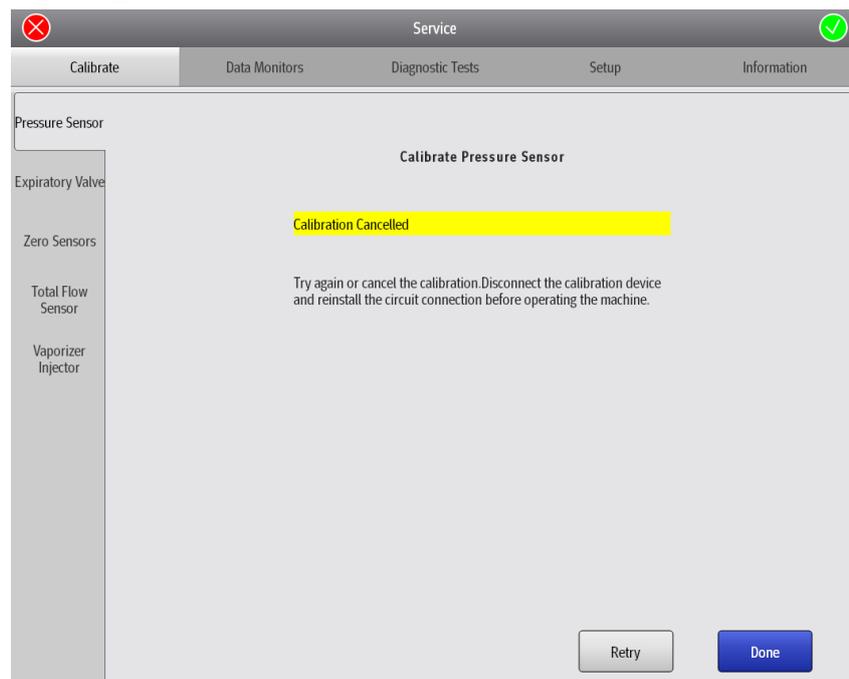


Figure 3 Three ports of the pressure calibration test fixture

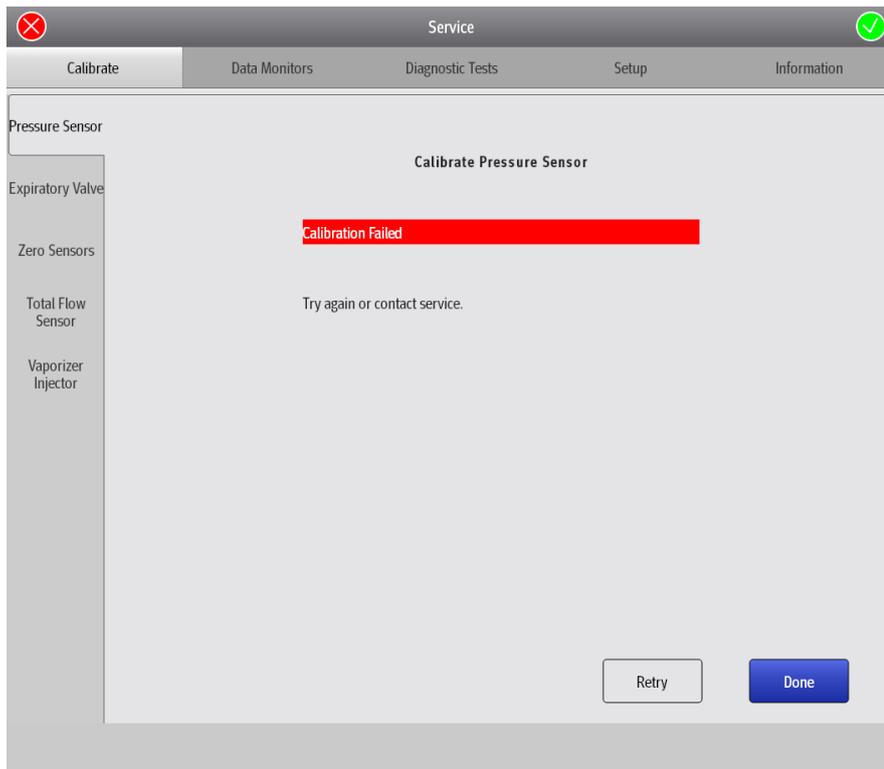
4. Connect the power system of the anesthesia machine calibration device and select the calibration device.
5. Select **Begin** to access the calibration screen shown below. During calibration, you can select **Cancel** to abort the calibration.



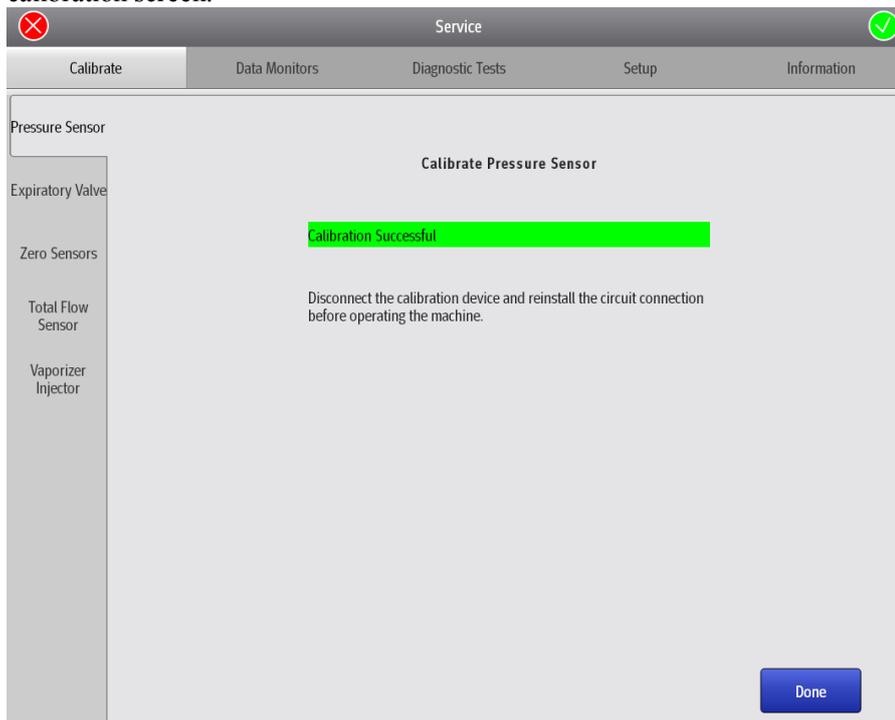
6. The screen shown below is displayed if the ongoing calibration is aborted. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.



7. The screen shown below is displayed upon successful calibration. The screen shown below is displayed if the calibration fails. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.



The screen shown below is displayed upon successful calibration. Select **Done** to exit the calibration screen.



8. Reset the machine after pressure calibration is completed. Note: Set the auto/manual switch to Manual before you install the patient circuit.

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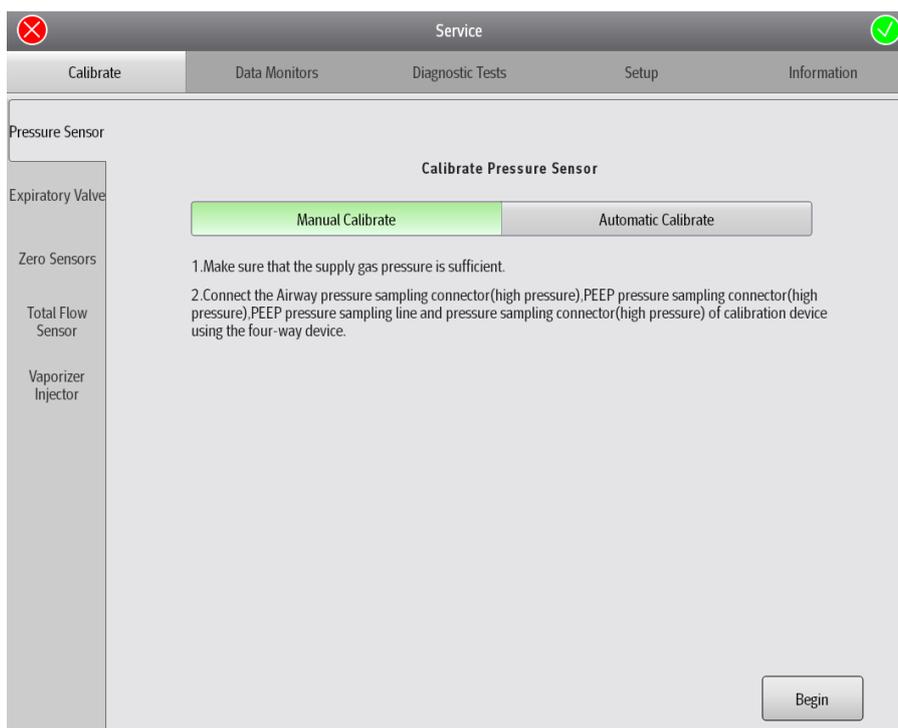
## Manual Calibration

### NOTE

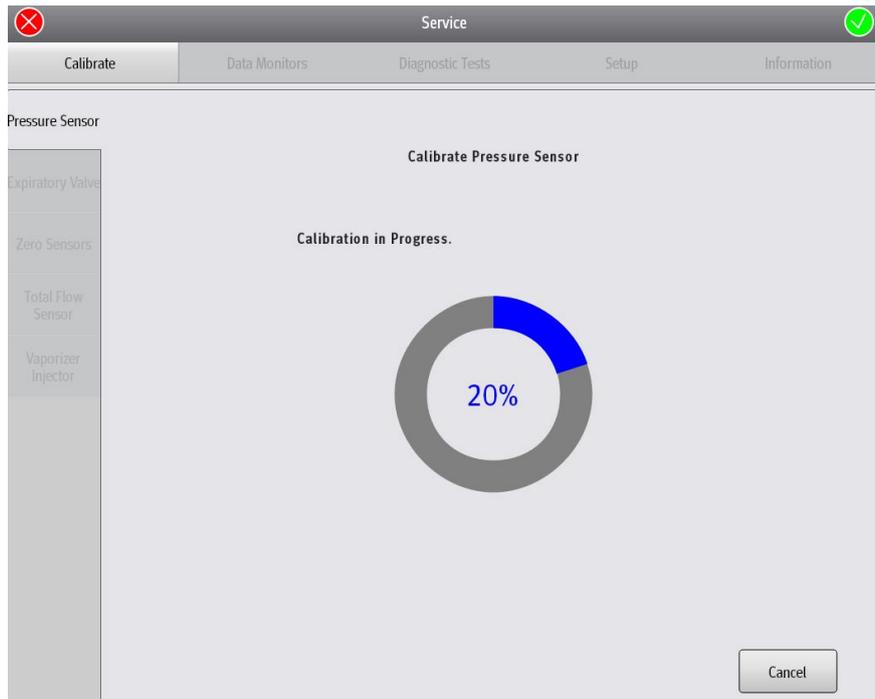
- The accuracy error of the pressure gauge for pressure calibration is not greater than  $\pm 0.5$  cmH<sub>2</sub>O or  $\pm 2\%$  of the reading value (whichever is larger).
- 

Perform the following steps to manually calibrate the pressure sensor and PEEP proportional valve.

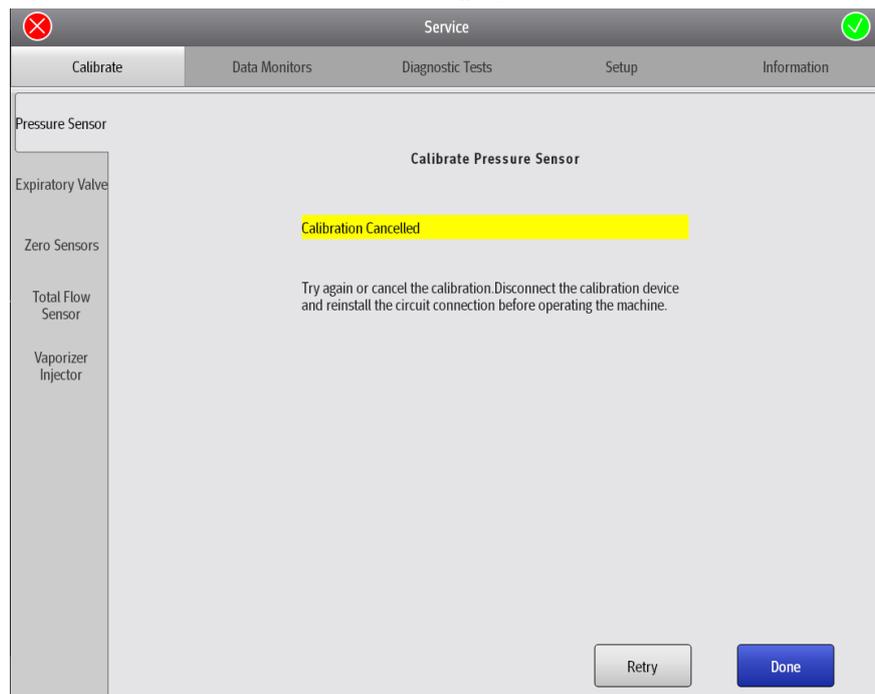
1. Ensure that the anesthesia machine is in standby mode.
2. Choose **Setup** > **Service** > **Calibrate** > **Pressure Sensor** and select **Manual Calibrate** to access the screen shown below.



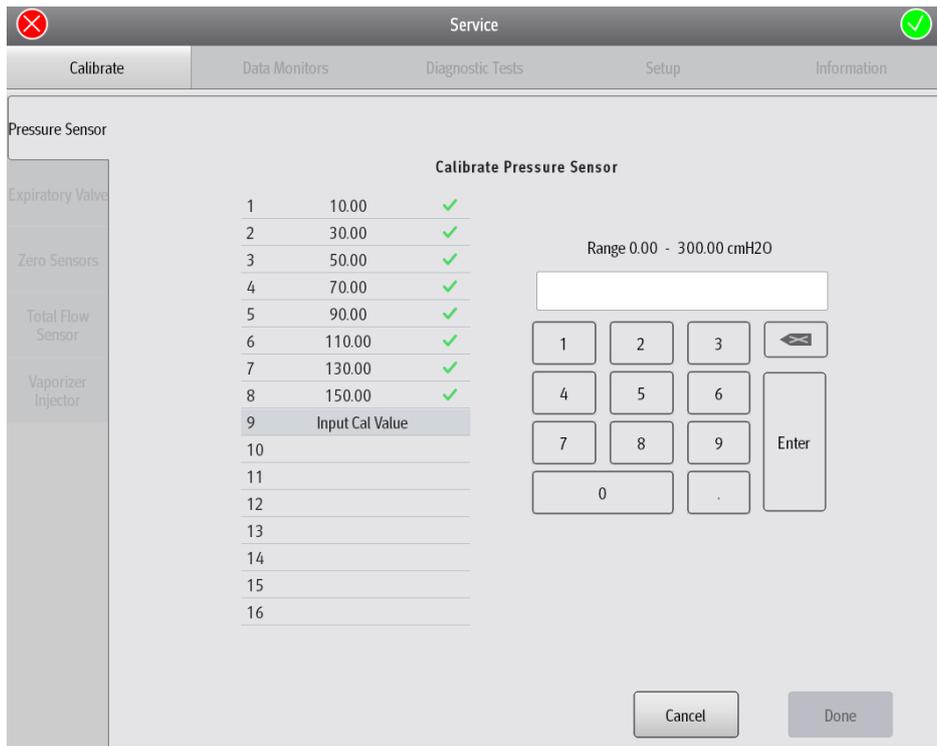
3. Use a communication cable to connect the calibration device and the anesthesia machine according to the instructions on the screen. Connect the pressure sampling line to the calibration device according to steps 2 and 3.
4. Complete the pneumatic connection by referring to step 3 in Automatic Calibration Automatic Calibration.
5. Select **Begin** to access the screen shown below.



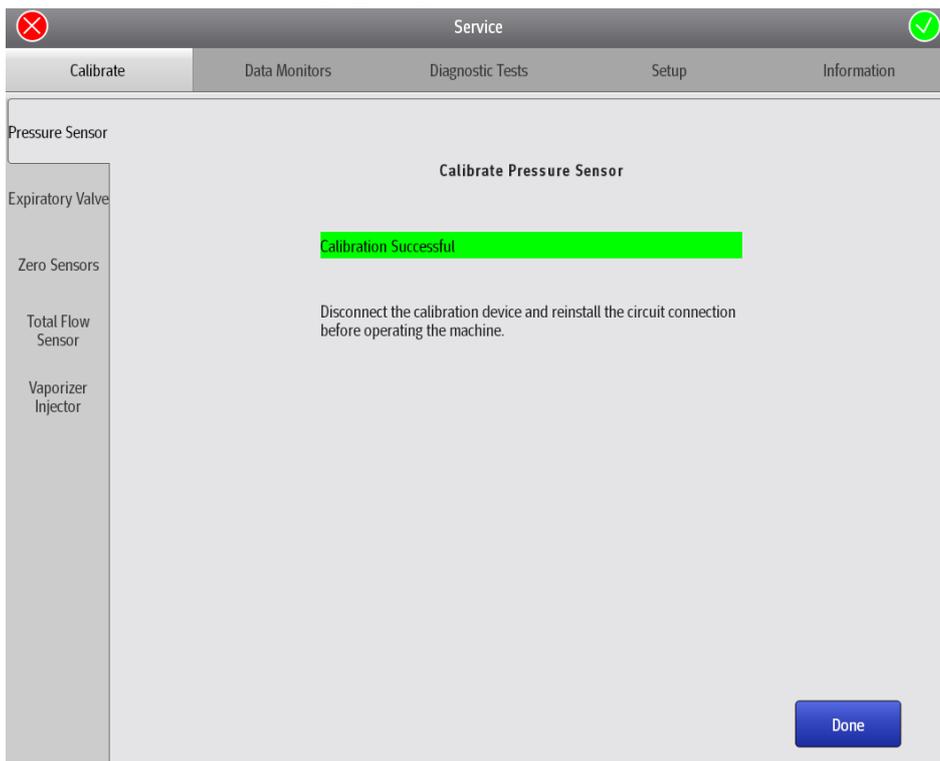
6. Select **Cancel**. The screen shown below is displayed.



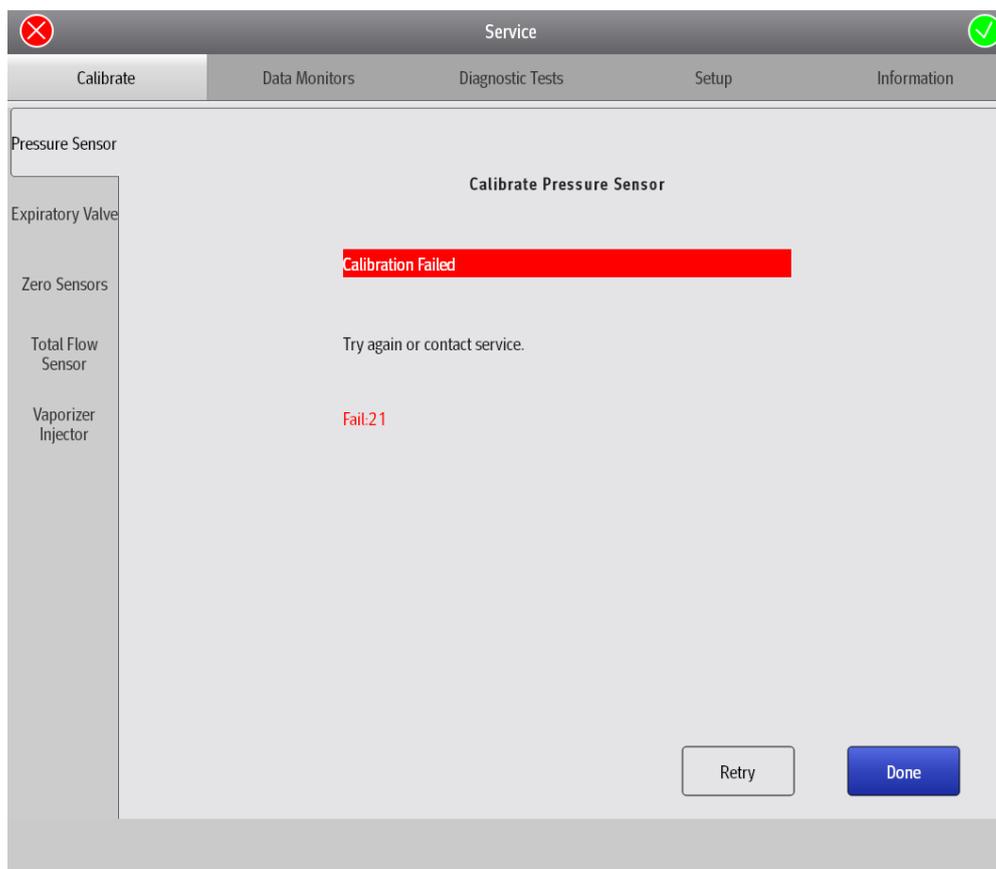
7. The screen shown below is displayed after the first step of manual calibration is completed. The system calibrates 16 calibration points one by one. Of the 16 calibration points, points 1 to 8 map to the rising curve while points 8 to 16 map to the falling curve. You can select to recalibrate any calibration point during calibration. When a calibration point mapped to the falling curve is calibrated, you cannot change the points mapping to the rising curve. If **Waiting** is displayed in the cell, wait for the system to implement pressure control. If **Input Cal Value** is displayed in the cell, enter the standard pressure displayed on the calibration device. After entering standard pressures of all the 16 calibration points, select **Done** to check and save the calibration data.



8. The screen shown below is displayed upon successful calibration.



The screen shown below is displayed if the calibration fails.



### 10.3.6.4 Common Failures and Recommended Actions

Failure Description	Possible Cause	Recommended Action
Display 1	An error occurs in the communication with the calibration device.	<ol style="list-style-type: none"> <li>1. Restart the anesthesia machine and/or calibration device.</li> <li>2. Check the communication cable.</li> <li>3. Replace the VCM or calibration device.</li> </ol>
Display 2	The zero point of the calibration device is beyond the valid range of $[-0.3, 0.3]$ cmH <sub>2</sub> O.	Zero the calibration device.
Display 3	The pressure cannot be controlled within the range of $[1, 3]$ cmH <sub>2</sub> O.	<ol style="list-style-type: none"> <li>1. Use the valve diagnosis tool for diagnosis. Open the PEEP valve within the range of 0–500 mA. If the AD values collected by the inspiratory pressure sensor increase gradually, recalibration is recommended.</li> <li>2. Replace the PEEP valve.</li> </ol>
Display 4	The pressure cannot be controlled	<ol style="list-style-type: none"> <li>1. Use the valve diagnosis tool</li> </ol>

Failure Description	Possible Cause	Recommended Action
	within the range of [maximum pressure – 20, maximum pressure – 5] cmH <sub>2</sub> O.	<p>for diagnosis. (1) Open the PEEP valve based on 500 mA. The pressure measured by the calibration device is greater than or equal to 100 cmH<sub>2</sub>O.</p> <p>(2) Close the PEEP valve and increase the opening of the PEEP valve based on a certain current. The AD values collected by the Paw sensor increase gradually.</p> <p>Recalibration is recommended if the preceding conditions are met.</p> <p>2. Replace the PEEP valve.</p>
Display 5	The maximum valve sealing pressure is low.	<ol style="list-style-type: none"> <li>1. Check whether the gas supply is within the range of 280–600 kPa for the whole calibration process.</li> <li>2. Use the valve diagnosis tool to check whether the maximum output pressure of the PEEP valve is greater than or equal to 100 cmH<sub>2</sub>O. If not, replace the inspiratory valve assembly.</li> </ol>
Display 6	A zero point error occurs in the Paw sensor.	<ol style="list-style-type: none"> <li>1. Zero the sensor.</li> <li>2. Replace the VCM.</li> </ol>
Display 7	A zero point error occurs in the PEEP sensor.	<ol style="list-style-type: none"> <li>1. Zero the sensor.</li> <li>2. Replace the VCM.</li> </ol>
Display 8	A zero point error occurs in the esophageal pressure sensor.	<ol style="list-style-type: none"> <li>1. Zero the sensor.</li> <li>2. Replace the VCM.</li> </ol>
Display A	The calibration data of the Paw sensor does not conform to monotonicity (the AD value of the former calibration point is greater than that of the latter calibration point).	<ol style="list-style-type: none"> <li>1. Check the pipeline connection and the gas tightness.</li> <li>2. Check whether the gas supply pressure ranges from 280 kPa to 600 kPa.</li> <li>3. Perform the calibration again.</li> <li>4. Replace the VCM.</li> </ol>
Display B	The calibration data of the PEEP sensor does not conform to monotonicity (the AD value of the former calibration point is greater than that of the latter calibration point).	<ol style="list-style-type: none"> <li>1. Check the pipeline connection and the gas tightness.</li> <li>2. Check whether the gas supply pressure ranges from 280 kPa to 600 kPa.</li> <li>3. Perform the calibration again.</li> <li>4. Replace the VCM.</li> </ol>
Display C	The calibration data of the esophageal pressure sensor does not conform to monotonicity (the AD value of the	<ol style="list-style-type: none"> <li>1. Check the pipeline connection and the gas tightness.</li> <li>2. Check whether the gas supply</li> </ol>

Failure Description	Possible Cause	Recommended Action
	former calibration point is greater than that of the latter calibration point).	pressure ranges from 280 kPa to 600 kPa. 3. Perform the calibration again. 4. Replace the VCM.
Display 9	The pressure change is not monotonic.	1. Perform the calibration again. 2. Replace the VCM.
Display 34	The drive gas pressure is low.	1. Check whether the gas supply pressure ranges from 280 kPa to 600 kPa. 2. If the gas supply is normal, replace the gas supply pressure switch.
Display 39	The system fails to write data into EEPROM.	1. Perform the calibration again. 2. Replace the VCM.
Display 3B	The ACGO switch is in the <b>ON</b> position.	1. Check whether the ACGO switch is set to <b>OFF</b> . 2. Check the monitoring status of the ACGO switch on the screen of the anesthesia machine.

### 10.3.7 Expiratory Valve Calibration (Service)

#### 10.3.7.1 Principles

##### NOTE

- Perform expiratory valve calibration (service) when the expiratory valve assembly or VCM is replaced.
- When a great deviation (5 cmH<sub>2</sub>O and 20% of the valve opening setting, whichever is larger) is detected between the control effect of the machine expiratory valve and the setting, you need to perform expiratory valve calibration (service).
- Before calibration, ensure that the drive gas supply is connected. This calibration item is intended to calibrate the expiratory valve by using the anesthesia machine's internal pressure sensor on which pressure calibration has been performed as the calibration reference. No ventilator calibration device is required.

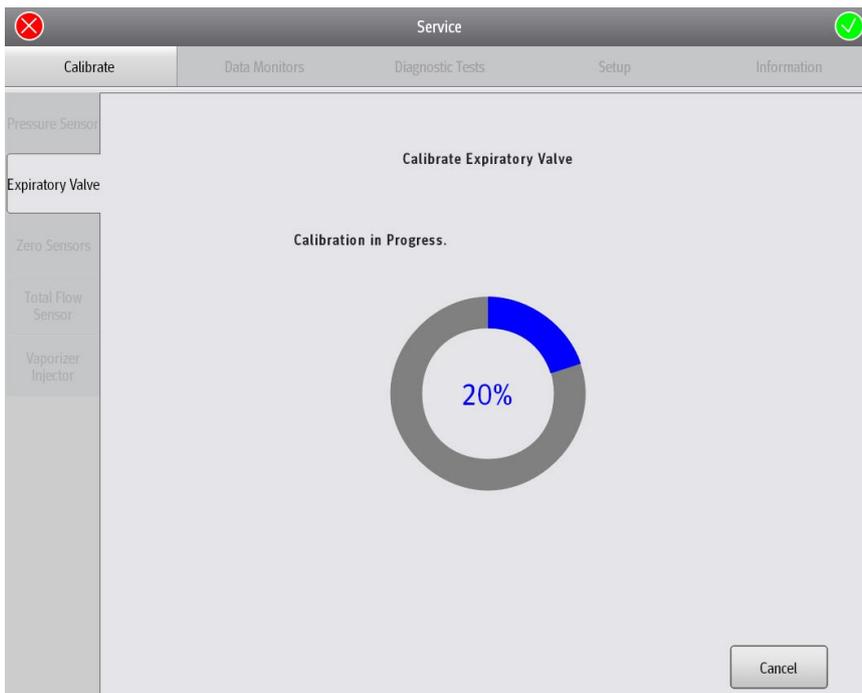
#### 10.3.7.2 Calibration Procedure

Perform the following steps to calibrate the expiratory valve.

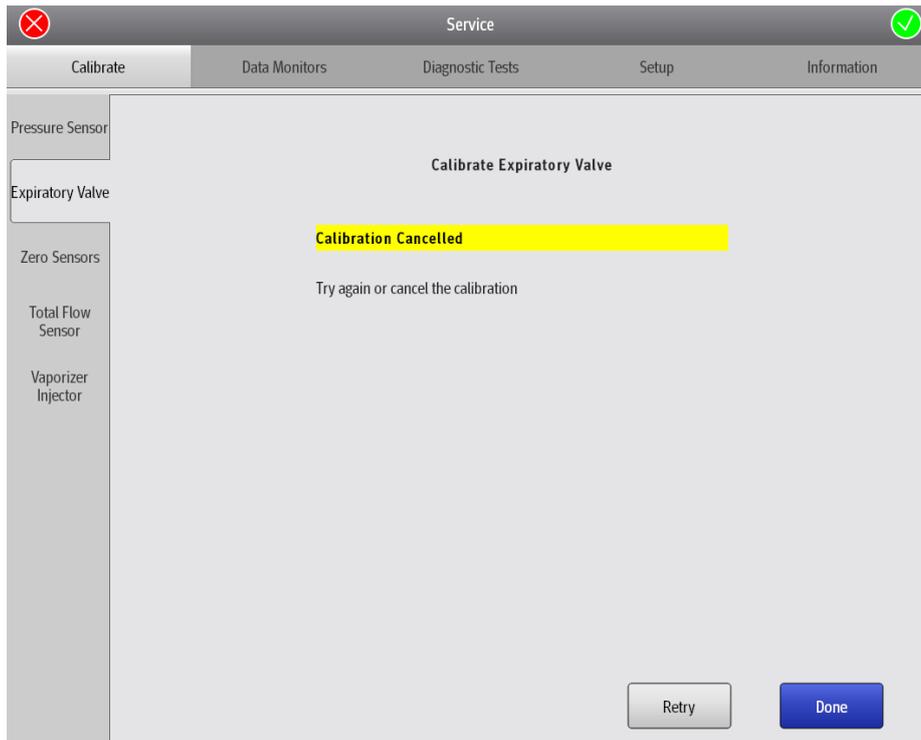
1. Enter the standby mode.
2. Choose **Setup > Service > Calibrate > Expiratory Valve** to access the screen shown below.



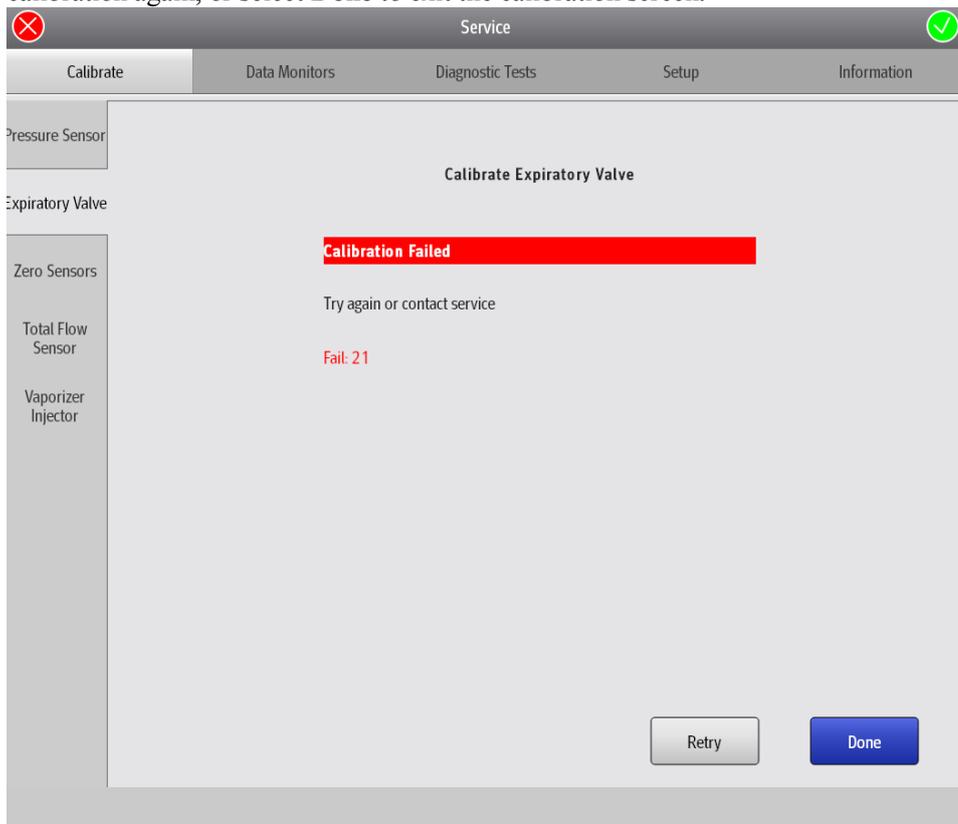
3. Select **Begin** to start calibration. During calibration, you can select **Cancel** to abort the calibration.



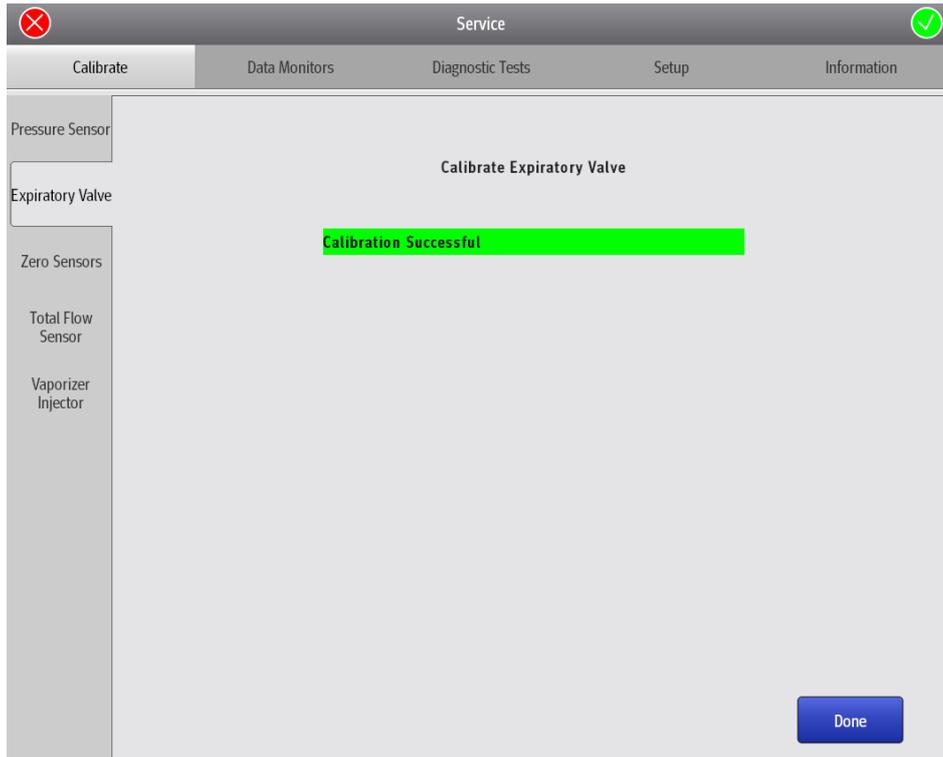
4. The screen shown below is displayed if the ongoing calibration is aborted. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.



5. The screen shown below is displayed if the calibration fails. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.



6. The screen shown below is displayed upon successful zeroing. Select **Done** to exit the calibration screen.



### 10.3.7.3 Common Failures and Recommended Actions

Failure Description	Possible Cause	Recommended Action
Display E	A zero point error occurs in the PEEP sensor.	<ol style="list-style-type: none"> <li>1. Calibrate the sensor.</li> <li>2. Replace the VCM.</li> </ol>
Display F	<p>The pressure change is not monotonic.</p> <p>The larger the expiratory valve sealing current, the smaller the pressure.</p>	<ol style="list-style-type: none"> <li>1. Check for leakage.</li> <li>2. Replace the inspiratory valve.</li> </ol>
Display 10	<p>The expiratory valve is not monotonic.</p> <p>The larger the expiratory valve sealing current, the smaller the sampling current.</p>	Replace the inspiratory valve.
Display 34	The drive gas pressure is low.	<ol style="list-style-type: none"> <li>1. Replace or connect a gas supply to keep the gas supply pressure within 280–600 kPa.</li> <li>2. If the gas supply is normal, check the gas supply pressure switch.</li> </ol>
Display 39	The system fails to write data into EEPROM.	<ol style="list-style-type: none"> <li>1. Perform the calibration again.</li> <li>2. Replace the VCM.</li> </ol>

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## 10.3.8 Pressure and Flow Zeroing (Service)

### 10.3.8.1 Principles

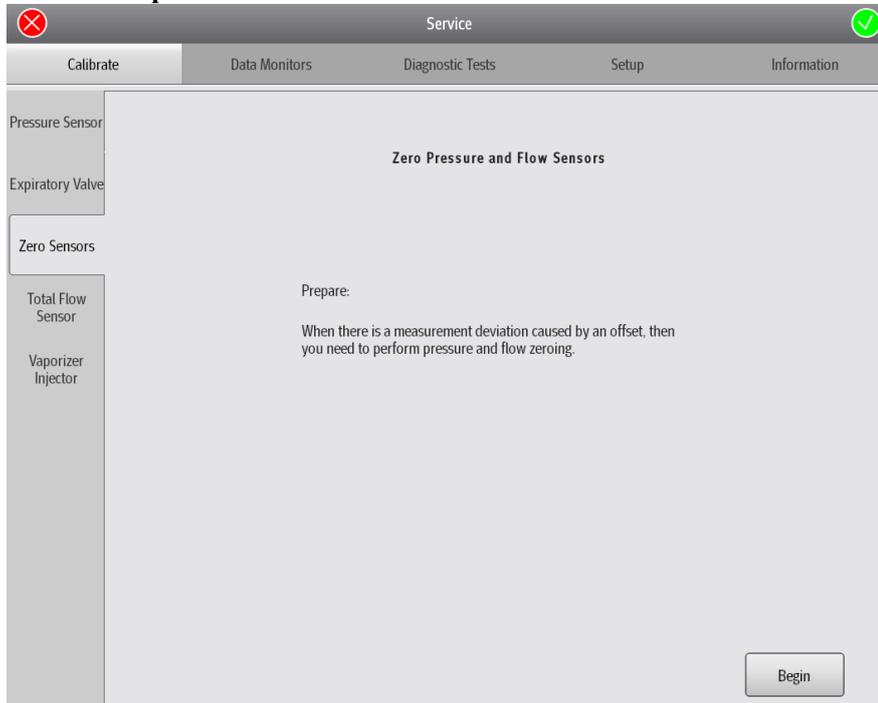
The anesthesia machine automatically performs pressure and flow zeroing at regular intervals during operation. You can also perform pressure and flow zeroing manually in the factory maintenance menu. Manual zeroing can immediately eliminate measurement deviations caused by zero offset of sensors. The anesthesia machine supports automatic and periodic pressure and flow zeroing. The first four zeroing operations are done automatically 5, 15, 30, and 60 minutes after ventilation starts. Then automatic zeroing takes place every 120 minutes. The three-way valve is opened and closed for valve flushing during mechanical ventilation and before automatic zeroing. A dent appears in the waveform during zeroing, or opening and closing of the three-way valve.

The zeroing principles are as follows: During manual zeroing in standby mode, the VCM closes the inspiratory valve and PEEP valve, and opens the three-way valve to start zeroing. The VCM collects the pressures or flow AD values of the Paw sensor, PEEP sensor, inspiratory flow sensor, expiratory flow sensor, and built-in flow sensor, and uses them as the AD values of the sensors at zero point. It closes the three-way valve, and the zeroing ends. The VPM is instructed to synchronize zeroing during manual zeroing in standby mode. Processing in manual zeroing is the same as that in automatic zeroing during ventilation. The opening and closing of the three-way valve are controlled to zero the Paw sensor, inspiratory flow sensor, and expiratory flow sensor. After zeroing is enabled, the three-way valve is opened for zeroing, the pressure or flow AD value of each sensor is collected and used as the AD value of each sensor at zero point. Then the three-way valve is closed, and the zeroing ends.

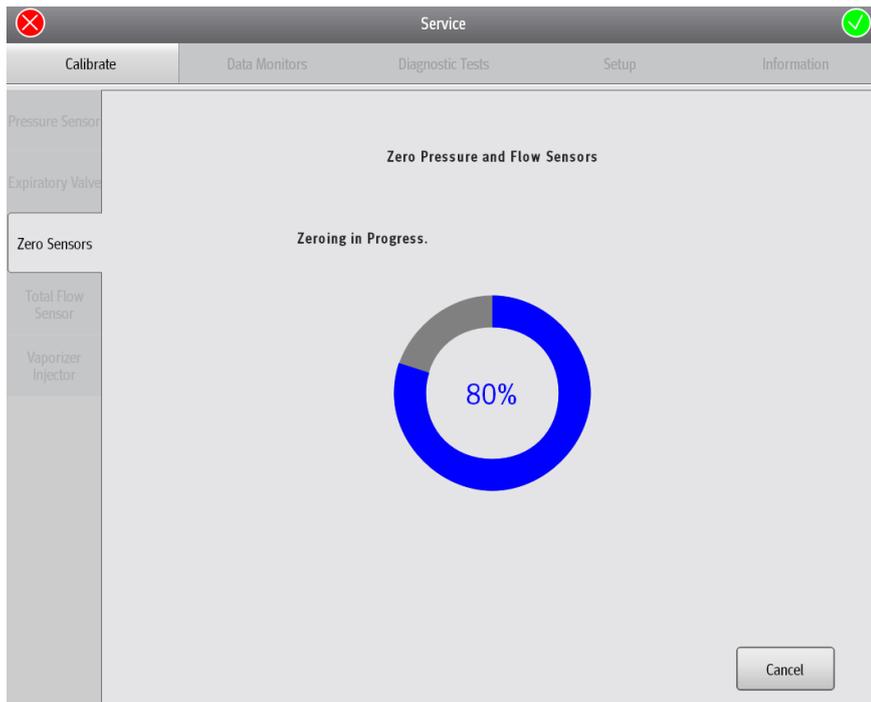
### 10.3.8.2 Zeroing Procedure

Perform the following steps to zero pressure and flow sensors.

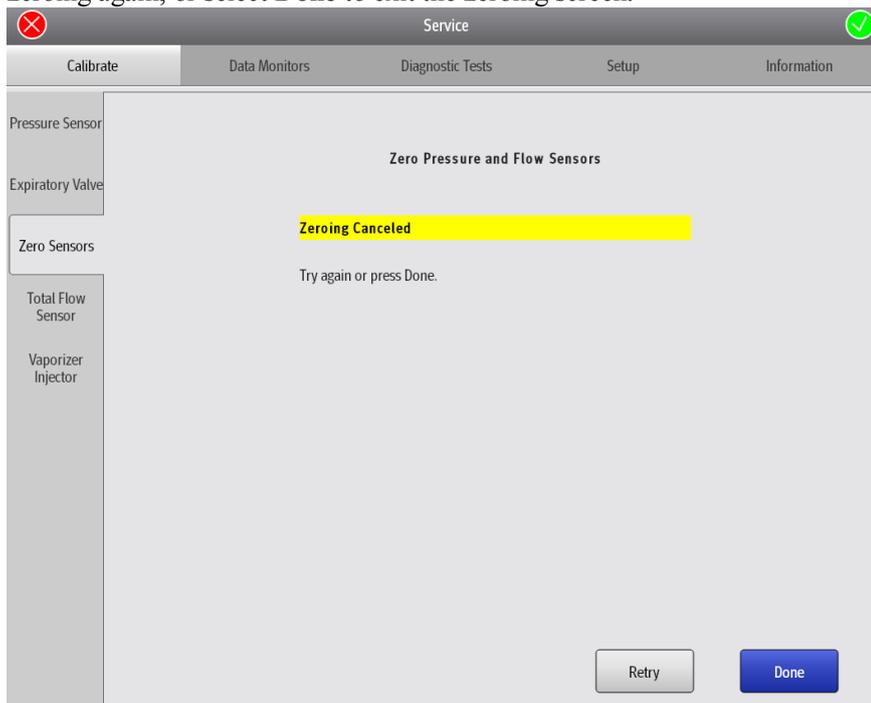
1. Choose **Setup > Service > Calibrate > Zero Sensors** to access the screen shown below.



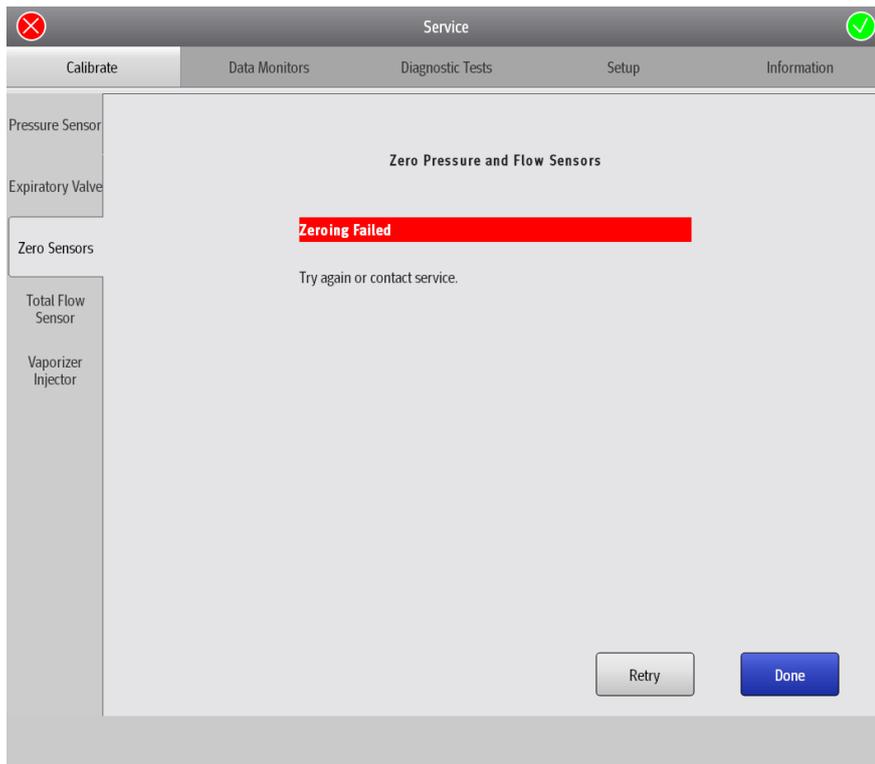
2. Select **Begin** to access the screen shown below. During zeroing, you can select **Cancel** to abort the zeroing.



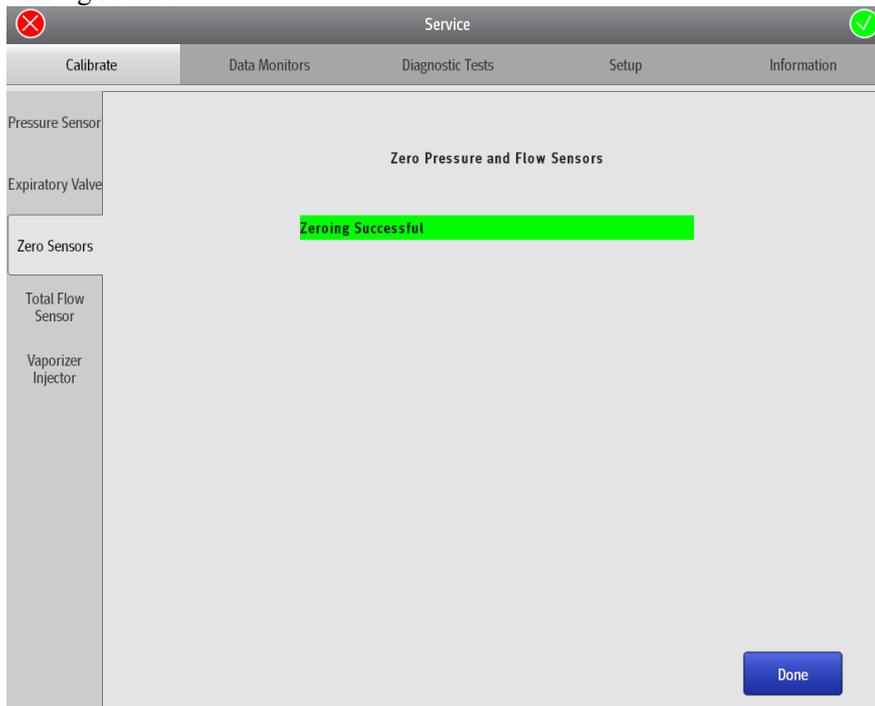
3. The screen shown below is displayed if the ongoing zeroing is aborted. Select **Retry** to do the zeroing again, or select **Done** to exit the zeroing screen.



4. The screen shown below is displayed if the zeroing fails. Select **Retry** to do the zeroing again, or select **Done** to exit the zeroing screen.



5. The screen shown below is displayed upon successful zeroing. Select **Done** to exit the zeroing screen.



## NOTE

- **Other faults may exist in the machine if the zeroing fails. You must locate and rectify the faults.**

---

### 10.3.8.3 Zeroing Failure Troubleshooting

If the zeroing fails, perform the following steps to locate and rectify the fault.

1. Disconnect all gas supplies. Remove breathing tubes from the breathing system so that the inspiratory and expiratory connectors are exposed in the air. Adjust the fresh gas flows to the maximum, wait 10s, and turn off all fresh gas flows. Start the valve diagnosis tool. Ensure that no flow or pressure enters the flow or pressure sensor inside the machine.
2. Check whether the zero points of sensors are abnormal (the values are in red font).
3. If a zero point error is detected, remove the sampling line from the sensor to eliminate effects caused by the sampling line occlusion or three-way valve. If the zero point is still incorrect, the VCM is faulty. Replace the VCM.
4. If the zero points of sensors are correct but zeroing still fails, the three-way valve assembly is faulty. Replace the three-way valve assembly.

### 10.3.9 Total Flow Sensor Calibration (Service)

#### 10.3.9.1 Principles

To support flow sensor self-test, it is necessary to find out the relationship of N2O measurement between the O2 flow sensor in the total limb and the flow sensor in the N2O limb. Therefore, it is necessary to vent in N2O to the machine to calibrate the O2 flow sensor in the total limb. This operation is performed manually.

The calibration principles are as follows: When the EFCS opens the proportional valve in the N2O limb with a fixed flow for a period of time, read the N2O measured value by the O2 flow sensor in the total limb. After averaging for a certain period of time, this average value and the N2O measured value by the flow sensor in the N2O limb form a data point in the calibration table and so on. The points after calibration is completed form a calibration table.

#### 10.3.9.2 Precautions

##### **NOTE**

- 
- **Ensure that the N2O supply is connected and its pressure is within the normal range.**
  - **Ensure that the machine is in the EFCS state.**
  - **Ensure that the machine is in the EFCS state. Connect the N2O supply and ensure the gas supply pressure is within the normal range. In the manual test of the FCS test menu, open the N2O valve to make the measured value of the N2O flow sensor become 0, 0.5, 1, 2, 4, 6, 8, and 10 respectively. Then observe whether the value of each point measured by the flow sensor in the total limb is within the accuracy range, and calibrate the value if it exceeds the accuracy range.**
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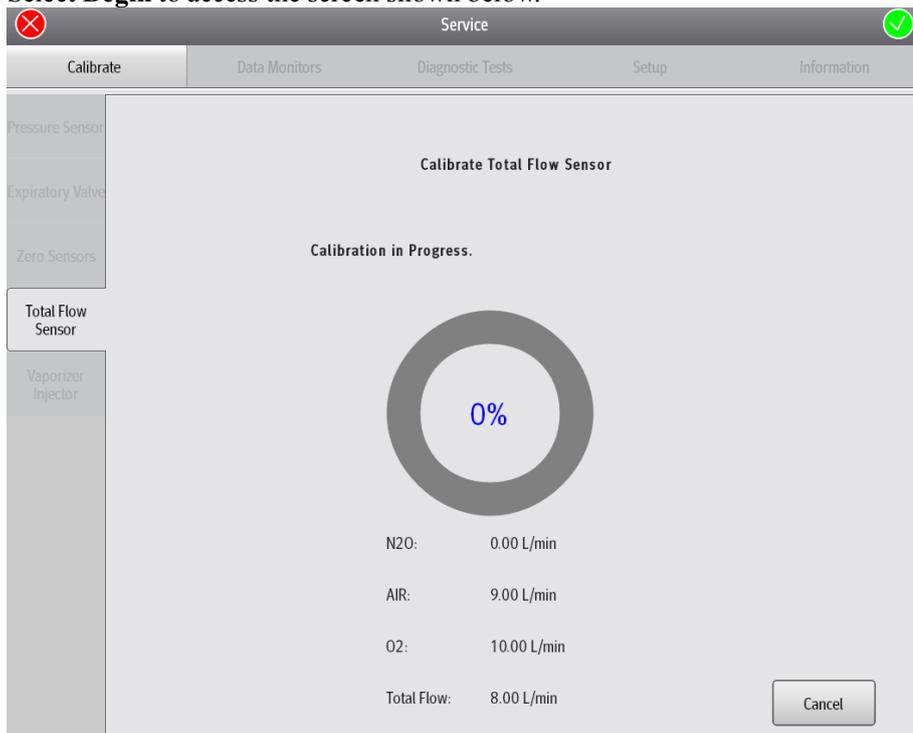
#### 10.3.9.3 Calibration Procedure

Perform the following steps to calibrate flow sensors.

1. Enter the standby mode.
2. Choose **Setup > Service > Calibrate > Total Flow Sensor** to access the screen shown below.



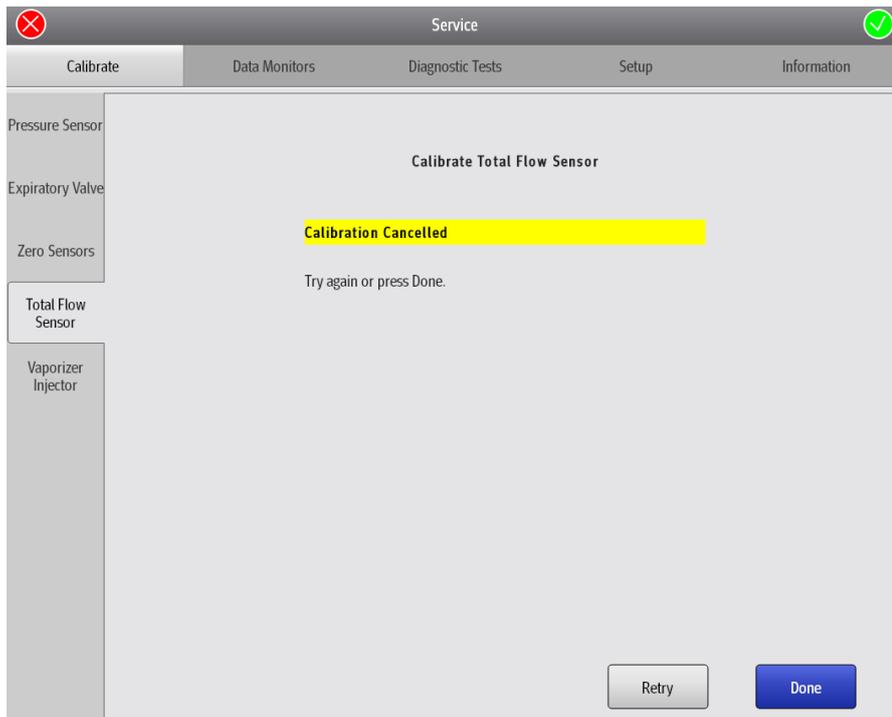
3. Select **Begin** to access the screen shown below.



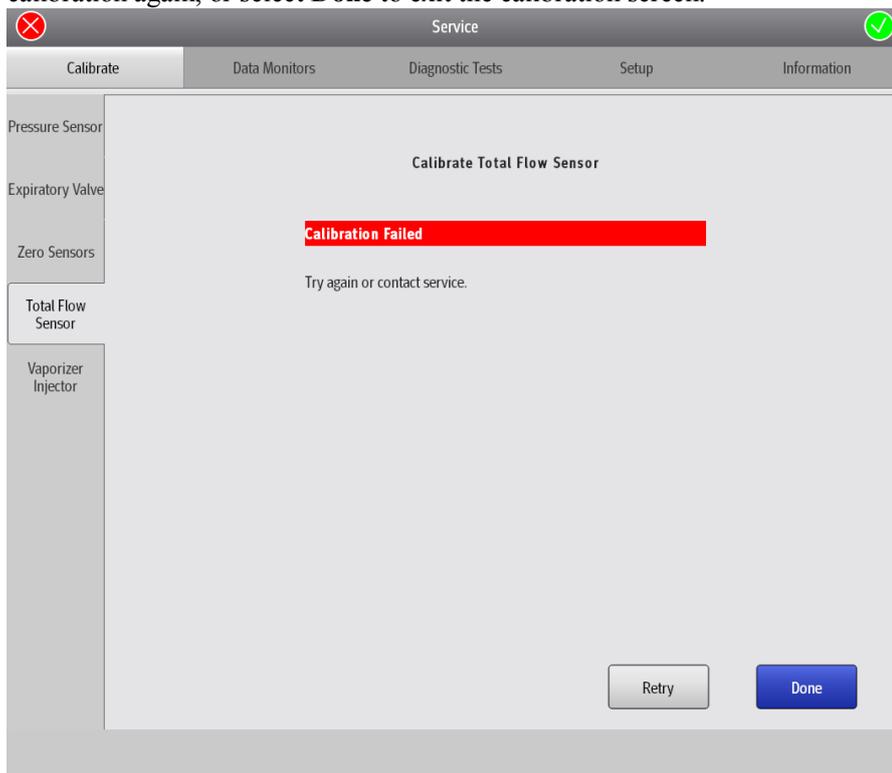
## NOTE

- The real-time 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 small all the time.

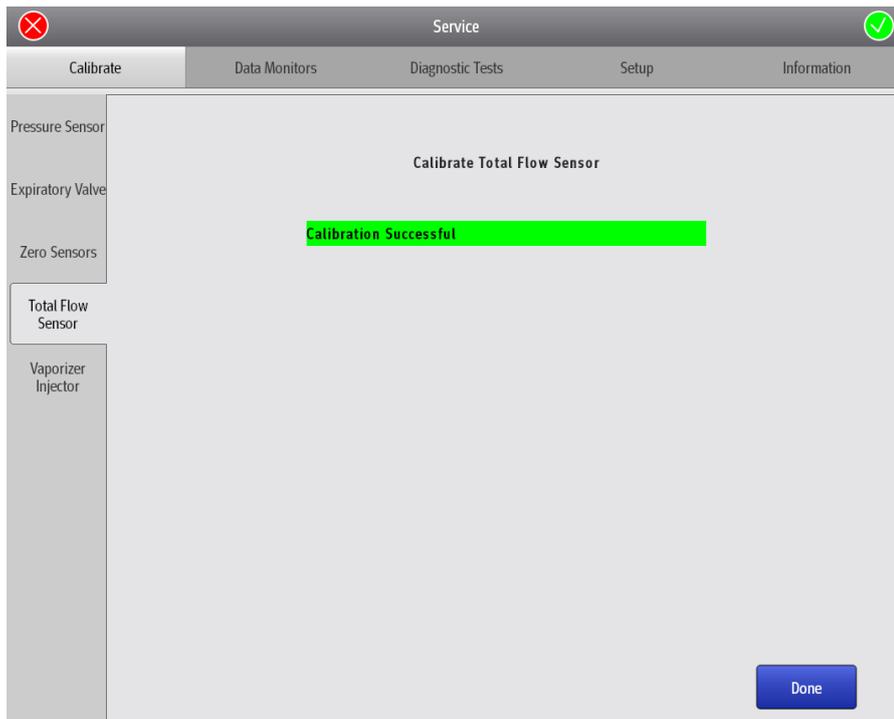
4. The screen shown below is displayed if the ongoing calibration is aborted. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.



5. The screen shown below is displayed upon successful calibration. The screen shown below is displayed if the calibration fails. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.



The screen shown below is displayed upon successful calibration. Select **Done** to exit the calibration screen.

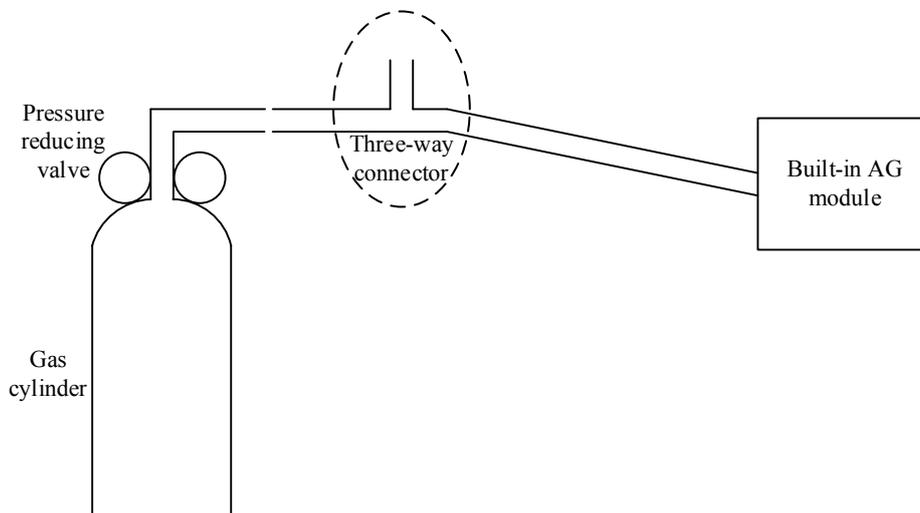


#### 10.3.9.4 Common Failures and Recommended Actions

Failure Description	Possible Cause	Recommended Action
After <b>Begin</b> is selected, calibration failure is displayed very soon.	The machine is in the BFCS state.	Set the machine to the EFCS state.
	The N2O supply pressure is low.	Replace or connect a gas supply to ensure that N2O pressure is within the specified range.
After <b>Begin</b> is selected, calibration fails about 1 minute later.	The calibration points do not conform to monotonicity.	<ol style="list-style-type: none"> <li>1. Perform the calibration again.</li> <li>2. Replace the EFCS flowmeter assembly.</li> </ol>

#### 10.3.10 Built-in AG Calibration (User)

Connect the built-in AG module to standard gases (concentration: CO2: 5%, O2: 45%, N2O: 45%, and DES: 5%), as shown in the figure below.



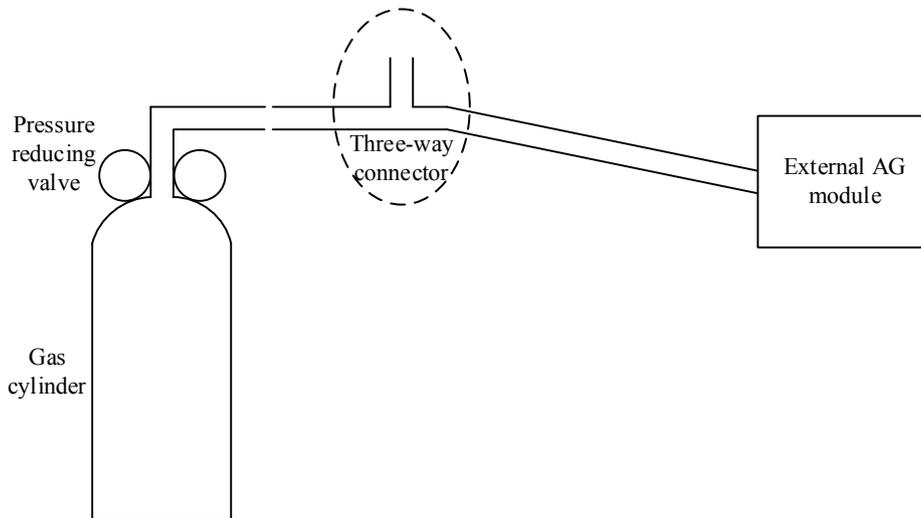
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Preheat the module for 10 minutes. In standby mode, choose **Setup > System**, enter the password 1234, press **ENTER**, click **Calibrate**, and select **Internal AG Module** to access the built-in AG module calibration screen.

Turn on the gas cylinder switch and regulate the flow valve. Read the concentration of the anesthesia gas DES on the calibration screen, which should be  $(5 \pm 0.2)\%$ .

If the accuracy of the concentration of gases to be measured is beyond the preceding indication range, click the button on the right of the displayed value to set the target value based on the concentration of the standard gases, and click **Calibrate** to calibrate the module.

### 10.3.11 External AG Calibration (User)



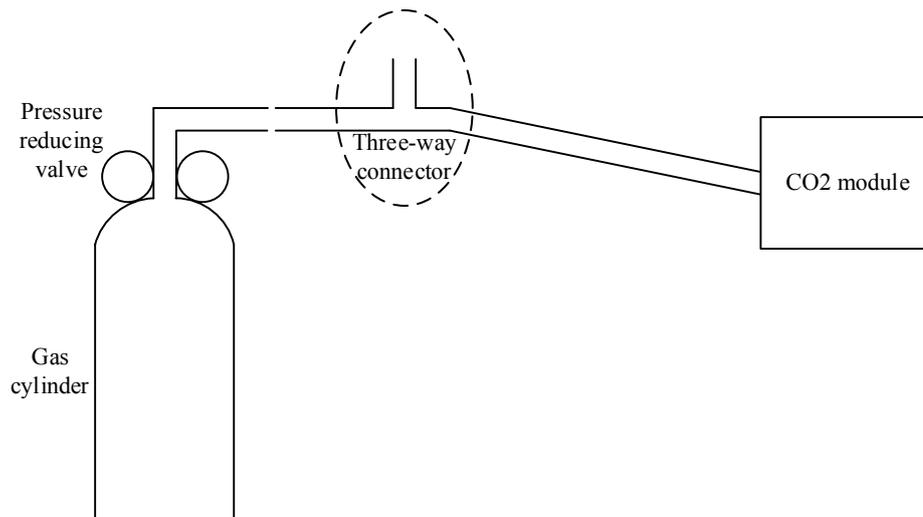
Connect the gas cylinder containing standard gases (concentration: CO<sub>2</sub>: 5%, O<sub>2</sub>: 45%, N<sub>2</sub>O: 45%, and DES: 5%), pressure reducing valve, water trap, and anesthesia machine through the sampling line. Preheat the module and then perform the following test: Turn on the gas cylinder valve, and access the system gas calibration screen (the detailed mode of access will be mentioned later). Observe the concentration of CO<sub>2</sub> and O<sub>2</sub> and ensure that they are within the following ranges: CO<sub>2</sub>:  $5.0\% \pm 0.2\%$  and O<sub>2</sub>:  $45\% \pm 2\%$ . Note that the concentration of O<sub>2</sub> will not be displayed for the module irrelevant to O<sub>2</sub>.

#### NOTE

- a. Mode of access to the calibration screen: In standby mode, choose **Setup > System**, enter the password 71234, press **ENTER**, click **Calibrate**, and select **AG Module** to access the system gas calibration screen.
- b. If the gas concentration is beyond the range, set the target value to the value of the gas type corresponding to the standard gas, and then click **Calibrate**.

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## 10.3.12 CO2 Module Calibration (User)



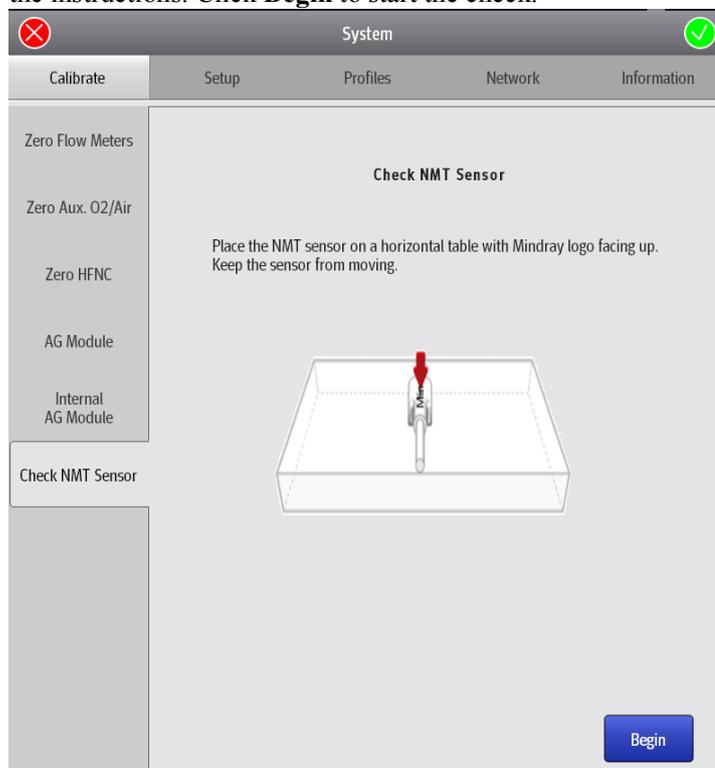
Before calibration, ensure that the module has been running for over 15 minutes: Click **Zero**, select **Continue**, set **Concentration Selection** to 5% on the CO2 module calibration screen. Then feed the standard CO2 (5%) and click **Calibration Confirmation** 20s after the reading becomes stable.

## 10.3.13 NMT Sensor Check (User)

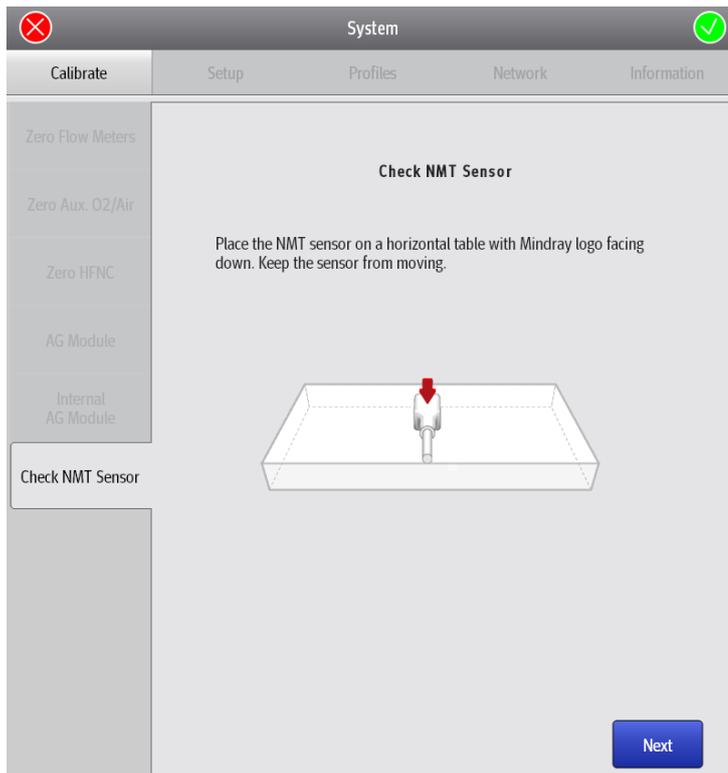
### 10.3.13.1 Check Procedure

Perform the following steps to check the NMT sensor.

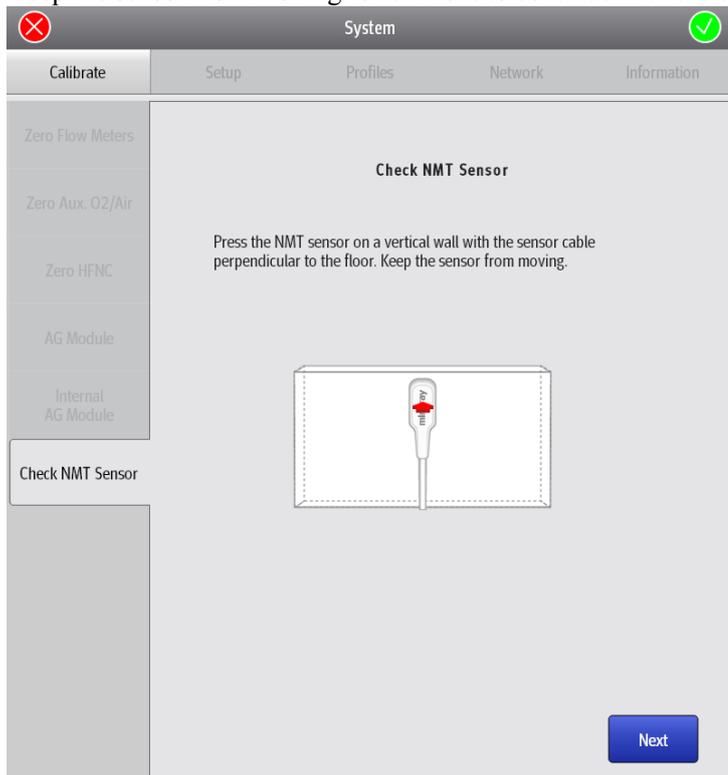
1. Enter the standby mode.
2. Choose **Setup** > **System** > **Calibrate** > **Check NMT Sensor** to access the screen shown below. Place the NMT sensor on a horizontal table with Mindray logo facing up according to the instructions. Click **Begin** to start the check.



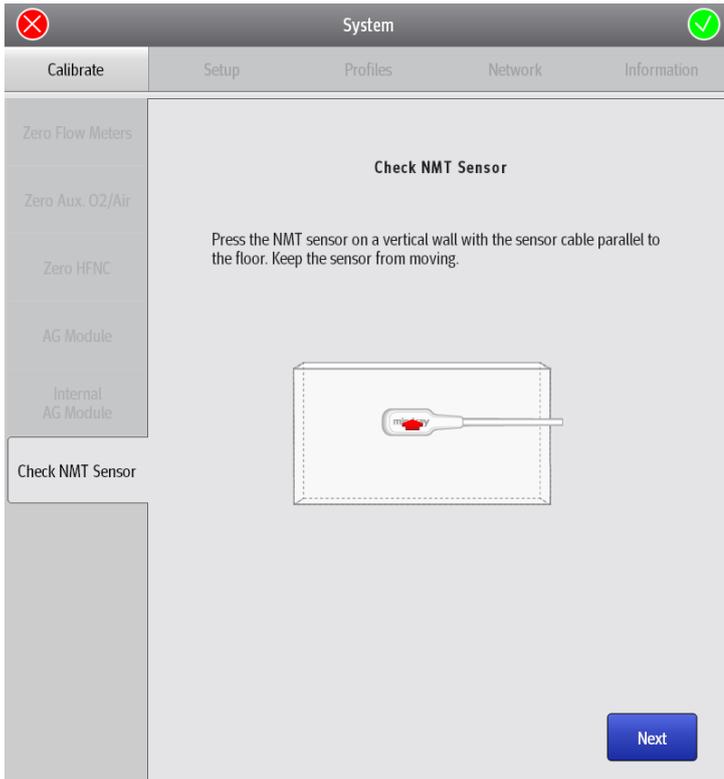
3. Place the NMT sensor on a horizontal table with Mindray logo facing down. Keep the sensor from moving. Click **Next** to continue with the check.



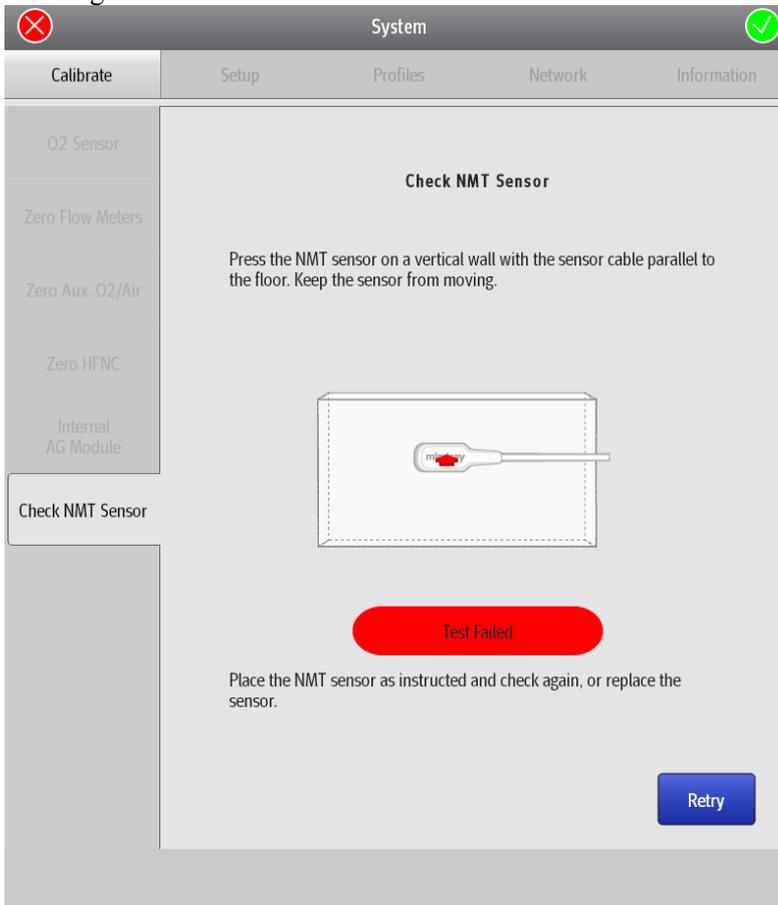
4. Press the NMT sensor on a vertical wall with the sensor cable perpendicular to the floor. Keep the sensor from moving. Click **Next** to continue with the check.



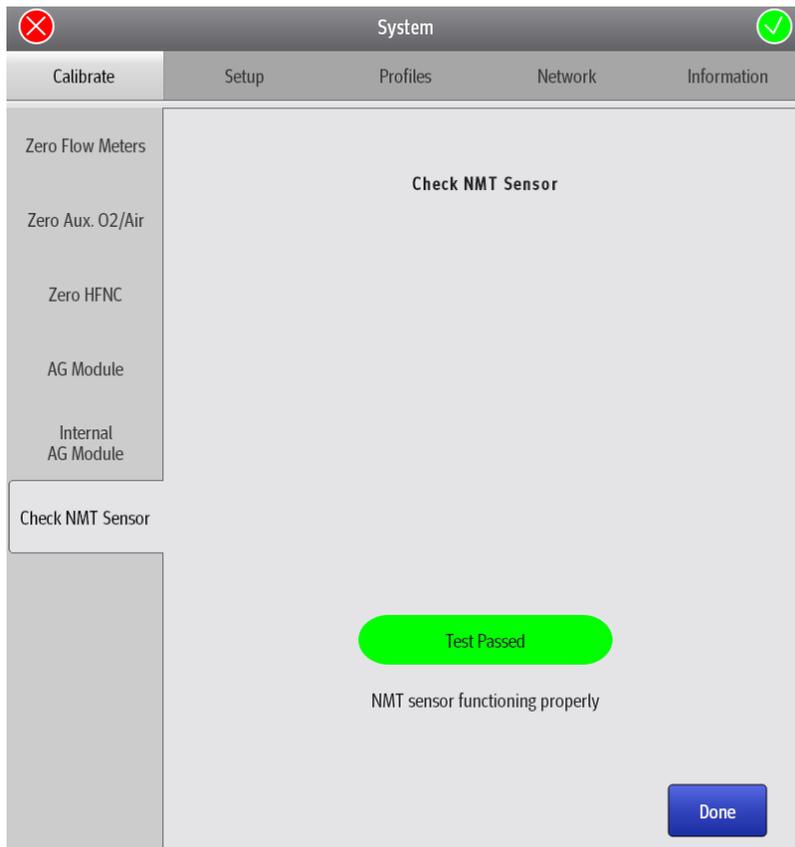
5. Press the NMT sensor on a vertical wall with the sensor cable parallel to the floor. Keep the sensor from moving. Click **Next** to continue with the check.



6. The screen shown below is displayed after the NMT sensor check is completed. The screen shown below is displayed if the NMT sensor check fails. Select **Retry** to do the check again.



The screen shown below is displayed if the NMT sensor check is successful. Select **Done** to exit the check screen.



### 10.3.14 Vaporizer Injector Calibration (Service)

#### 10.3.14.1 Principles

Insert the electronic vaporizer in standard equipment with an AG module meeting the accuracy requirement. Measure the anesthetic concentration of the mixed gas produced by the electronic vaporizer and electronic flowmeter. Calibrate the amount of anesthetic agent injected by the electronic vaporizer injector each time combined based on the fresh gas flow.

#### NOTE

- **Perform the following steps to calibrate the vaporizer injector when the deviation between the concentration setting of the vaporizer and the measured value of the external AG module exceeds  $\pm 15\%$  or (maximum value  $\pm 5\%$ ), whichever is larger.**

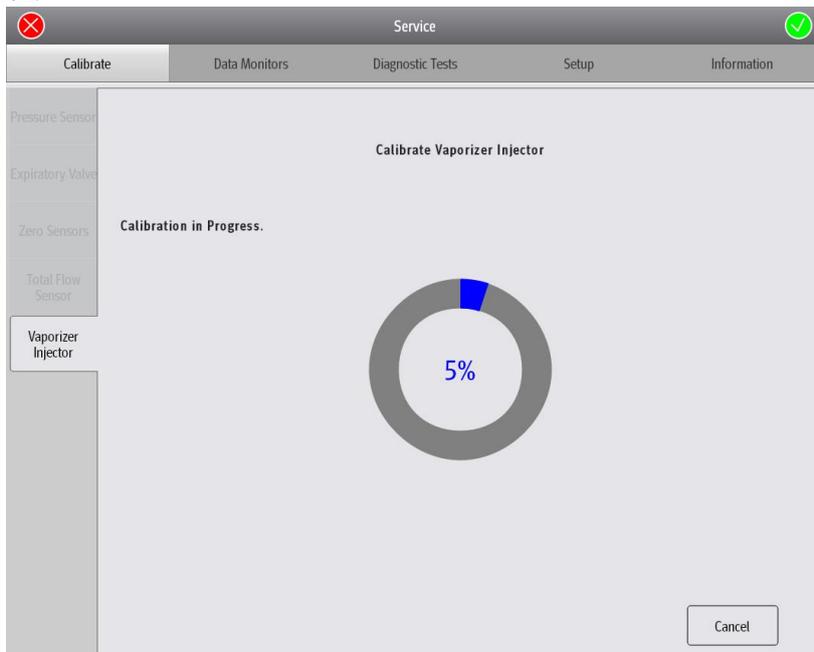
#### 10.3.14.2 Calibration Procedure

Perform the following steps to calibrate the vaporizer injector.

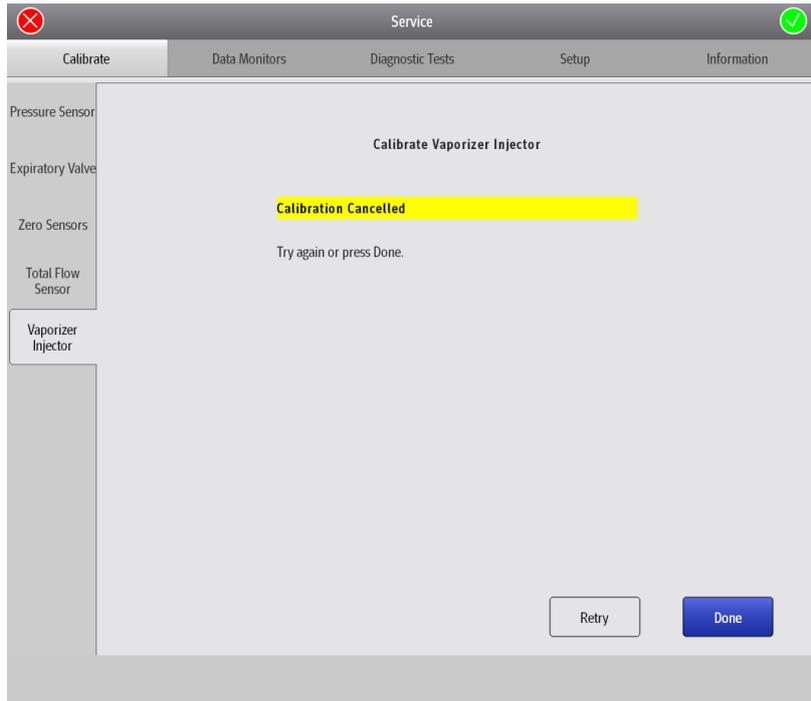
1. Enter the standby mode.
2. Choose **Setup > Service > Calibrate > Vaporizer Injector** to access the screen shown below. Select vaporizer 1 (for example, Iso vaporizer). (Note: The calibration steps of vaporizer 2 are the same as those of vaporizer 1.)



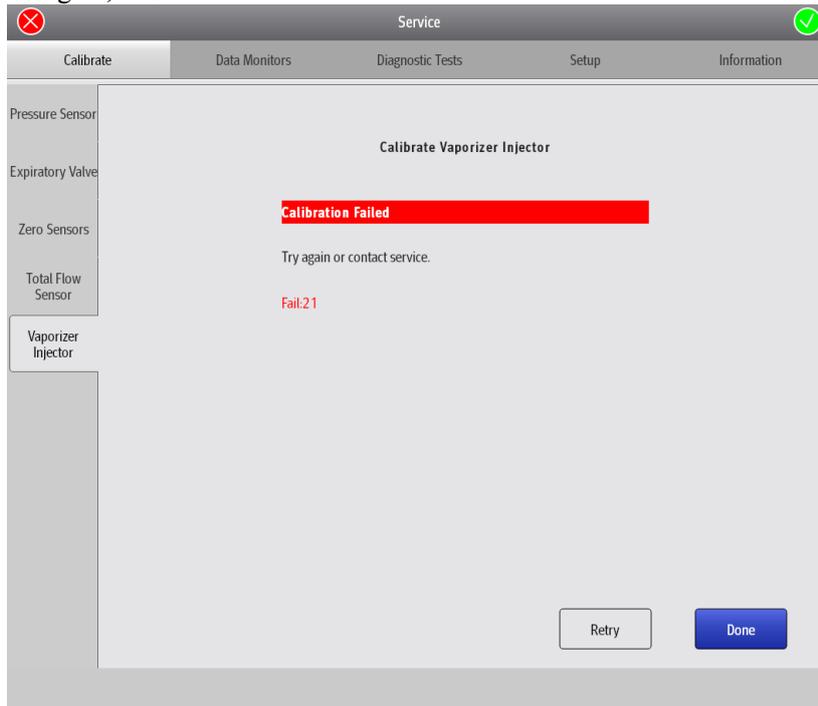
3. Select **Begin** to start calibration. During calibration, you can select **Cancel** to abort the calibration.



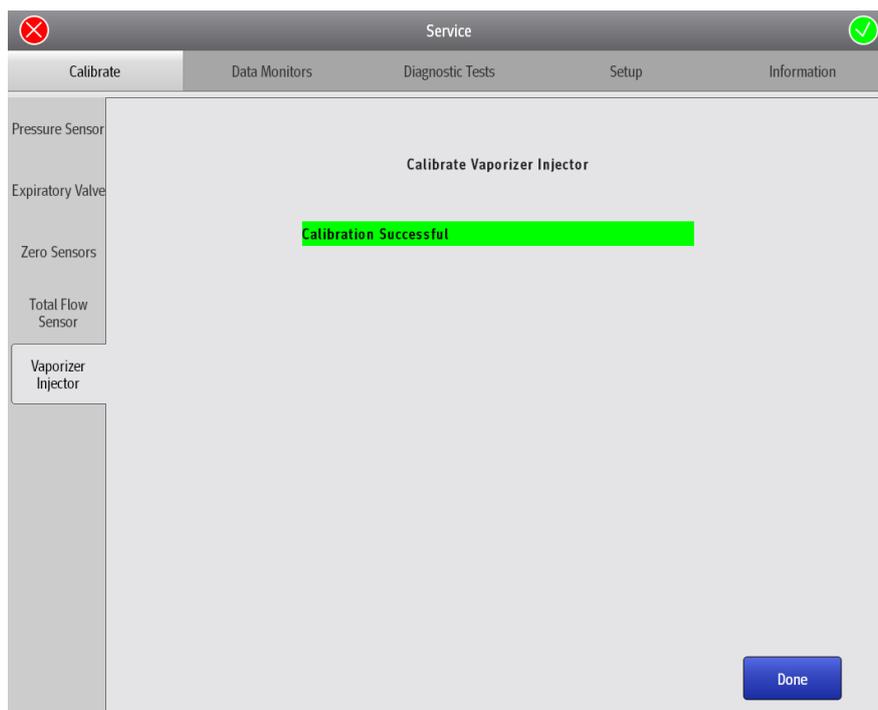
4. The screen shown below is displayed if the ongoing calibration is aborted. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.



5. The screen shown below is displayed if the calibration fails. Select **Retry** to do the calibration again, or select **Done** to exit the calibration screen.



6. The screen shown below is displayed upon successful calibration. Select **Done** to exit the calibration screen.



### 10.3.14.3 Common Failures and Recommended Actions

Failure Description	Possible Cause	Recommended Action
00000001	There is no drive gas.	<ol style="list-style-type: none"> <li>1. Check whether the gas supply is connected and is sufficient (280–600 kPa).</li> <li>2. Check whether the cover of the electronic vaporizer is closed.</li> <li>3. Replace the electronic vaporizer.</li> <li>4. Replace the electronic vaporizer manifold.</li> </ol>
00000002	The fresh gas flow is invalid.	<ol style="list-style-type: none"> <li>1. Check whether the gas supply is connected and is sufficient (280–600 kPa).</li> <li>2. Check whether the electronic flowmeter works properly.</li> </ol>
00000004	There is no fresh gas.	<ol style="list-style-type: none"> <li>1. Check whether the gas supply is connected and is sufficient (280–600 kPa).</li> <li>2. Check whether the electronic flowmeter works properly.</li> </ol>
00000008	The temperature does not meet the requirement.	<ol style="list-style-type: none"> <li>1. Replace the electronic vaporizer.</li> </ol>
00000010	The AG module is not ready.	<ol style="list-style-type: none"> <li>1. Check whether the AG module is connected and works in full accuracy mode.</li> <li>2. Check whether the water trap and sampling line of the AG</li> </ol>

Failure Description	Possible Cause	Recommended Action
		<p>module are connected properly and whether leakage occurs.</p> <ol style="list-style-type: none"> <li>3. Check whether there is any other type of anesthetic gas remaining in the line. If yes, turn on the fresh gas for flushing or turn on the injector of the electronic vaporizer to be calibrated for flushing.</li> <li>4. Check whether leakage occurs in the internal pipeline of the machine so that the fresh gas cannot flow through the sampling point.</li> <li>5. Replace the internal AG module.</li> <li>6. Replace the electronic vaporizer.</li> </ol>
00000020	There is no concentration output.	<ol style="list-style-type: none"> <li>1. Check whether the AG module is connected and works in full accuracy mode.</li> <li>2. Check whether the water trap and sampling line of the AG module are connected properly and whether leakage occurs.</li> <li>3. Check whether there is any other type of anesthetic gas remaining in the line. If yes, turn on the fresh gas for flushing or turn on the injector of the electronic vaporizer to be calibrated for flushing.</li> <li>4. Check whether leakage occurs in the internal pipeline of the machine so that the fresh gas cannot flow through the sampling point.</li> <li>5. Replace the internal AG module.</li> <li>6. Replace the electronic vaporizer.</li> </ol>
00000040	The system exits the standby state.	During calibration, the system exits the standby state.
00000080	The linearity does not meet the requirement.	<ol style="list-style-type: none"> <li>1. Check whether the gas supply is sufficient.</li> <li>2. Check whether the water trap and sampling line of the AG module are connected properly and whether leakage</li> </ol>

Failure Description	Possible Cause	Recommended Action
		<p>occurs.</p> <ol style="list-style-type: none"> <li>3. Check whether leakage occurs in the internal pipeline of the machine so that the fresh gas cannot flow through the sampling point.</li> <li>4. Replace the internal AG module.</li> <li>5. Replace the electronic vaporizer.</li> </ol>
00000100	The system fails to write data into EEPROM.	Replace the electronic vaporizer.
00000200	The electronic vaporizer is automatically turned off due to an error.	Perform diagnosis based on the fault code of the electronic vaporizer.
00000400	The measured value of the AG module exceeds the upper limit during verification.	<ol style="list-style-type: none"> <li>1. Calibrate the electronic vaporizer again.</li> <li>2. Check whether the water trap and sampling line of the AG module are connected properly and whether leakage occurs.</li> <li>3. Check whether leakage occurs in the internal pipeline of the machine so that the fresh gas cannot flow through the sampling point.</li> <li>4. Replace the AG module.</li> </ol>
00000800	The measured value of the AG module exceeds the lower limit during verification.	<ol style="list-style-type: none"> <li>1. Calibrate the electronic vaporizer again.</li> <li>2. Check whether the water trap and sampling line of the AG module are connected properly and whether leakage occurs.</li> <li>3. Check whether leakage occurs in the internal pipeline of the machine so that the fresh gas cannot flow through the sampling point.</li> <li>4. Replace the AG module.</li> </ol>

## 10.4 Tests After Calibration

For test items after calibration, see 7.2 System Check and 7.14 System Ventilation Performance Tests.

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**FOR YOUR NOTES**

# 11 Software Upgrade

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List of software upgrade functions

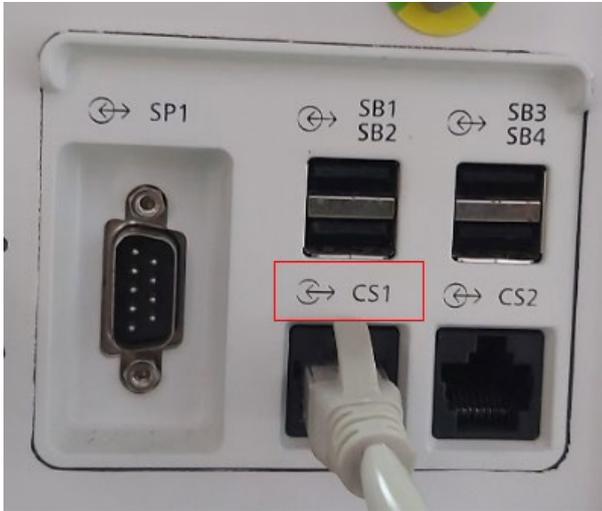
SN	Software Upgrade Package	Modules Included	Latest Version
01	Avatar.mpkg	Bundle Version	01.00.00.04
		Host Software	01.00.00.04
		Linux Kernel	02.07.00.14
		Status Screen Software	01.00.00.02
		Linux Kernel (Status Screen)	02.07.00.14
		Ventilator Control Module	01.00.00.01
		Ventilator Protect Module	01.00.00.01
		EFCS	01.00.00.01
		EFCS PM	01.00.00.00
		Power Board	06.01.00.03
		Keyboard	05.00.00.08
		FPGA	03.00.00.04
02	02_AAOS.pkg	Auxiliary O2/Air Assembly	01.00.00.01
03	02_HFNC.pkg	High-Flow O2 Supply Assembly	01.00.00.01
04	03_EVAP1_EVAP2.mpkg	Electronic Vaporizer 1	01.00.00.00
		Electronic Vaporizer 2	01.00.00.00
05	04_EVAP1.pkg	Electronic Vaporizer 1	01.00.00.00
06	04_EVAP2.pkg	Electronic Vaporizer 2	01.00.00.00

Note: Electronic Vaporizer 1 is used for upgrade when the electronic vaporizer is inserted in the left vaporizer manifold of the machine. Electronic Vaporizer 2 is used for upgrade when the electronic vaporizer is inserted in the right vaporizer manifold of the machine. The software versions in the upgrade packages are the same. To upgrade two vaporizers together, use the combination package for electronic vaporizers.

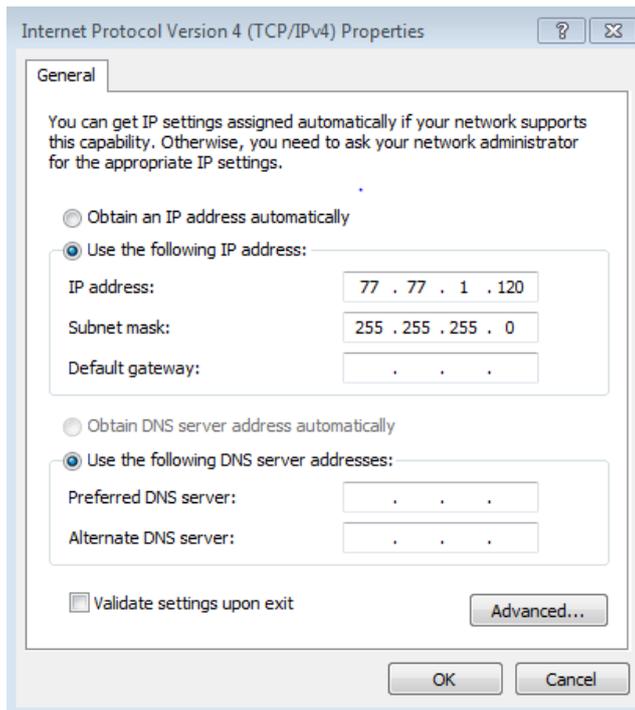
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## 11.1 Preparations

1. Connect the network port of the PC to the CS1 port of the Avatar by using a crossover network cable, as shown in the figure below.



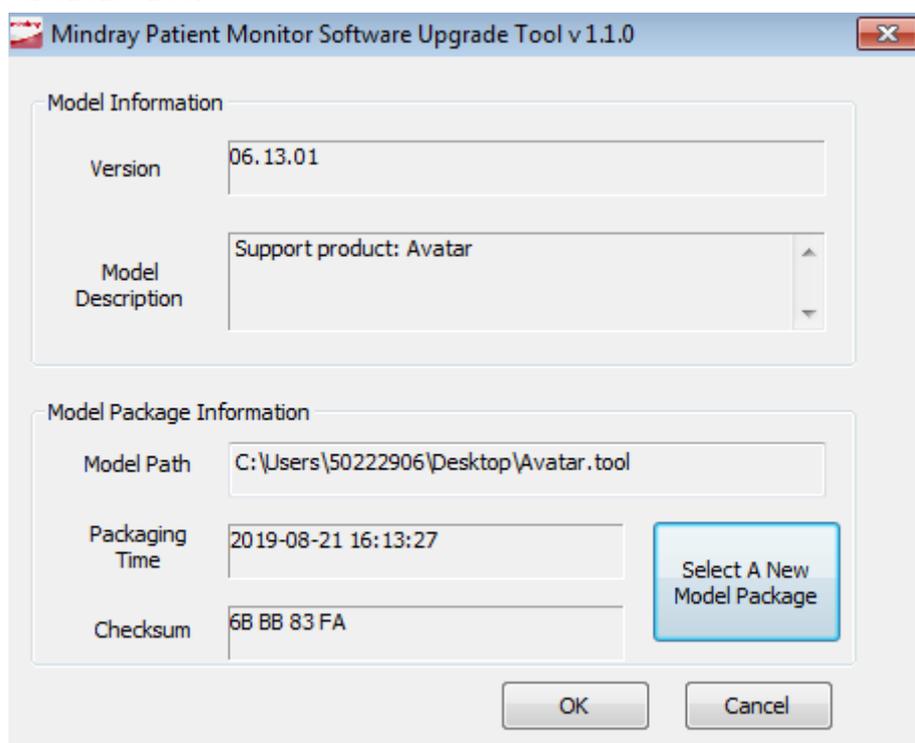
2. Before running the Mindray anesthesia machine and ventilator software upgrade tool, set the IP address of the PC to **77.77.1.1** and the subnet mask to **255.255.255.0**. Check and set the IP address according to the instructions below.
  - (1) On the PC, choose Start > Control Panel > Network and Sharing Center.
  - (2) Click Change adapter settings, double-click Local Area Connection, and click Properties.
  - (3) Scroll down to Internet Protocol Version 4 (TCP/IPv4), click Internet Protocol Version 4 (TCP/IPv4), and click Properties.
  - (4) Select Use the following IP address, set IP address and Subnet mask, and click OK.



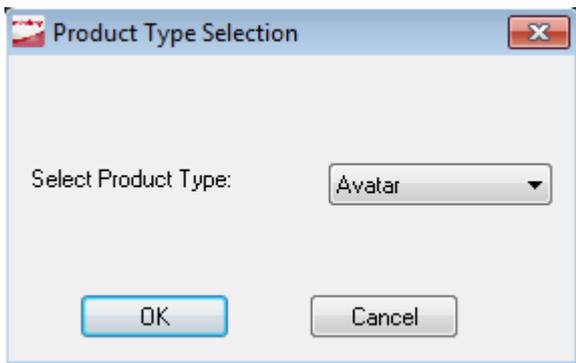
- 
3. Ensure that the upgrade tool in the software package has been installed on the PC and that the version is correct. If the tool has not been installed, perform the following steps:
    - (1) Run the SystemUpdateTool.exe file.
    - (2) When you are prompted to set a language, select **English** and click **OK**.
    - (3) When the **Welcome** dialog box is displayed, click **Next**.
    - (4) When the **Customer Information** dialog box is displayed, enter the following information:
      - (5) **User Name:** Mindray
      - (6) **Company Name:** Mindray
      - (7) **Serial Number:** 26582640
      - (8) Click **Next**.
    - (9) When the **Destination Location** dialog box is displayed, click **Next** to accept the default destination folder.
    - (10) When the **Select Program Folders** dialog box is displayed, click **Next** to accept the default program folder.
    - (11) When the **Install Shield Wizard** dialog box is displayed, click **Finish** to complete the installation.

## 11.2 Upgrading the Software

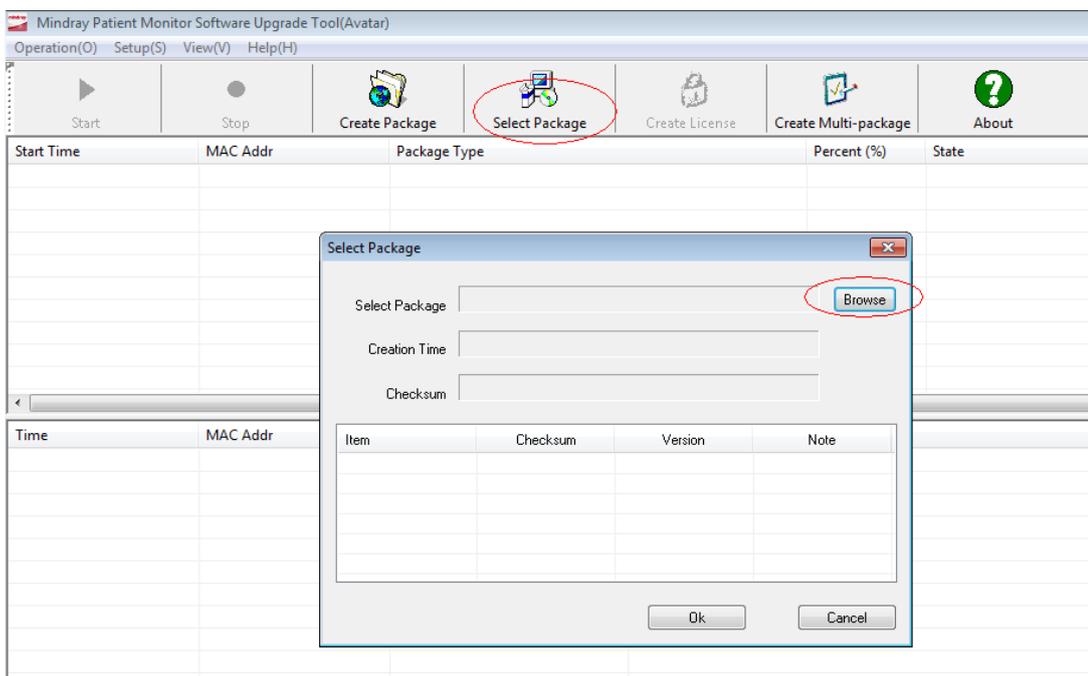
- 1) The upgrade sequence is as follows: combination package -> auxiliary O2/air assembly or high-flow O2 supply assembly. Before upgrading the O2/air assembly and high-flow O2 supply assembly, enable auxiliary O2/air and high-flow O2 supply (the flowmeter backlight is on).
- 2) Start the network upgrade tool and select the new model package **Avatar.tool** to access the screen shown below:



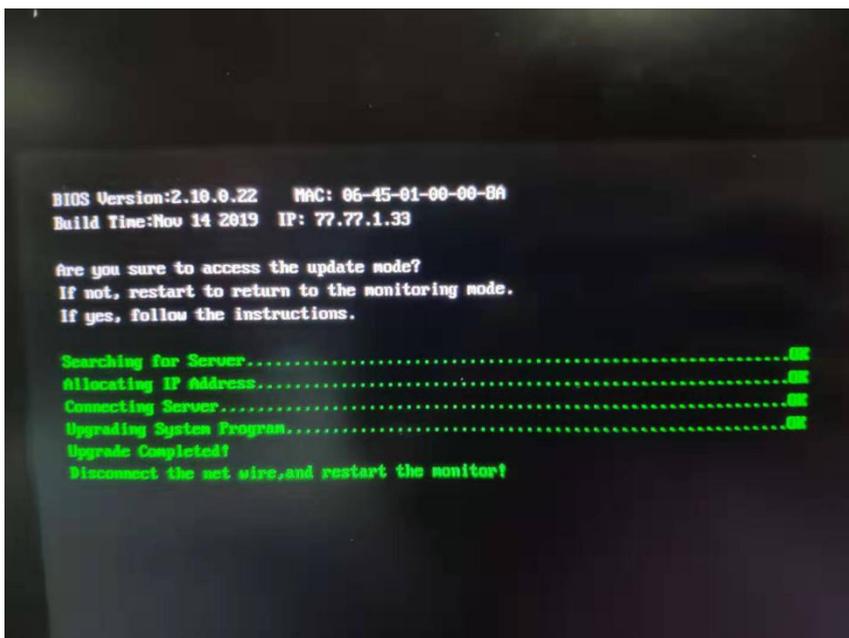
- 3) Click **OK** to access the screen shown below, set **Select Product Type** to **Avatar**, and click **OK** to access the tool upgrade screen.



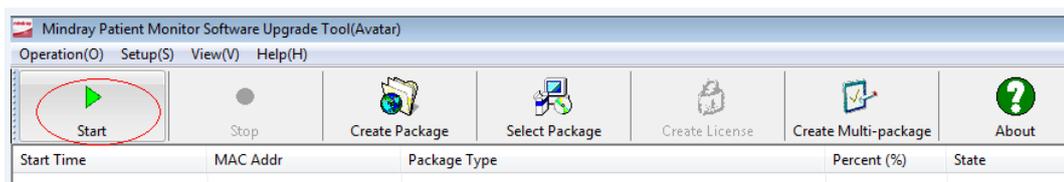
- 4) Click **Select Package**, select the **.mpkg** or **.pkg** package, and click **OK**.



After the PC is connected to the anesthesia machine via the network, keep the anesthesia machine in the off state, click **Start**, and then turn on the anesthesia machine to access the upgrade screen. The primary screen of the anesthesia machine displays "Upgrade Completed!" and "Disconnect the net wire, and restart the monitor!" when the upgrade is completed.



- 5) Click **Stop** in the upgrade tool and turn off the machine.



- 6) Repeat steps (3) and (4) to go to the next upgrade. Note: Before upgrading the O2/air assembly and high-flow O2 supply assembly, enable auxiliary O2/air and high-flow O2 supply (the flowmeter backlight is on). (The difference lies in that the measurement range of the float flowmeter for the auxiliary O2/air assembly on the machine is 0–15 L/min, and that of the float flowmeter for the high-flow O2 supply assembly is 0–60 L/min. The upgrade can be performed successfully only when the correct upgrade package is selected.)
- 7) Restart the anesthesia machine after all software upgrades are completed.

## NOTE

- Upgrade the software when replacing the CPU board, VCM, sensor board, power board, EFCS flowmeter sensor, EFCS flowmeter, or EFCS monitoring board.
- The latest versions in the above table are merely examples. Check the technical bulletins to obtain the correct software version information.
- Upgrade the software one by one according to the order in the software package.

To check the software version on the Avatar, choose **Setup > Service**, enter the service password (789789), and press **Enter**. The service screen is displayed, and you can check system information and view the united version number. Verify that the united version number conforms to the bundled version.

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## 11.3 Upgrade via USB Drive

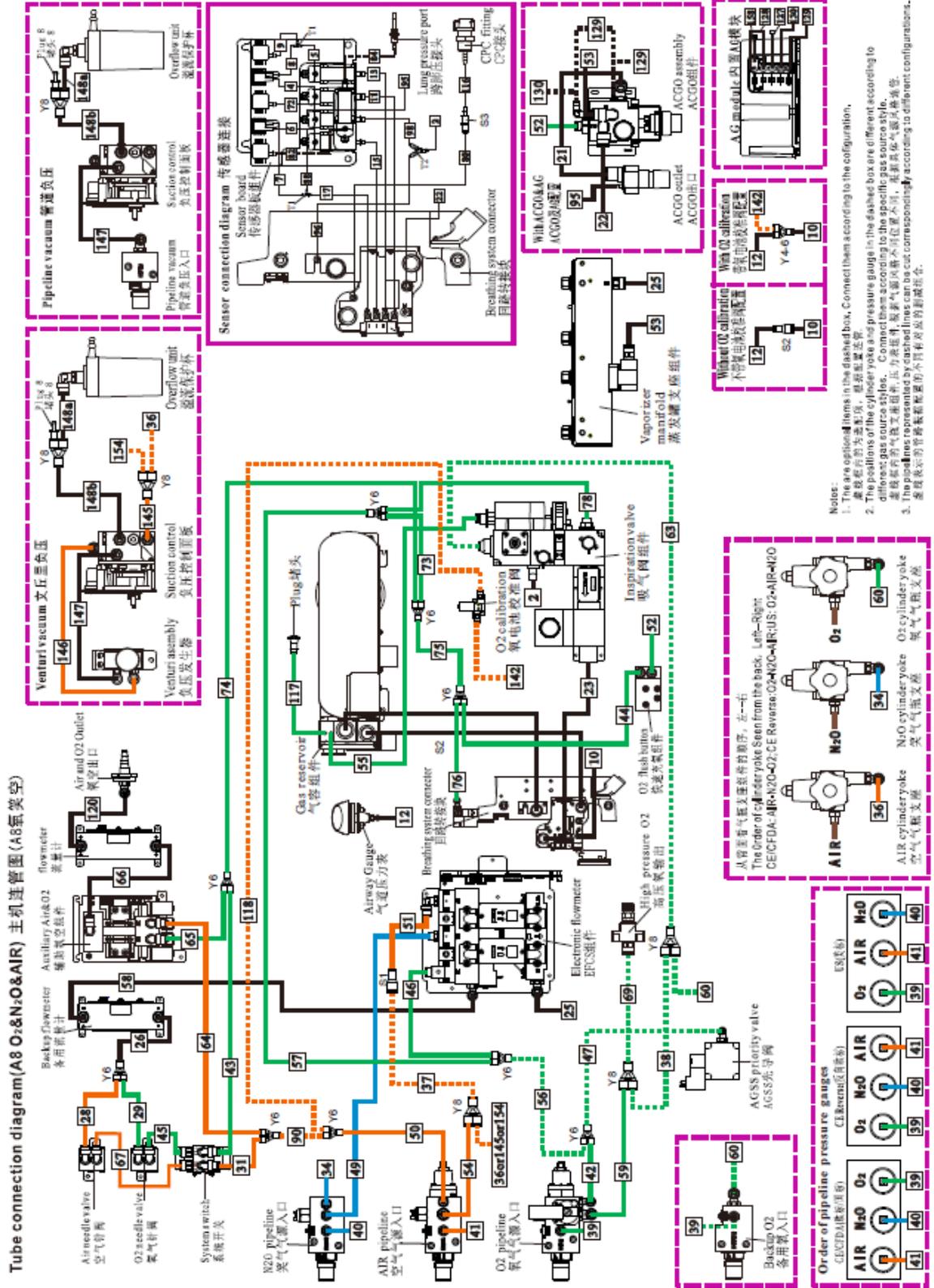
- 1) Create the **UPGRADE\_AMP** folder under the root directory of the USB drive.
- 2) Create the **Avatar** sub-folder under the **UPGRADE\_AMP** folder.
- 3) Place the **Avatar\_Installer.pkg** file and software upgrade package under the **Avatar** folder.  
Note: Before upgrading the O2/air assembly and high-flow O2 supply assembly, enable auxiliary O2/air and high-flow O2 supply (the flowmeter backlight is on).
- 4) Insert the USB drive in the machine and turn on the machine. When the system displays the USB upgrade screen, click **OK Enter** to start the upgrade.
- 5) After the upgrade is completed, restart the machine for the upgrade to take effect.

## 11.4 Test After Upgrade

For test items after upgrade, see 7.2 System Check.

# A Tube Connection Diagrams

## A.1 A8 Tube Connection Diagram

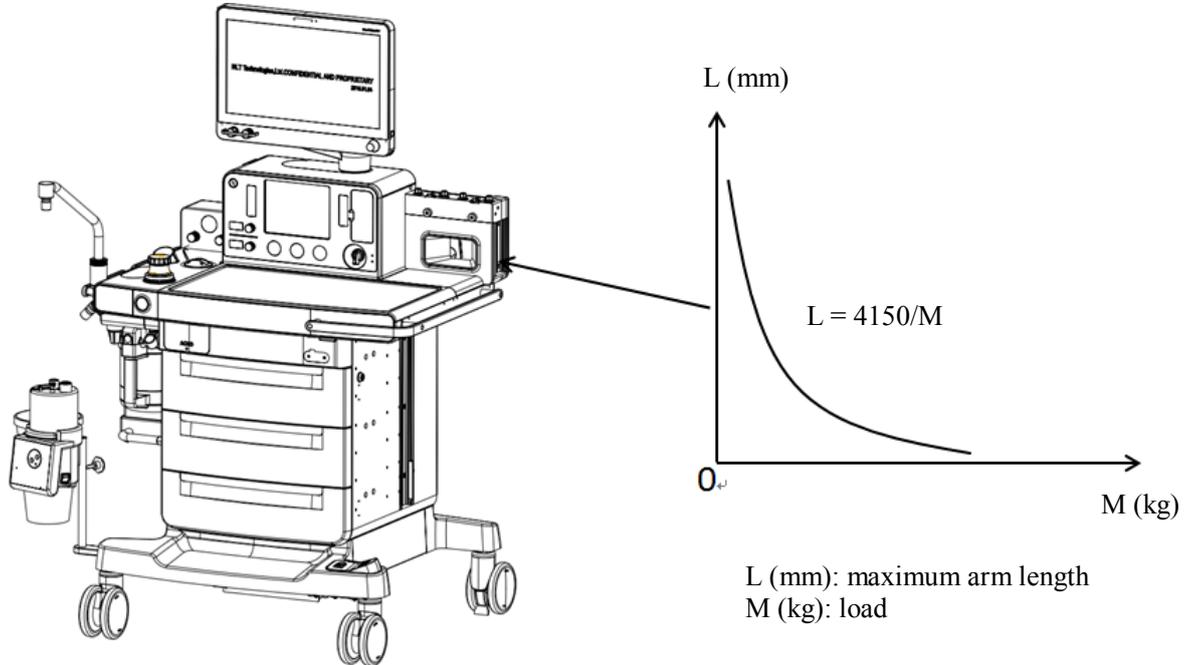




# B Guide Rail Load

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The load of the GCX guide rail for the A8 anesthesia machine is as follows:

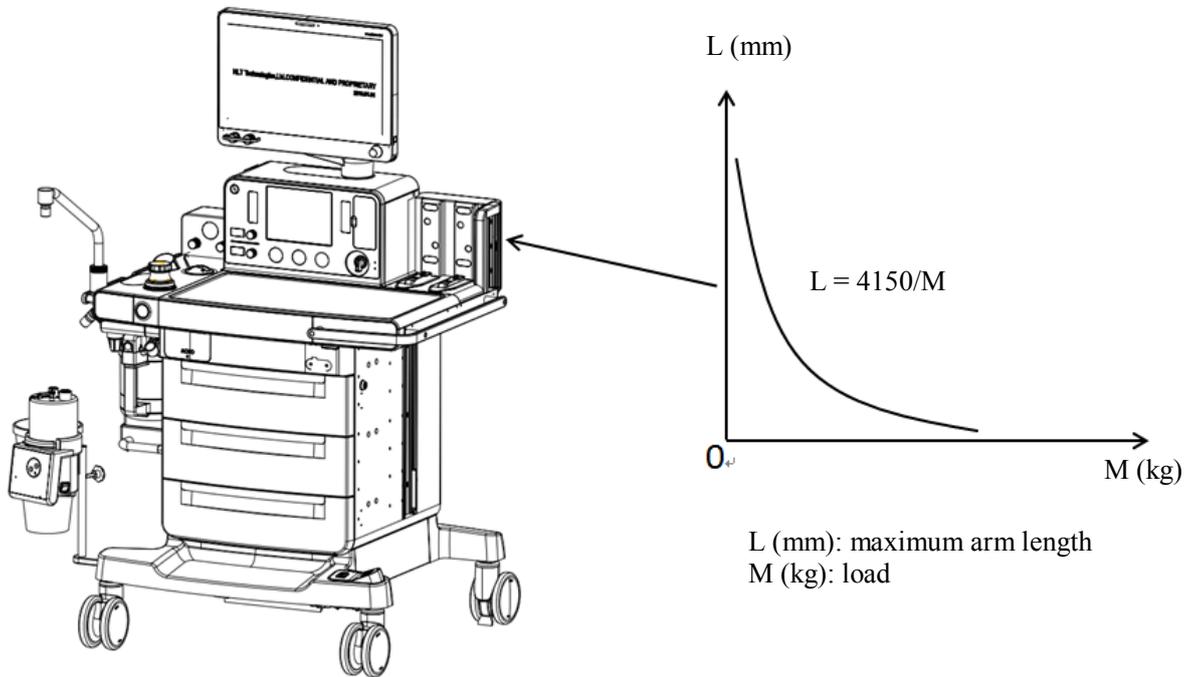


CIS is mounted. The 12-inch arm accessory has the largest load (bending moment) among all arm accessories recognized by Mindray, with a maximum load of 13.6 kg. Therefore, the force can be calculated as follows:

$$W_{\max} = 13.6 \text{ kg} \times 304.8 \text{ mm} = 4150 \text{ kgf.mm}$$

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The load of the GCX guide rail for the A9 anesthesia machine is as follows:

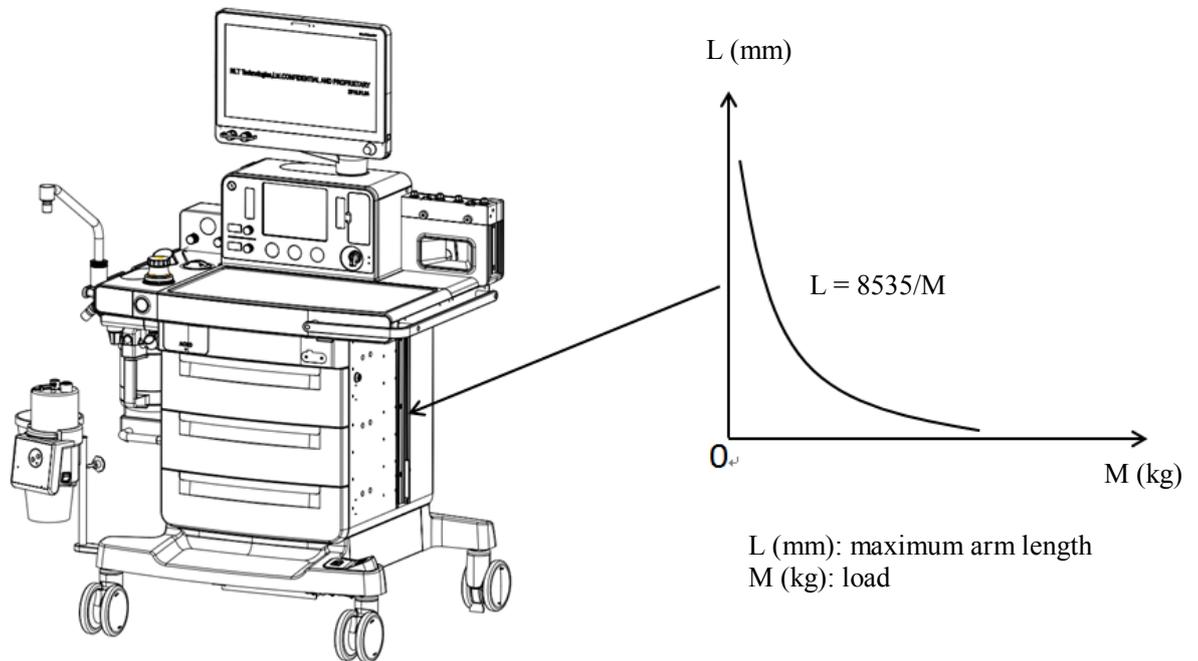


CIS is mounted. The 12-inch arm accessory has the largest load (bending moment) among all arm accessories recognized by Mindray, with a maximum load of 13.6 kg. Therefore, the force can be calculated as follows:

$$W_{\max} = 13.6 \text{ kg} \times 304.8 \text{ mm} = 4150 \text{ kgf.mm}$$

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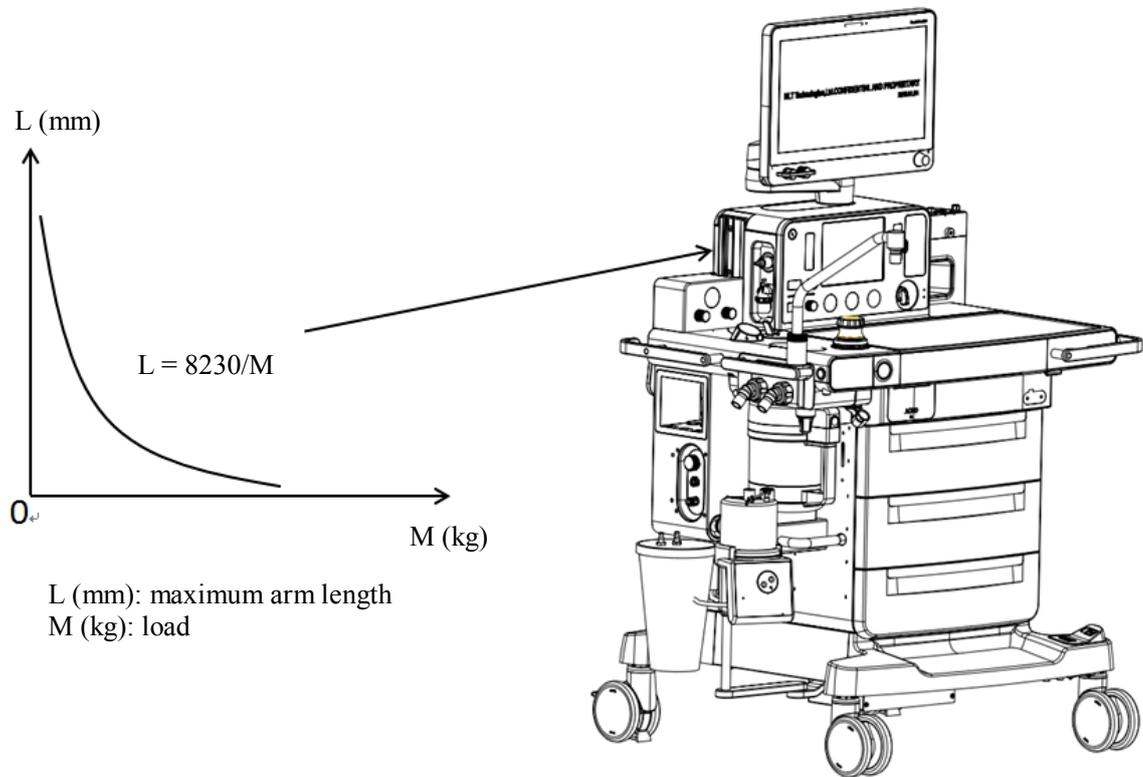
The load of the GCX guide rail for the A8/A9 anesthesia machine is as follows:



A collapsible auxiliary work surface is mounted. The (12+12)-inch double-hinged arm has the largest load (bending moment) among all arm accessories recognized by Mindray, with a maximum load of 14 kg. Therefore, the force can be calculated as follows:  
 $W_{max} = 14 \text{ kg} \times 609.6 \text{ mm} = 8535 \text{ kgf.mm}$

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The load of the GCX guide rail for the A8/A9 anesthesia machine is as follows:



The monitor bracket is mounted. The 12-inch arm accessory has the largest load (bending moment) among all arm accessories recognized by Mindray, with a maximum load of 27 kg. Therefore, the force can be calculated as follows:

$$W_{\max} = 27 \text{ kg} \times 304.8 \text{ mm} = 8230 \text{ kgf.mm}$$



