A7

Anesthesia System

Operator's Manual

CE 0123

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- all installation operations, expansions, changes, modifications and repairs of this product are conducted by Mindray authorized personnel;
- the electrical installation of the relevant room complies with the applicable national and local requirements; and
- the product is used in accordance with the instructions for use.

WARNING: It is important for the hospital or organization that employs this equipment to carry out a reasonable service/maintenance plan. Neglect of this may result in machine breakdown or personal injury.

NOTE: This equipment must be operated by skilled/trained clinical professionals.

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- Malfunction or damage caused by improper operation or repair by unqualified or unauthorized service people.
- Malfunction of the instrument or part whose serial number is not legible enough.
- Other malfunctions not caused by instrument or part itself.

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As a health care provider, you may report the occurrence of certain events to SHENZHEN MINDRAY BIO-MEDICAL ELECTRONICS CO., LTD., and possibly to the competent authority of the Member state in which the user and / or patient is established. These events, include device-related death and serious injury or illness. In addition, as part of our Quality Assurance Program, SHENZHEN MINDRAY BIO-MEDICAL ELECTRONICS CO., LTD. requests to be notified of device failures or malfunctions. This information is required to ensure that SHENZHEN MINDRAY BIO-MEDICAL ELECTRONICS CO., LTD. provides only the highest quality products.

Foreword

The Operator's Manual for the A7Anesthesia System (hereinafter referred to as Anesthesia System, Equipment, A7) contains the instructions necessary to operate the product safely and in accordance with its function and intended use. Observance of this manual is a prerequisite for proper product performance and correct operation and ensures patient and operator safety.

This manual is based on the maximum configuration and therefore some contents may not apply to your product. The released functions are different in different regions. If you have any question, please contact us.

This manual is an integral part of the product. It should always be kept close to the equipment so that it can be obtained conveniently when needed.

Intended Audience

This manual is geared for clinical professionals who are expected to have a working knowledge of medical procedures, practices and terminology as required for monitoring of critically ill patients.

Illustrations

All illustrations in this manual serve as examples only. They may not necessarily reflect the setup or data displayed on your anesthesia system.

Responsibilities of Operators

The proper function of the Anesthesia System can only be guaranteed if it is operated and serviced in accordance with the information provided in this manual and by an authorized Mindray service representative. Non-compliance with this information voids all guarantee claims.

The Anesthesia System must be operated by qualified and trained personnel only. All operators must fully observe this operator's manual and relevant additional documentation. They must also comply with the WARNINGS, CAUTIONS, and NOTES detailed in this manual.

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1.0 Safety

1.1 Safety Information

WARNING — Indicates a potential hazard or unsafe practice that, if not avoided, could result in death, serious injury or property damage.

CAUTION — Indicates a potential hazard or unsafe practice that, if not prevented, could result in minor personal injury, product fault, damage or property loss.

NOTE — Highlights important precautions and provides descriptions or explanations for better use of this product.

1.1.1 Warnings

WARNING: Do not operate the anesthesia system before reading this manual.

WARNING: 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.

WARNING: The Anesthesia System is only to be used by appropriately trained healthcare professionals who are qualified or accredited in accordance with national law for the application of general anesthesia.

WARNING: 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.

WARNING: To avoid the risk of electric shock, this equipment must be connected to a supply network with protective earth. 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.

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 additional MPSOs (Multiple Portable Socket Outlets, i.e. multiple outlet extension cords) or extension cords to these outlets.

WARNING: Do not place MPSOs on the floor.

WARNING: Connect the anesthesia system to an AC power source before the internal battery is depleted.

WARNING: Do not open the equipment housings. All servicing and future upgrades must be carried out only by trained and authorized Mindray personnel.

WARNING: Do not rely exclusively on the audible alarm system for patient monitoring.

WARNING: Adjustment of alarm volume to a low level may result in a hazard to the patient.

WARNING: 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.

WARNING: 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.

WARNING: Dispose the packaging material, observing the applicable waste control regulations and keeping it out of children's reach.

WARNING: 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 anesthesia system can be used with Halothane, Isoflurane, Sevoflurane and Desflurane. Only one anesthetic agent can be used at a time.

WARNING: 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.

WARNING: 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.

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

WARNING: The patient should be visually monitored by appropriately trained healthcare professionals. In certain situations, life-threatening circumstances may occur that may not necessarily trigger an alarm.

WARNING: 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.

WARNING: 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 limits.

WARNING: Electric shock and fire hazard. Do not clean the equipment while it is powered on and/or plugged into an outlet.

WARNING: Disconnect the power plug from the mains supply before removing the rear panels or servicing the equipment.

WARNING: Malfunction of the central gas supply system may cause more than one or even all devices connected to it to stop their operation simultaneously.

WARNING: The anesthesia system will cease to deliver gas when the gas supply pressure is smaller than 200 kPa.

WARNING: 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.

WARNING: 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.

WARNING: 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.

WARNING: All gas supplies should be of medical grade.

WARNING: 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.

WARNING: Do not maintain the equipment when it is used on a patient.

WARNING: Review the performance specifications of the disposal system that the transferring and receiving systems are intended to be used with, to ensure compatibility.

WARNING: 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.

WARNING: Ensure that the current alarm presets are appropriate before use on each patient.

WARNING: A hazard can exist if different alarm presets are used for the same or similar equipment in any single area.

WARNING: Due to the size and weight of the equipment, it should only be moved by qualified personnel.

WARNING: 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.

WARNING: 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.

WARNING: Leaks or internal venting of sampled gas may affect accuracy. Perform proper preoperative tests to ensure that the equipment is operating properly. Leaky circuits can not be used.

WARNING: 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.

WARNING: 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.

WARNING: Operation of the equipment below the minimum flow values may cause inaccurate results.

WARNING: 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.

WARNING: Ensure that an independent means of ventilation (e.g. a self-inflating manual resuscitator with mask) is available whenever the equipment is in use.

WARNING: The use of accessories with damaged packaging may cause biocontamination or failure. The operator should check the integrity of accessory packaging before use.

WARNING: If the equipment is damaged in any way that compromises the safety of the patient or user, discontinue use and attach a visible label indicating that the equipment is unusable. Please contact Mindray Technical Support.

WARNING: 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.

WARNING: Use of lubricants not recommended by Mindray may increase the danger of fire or explosion. Please use lubricants as approved by Mindray.

WARNING: 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 the authorized personnel.

WARNING: Do not disassemble the low-pressure regulator, flow-metering device, or connector while under pressure. Sudden release of pressure may cause injury.

WARNING: Check the specifications of the Anesthesia Gas Scavenging System (AGSS) and the specifications of the anesthesia system to ensure compatibility and to prevent a mismatched processing system.

WARNING: Avoid connecting two or more hose assemblies in series as this may cause a loss of pressure and flow.

WARNING: A hazard may exist due to the use of improper connectors. Ensure all assemblies use the proper connectors.

WARNING: Avoid replacing a high-pressure flexible connection with one of lower nominal inlet pressure.

WARNING: Reusing breathing system or reusable accessories that are not disinfected may cause cross-contamination. Disinfect the breathing system and reusable accessories before use.

WARNING: 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.

WARNING: Use breathing circuits and manual bags in accordance with ASTM F1208 and compatible with standard 22 mm male conical fittings per ASTM specifications F1054.

WARNING: 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.

WARNING: 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.

WARNING: If the [Drive Gas Pressure Low] alarm occurs when the gas supply pressure is greater than 200 kPa, contact the service personnel or Mindray Technical Support.

WARNING: Make sure that CO_2 can be fully absorbed by the absorbent after the CO_2 absorbent is replaced or a CO_2 absorbent canister is installed.

WARNING: 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.

WARNING: When anesthetic gas delivery equipment needs to be configured for the 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.

WARNING: 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 will not be able to guarantee the monitoring precision of the AG module. For the monitorable range of the AG module configured in this anesthesia system, see section 13.11.1 (Pages 13-14) "AG Module".

WARNING: As required by the relevant laws and regulations, oxygen concentration should be monitored when the equipment is used on the patient. If the equipment you are using is not configured with this feature, please use a monitor compliant with the corresponding standards for O_2 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.

WARNING: CO_2 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 standards for CO_2 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.

WARNING: The anesthesia system may lose its balance if it is tilted more than 10 degrees. Exercise caution when moving or resting the equipment on a slope greater than 10 degrees. Do not hang objects on the sides of the unit that would cause an excessive imbalance.

WARNING: No modification of this equipment is allowed.

WARNING: The anesthesia system may only be unpacked by authorized service personnel. The user cannot move the anesthesia system before unpacking.

WARNING: **General anesthesia procedure-related risks are found in the literature search for clinical risk situations, such as: nausea, vomiting (postoperative nausea and vomiting); postoperative pain; residual neuromuscular block; emergence agitation; jaw-clenching, shivering; connected consciousness/ intraoperative awareness; postoperative delirium; postoperative cognitive dysfunction; hypotension; tachycardia; malignant hyperthermia as a reaction to potent inhalation anesthetics or succinylcholine (postoperative) pulmonary complications (hypoxemia, acute respiratory distress syndrome, pulmonary infiltrates, pneumonia, pleural effusions, atelectasis, pneumothorax, barotrauma, bronchospasm, cardiopulmonary edema, aspiration pneumonitis); airway complications, airway obstruction, cough, desaturation, laryngospasm, hoarseness, and breath holding; postoperative complications (overall cardiac events, myocardial infarction, acute renal failure, hepatic failure, disseminated intravasal coagulation, extrapulmonary infection, gastrointestinal failure, coma); psychogenic coma; cardiopulmonary complications; thrombosis; postoperative right shoulder pain; urinary retention; headache; hypersensitivity reactions; and anesthesia-related death.**

WARNING: **Device-specific risks of anesthesia systems are found in the literature search for clinical risk situations, such as: device failure including material defects, occlusion, leakage, user error, misuse; breathing circuit malfunction; monitoring device malfunction; ventilator malfunction; anesthesia system malfunction; accidental over-delivery of vaporizing agent; accidental under-delivery of vaporizing agent; administration of an incorrect agent; water condensation in flow sensor causing erroneous measurement of tidal volume; raised airway pressures due to the lack of timely maintenance (draining of the condenser water daily); impossible to ventilate the patient's lungs due to leak in the breathing circle system; raised end-tidal carbon dioxide and fraction of inspired carbon dioxide values due to an empty absorbent canister; erroneous ventilation failure message; false low capnography values due to partial opening of the solenoid zero valve allowing entrainment of room air causing artifactual dilution of the gas sample; ventilation failure due to temporary malfunctioning of adjustable pressure limiting (APL) valve (gas sample line coiled around the APL valve); erroneous detection of enflurane despite of the agent not being used due to lack of timely maintenance (sensor of gas monitor not replaced monthly); mask ventilation impossible due to a large gas leak (gas-sampling tubing had become lodged in the gap between the adjustable pressure-limiting valve dial and its housing); steadily increasing inspired carbon dioxide level due to missing rubber seal on the soda lime canister; anesthesia system problems resulting in hypoxemia, hyperoxia, hypercarbia, or hypocarbia; and anesthesia-related death.**

WARNING: **In order to avoid the occurrence of clinical risk situations found in the literature search, the operator of the anesthesia system is required to have professional qualification certificates. In addition to ensuring that professional skills are guaranteed, please use drugs under supervision with the doctor's dosing recommendations. Most clinical risks and postoperative sequelae are caused by side effects of drugs. Therefore, during the operation of the system, the doctor's medication should be evaluated based on the patient's disease history, allergy history, and medication status. Avoid clinical risks to patients caused by medication reactions.**

WARNING: **If any error occurs or auxiliary ventilation is affected during the use of the anesthesia system, the operator should stop using the anesthesia system immediately. And using manual ventilation or replacing the anesthesia equipment to avoid injury to the patient.**

WARNING: **The service life of this equipment is 10 years.**

1.1.2 Cautions

CAUTION: To ensure patient safety, use only parts and accessories specified in this manual.

CAUTION: 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.

CAUTION: 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 equipments, and MRI equipments are possible sources of interference as they may emit higher levels of electromagnetic radiation.

CAUTION: 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.

CAUTION: 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.

CAUTION: 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.

CAUTION: 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.

CAUTION: Ensure that the gas supply of the equipment always complies with the technical specifications.

CAUTION: Before clinical use, the equipment must be correctly calibrated and/or the respective tests must be performed, as described in this Operator's Manual.

CAUTION: 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.

CAUTION: After servicing, functional, sensor, and system tests must be performed before clinical use.

CAUTION: Only vaporizers with Selectatec® Interlock-Systems can be used with this equipment.

CAUTION: Each time you replace the vaporizer, please carry out leak test for the breathing system.

CAUTION: Use cleaning agent sparingly. Excess fluid could enter the equipment and cause damage.

CAUTION: 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.

CAUTION: Do not fumigate using peracetic acid or formaldehyde.

CAUTION: **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 removing the valve cage from the valve assembly.**

CAUTION: **Only connect Mindray approved devices to the equipment's communication ports. Devices connected to the ethernet ports must comply with IEC 60950.**

CAUTION: **To ensure measurement accuracy and to avoid possible damage to the equipment, use only Mindray-approved cables and accessories.**

CAUTION: **Use the power cord provided with the product. If a substitute is necessary, use power cord in compliance with the specification.**

CAUTION: **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.**

CAUTION: **Use of other oxygen sensors may cause incorrect oxygen concentration.**

CAUTION: **Unintended movement may occur if the casters are not locked. The operator should lock casters during use of the equipment.**

CAUTION: **Unsecured devices may slide off the top shelf. Devices should be securely attached to the top shelf.**

CAUTION: **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.**

CAUTION: **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.**

CAUTION: **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.**

CAUTION: **Do not push down on the bag arm forcefully or hang heavy objects onto it. Excessive weight may bend and damage the bag arm.**

CAUTION: **Use caution when disconnecting quick connectors, as the sudden release of pressure may cause injury.**

CAUTION: **Avoid factors that can contribute to deterioration of the hose assemblies. Factors include excessive bending, crushing, abrasion, pressures and temperatures that exceed hose ratings, and improper installation.**

CAUTION: **Be careful in lifting and manipulating the breathing system during disassembly of the system.**

CAUTION: **When the electronic flow control system is disabled, the backup flow control system will be enabled. The initial O_2 flow of backup flow control system is 1 L/min. The backup flow control system display only has a total flowmeter which can display a maximum flow of 15 L/min.**

CAUTION: **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 you turn a flow control knob clockwise to decrease flow, the flowmeter should reach 1L/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 counterclockwise increases flow.**

CAUTION: **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.**

1.1.3 Notes

NOTE: **Figures in this manual are provided for reference purposes only. Screens may differ based on the system configuration and selected parameters.**

NOTE: **Put the equipment in a location where you can easily see the screen and access the operating controls.**

NOTE: **Keep this manual close to the equipment so that it can be obtained conveniently when needed.**

NOTE: **The software was developed in compliance with IEC 60601-1. The possibility of hazards arising from software errors is minimized.**

NOTE: **This manual describes all features and options. Your equipment may not have all of them.**

NOTE: **The equipment is intended to be operated with its integral Breathing Pressure monitoring in use.**

NOTE: **The equipment is intended to be operated with its integral Breathing Pressure limiting devices in use.**

NOTE: **The equipment is intended to be operated with its integral Expiratory Volume monitoring in use.**

NOTE: **The equipment is intended to be operated with its integral Breathing System integrity Alarm System in use.**

NOTE: **The equipment is intended to be operated with its integral Continuous Pressure Alarm in use.**

NOTE: **The equipment is intended to be operated with its integral O_2 monitoring in use.**

NOTE: **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.**

NOTE: **Continuously monitor the anesthetic agent concentration when using the anesthesia system to ensure accurate output of the anesthetic agent.**

NOTE: **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. Refer to the vaporizer Instructions For Use for filling the vaporizer and other information.**

NOTE: **The system is designed to be equipped with an anesthetic vapor delivery device that complies with ISO 80601-2-13.**

NOTE: **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.**

NOTE: **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.**

NOTE: **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.**

NOTE: **Changes in inlet pressure, outlet resistance ambient temperature may affect the accuracy of flow values.**

NOTE: **The power supplies, terminal units and pipeline systems can be supplied by one or several different manufacturers.**

NOTE: **Regional or national regulations that apply to manufacturers of medical equipment can exist.**

NOTE: **The product does not contain latex parts.**

NOTE: **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.**

NOTE: **Some alarm settings on this equipment are not configurable by users.**

NOTE: **The tidal volume and minute ventilation displayed on this equipment are measured in BTPS conditions. The fresh gas flow is measured in STPD conditions.**

NOTE: **For the method of connecting this equipment to an external monitor or other devices, please see Anesthesia System Bracket Installation Instructions.**

NOTE: **All the materials of this equipment exposed to gases are compatible with O2, air and N_2O.**

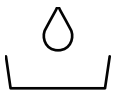
NOTE: **To avoid abnormal gas supply, the anesthesia system has a 758 kPa pressure relief valve installed at the gas supply inlet. When the gas supply pressure is abnormally elevated, the pressure relief valve is turned on to ensure the proper operation of the anesthesia system. When the pressure relief valve is on, the anesthesia system and the O_2 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_2 outlet will be elevated to 758 kPa, and the maximum flow rate meets requirements in the specifications.**

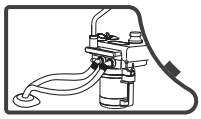
NOTE: **The defibrillation restoration time is 15 seconds unless otherwise stipulated.**

NOTE: **According to the conclusion of clinical evaluation and residual risk evaluation, for the intended patients, there is no known side effects that can occur during or after the use of the medical device. And there is no need for the operator to make extra preparations. Thus, no residual risk associated with using the medical device should be disclosed.**

1.2 Symbols

1.2.1 Symbols on the Anesthesia System/Package/Labeling

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	Caution!		Warnings
	Electrical: alternating current (AC)		Electrical: internal batteries
	Electrical: equipotentiality		Electrical: Protective earth (ground)
	Electrical: fuse or circuit breaker		Video signal port
	Switch on		Switch off
	Electrical: input/output port		USB interface
	Pipeline gas supply		Gas cylinder
	Gas outlet		Gas inlet
MAX	Maximum value	MIN	Minimum value
>PPSU<	Material: polyphenylsulfone	>PSU<	Material: polysulfone
	Operating instructions		O2 sensor cover switch
	Water trap	O_2+	Gas: O_2 flush button
	Locked		Unlocked
	Manual ventilation		Automatic ventilation
134°C	Autoclavable	APL ≈ cmH_2O ⚠	APL valve

	Caution: Hot		Direction
	Electricity: light	 5 kg MAX 11 lbs MAX	Weight limit
	ACGO mode		Automatic ventilation mode
	Canister opened (applicable to CO2 absorber canister with Pre-Pak only)		Canister closed (applicable to CO2 absorber canister with Pre-Pak only)
	Do not oil		Gas flow: flow control knob
IPX1	Protection level of anesthesia system against splashing water	IPX4	Protection level of BIS module against splashing water
	Date of manufacture		Serial number
	Manufacturer		European community representative
	Applied parts of defibrillator proof type CF equipment		Applied parts of defibrillator proof type BF equipment
	Atmospheric pressure limitation		Humidity limitation
	Temperature limitation		This way up
	Fragile, handle with care		Keep dry
	No rolling		Stacking limit by mass
	Unique Device Identifier		Medical Device
	Refer to instruction manual/booklet	Aux. Flow	Auxiliary flowmeter
	HFJV interface		

This product is provided with a CE marking in accordance with the regulations stated in Regulation (EU) 2017/745 or the Council Directive 93/42/EEC concerning Medical Devices. The number adjacent to the CE marking (0123) is the number of the EU-notified body certified for meeting the requirements of the Regulation.

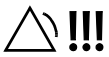
Electrical:
WEEE (Waste of Electrical and Electronic Equipment) Marking. Separate treatment from general waste at end of life.

The general meaning assigned to geometric shapes, safety colors and contrast colors for safety signs are as follows:

GEOMETRIC SHAPE	MEANING	SAFETY COLOR	CONTRAST COLOR	GRAPHICAL SYMBOL COLOR
	Prohibition	Red	White	Black
	Mandatory action	Blue	White	White
	Warning	Yellow	Black	Black

1.2.2 Interface Symbols

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	Battery is fully charged. AC power is connected and it is powering the system.		Alarm Audio Off icon
	Battery is partially charged. AC power supply is connected. It is charging the battery and powering the system.		Alarm Audio Pause icon
	Battery is fully charged and it is powering the system. AC power is not connected.		Alarm Off icon
	Battery is partially charged and it is powering the system. AC power is not connected.		Alarm Reset Icon
	Battery level is low and it is powering the system. Recharging recommended. AC power is not connected.		Low priority message

	Battery is not installed.		Medium priority message
	Patient type icon: adult		High priority message
	Patient type icon: pediatric		Patient type icon: Infant
	USB		Settings icon
	Network disconnected		Network connected
	WLAN disconnected		WLAN connected. The entity part indicates the network signal strength.
	4G disconnected		4G connected. The entity part indicates the network signal strength.
	5G disconnected		5G connected. The entity part indicates the network signal strength.
	Lower screen brightness		Higher screen brightness
	Volume is off		Lower volume (it can be turned off)
	Lower volume		Higher volume

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2.0 Product Description

2.1 Introduction

2.1.1 Intended Use

2.1.1.1 Intended Purpose

The Anesthesia System is a device used to administer to a patient, continuously or intermittently, a general inhalation anesthetic and to maintain a patient's ventilation, as well as monitoring relevant parameters.

2.1.1.2 Indication for Use

The Anesthesia System does not have a specific indication. The medical indications are related to the administration of inhalation anesthesia in accordance with the intended purpose during surgical or diagnostic interventions.

2.1.1.3 Intended User

The Anesthesia System is only to be used by appropriately trained healthcare professionals who are qualified or accredited in accordance with national law for the application of general anesthesia.

2.1.1.4 Target Treatment Population

The Anesthesia System can be used in adult, pediatric, and infant populations.

2.1.1.5 Medical Conditions

The Anesthesia System is used within a health care facility by licensed clinicians in the administration of general anesthesia.

2.1.1.6 Contraindications

There is no absolute contraindication to the Anesthesia System. However, for some specific situation (such as malignant hyperthermia susceptible patients, pneumothorax, bullae, severe pulmonary hemorrhage, acute myocardial infarction) requires the anesthesiologist to make a careful decision according to the patient's situation.

2.1.1.7 Side Effects

According to the conclusion of clinical evaluation and residual risk evaluation, for the intended patients, there is no known side effects caused from the Anesthesia System. There are side effects related to the applied inhalation anesthetic.

WARNING: This equipment is not suitable for use in an MRI environment.

2.1.2 Structure and Composition

The Anesthesia System consists of main unit, anesthetic ventilator, anesthetic gas delivery system, anesthetic vaporizer (V60 model, applicable anesthetic agents: Halothane, Isoflurane and Sevoflurane; V80 model, applicable anesthetic agent: Desflurane), anesthetic breathing system (including the airway pressure gauge, bellows, CO_2 absorbent canister, inspiratory and expiratory check valves, inspiratory and expiratory flow sensors, exhaust valves, Auto/Manual switch, manual bag port, inspiratory and expiratory ports and connectors), Anesthetic Gas Scavenging System (AGSS), negative pressure suction device, CO_2 gas monitoring module, anesthetic gas monitoring module, BIS module, neuromuscular monitoring (NMT) module, O_2 cell and accessories.

2.1.3 Functions and Features

The anesthesia system is intended to provide continuous or intermittent general inhalation anesthesia and maintain ventilation for patients. This equipment also provides ventilation monitoring for patients. The anesthesia system is applicable to patient environments.

Applied parts of the anesthesia system are the breathing tubes, masks, BIS electrodes, NMT electrodes and cables. The anesthesia system provides the following ventilation modes:

- Manual ventilation
- Volume Control Ventilation (VCV)
- Pressure Control Ventilation
  - Pressure Control Ventilation (PCV)
  - Pressure Control Ventilation - Volume Guarantee (PCV-VG)
- Synchronized Intermittent Mandatory Ventilation (SIMV)
  - 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 Ventilation (CPAP/PS)
- Airway Pressure Release Ventilation (APRV)
- Adaptive Minute Ventilation (AMV)
- High Frequency Jet Ventilation (HFJV)

The anesthesia system provides the following frequently-used features or configurations:

- Cardiopulmonary bypass
- Monitor mode
- Lung recruitment
- High-flow Nasal Cannula (HFNC)
- Flow pause
- Agent usage calculation
- Prediction of anesthesia
- AnaeSight

- Remote operation of the anesthesia system
- Inspiration Hold
- Expiration Hold
- IntelliCycle
- Anesthetic gas (AG) monitoring
- O_2 concentration monitoring
- CO_2 monitoring
- Bispectral index (BIS) monitoring
- Neuromuscular (NMT) monitoring
- Selftest visualization
- Alarm visualization
- Auxiliary Common Gas Outlet (ACGO)
- Sample gas return to the anesthesia breathing system
- Anesthetic Gas Scavenging System (AGSS)
- Negative pressure suction device
- Foldable worktable

2.2 Equipment Views

2.2.1 Main Unit (Front View)

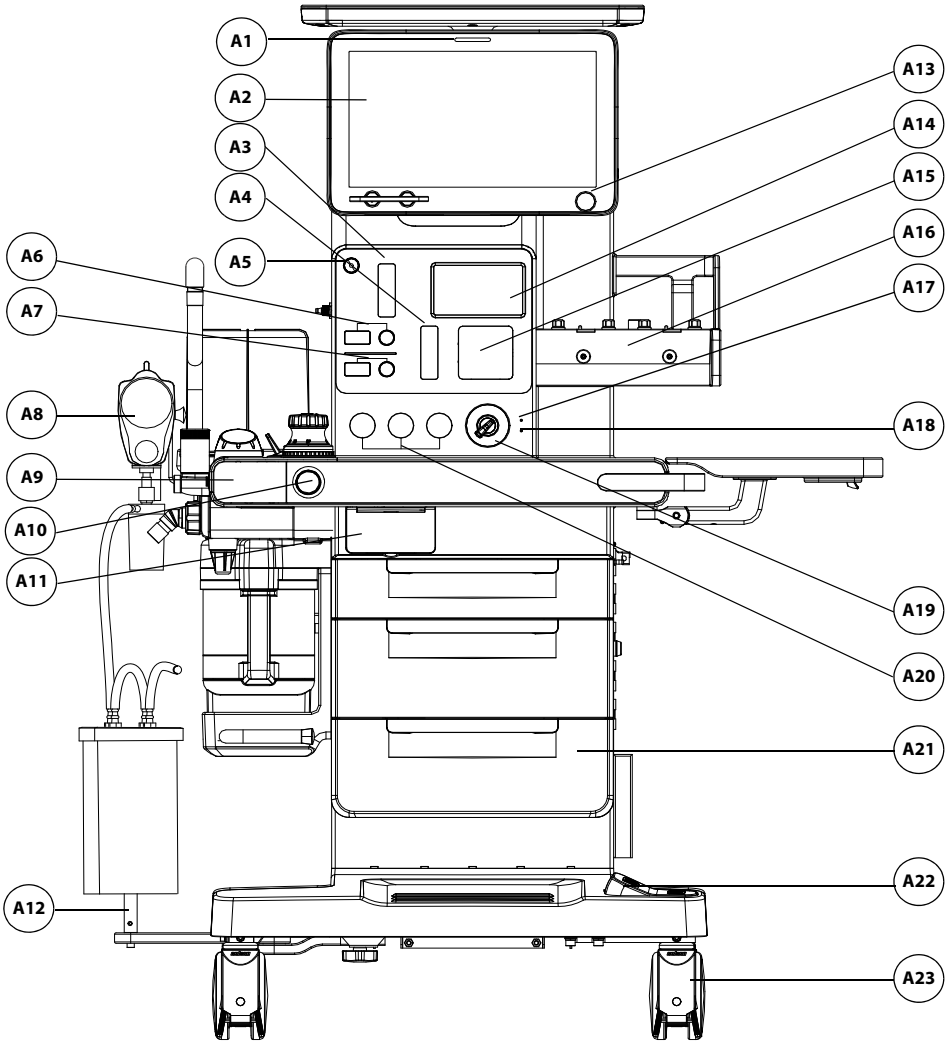

FIGURE 2-1 Main Unit (Front View)

PARTS		DESCRIPTION
A1	**Alarm LED**	The alarm LED may turn red, yellow, or cyan, indicating different priorities. Red indicates a high priority, yellow indicates a medium priority, and cyan indicates a low priority. If the alarm LED is off, no alarm is generated.
A2	**Main screen**	See section 4.1 (Pages 4-2) "Main Screen".
A3	**Auxiliary flowmeter or High-flow Nasal Cannula (HFNC) flowmeter**	There is a float in the flow tube, and the scale line that the middle of the float is aligned to indicate the current gas flow.

PARTS		DESCRIPTION
A4	**Total flowmeter of Backup Flow Control System (BFCS)**	Displays the total fresh gas flow of the BFCS.
A5	**Auxiliary flowmeter or High-flow Nasal Cannula (HFNC) switch**	Used to enable or disable the auxiliary flowmeter or HFNC function.
A6	**Total flow control knob for auxiliary flow or HFNC**	Rotate the knob to adjust the total flow of the auxiliary flowmeter or HFNC.
A7	**Oxygen concentration control knob for auxiliary flow or HFNC**	Rotate the knob to adjust the O_2 concentration of the auxiliary flowmeter or HFNC.
A8	**Negative pressure suction device**	Used to collect the medical effluent. The unit supports overfill protection to prevent backflow of effluent after the bottle is full to ensure pipeline and tube safety.
A9	**Oxygen sensor cover**	Open the cover to install the O_2 sensor.
A10	**O_2 Flush button**	Used to provide high-flow O_2 for the inspiratory branch of the breathing system.
A11	**ACGO (independent outlet and switch)**	The ACGO switch is used to enable/disable the ACGO function. The ACGO standalone outlet is used to output fresh gas.
A12	**Liquid collection bottle and humidifier bracket**	Used to support the negative pressure suction liquid collection bottle and humidifier.
A13	**Main control knob of display**	Press the control knob to select an item on the menu or confirm the settings. Rotate the knob clockwise or counter clockwise to scroll the items on the menu or change the settings.
A14	**Status display**	Used to display the gas supply pressure and bar graph.
A15	**Backup Flow Control System (BFCS) cover**	Pull the BFCS cover switch outward to start the BFCS. Rotate the flow control knob to control the O_2 flow. Rotate the knob counter clockwise to increase the gas flow and rotate the knob clockwise to reduce the gas flow.
A16	**Vaporizer mount spot**	Used to install two Selectatec vaporizers. One installing stem can support 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.
A17	**Battery indicator**	The indicator is on when the battery is being charged. The indicator flashes when the battery is in use.
A18	**AC status indicator**	The indicator is on when the system is connected to an AC power source.
A19	**System switch**	Used to turn on or off the system.
A20	**Gas supply pressure gauge**	Used to indicate the inlet pressure of the O_2, air and N_2O pipelines for the anesthesia system not configured with backup gas cylinders. Used to indicate the pressure of the O_2, air and N_2O backup gas cylinders for the anesthesia system configured with backup gas cylinders.
A21	**Storage drawers**	Three (3) storage drawers (lockable) are available.

PARTS		DESCRIPTION
A22	**Central brake**	Lock/release the brakes for all casters when depressed.
A23	**Caster**	The system is moved with the casters. Caster lock of the equipment is controlled by the central brake and caster brake.

TABLE 2-1 Parts List of Main Unit (Front View)

2.2.2 Main Unit (Rear View)

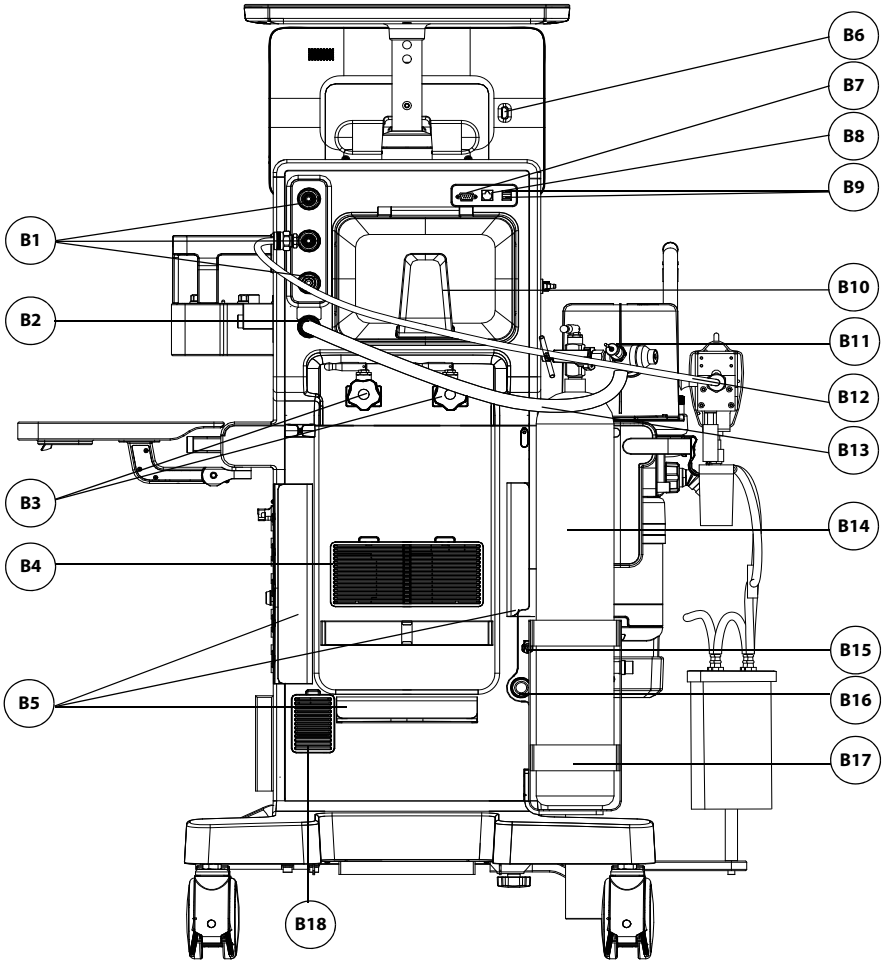

FIGURE 2-2 Main Unit (Rear View)

PARTS		DESCRIPTION
B1	**Pipelined gas supply ports**	The connecting ports for pipelined gas supply of O_2, air and N_2O. **NOTE: Check if the sealing ring at the gas supply connection is in good condition before connecting the gas supply hose. If the sealing ring is damaged, do not use the hose. Replace the sealing ring to prevent leakage.**
B2	**Backup gas cylinder port or backup oxygen supply port**	Used to connect the backup gas cylinder or backup oxygen supply.
B3	**Backup gas cylinder yoke**	Used to connect the backup high-pressure cylinder. Gas cylinders are act as a backup supply if the pipeline supply is removed. **NOTE: Cylinders are not supplied by Mindray.**
B4	**Blower air inlet (only applicable to the anesthesia system configured with blower)**	Air inlet of blower.
B5	**Cable management bracket**	Used to fasten cables.
B6	**Video signal port**	One HDMI TYPE A port, supporting technical standard HDMI 2.0a. It can connect to an external display and output the video signal of the main display. Connect the video signal cable before powering on the anesthesia system.
B7	**Communication Interface**	One DB9 male port, with TTL serial port. It can connect to the external calibration device. An external medical device, information system or patient monitor can be connected via this connector to communicate with the anesthesia system. It complies with serial protocol, HL7 protocol, OpenInterface protocol and Mindray internal protocol. The intended information flow is from the anesthesia system to the external medical device or calibration device. The interface must be used by the specified service personnel. **CAUTION: Do not connect any non-isolated devices to the DB9/RS232 interface of the equipment.**

PARTS		DESCRIPTION
B8	**Wired network interface**[a]	RJ-45 network interface. It can connect with a PC to perform software upgrading. It can connect with remote control system, infusion supervision system and synchronize time with external device through SNTP protocol. It supports wired network 10 M/100 M, and comply with technical standard IEEE 802.3. It complies with Mindray internal protocol, HL7 protocol and SNTP protocol. The intended information flow is between the PC/ remote control system/infusion supervision system and the anesthesia system. The interface must be used by the specified service personnel.
B9	**USB interface**	Type A interface, complied with USB 2.0 standard and Mindray internal protocol. It can connect to a USB device or the mouse; export configuration information and historical data; importing/exporting ventilation data and device running data; transfer configuration data between machines of the same type and upgrade the software for anesthesia system. The intended information flow is between the anesthesia system and the U disk. The interface must be used by the specified service personnel. **CAUTION: Do not connect any devices to the USB of the machine, except Mindray-approved USB devices and supported USB mouses.**
B10	**Cable management and cable hanger**	Used to fasten cables and hang gas supply hoses.
B11	**Pressure relief valve of the backup gas cylinder**	Used to connect the backup high-pressure cylinder.
B12	**Negative pressure suction device**	Used to connect negative pressure suction device and gas supply connector.
B13	**Connection tube of the backup gas cylinder**	Used to connect the backup gas cylinder and gas supply connector.
B14	**Backup gas cylinder**	Backup gas cylinder.
B15	**Sample gas recirculation connector**	The sample gas return port of the gas module.
B16	**Waste Gas Scavenging outlet**	Used to connect to the waste gas scavenging system. **NOTE: Use a waste gas scavenging system that complies with the ISO 80601-2-13 standard.**
B17	**Fixing seat of the backup gas cylinder**	Used to fasten the backup gas cylinder.
B18	**Internal air supply inlet**	When the pipelined gas supply or the air cylinder is not available, the internal air supply can be used to provide fresh air.

a. *In addition to the wired network, the anesthesia system also configures with wireless network and mobile cellular network.*
Mobile cellular network:
It can connect with central monitoring system and communicate with the central monitoring system.
Supported 4G operating frequency: LTE FDD:B1/B3/B7/B8/B20/B28A, LTE TDD: B38/B40/B41, WCDMA: B1/B8, and GSM: B3/B8.
Supported 5G operating frequency: 5G NR: n1/n2/n3/n5/n7/n8/n12/n20/n28/n38/n40/n41/n48/n66/n71/n77/n78/n79, LTE-FDD: B1/B2/B3/B4/B5/B7/B8/B9/B12/B13/B14/B17/B18/B19/B20/B25/B26/B28/B29/B30/B32/B66/B71, LTE-TDD: B34/B38/39/B40/B41/B42/B48.
It complies with Mindray internal protocol.
The intended information flow is from the anesthesia system to the central monitoring system.
The mobile cellular network must be used by the specified service personnel.
***Wireless network**:*
It can connect with the external device and communicate with the external device; connect with infusion supervision system, infusion pump or syringe pump; comply with standard IEEE 802.11 a/b/g/n/ac and synchronize time with external device through SNTP protocol.
It complies with Mindray internal protocol, HL7 protocol and SNTP protocol.
The intended information flow is between the external device and the anesthesia system.
The wireless network must be used by the specified service personnel.

TABLE 2-2 Parts List of Main Unit (Rear View)

2.2.3 Main Unit (Left View)

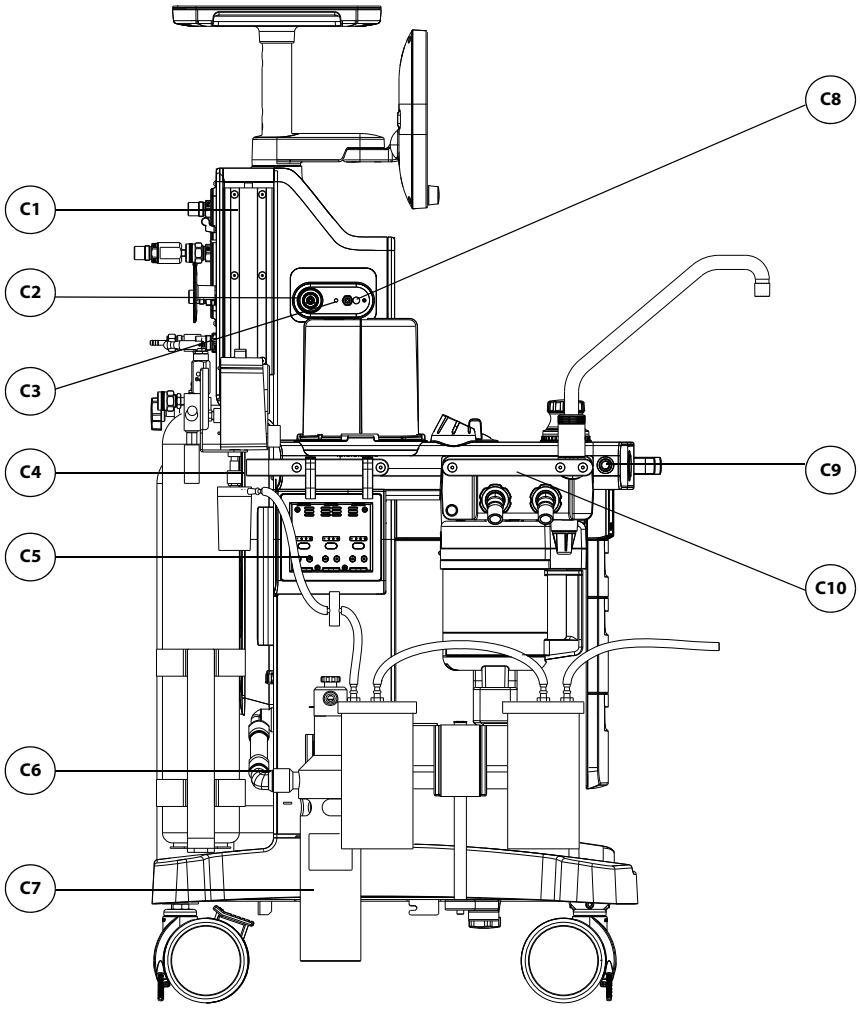

FIGURE 2-3 Main Unit (Left View)

PART		DESCRIPTION
C1	**Installing rail**	Used to install the standard attachment arms of the monitor and other equipment. Installing rails are available on both sides of the equipment.
C2	**Auxiliary O_2 outlet, auxiliary O_2/air outlet or high-flow nasal cannula (HFNC) O_2 outlet**	The outlet is used to output auxiliary O_2, or mixture of O_2 and air when the auxiliary O_2 feature or auxiliary O_2/air feature is configured. The outlet is used to output the mixture of O_2 and air when the HFNC feature is configured.
C3	**HFJV port/Auxiliary high-pressure O_2 outlet**	Used to connect the tubes of HFJV when the HFJV feature is configured. Used to connect to an external device (such as a jet ventilator) when the auxiliary high-pressure O_2 feature is configured.
C4	**Handle**	Used to push, pull or rotate the anesthesia system, with a maximum force capacity of 80kgf.
C5	**Module slot**	Used to be inserted with and recognize the NMT, CO_2, AG, and BIS modules mentioned in this manual.
C6	**Waste gas transfer hose**	Used to connect to the waste gas scavenging outlet and waste gas scavenging system.
C7	**AGSS**	Waste gas scavenging system.
C8	**HFJV pressure monitoring port**	Used to monitor the HFJV airway pressure. **NOTE: There is no port when the auxiliary high-pressure O2 feature is configured.**
C9	**Oxygen sensor cover switch**	Used to open the O_2 sensor cover.
C10	**Handle**	**WARNING: The handle is intended to be used for disassembling the breathing system only and shall not be used for pushing, pulling or lifting the anesthesia system.**

TABLE 2-3 Parts List of Main Unit (Left View)

2.2.4 Main Unit (Right View)

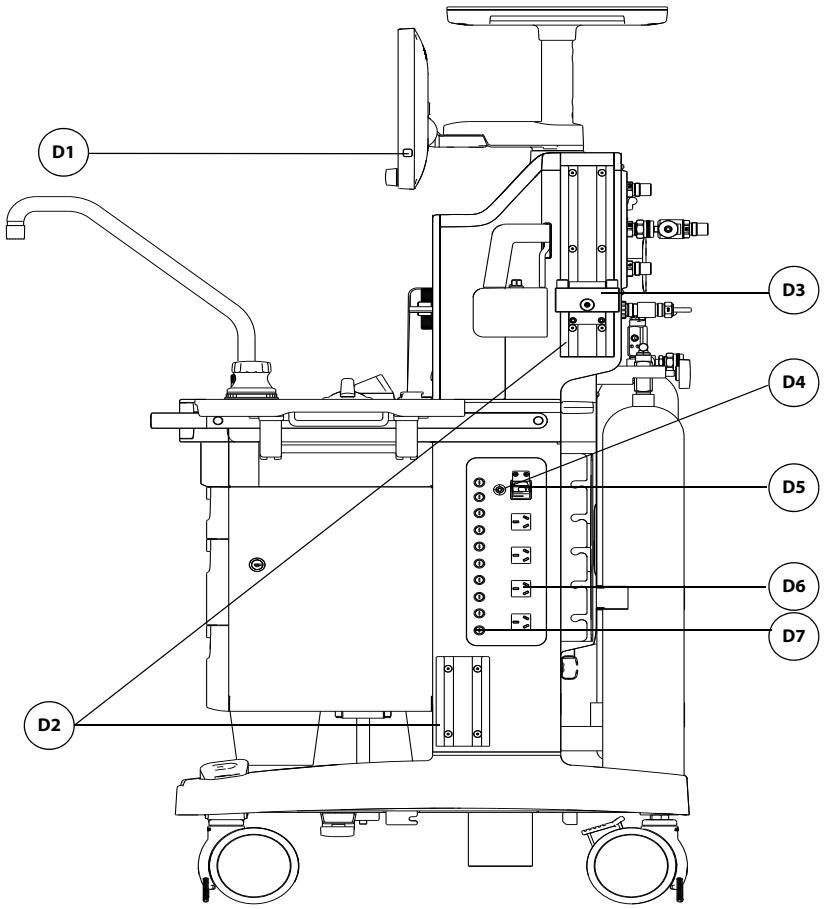

FIGURE 2-4 Main Unit (Right View)

PART		DESCRIPTION
D1	**Work lamp switch**	Used to turn on/off the work lamp. Three settings are available: off, low-light, and high-light. You can turn on the work lamp only when the system switch is turned on.
D2	**Installing rail**	Used to install the standard attachment arms of the monitor and other equipment.
D3	**Parking position of vaporizer**	Used to fix an additional vaporizer that is not used temporarily.
D4	**Equipotentiality**	Used to provide a grounding point. Used to eliminate the electric potential difference between the ground wires of different devices to ensure safety.
D5	**Power socket**	Used to connect to the gridded power cord.
D6	**Auxiliary AC power outlet**	Four auxiliary AC power outlets are available.
D7	**Fuse**	Each auxiliary power outlet is equipped with a fuse.

TABLE 2-4 Main Unit (Right View) Parts List

2.2.5 Main Unit (Top View)

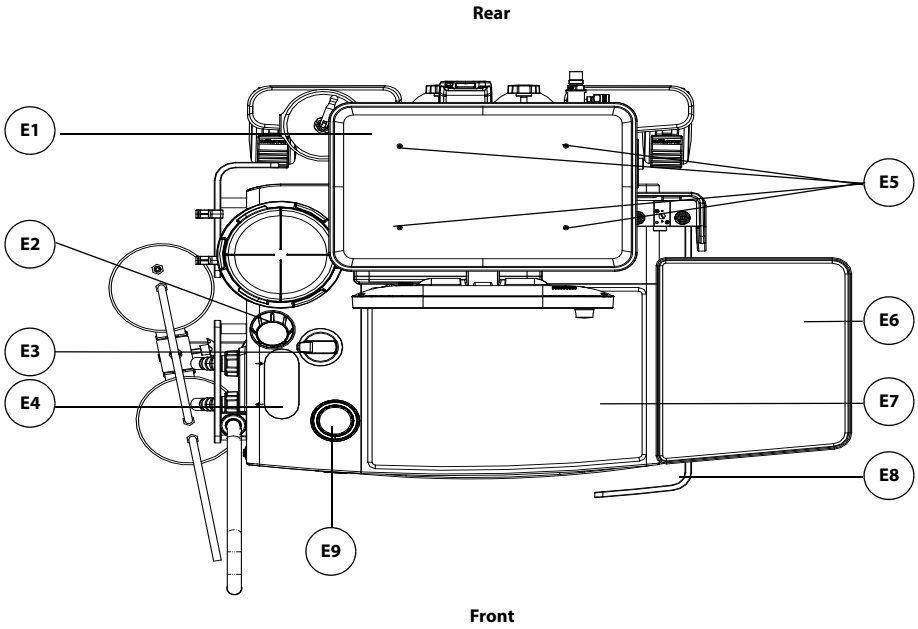

FIGURE 2-5 Main Unit (Top View)

PART		DESCRIPTION
E1	**Top plate**	It bears maximum load of 15kg.
E2	**Airway pressure gauge[1]**	The gauge is used to indicate the airway pressure of patients. **NOTE: A slight difference between the readings of the airway pressure gauge and the electronic readings is normal. Contact the customer service department of Mindray if the difference exceeds 15%.**
E3	**Manual/Auto switch**	Used to switch between mechanical ventilation and manual ventilation modes.
E4	**Observation window of expiratory/ inspiratory check valve**	Used to observe the status of expiratory and inspiratory check valves from outside the equipment.
E5	**Installing hole**	Used to install the additional equipment to the top plate.
E6	**Foldable worktable**	It can be rotated horizontally for 90 degrees. It bears maximum load of 15 kg.
E7	**Workbench**	It bears maximum force of 30 kgf.
E8	**Handle**	The handle is used for pushing, pulling or rotating the anesthesia system with a maximum force of 80 kgf.
E9	**APL valve[a]**	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. Elevate the APL valve upward as needed to release the pressure quickly.

a. Values on the APL valve and airway pressure gauge are for reference only. The calibrated patient airway pressure is displayed on the user interface.

TABLE 2-5 Parts List of Main Unit (Top View)

2.2.6 Breathing System

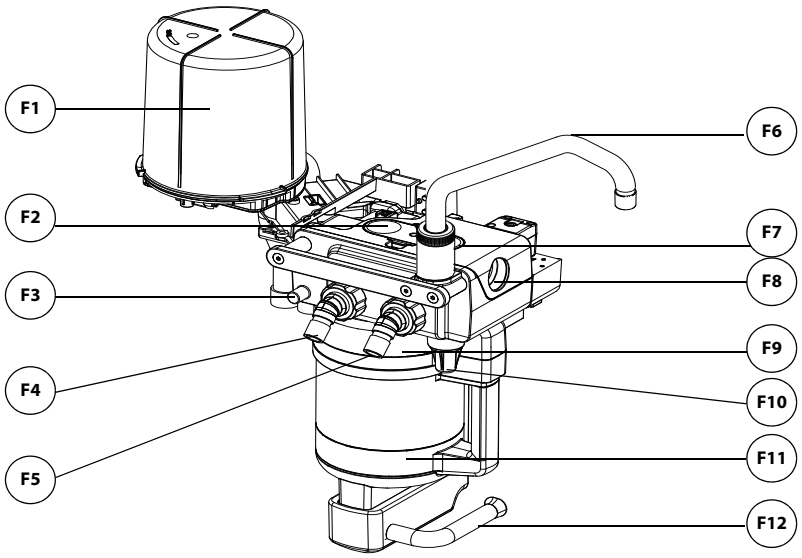

FIGURE 2-6 Breathing System

PART		DESCRIPTION
F1	**Bellows**[a]	The state of the bellows can be observed from outside the equipment.
F2	**Expiratory check valve**	It allows patient exhaled gas to flow to the breathing system and prevents backflow.
F3	**Leak test plug**	The leak test plug is used to connect the breathing tube for the leak test.
F4	**Expiration connector**	The expiration connector of the breathing circuit.
F5	**Inspiration connector**	The inspiration connector of the breathing circuit.
F6	**Bag arm**	The bag arm is used to connect the manual bag.
F7	**Inspiratory check valve**	The inspired gas is allowed to flow to the patient and backflow is prevented.
F8	**O_2 sensor connector**	Used to install the O_2 sensor and monitor the O_2 concentration.
F9	**Canister bypass assembly**	Used to maintain the pressure in the breathing circuit when the soda lime in the CO_2 absorbent canister is being replaced.
F10	**Watertrap**	Used to collect the condensate water in the breathing system. The watertrap must be emptied on a regular basis.

PART		DESCRIPTION
F11	**CO_2 absorbent canister**	The container for holding the CO_2 absorbent (bulk CO_2 absorbent or Pre-pak CO_2 absorbent).
F12	**Canister lock**	The canister lock is a lever locking mechanism for locking (in the horizontal position)/unlocking (in the vertical position) the canister.

a. The bellows housing is a transparent cover with a scale mark ranging from 300 ml to 1500 ml. These tick marks are for information only and the tidal volume should be read from the user interface. The delivered tidal volume is the sum of the bellows displacement and the fresh gas flow.

TABLE 2-6 Parts List of Breathing System

2.2.7 AGSS (Top, Right and Rear Views)

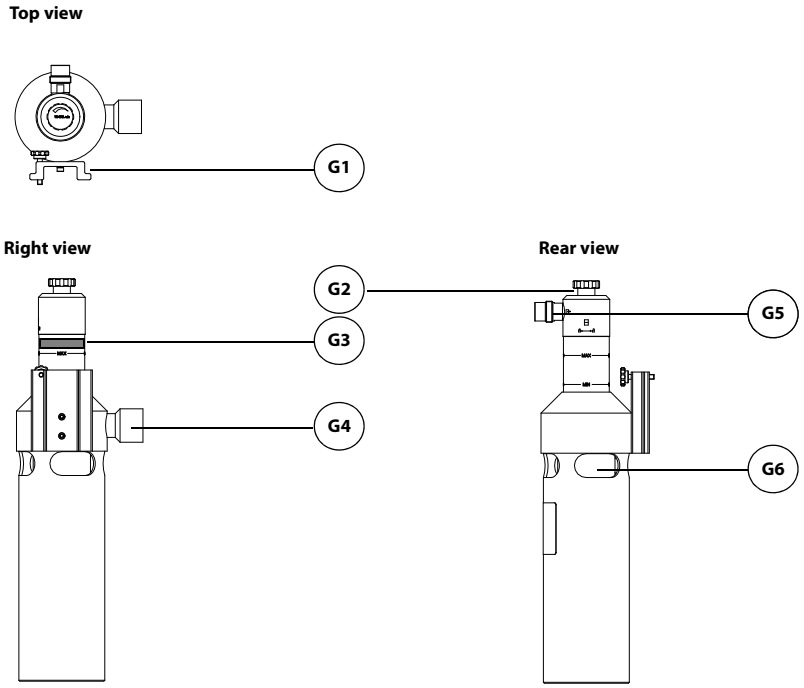

FIGURE 2-7 AGSS (Top, Right and Rear Views)

PART		DESCRIPTION
G1	**Installing rail attachment**	It allows the AGSS to be installed on the side rail. It contains a thumbscrew that must be tightened against the installing rail.
G2	**Flow control knob**	Turn clockwise or counter clockwise to adjust the flow in the AGSS until the float is between Min and Max marks.
G3	**Float**	Indicates exhaust flow. Adjusted by turning the flow control knob (G2) until the float is between the Min and Max marks.
G4	**Gas Inlet**	Intake for exhaust gases from the breathing system. The waste gas transfer hose connects the inlet port and the waste gas scavenging connector (see FIGURE 2-2) to transfer the exhaust gases.

PART		DESCRIPTION
G5	**Gas outlet**	Connects to the hospital's waste gas scavenging system.
G6	**Pressure compensation port**	Do not block the pressure compensation port during usage.

TABLE 2-7 Parts List of AGSS (Top, Right and Rear Views)

2.2.8 Negative Pressure Suction Device

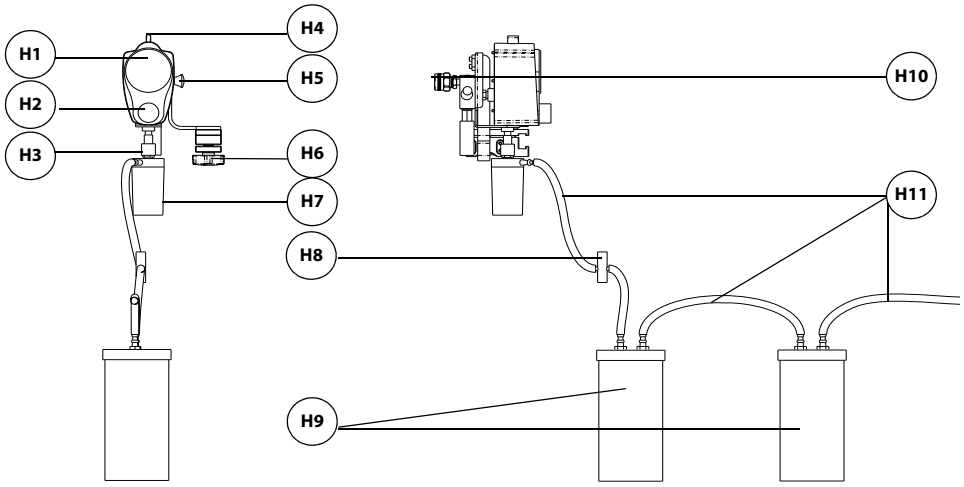

FIGURE 2-8 Negative Pressure Suction Device

PART		DESCRIPTION
H1	**Negative pressure gauge**	Used to indicate the negative pressure.
H2	**Negative pressure control knob**	Used to adjust the pressure of the negative pressure suction device.
H3	**Nuts**	Lift the nut and adjust the direction of the suction opening. Screw down the nut after adjusting the direction correctly.
H4	**Selector 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.

PART		DESCRIPTION
H5	**Negative pressure suction switch (applicable only to the venturi negative pressure suction device)**	The switch of the negative pressure suction device can be set to ON or OFF. When it is set to ON, the negative pressure suction device is connected with the gas supply. When it is set to OFF, the negative pressure suction device is disconnected with the gas supply.
H6	**Locking nut**	Fix the negative pressure suction device to the rail on the side of the anesthesia system with a nut.
H7	**Overfill protection**	Used to prevent backflow of effluent after the bottle is full to ensure pipeline safety.
H8	**Filter**	Used to filter out moisture and impurities.
H9	**Liquid collection bottle**	Used to transmit the hydrops, hematocele, pus and other contaminants from the patient's pharynx.
H10	**Gas supply connector**	Connect via hose to the gas supply inlet of the anesthesia system.
H11	**Suction tube**	Used to transmit the hydrops, hematocele, pus and other contaminants from the patient's pharynx. The inner diameter of the suction tube is Φ8. The suction tube is directly inserted in the connector.

TABLE 2-8 Parts List of Negative Pressure Suction Device

2.2.9 Anesthesia System with Large Backup Cylinder

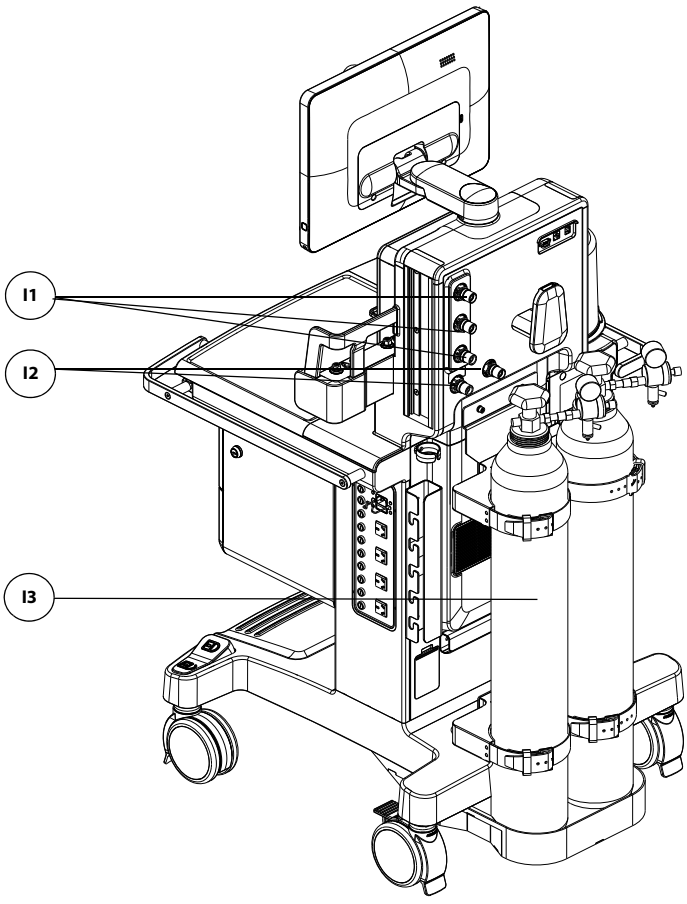

FIGURE 2-9 Anesthesia System with Large Backup Cylinder

PART		DESCRIPTION
I1	**Pipelined gas supply ports**	The connecting ports for pipelined gas supply of O_2, air and N_2O.
I2	**Large backup cylinder ports**	Used to connect the large backup cylinder.
I3	**Large backup cylinder**	Large backup cylinder.

TABLE 2-9 Parts List of Anesthesia System with Large Backup Cylinder

2.2.10 Pendant-mounted Anesthesia System

WARNING: For the anesthesia system intended to be mounted, when removed from its wall or ceiling mount, does not meet the stability requirements of IEC 80601-2-13 and IEC 60601-1 respectively. Special caution has to be taken.

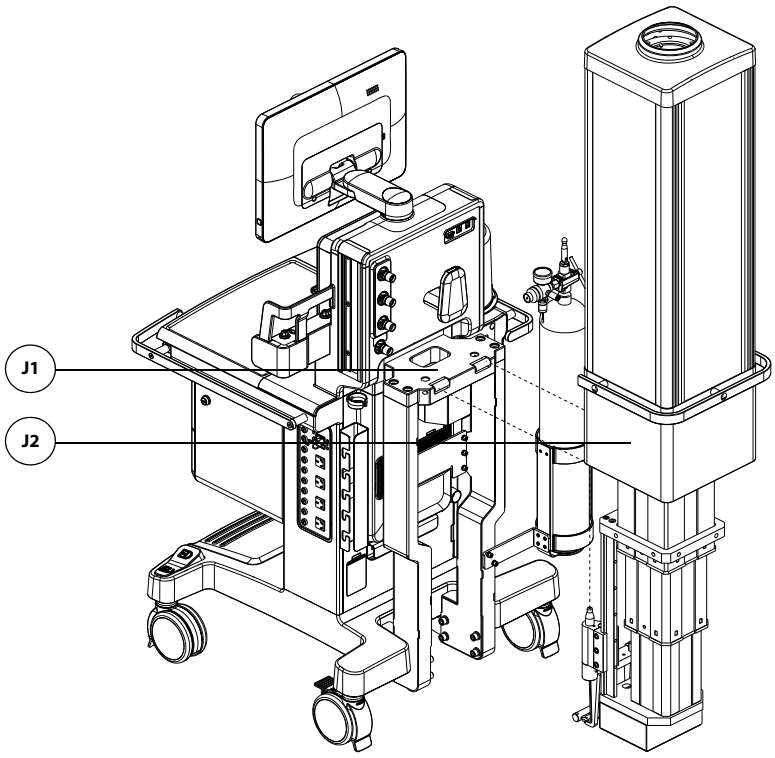

FIGURE 2-10 Pendant-mounted Anesthesia System (Standard Version)

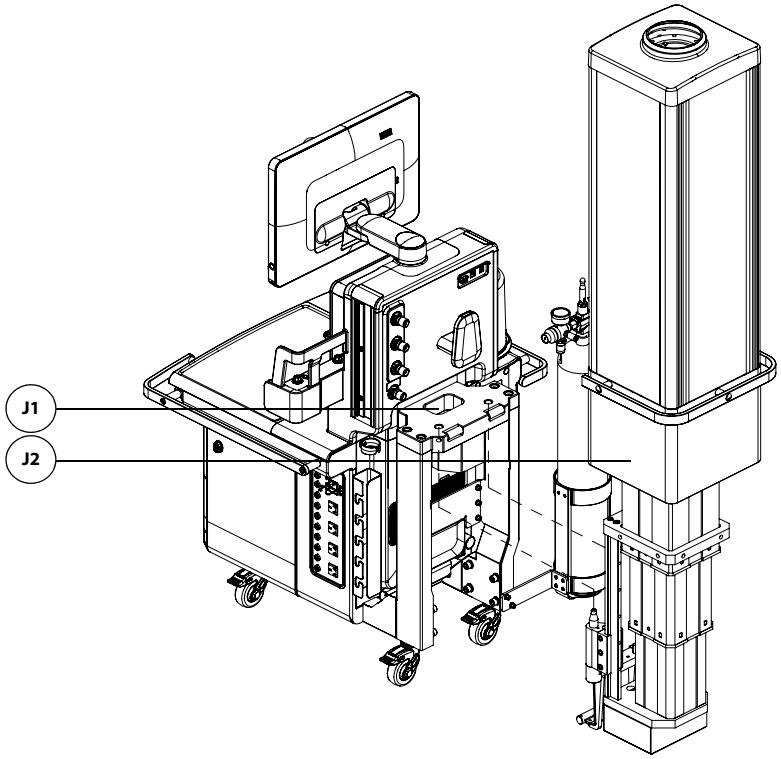

FIGURE 2-11 Pendant-mounted Anesthesia System (Professional Version)

PART		DESCRIPTION
J1	**Bracket**	The anesthesia system can be mounted onto the pendant through the bracket.
J2	**Pendant**	

TABLE 2-10 Parts List of Pendant-mounted Anesthesia System

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3.0 Installations

WARNING: This equipment must be installed by a factory authorized representative.

WARNING: Continuous use of desiccated soda lime may endanger patient safety. Adequate precautions should be taken to ensure that the soda lime in the CO_2 absorbent canister does not become desiccated. Turn off all gases when finished using the system.

WARNING: When electrosurgical equipment is used, keep the electrosurgical leads away from the breathing system, the O_2 sensor, and other parts of the anesthesia system. Keep available backup manual ventilation and a respirator with mask in case the electrosurgical equipment prevents safe use of the system. Ensure the correct operations of all life support and monitoring equipment.

WARNING: Do not use masks or breathing tubes that are antistatic or conductive. They can cause burns if they are used near high frequency electrosurgical equipment.

WARNING: This anesthesia system has waste gas exhaust ports. You should pay attention to the disposal of the residual breathing gas scavenged.

CAUTION: The operational environment and the power source of the equipment must comply with the requirements as specified in the 13.0 (Pages 13-1) "Product Specifications".

3.1 Unpacking

When the anesthesia system is delivered, IMMEDIATELY inspect the box for any damage.

a. If there is NO damage and ALL tip indicators on the box exterior are intact, then sign and date the bill of lading or airway bill to indicate safe receipt of the equipment.

b. If there is DAMAGE or ANY of the tip indicators on the box exterior have been activated, then conditionally accept the delivery and clearly describe the damages on the bill of lading or airway bill. BOTH the carrier and recipient must sign and date the bill of lading or airway bill. Save all damaged factory packaging until further instructed by Mindray. The receiver should immediately contact Mindray Customer Service Department.

3.2 Initial Setup

The initial setup of the anesthesia system must be performed by an authorized Mindray service representative. Please contact Mindray Technical Support for any additional assistance.

3.3 Breathing System

Please install the breathing system in the reverse order of 12.10.3.5 (Pages 12-19) "Reassembly".

3.4 Vaporizer

The equipment contains a 2-position vaporizer installing system to enable anesthetic agents to be introduced into the fresh gas flow. Two vaporizers are supported, but only one vaporizer can be opened at a time.

CAUTION: Only vaporizers with Selectatec® Interlock-Systems may be used with this equipment.

WARNING: Use vaporizers compliant with ISO 80601-2-13. Refer to the vaporizer manufacturer's Instructions For Use for installing, filling or draining the vaporizer and other information.

WARNING: Use care in lifting and manipulating vaporizers during the installing process as their weight may be greater than expected.

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

1. To replace or disassemble a vaporizer, lift each vaporizer straight up off the manifold. Do not pull the vaporizer forward. Do not rotate the vaporizer on the manifold.
2. Align the new vaporizer over the valve cartridges of the installing bar, slightly tilting back the vaporizer. Hang the vaporizer on the installing bar as shown in FIGURE 3-1. Ensure that the locking mechanism handle is in the unlocked position.

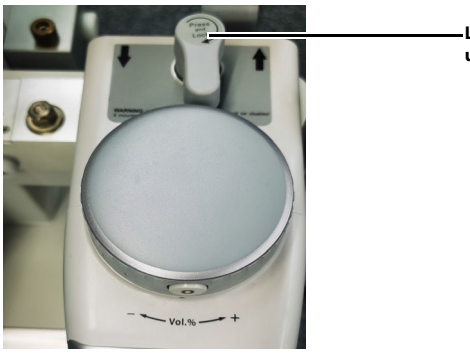


FIGURE 3-1 Vaporizer (unlocked)

3. Rotate the locking mechanism handle clockwise into the locked position as shown in FIGURE 3-2.

NOTE: For how to install the desflurane vaporizer, see the vaporizer manufacturer's instructions for use.

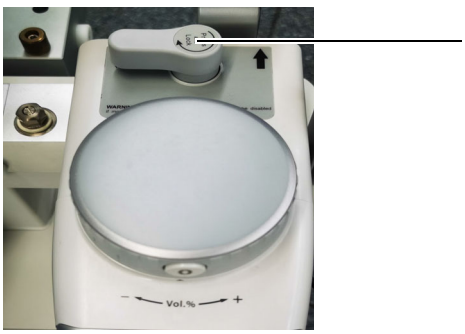


FIGURE 3-2 Vaporizer (locked)

4. Finally, check the following items:
   - **a.** Ensure that the top of the vaporizer is horizontal. If not, remove and reinstall the vaporizer.
   - **b.** If a vaporizer lifts off the manifold, repeat steps 1 through 3 to reinstall the vaporizer. If the vaporizer lifts off a second time, do not use the system.

WARNING: For the anesthesia system, using or turning on more than one vaporizer simultaneously is prohibited and prevented by a mechanical interlock. Do not ignore the safety mechanism.

3.4.1 Filling and Draining the Vaporizer

Install the vaporizers with a Selectatec® interlock system that are compliant with ISO 80601-2-13 on the unit. Refer to the vaporizer manufacturer's Instructions For Use for filling or draining the vaporizer and other information.

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

WARNING: The anesthetic liquid discharged from the vaporizer must not be used again. Please regard it as a dangerous chemical and dispose of it properly in accordance with local regulations.

3.5 AGSS

1. Hang the AGSS on the bracket on the side of the anesthesia system and tighten the fixing nut.

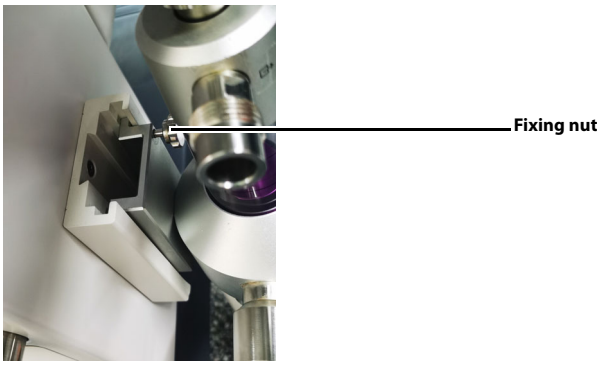


FIGURE 3-3 Install the AGSS

2. Connect the gas inlet of AGSS to the waste gas scavenging connector of the anesthesia system through the waste gas transfer hose. The gas outlet of AGSS is connected to the waste gas scavenging system of the hospital through the AGSS tube.

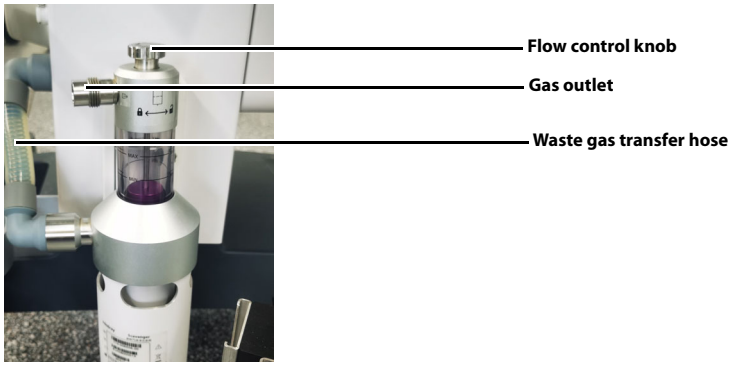


FIGURE 3-4 Connect the Waste Gas Transfer Hose

3.6 Negative Pressure Suction Device

1. Fix the negative pressure suction device to the rail on the side of the anesthesia system with a nut.

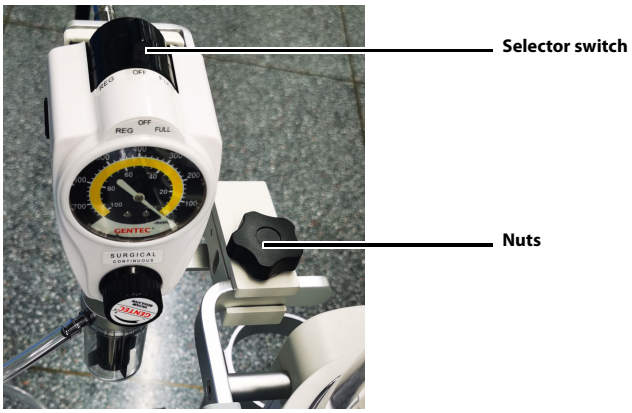


FIGURE 3-5 Fix the Negative Pressure Suction Device

2. For the venturi negative pressure suction device, connect the other end of the gas supply hose of the negative pressure suction device to the drive gas connector of the anesthesia system. For the continuous negative pressure suction device, connect the other end of the gas supply hose of the negative pressure suction device to the wall terminal of the hospital.

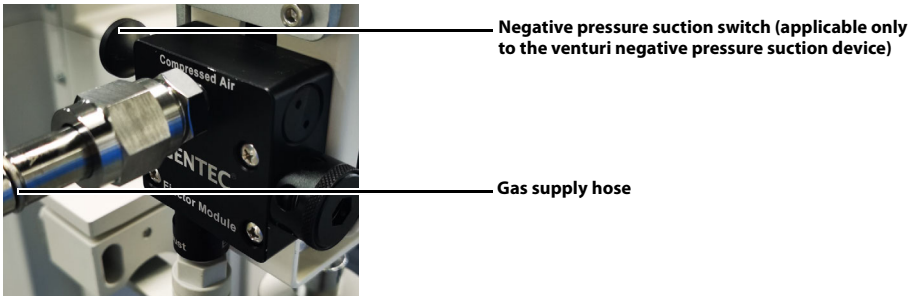


FIGURE 3-6 Connect the Gas Supply Hose

3. Fix the liquid collection bottle bracket with two screws.

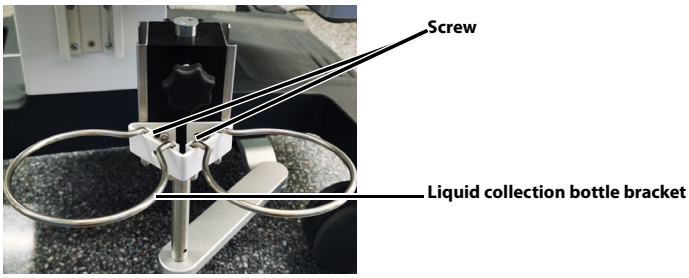


FIGURE 3-7 Install the Liquid Collection Bottle Bracket

4. Place the liquid collection bottle to the bracket. Connect the suction tube, filter and the liquid collection bottle by following the printed instructions on the bottle. Insert the suction tube to the overfill protection connector.

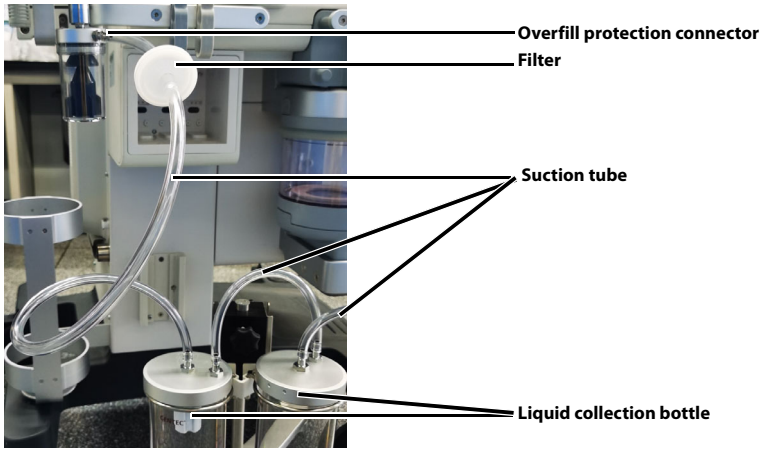


FIGURE 3-8 Install the Liquid Collection Bottle, Filter and Suction Tube

NOTE: **When installing the filter to the suction tube, pay attention to keeping the side printed with IN facing the liquid collection bottle.**

NOTE: **Avoid twisting or bending suction tubes during use.**

3.6.1 Turn on Negative Pressure Suction Device

1. Assemble the negative pressure suction device.
2. Turn on the negative pressure pipeline supply.
3. For the venturi negative pressure suction device, set its switch to **ON**.
4. Set the selector switch to **REG**.
5. Adjust the negative pressure control knob to keep the pressure gauge reading smaller than -40 kPa.

3.6.2 Turn off Negative Pressure Suction Device

1. Set the selector switch to **OFF**.
2. For the venturi negative pressure suction device, set its switch to **OFF**.

WARNING: **Keep the negative pressure suction switch in the OFF state when the negative pressure suction device is not in use.**

3.7 High-flow Nasal Cannula (HFNC) Tube

1. Hang the humidifier on the bracket on the side of the anesthesia system.

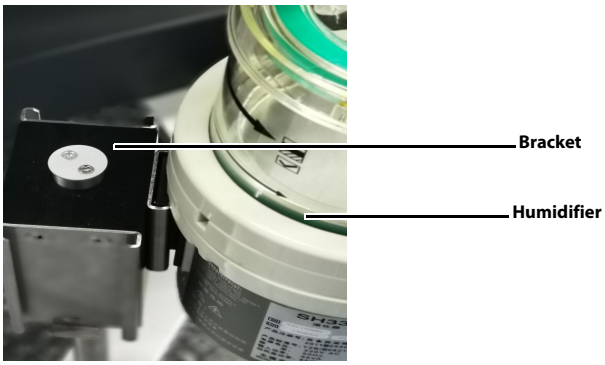


FIGURE 3-9 Install the Humidifier

2. Connect the gas inlet of the humidifier and the HFNC outlet of the anesthesia system with a breathing tube. Connect the gas outlet of the humidifier and the patient with another breathing tube.

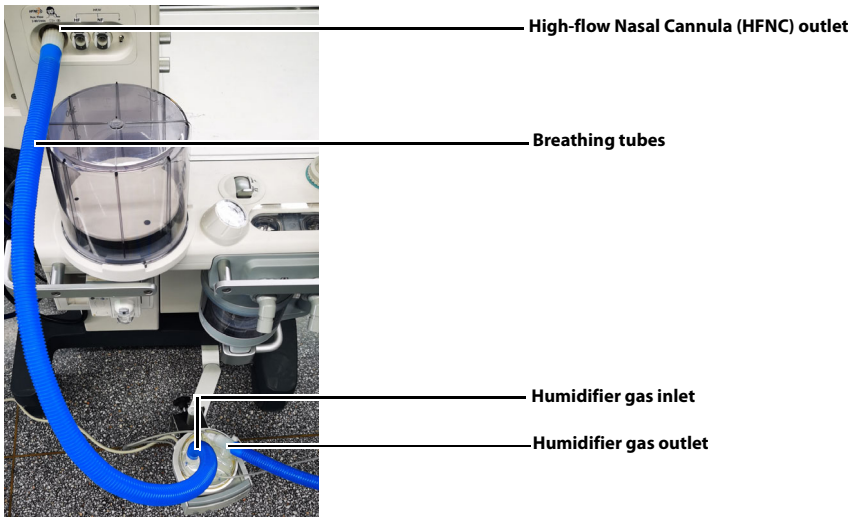


FIGURE 3-10 Connect Tubes

3. To disassemble the humidifier, draw out the breathing tubes and lift the humidifier upward.

3.8 High Frequency Jet Ventilation (HFJV) Tube

WARNING: Use only with tested accessories listed in the manual. The use of high frequency jet ventilation mode with non-original accessories may result in performance degradation or monitoring errors. The built-in safety and alarm system of the equipment may be invalid, or the equipment operation may be incorrect. The Operating Company needs to ensure that the equipment and accessories used with the machine match the anesthesia system.

WARNING: The diameter of the jet catheter used must not exceed 50% of the narrowed airway. When the expiratory cross-sectional area of the airway is less than 50% of the cross-sectional area, subglottic jet ventilation cannot be performed with a jet catheter.

WARNING: The jet catheter may be cannulated orally or nasally. Observe the markings on the jet catheter to check the position. After intubation, secure the jet catheter.

When the HFJV tube, pressure monitoring tube and gas sampling tube are used together, the installation steps are as follows:

1. Connect one end of the HFJV tube to the corresponding connector of the anesthesia system and the other end to the corresponding connector of the HFJV adapter.
2. Connect one end of the pressure monitoring tube to the corresponding connector of the anesthesia system and the other end to the corresponding connector of the HFJV adapter.
3. Connect one end of the gas sampling tube to the AG/CO2 module and the other end to the corresponding connector of the HFJV adapter.

4. Connect one end of the jet catheter to the corresponding port of the HFJV adapter and the other end to the patient.

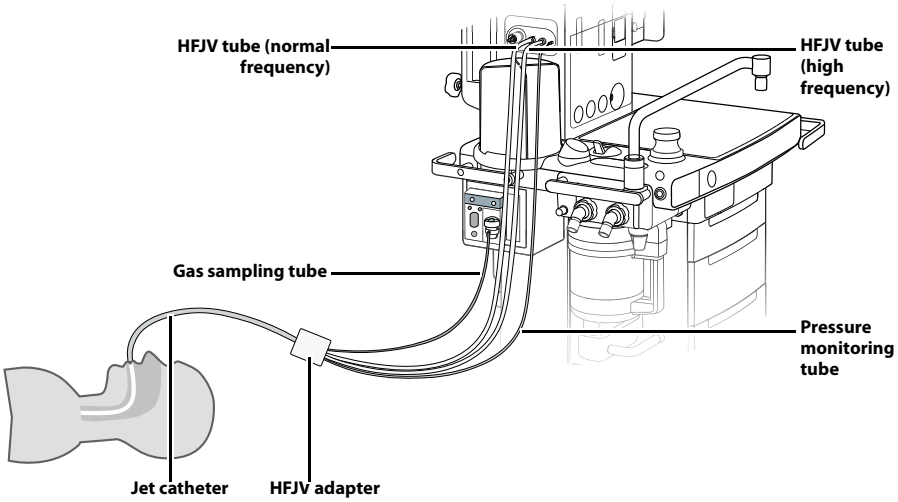


FIGURE 3-11 Install HFJV Tube

When the HFJV tube is used with the needle, the installation steps are as follows:

1. Loosen the screws, adjust the relative position of the needle and the fixing base, and reserve a proper length.
2. Connect one end of the HFJV tube to the corresponding connector of the anesthesia system and the other end to the corresponding connector of the needle.
3. After placing the trachea cannula, install the fixing base on the connector of the trachea cannula.
4. If the position of the needle is not proper, loosen the screws, readjust the position of the needle, and then tighten the screws.

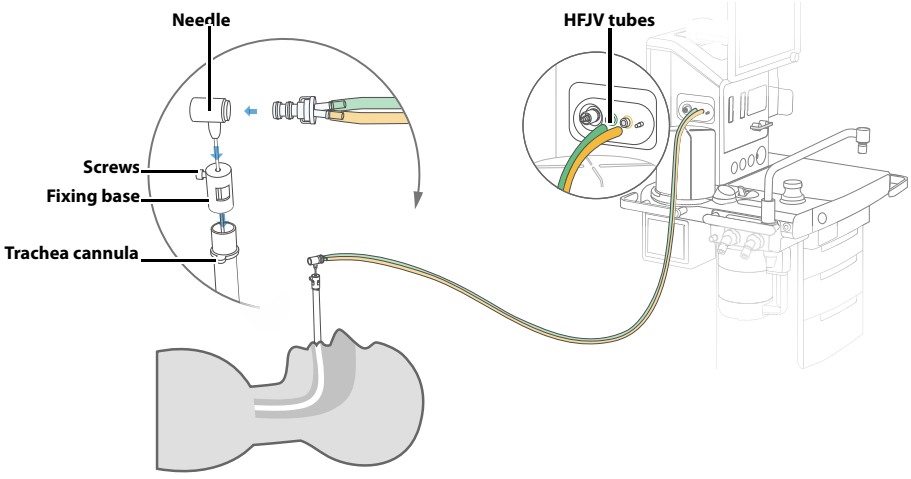


FIGURE 3-12 Install HFJV Tube and Needle

When the HFJV tube is used with the bronchoscope adapter, the installation steps are as follows:

1. Connect one end of the HFJV tube to the corresponding connector of the anesthesia system and the other end to the corresponding connector of the bronchoscope adapter.

2. Once the bronchoscope sheath is in place, insert the adapter into the appropriate bronchoscope sheath as shown below. The raised part of the adapter must be aligned with the sheath notch.

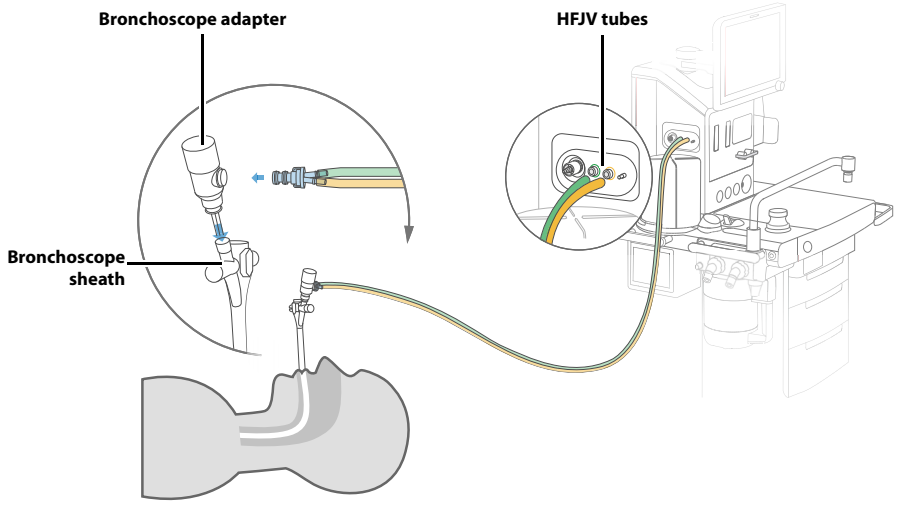


FIGURE 3-13 Install HFJV Tube and Bronchoscope Adapter

When the HFJV tube, the bronchoscope adapter and the humidifier are used together, the installation steps are as follows:

1. Preheat the humidifier. Connect one connector of the humidifier to the corresponding connector of the anesthesia system through the tube.
2. Connect another connector of the humidifier to the middle connector of the 3-way adapter through the tube.
3. Connect one end of the HFJV tube to the corresponding connector of the anesthesia system, and insert the other end into the corresponding connector of the bronchoscope adapter.
4. Insert the smaller end of the 3-way adapter into the connector of the bronchoscope adapter.
5. Once the bronchoscope sheath is in place, insert the adapter into the appropriate bronchoscope sheath as shown below. The raised part of the adapter must be aligned with the sheath notch.

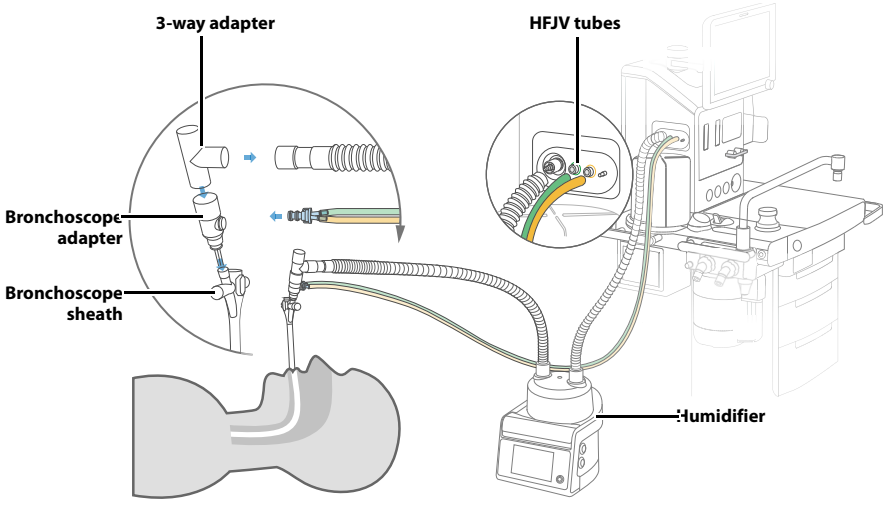


FIGURE 3-14 Install HFJV Tube, Bronchoscope Adapter and Humidifier

3.9 Connect Anesthesia System with Information System

3.9.1 Connect Anesthesia System with Information System Through Serial Interface

The anesthesia system can be connected to the information system through a serial interface and sends its ventilation modes, status, parameters, alarms, alarm limits and patient information to the information system with the HL7 protocol.

1. The communication cable is connected to the communication interface of the anesthesia system on one end and connected to the matched interface of the information system on the other end.
2. Enter the standby mode.
3. Select the icon and open the [**Setup**] menu.
4. Select the [**System**] key, enter the system password and confirm the password.
5. Select the [**Network**] tab in the system menu.
6. Select the [**Serial**] tab.
7. Set [**Protocol**] to [**HL7**].
8. Configure related settings. See section 4.15.13.4 (Pages 4-33) "Network".

3.9.2 Connect Anesthesia System with Information System Through Network

The anesthesia system can be connected to the information system through network and sends its ventilation modes, status, parameters, alarms, alarm limits, patient information and waveforms to the information system with the HL7 protocol.

1. Enter the standby mode.
2. Select the icon and open the [**Setup**] menu.
3. Select the [**System**] key, enter the system password and confirm the password.
4. Select the [**Network**] tab in the system menu.
5. To connect the anesthesia system through LAN, select the [**Network Type**] tab and set [**Network Type**] to [**LAN**]. Connect one end of the network cable to the network interface of the anesthesia system and the other end to the corresponding interface of the information system. Select the [**Ethernet1**] tab to configure settings. See section 4.15.13.4 (Pages 4-33) "Network".
6. To connect to the information system through WLAN, select the [**Network Type**] tab and set [**Network Type**] to [**WLAN**]. Select the [**WLAN Setup**] tab, and then select the available WLAN or add WLAN.
7. Select the [**HL7**] tab.
8. Configure related settings. See section 4.15.13.4 (Pages 4-33) "Network".

NOTE: The IP addresses of the anesthesia system and the information system must be in the same segment.

3.10 Connect Anesthesia System with Monitor

3.10.1 Connect Anesthesia System with Monitor Through Serial Interface

The anesthesia system can be connected to Mindray's monitor through a serial interface and the BeneLink module and sends the ventilation modes, parameters, alarms, alarm limits, waveforms and patient information to the monitor with MR-WATO protocol.

The anesthesia system can be connected to the Philips monitor through a serial interface and the IntelliBridge module and sends the partial ventilation modes, parameters, alarms, alarm limits and waveforms of the anesthesia system to the monitor with the Philips IntelliBridge protocol.

1. The communication cable is connected to the communication interface of the anesthesia system on one end and connected to the matched interface of the monitor on the other end.
2. Enter the standby mode.
3. Select the icon and open the [**Setup**] menu.
4. Select the [**System**] key, enter the system password and confirm the password.
5. Select the [**Network**] tab in the system menu.
6. Select the [**Serial**] tab.
7. Set [**Protocol**] to [**MR-WATO**] or [**Philips**].
8. Configure related settings. See section 4.15.13.4 (Pages 4-33) "Network".

3.10.2 Connect Anesthesia System with Monitor Through Network

1. Enter the standby mode.
2. Select the icon and open the [**Setup**] menu.
3. Select the [**System**] key, enter the system password and confirm the password.
4. Select the [**Network**] tab in the system menu.
5. To connect the patient monitor through LAN, select the [**Network Type**] tab, set [**Network Type**] to [**LAN**], and connect one end of the network cable to the anesthesia system network interface, and the other end to the corresponding interface of the patient monitor. Select the [**Ethernet1**] tab to configure settings. See section 4.15.13.4 (Pages 4-33) "Network".
6. To connect to the monitor through WLAN, select the [**Network Type**] tab and set [**Network Type**] to [**WLAN**]. Select the [**WLAN Setup**] tab, and then select the available WLAN or add WLAN.
7. Select the [**Monitor**] tab.
8. Set [**IP Address**] to the IP address of the monitor.

NOTE: The IP addresses of the anesthesia system and the monitor must be in the same segment.

3.11 Connect Anesthesia System with Central Monitoring System

1. Enter the standby mode.
1. Select the icon and open the [**Setup**] menu.
2. Select the [**System**] key, enter the system password and confirm the password.
3. Select the [**Network**] tab in the system menu.
4. To connect the Central Monitoring System (CMS) through LAN, select the [**Network Type**] tab, set [**Network Type**] to [**LAN**], and connect one end of the network cable to the anesthesia system network interface, and the other end to the corresponding interface of the information system. Select the [**Ethernet1**] tab to configure settings. See section 4.15.13.4 (Pages 4-33) "Network".
5. To connect the CMS through WLAN, select the [**Network Type**] tab and set [**Network Type**] to [**WLAN**]. Select the [**WLAN Setup**] tab, and then select the available WLAN or add WLAN.
6. To connect the CMS through 4G/5G, select the [**4G/5G**] tab and set it to (ON).
7. Select the [**4G/5G**] tab, and set [**CMS Station**] to (ON).
8. Select the [**MD2**] tab, and set [**MD2**] to (ON).
9. Set [**Destination IP**] to the IP address of the CMS.
10. Select the [**Test**] key, and the system will start the network test and display the test results.

NOTE: **The IP addresses of the anesthesia system and the central monitoring system must be in the same segment.**

3.12 Connect Anesthesia System with eGateway

The anesthesia system can be connected to the ADT server through eGateway to download patient information from the ADT server. See section 4.2.2 (Pages 4-5) "Get Patient Information from ADT Server".

If the patient information in the eGateway is updated, eGateway will also update the information to the anesthesia system synchronously. See section 4.2.3 (Pages 4-5) "Synchronize Patient Information".

3.13 Connect Anesthesia System with Infusion Supervision System, Infusion Pump or Syringe Pump

1. Enter the standby mode.
2. Set the network of the anesthesia system. Perform the following operations:

1. Select the icon and open the [**Setup**] menu.
2. Select the [**System**] key, enter the system password and confirm the password.
3. Select the [**Network**] tab in the system menu.
4. To connect the infusion supervision system through WLAN, select the [**Network Type**] tab, set [**Network Type**] to [**LAN**]. Select the [**Ethernet1**] tab to configure settings. See section 4.15.13.4 (Pages 4-33) "Network".
5. To connect the infusion supervision system, infusion pump or syringe pump through WLAN, select the [**Network Type**] tab and set [**Network Type**] to [**WLAN**]. Select the [**WLAN Setup**] tab, and then select the available WLAN or add WLAN.

3. Set the network of the infusion supervision system, infusion pump or syringe pump. For details, see the user manual of the device.

4.

- When you set > [**System**] > enter system password > [**Setup**] > [**Infusion Device Connection**] > [**Infusion device control auth operation**] to (ON), you need to perform connection authorization and control authorization operations to enable the anesthesia system to control the pump. Perform the following operations:

  1. Establish the connection authorization of the anesthesia system and infusion supervision system/infusion and syringe pump. After the connection authorization is established, the icon is displayed in the icon area of the anesthesia system. Only the infusion pump information can be viewed and the infusion and syringe pump cannot be controlled.

     a. Select > [**System**] > enter the system password > [**Setup**] > [**Infusion Device Connection**]. This menu displays the current position of the anesthesia system, including the department, room number and bed number. When the department, room number and bed number of the infusion supervision system/infusion and syringe pump are consistent with those of the anesthesia system, this menu displays the ID and name of the device that can be connected.

     b. Type in [**Connection Auth Code**]. Set [**Connection Auth Code**] in the infusion supervision system, infusion pump or syringe pump. For details, see the operator's manual of the device. When the authorization code is correct, [**Connection**] is automatically set as (ON).

  2. The anesthesia system obtains the control authorization of the infusion supervision system/infusion and syringe pump. After the control authorization is established, the icon is displayed in the icon area of the anesthesia system. The infusion and syringe pump can be observed and controlled on the anesthesia system.

     - The infusion and syringe pump send the authorization and the dialog box is prompted on the anesthesia system. You can set [**Accept control auth**] to (ON), and then select [**Yes**].
     - The infusion and syringe pump send the authorization and the icon is prompted on the anesthesia system. You can set [**Accept control auth**] to (ON), and then select to save the changes.

- When you set > [**System**] > enter system password > [**Setup**] > [**Infusion Device Connection**] > [**Infusion device control auth operation**] to (OFF). After the connection authorization is completed, the function of the anesthesia system controlling the pump can be realized. The control authorization operation is not needed. Perform the following operations:

1. Select > [**System**] > enter the system password > [**Setup**] > [**Infusion Device Connection**]. This menu displays the current position of the anesthesia system, including the department, room number and bed number. When the department, room number and bed number of the infusion supervision system/ infusion and syringe pump are consistent with those of the anesthesia system, this menu displays the ID and name of the device that can be connected.
2. Type in [**Connection Auth Code**]. Set [**Connection Auth Code**] in the infusion supervision system, infusion pump or syringe pump. For details, see the operator's manual of the device. When the authorization code is correct, [**Connection**] is automatically set as (ON). The icon is displayed in the icon area of the anesthesia system.

5. After the anesthesia system exits the standby mode, the infusion and syringe pump can be controlled.

NOTE: **The IP addresses of the anesthesia system and the infusion supervision system, infusion pump or syringe pump must be in the same segment.**

3.14 Connect Anesthesia System with Endoscopy

1. Enter the standby mode.
2. Select the icon and open the [**Setup**] menu.
3. Select the [**System**] key, enter the system password and confirm the password.
4. Select the [**Network**] tab in the system menu.
5. To connect the endoscopy through LAN, select the [**Network Type**] tab, set [**Network Type**] to [**LAN**], and connect one end of the network cable to the anesthesia system network interface, and the other end to the corresponding interface of the endoscopy. Select the [**Ethernet1**] tab to configure settings. See section 4.15.13.4 (Pages 4-33) "Network".
6. To connect the endoscopy through WLAN, select the [**Network Type**] tab and set [**Network Type**] to [**WLAN**]. Select the [**WLAN Setup**] tab, and then select the available WLAN or add WLAN.
7. Select the [**Endoscope**] tab.
8. Sets [**IP Address**] to the IP address of the endoscopy.

NOTE: **The IP addresses of the anesthesia system and the endoscopy system must be in the same segment.**

4.0 System Interface

4.1 Main Screen

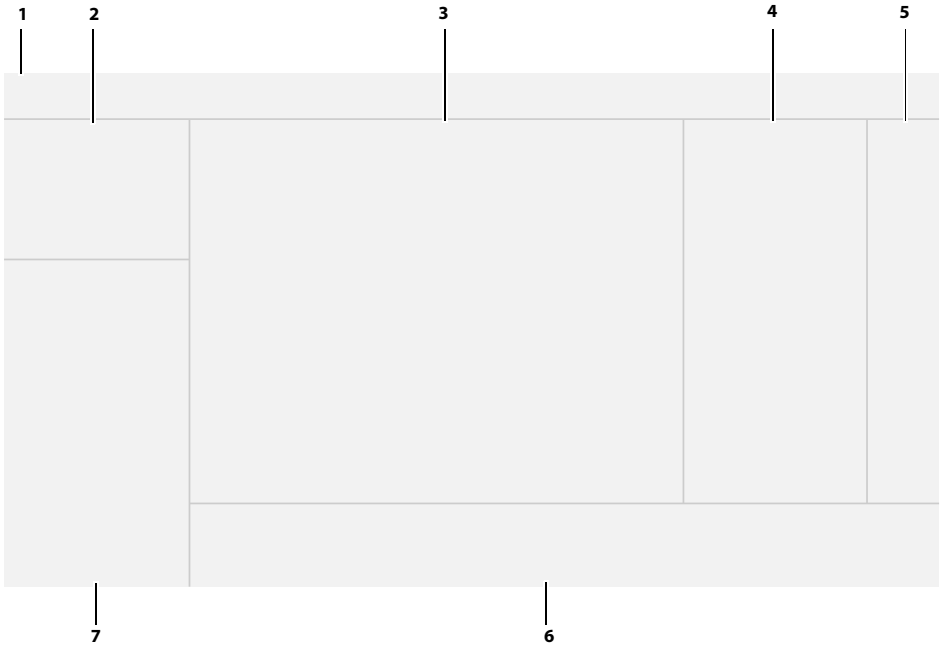


FIGURE 4-1 Main Screen

NO.	MAIN SCREEN	DESCRIPTION
1	Icon field	This area can display the following information: • Patient information, including patient type, weight, and age. Select this area to view more patient information. • Timer: you can choose to start, stop or reset the timer. • Current ventilation mode. • For the anesthesia system configured with the drive gas switch feature, when the default drive gas pressure is insufficient and the backup drive gas pressure is sufficient, or the current drive gas is the backup drive gas, the [**Drive Gas**] key is displayed. Select the [**Drive Gas**] key and set the drive gas type from the pop-up menu. • Physiological alarms, technical alarms, prompt messages, and the current number of active alarms and prompts. Select the zone to display a list of all active alarms. • When the [**Audio Pause**] or [**Alarm Reset**] soft key is selected, the **Audio Pause** or **Alarm Reset** icon is displayed along with a 120-second countdown timer. • USB drive icon is displayed when the anesthesia system recognizes that the USB drive is connected to the anesthesia system. • Settings icon: you can select the icon to open the [**Setup**] menu. • Date and time. • Network connection status. • Main power supply and battery status.
2	Gas parameters/O_2 concentration field	It displays parameter information in real time when the AG module or O_2 Sensor is configured.
3	Waveform/Parameter/ Spirometry/Trend field	It displays the waveforms, monitoring parameters, loops, and trends Information.
4	Split screen field	Select the icon  or to show or hide the split screen. It displays related parameters and setting items of the prediction of anesthesia, eMAC, flow pause, HFNC, ACGO, Monitor, Bypass, and modules.
5	Functional keys field	The functional keys include **Audio Pause**, **Alarm Reset**, **Alarms**, **History**, **Capture Event/Screen**, **Procedures**, **Flow Pause**, **Bypass**, **End Case** and **Start Case**.

TABLE 4-1 Main Screen

NO.	MAIN SCREEN	DESCRIPTION
6	Ventilation mode and parameter setup field	It displays all the ventilation mode tabs. Each tab displays the ventilation mode and its parameters. Select a tab and the [**Set Mode**] key to change the ventilation mode. Select the parameter key to change the parameter settings. See section 6.6 (Pages 6-5) "Set Ventilation".
7	Display zone of fresh gas control/anesthesia consumption speed	It displays the real-time flow level of oxygen or balance gas and an indication of optimal flow. Select this area to set the fresh gas flow in the opened menu. It displays the anesthetic agent consumption speed and cost.

TABLE 4-1 Main Screen

4.2 Patient Information Field

The current patient information is displayed in the icon field of the main screen. Select the patient icon to open the Patient Information menu. You can set the data for patients and hospitals in the Patient Information menu.

NOTE: **The equipment saves the latest patient parameter settings for each patient type. Changing to another patient size does not clear the parameter settings for the previous patient size. For example, changing from Adult to Pediatric and back to Adult will result in the Adult patient parameter settings still being saved.**

EDITABLE FIELD	DESCRIPTION
Patient ID	Enter up to 30 digits for each field. The fields will be cleared when the equipment powers off or enters the standby mode.
Visit Number	
First Name	
Last Name	
Size	Radio option.
Gender	Radio option.
Height	Enter information using the virtual keyboard. The system will display prompt messages if the entered information exceeds the allowed range.
Age	
Weight	
IBW	
DOB	
Bed	Enter up to 30 digits for each field.
Room	
Department	
Facility	

TABLE 4-2 Patient information

4.2.1 Set Patient Information in Anesthesia System

NOTE: **The patient type can be changed only when the equipment is in the standby or manual mode.**

1. Select the Patient Information icon to open the Patient Information settings menu.
2. Set the patient information.
3. Select to confirm the change and close the menu.

4.2.2 Get Patient Information from ADT Server

The anesthesia system can be connected to the ADT server through eGateway to download patient information from the ADT server.

1. Connect the network cable.
2. Set the network and ensure that the network access is normal.
   a. Enter the Standby mode.
   b. Select the icon and open the [**Setup**] menu.
   c. Select the [**System**] key, enter the system password and confirm the password.
   d. Select the [**Network**] tab in the system menu.
   e. Select [**ADT**] and set the [**ADT**] to (ON) in the pop-up screen.
   f. Set [**Destination IP**] and [**Port**].
   g. Select the [**Test**] tab.
   h. Confirm that the test result is [**Pass**].
3. Select the [**Find Patient**] tab in the Patient Information menu.
4. Enter the key information in the pop-up screen.
5. Select the [**Search**] tab and a list of conforming patient information will be displayed on the screen.
6. Select the desired patient information in the list and select the [**Import**] tab. The imported data includes patient ID, visit number, first name, last name, bed, room, department and facility.

4.2.3 Synchronize Patient Information

With the anesthesia system connected to the eGateway, if the patient information in the eGateway is updated, eGateway will also update the information to the anesthesia system synchronously. Synchronizable patient information include: patient ID, visit number, last name, first name, date of birth, age, weight, height and gender.

1. Connect the network cable.
2. Set the network and ensure that the network access is normal.
   a. Enter the Standby mode.
   b. Select the icon and open the [**Setup**] menu.
   c. Select the [**System**] key, enter the system password and confirm the password.
   d. Select the [**Network**] tab in the system menu.
   e. Set [**Destination IP**] and [**Port**].
   f. Select the [**Test**] tab.
   g. Confirm that the test result is [**Pass**].

NOTE: **Key information is defined by the eGateway. For specific operations, see the eGateway Integrated Management and Installation Guide.**

4.3 Timer

It displays the elapsed timer, the countdown timer or both of the two timers. Timer is displayed in the con field of the main screen. You can select the Timer icon to open its menu.

Elapsed timer: Select the [**Start**] soft key to start the elapsed timer. Select the [**Stop**] soft key to stop the elapsed timer. Select the [**Reset**] key to reset the timer.

Countdown timer: Set the remaining time for countdown and select the [**Start**] soft key to start the countdown. Select the [**Stop**] soft key to stop the countdown timer. Select the [**Reset**] key to reset the timer. The system will pop up a dialog box and beep when the countdown is over. In the dialog box, select ✔ to turn off the system beep.

4.4 Drive Gas

For the anesthesia system configured with the drive gas switch feature, when the [**Drive Gas**] key is displayed, select the [**Drive Gas**] key and set the drive gas type from the pop-up menu. When the default drive gas pressure is low, select whether to change to the backup drive gas in the pop-up menu. When the default drive gas pressure becomes normal, select whether to recover the default drive gas in the pop-up menu.

4.5 Alarm and Prompt Information

Physiological alarms, technical alarms and prompt messages are displayed in the icon field of the main screen. The most recent and top-priority alarm is displayed in the topmost section. Other alarms are displayed in the lower section, grouped by priority. In each group, the most recent alarm is displayed on the top of the list. Select the zone to display a list of all active alarms. See the table in Section 11.8 (Pages 11-8) "Alarms and Prompt Messages" for a list of prompt messages and related priorities. Alarms with a high priority are displayed in red. Alarms with a medium priority are displayed in yellow. Alarms with a low priority are displayed in cyan. Prompt messages are displayed in white.

FIGURE 4-2 Alarms and Prompt Messages

4.6 Audio Pause/Alarm Reset Icon

Audio Pause/Alarm Reset icon is displayed in the icon field of the main screen.

Select the [**Audio Pause**] soft key to display the Audio Pause icon and a 120-second countdown timer, indicating that all the audio alarms will be paused for 120 seconds.

When there is a medium priority or high priority alarm in the active alarms, select the [**Alarm Reset**] soft key to display the Alarm Reset icon and a 120-second countdown timer, indicating that all the current audio alarms will be paused for 120 seconds.

4.7 Date and Time

The current system date and time are displayed in the icon field of the main screen.

To adjust the date and time:

1. Enter the Standby mode.
2. Select the icon and open the [**Setup**] menu.
3. Select the [**System**] key, enter the system password and confirm the password.
4. Select the [**Setup**] tab in the system menu.
5. Select the [**Time/Date**] tab.
6. Adjust [**24 Hour Time**], [**Time Zone**], [**Date**], [**Time**], [**Date Format**] and [**DayLight Savings**] in the pop-up menu. See section 4.15.13.2 (Pages 4-29) "Setup".

NOTE: Select [DayLight Savings], if applicable, before performing other settings.

7. Select to confirm the changes.

4.8 Main Power Supply and Battery Status

The main power supply and battery status are displayed in the icon field of the main screen.

The power management system of the equipment supplies AC power to primary system features and charges the internal battery of the system. When the AC power supply suffers a fault, the equipment will be powered by the battery. Refer to 13.6 (Pages 13-5) "Electrical Specifications".

The equipment provides auxiliary AC power outlets. When the equipment is powered by its internal battery, the auxiliary outlet is not live.

NOTE: To extend the service life of the battery, please use the battery at least once a month. Charge the battery before the battery runs out.

NOTE: Check and replace the battery regularly. The service life of the battery depends on the frequency and duration of use. Improper use of the battery may shorten its service life. It is recommended that the battery be replaced once every three (3) years.

NOTE: The battery's power supply time depends on the equipment configuration and operation.

NOTE: In the event of a fault with the battery, contact Mindray service personnel for replacement.

The anesthesia system is equipped with an internal chargeable battery to ensure normal operation of the system in a power failure. When the equipment is connected to an AC power supply, the battery is charged regardless of whether the equipment is on or off. In the event of a sudden power failure, the system will automatically switch to the battery power supply mode without interrupting the operation of the system. When the AC power supply resumes within a specified period of time, the battery will start to be charged and the system will automatically switch from the battery to the AC power supply to ensure continuous operation.

When the power failure lasts shorter than 60 seconds (inclusive), the alarming settings before the power failure will be automatically restored.

Low battery may cause power supply faults. The equipment will trigger a high priority alarm and display [**Low Battery Voltage!**] in the Technical Alarm area. In this case, use the AC power supply to power the anesthesia system to resume its normal operation and charge the battery.

4.9 Fresh Gas Flow Display

4.9.1 Electronic Flow Control System

It displays the real-time flow of O_2 and balance gas. The balance gas can be set to air or N_2O.

The flowmeter numerics display a precision to two decimal digits for flows < 1 L/min and one decimal digit for flows ⩾ 1 L/min.

In this equipment, the electronically-controlled flowmeter is called the Electronic Flow Control System (hereinafter referred to as the EFCS). EFCS has two control modes: Total Flow and Direct Flow.

4.9.1.1 Total Flow Control Mode

The total flow control mode of the EFCS is shown in the figure below:

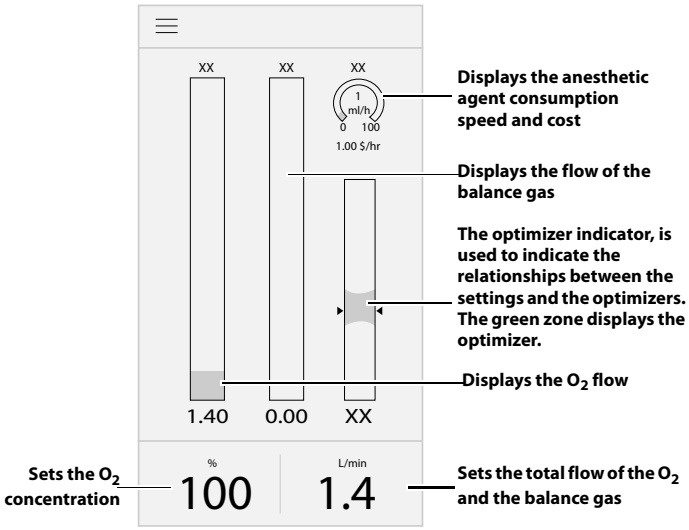


FIGURE 4-3 Total Flow Control Mode

Select the fresh gas flow display zone, and open the [**Fresh Gas Control**] menu. You can perform the following settings in the [**Fresh Gas Control**] menu:

- Set 100% O2 flow rate using quick keys.
- Set [**Control Mode**] to [**Total Flow**] or [**Direct Flow**].
- Set [**Balance Gas**] to [**Air**], [**N2O**] or [**None**].
- Set the total flow.
- Set the O_2 concentration value.

4.9.1.2 Direct Flow Control Mode

The direct flow control mode of the EFCS is shown in the figure below:

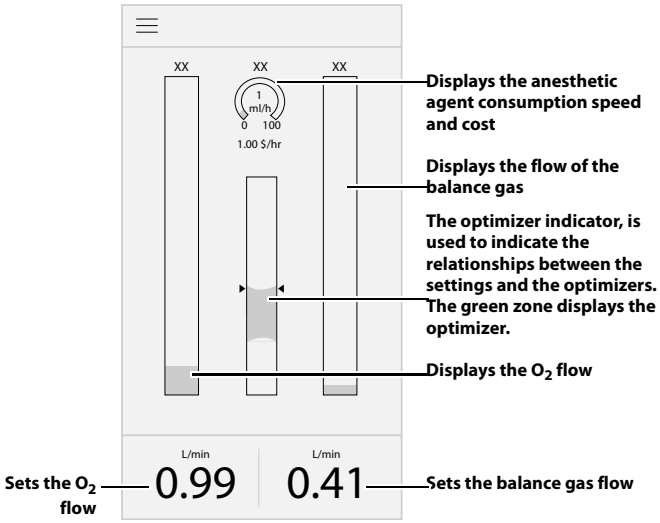


FIGURE 4-4 Direct Flow Control Mode

Select the fresh gas flow display zone, and open the [**Fresh Gas Control**] menu. You can perform the following settings in the [**Fresh Gas Control**] menu:

- Set 100% O2 flow rate using quick keys.
- Set [**Control Mode**] to [**Total Flow**] or [**Direct Flow**].
- Set [**Balance Gas**] to [**Air**], [**N2O**] or [**None**].
- Set the balance gas flow.
- Set the O_2 flow.

4.9.1.3 Optimizer

WARNING: The fresh gas optimizer indicator must not be used when high-flow fresh gas is needed.

NOTE: The optimizer is effective only when the anesthesia system is configured with the AG or CO_2 module, and the anesthesia system is in the automatic ventilation mode.

NOTE: The optimizer feature will become ineffective and unavailable when the data for optimizer calculation is not valid.

The optimizer indicator is used to indicate the relationships between the fresh gas flow settings and the optimizers. The optimizer is calculated based on the fresh gas flow settings, patient respiratory status, Oxygen uptake and exhaled CO_2, and leakage of the breathing system.

The green zone displays the optimizer in a 1 L/min range. The triangle pointers indicate the measured value of the total flow. If the triangle pointers are higher than the green zone, the triangle pointers and the indication text of [**High**] are in yellow. If the triangle pointers are in the green zone, the triangle pointers and the indication text of [**Efficient**] are in green. If the triangle pointers are lower than the green zone, the triangle pointers and the indication text of [**Low**] are in red.

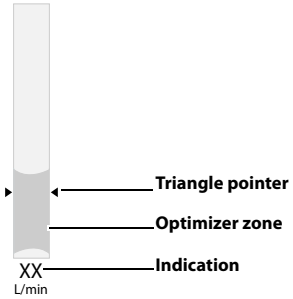


FIGURE 4-5 Optimizer

To enable or disable the optimizer indicator, do the following:

1. Enter the Standby mode.
2. Select the icon and open the [**Setup**] menu.
3. Select the [**System**] key, enter the system password and confirm the password.
4. Select the [**Setup**] tab in the system menu.
5. Select the [**Optimizer**] tab.
6. Set [**Optimizer**] to (OFF) or (ON).

4.9.2 Backup Flow Control System

When the EFCS fails, press the Backup Flow Control System (hereinafter referred to as the BFCS) cover, and adjust the gas flow with the needle valve of flowmeter. Before the EFCS is restored, you cannot disable the BFCS.

After the BFCS is enabled, the system will automatically provide O2 flow at 1 L/min. Rotate the needle valve to adjust the flow, and the flow will increase the flow from 1L/min. The total flowmeter is used to display the total flow. By pressing the [**Audio Pause**] or [**Alarm Reset**] button, you can disable the audio alarm [**Backup Flow Control is enabled**].

When the EFCS is still on, you can pull the BFCS cover outward to start the BFCS. To disable the BFCS, close all the needle valves and press the [**Disable Backup Flow Control**] button on the screen. Then select [**Yes**] in the pop-up dialog box and close the BFCS cover to disable the BFCS.

When the [**Low Battery Voltage!**] alarm shows, the system will prompt to use the BFCS to control the flow. Please connect the system to an AC power supply as soon as possible.

In the event of an unexpected power failure, you can activate the BFCS by pulling the BFCS door open to maintain manual ventilation.

4.10 Waveform/Parameter/Spirometry/Trend Screen

- Waveform and parameter field:

  - It displays the pressure, flow rate, volume, CO_2, O_2, N_2O, or AA waveform and its monitoring parameters. Up to five waveforms can be displayed on this screen. When data is displayed in the bottom functional area, up to four waveforms can be displayed on this screen.
  - Mini trends. By selecting the mini trends waveform, you can set the duration of the mini trends in the opened interface.
- Bottom functional field:
  - Monitoring parameters
  - Monitoring parameters of the BIS module or NMT module. Select this parameter to expand the split screen area.
  - Spirometry. Select this parameter to expand the split screen area.
  - Compl/PEEP trends waveform

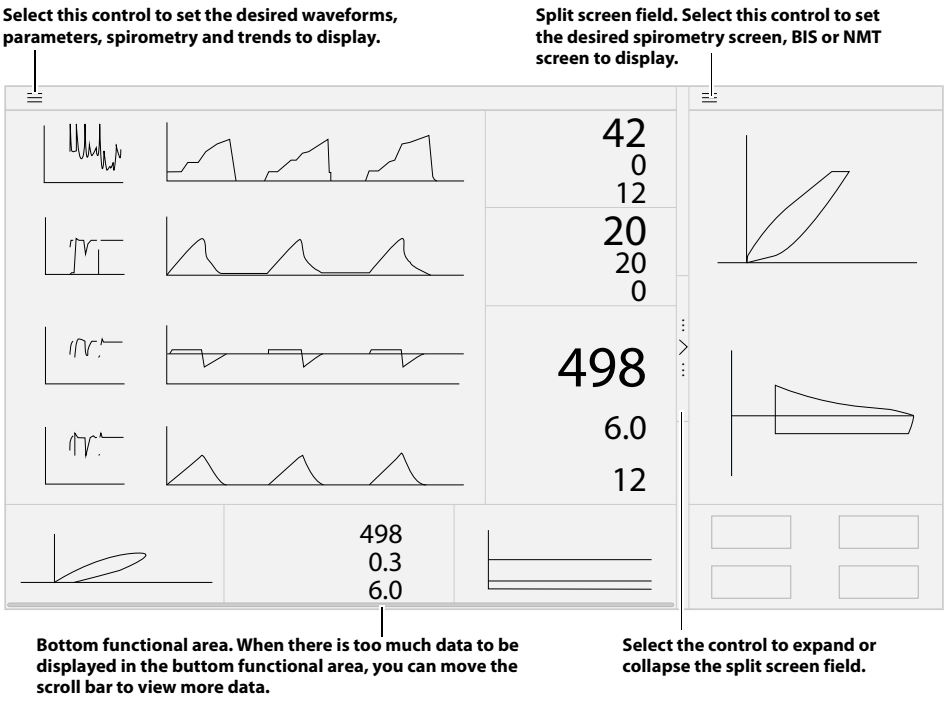


FIGURE 4-6 Waveform/Parameter/Spiometry/Trend Field (Controls)

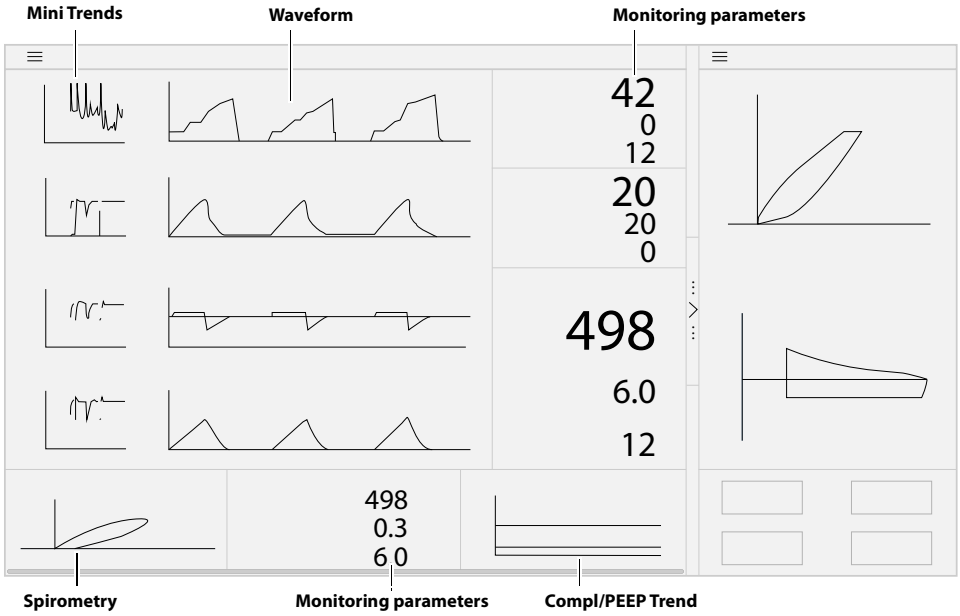


FIGURE 4-7 Waveform/Parameter/Spiometry/Trend Screen

4.10.1 Spirometry Screen

Spirometry loops reflect patient lung function and ventilation. They also indicate other related parameters such as compliance, over-inflation, breathing system leak, and airway blockage.

The system provides three types of spirometry loops: pressure-volume loop (P-V), flow-volume loop (F-V) and pressure-flow loop (P-F). Loops data comes from pressure and flow data. A maximum of two loops are displayed at a time.

Four soft keys are displayed on the Spirometry screen: [**Loop Type**], [**Show Reference**], [**Save Loop**] and [**Review Loops**].

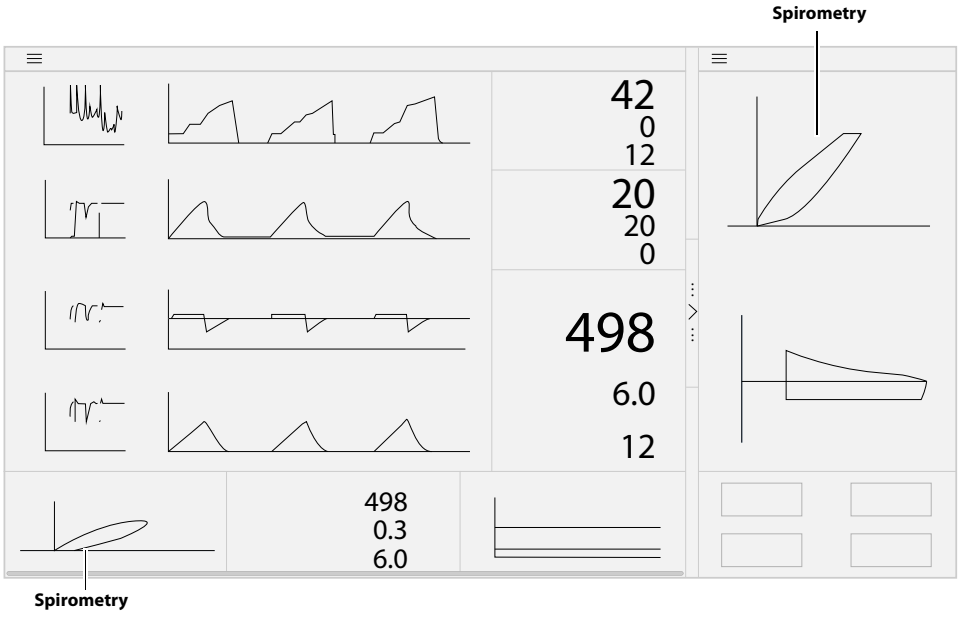


FIGURE 4-8 Spirometry

4.10.1.1 Loop Type

The [**Loop Type**] option is used to display the P-V loop, the F-V loop, or the P-F loop on the spirometry screen.

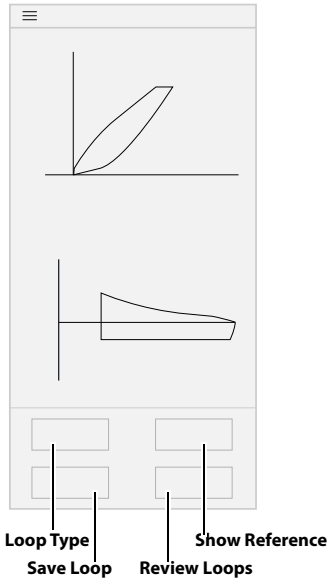


FIGURE 4-9 Soft Keys of Spirometry: Loop Type, Show Reference, Save Loop and Review Loops

4.10.1.2 Show Reference

Select [**Show Reference**] soft key only after saving a baseline via the [**Save Loop**] soft key.

[**Show Reference**] soft key is used to select and display the saved baseline loop and reference loop, or hide the loops (disable) in the loop window. The selected baseline loop or reference loop will be shown overlapped with the current loop. Only the most recent five reference loops saved will be displayed in the chronological order.

After the reference loop or baseline loop to display in the loop window are selected, the timestamp will also be displayed.

4.10.1.3 Save Loop

Select the [**Save Loop**] soft key to save the current loop (including its monitoring parameter data) as a baseline loop or reference loop. You can save a maximum of one baseline loop and five reference loops. Other loops can be saved to replace the baseline loop or reference loops. Only the most recent five reference loops are saved.

Review the saved baseline or reference loop with its numeric data (via [**Review Loops**] soft key) or displayed with the currently plotting loop on the same graph for comparison (via [**Show Reference**] soft key).

NOTE: **A reference loop cannot be saved without first saving a baseline loop. The System always makes the first saved loop as the baseline loop if no previous loops have been saved. Afterward, additional loops can be saved either as a baseline replacement or as a new reference loop.**

To save a baseline loop:

1. On the Spirometry Screen, select the [**Save Loop**] soft key. If no baseline loop has been saved, the current loop will be automatically saved as a baseline loop.
2. If a baseline loop has been saved, a dialog box will pop up, offering the [**Baseline**] and [**Reference**] options. After saving a loop as a [**Baseline**], a confirmation box will pop up with a prompt message saying [**Selecting Yes will replace the currently saved Baseline loop. Do you want to proceed?**]. If [**Yes**] is selected, the currently saved baseline loop will be replaced. If [**No**] is selected, the save will be canceled.

To save a reference loop:

1. On the Spirometry Screen, select the [**Save Loop**] soft key. If a baseline loop has been saved, a dialog box will pop up, offering the [**Baseline**] and [**Reference**] options. Select [**Reference**].
2. When the maximum of five (5) loops is reached, and the user attempts another save, a confirmation dialog will be displayed with the following text, [**Selecting Yes will replace the oldest reference loop.Do you want to proceed?**]. If [**Yes**] is selected, the earliest data will be removed as the new data is added. If [**No**] is selected, the save will be canceled.

4.10.1.4 Review Loops

Select the [**Review Loops**] soft key to display the [**Review Loops**] screen, with the following zones and options available:

Small Loop Window: These small loop windows display the baseline loop and the reference loops. The baseline loop is always displayed on the top. The reference loops are displayed under the baseline loop. The reference loops are sorted in the chronological order from the earliest (up) to the latest (bottom).

Large Loop Window: The loop window displays the enlarged view of the selected reference loop.

Loop Type: The [**Loop Type**] option is used to select the type of the loop to be reviewed. P-V loop, F-V loop and P-F loop options are available.

Delete Loops: The [**Delete**] option is used to delete a selected reference loop. After a reference loop is deleted, the new reference loop will move to the top. If no reference loops have been saved, the [**Delete**] key will be disabled (turning gray). The baseline loop cannot be deleted. It can only be replaced by a new baseline loop.

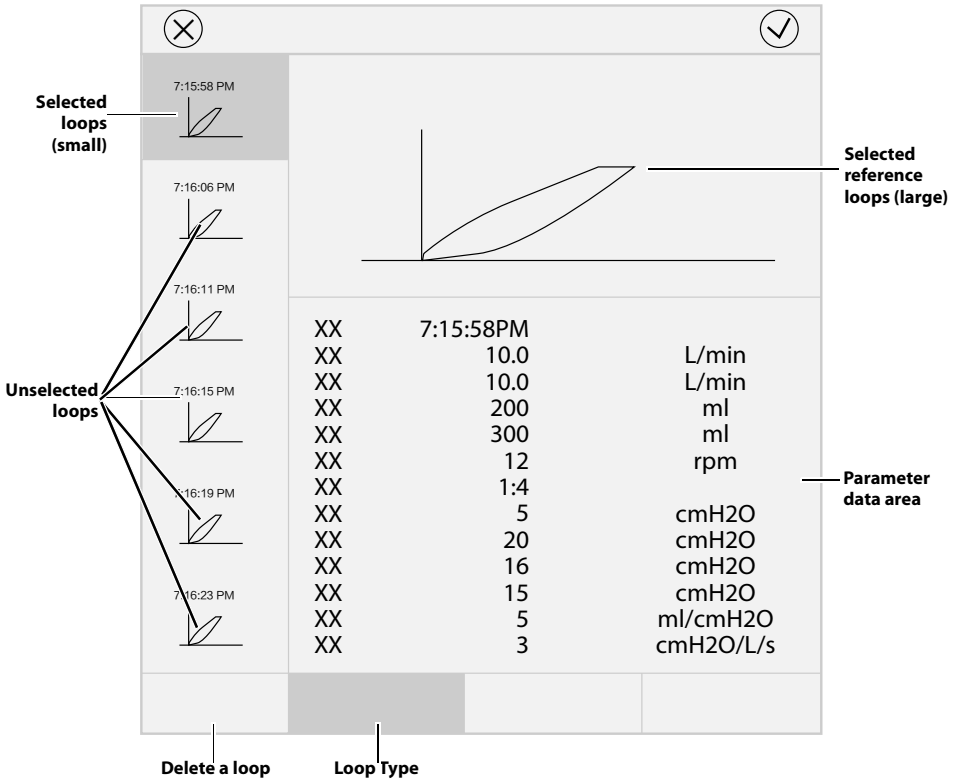


FIGURE 4-10 Review Loops Window

Parameter data zone: it displays the monitoring parameter data related to the saved baseline loop and reference loops. Listed parameters include: time, minute expiratory volume (**MVe**), minute inspiratory volume (**MVi**), expired tidal volume (**Vte**), inspiratory tidal volume (**Vti**), inspiration/expiration ratio (**I:E**), positive end expiratory pressure (**PEEP**), respiratory rate (**RR**), peak inspiratory pressure (**PEAK**), inspiratory plateau pressure (**PLAT**), mean pressure (**MEAN**), airway compliance (**Compl**) and airway resistance (**Raw**).

4.11 Prediction Screen

WARNING: The pharmacokinetic models used for anesthesia prediction are constructed based on population sampling statistics. Do not make anesthetic delivery decisions solely relying on the displayed predicted curve.

NOTE: The predicted gas concentrations in the Prediction interface are calculated based on public models, and do not represent the actual inhaled or exhaled concentrations of patients.

It displays the historical curves and prediction curves of anesthetic agent concentration and O_2 concentration. The anesthesia prediction feature utilizes public pharmacokinetic models to calculate the trends of inhaled and exhaled gas concentrations of patients within a period of time based on preset anesthesia machine parameters, including fresh gas settings, vaporizer settings, and ventilation settings. The model used by the anesthesia prediction feature was proposed by Lerou. For details, see Reference [1]. After ventilation is started, the anesthesia system predicts and displays the prediction trend after three stable breathing cycles. The anesthesia prediction feature is only applicable to adults.

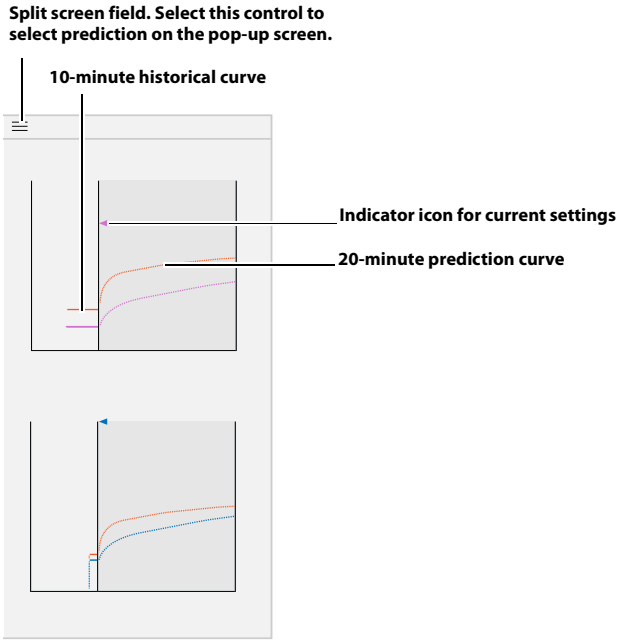


FIGURE 4-11 Prediction Screen

About prediction screen:

- It displays the FiAA, EtAA, FiO_2 and EtO_2 concentration curves. AA stands for any of the following three anesthetic agents: Des (Desflurane), Hal (Halothane), Iso (Isoflurane), and Sev (Sevoflurane).
- It displays the 10-minute historical curve with a black background.
- It displays the 20-minute prediction curve with a gray background.
- The indicator icon for current settings indicates the current vaporizer setting or O_2% setting.
- Prediction only functions when the system is in automatic ventilation mode.
- Prediction only functions when the AG module is configured in the anesthesia system.
- Prediction is unavailable when age, weight or height is not configured, or when the setting exceeds the allowable range. The allowable ranges of age, weight and height settings supported by the anesthesia prediction models are:

Age	18 years old to 90 years old

1. Lerou JGC, et al. Model-based administration of inhalation anaesthesia 1. Developing a system model. B J Anaesth, 2001, 86(1): 12- 28.

Weight	40 kg to 140 kg
Height	150 cm to 200 cm

- No prediction curve will be displayed when the deviation between the predicted concentration and the actual concentration exceeds the values indicated in the following table.

EtAA = 0	≤ 0.05 vol.%
EtAA ≠ 0	-20% to 30% of the actual EtAA value measured, or -5% to 7.5% of the maximum concentration set for the evaporator, whichever is greater.
EtO_2	-10% to 15% of the actual EtO2 value measured, or -5 vol.% to 7.5 vol.%, whichever is greater.

- Prediction is unavailable when the BFCS is in use.
- Prediction issues can be solved as per the prompts on the Main Screen. Please contact Mindray Technical Support if the problem persists.

4.12 AnaeSight Screen

The AnaeSight screen can be configured. Select [**AnaeSight**] and set [**eMAC**], [**NMT**], [**HR/BP**], [**BIS**] or [**BIS+DSA**] to (ON) in the pop-up screen. The data of [**eMAC**] comes from the comprehensive efficacy results of intravenous and inhalation anesthetic drugs calculated by the Hierarchical model established by overseas people; The data of [**NMT**] comes from the NMT module; The data of [**HR/BP**] comes from the patient monitor; The data of [**BIS**] or [**BIS+DSA**] comes from the BIS module.

Select the key to expand the AnaeSight screen, which contains more information.

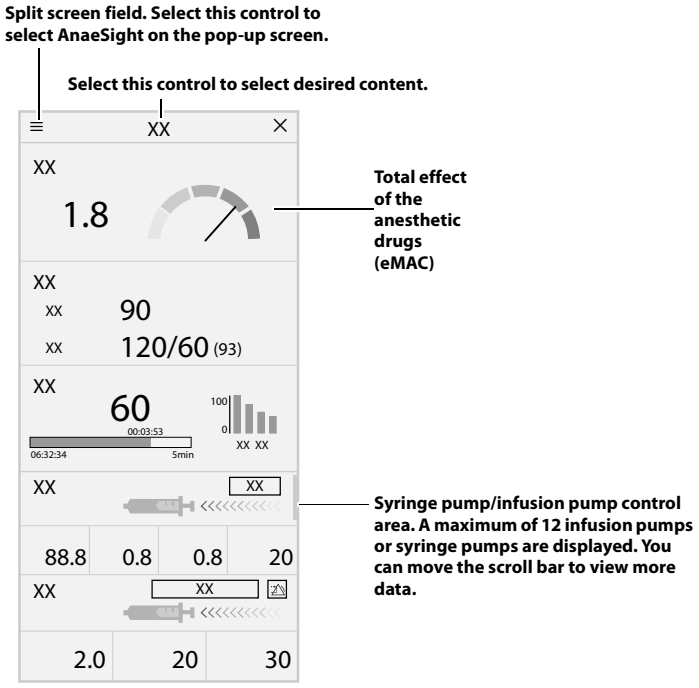


FIGURE 4-12 AnaeSight Screen

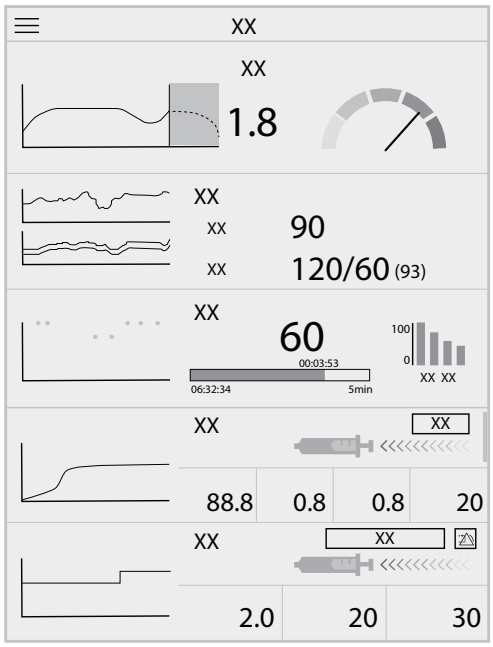


FIGURE 4-13 Expanded Screen of AnaeSight

4.12.1 Remote Operation of the Infusion Pump/Syringe Pump

WARNING: The anesthesia system cannot synchronize audible and visual alarms on the syringe pump or infusion pump (BeneFusion series).

CAUTION: To connect the power supply of the infusion supervision system to the auxiliary output port of the anesthesia system, the number of pumps powered by the infusion supervision system should not exceed 12.

The anesthesia system can connect to the infusion supervision system (BeneFusion series) through the LAN or WLAN interface.

The anesthesia system can connect to syringe pump/infusion pump (BeneFusion series) through the WLAN interface.

After the anesthesia system is connected to the devices above, select the [**AnaeSight**] button to implement the following functions.

- The anesthesia system supports setting the following parameters of the syringe pump: syringe mode, rate, VTBI, time, occlusion pressure, drug concentration, PK model, target concentration, induction pattern, weight, age, height, and gender.
- The anesthesia system supports setting the following parameters of the infusion pump: infusion mode, rate, VTBI, time, occlusion pressure, drug concentration and weight.
- The anesthesia system supports setting the syringe pump or infusion pump for start, stop, alarm reset, audio pause, and bolus operation.
- For settings on the anesthesia system, the parameters and functions of the syringe pump or infusion pump can correctly respond and the response time does not exceed 1000 ms.
- The anesthesia system supports displaying the infusion status of the syringe pump or the infusion pump (bolus, infusing, infusion paused, KVO or purging) and the applied drugs.

- The anesthesia system supports displaying the following parameters of the syringe pump: syringe mode, rate, VTBI, volume, dose rate, Cpt, Cp, Ce, Cet, bolus rate, bolus volume, bolus time, purge vol., purge rate and KVO time.
- The anesthesia system supports displaying the following parameters of the infusion pump: infusion mode, rate, VTBI, volume, dose rate, bolus volume, bolus time, purge vol., purge rate and KVO time.
- The anesthesia system supports displaying the alarm messages of the syringe pump or the infusion pump.
- The anesthesia system cannot support the following operations of the syringe pump/infusion pump (BeneFusion series): Start the first infusion of the syringe pump/infusion pump (BeneFusion series), perform purge, select the drug name and infusion set/syringe brand, and enter, exit the standby mode and Access the maintenance menu of the syringe pump/infusion pump (BeneFusion series).

The springe pump provides Rate mode, Dose mode, TIVA mode and TCI mode. The infusion pump provides Rate mode, Dose mode and Drip mode.

To connect the infusion supervision system, infusion pump or syringe pump, refer to 3.13 (Pages 3-12) "Connect Anesthesia System with Infusion Supervision System, Infusion Pump or Syringe Pump" for more information.

4.12.2 Total Effect of Anesthetic Drugs (eMAC)

WARNING: The pharmacokinetic and pharmacodynamic models used for the eMAC function are based on the statistical construction of population sampling. The results indicate only the calculation results of the pharmacodynamic model abroad, not the actual anesthesia conditions of patients, and do not provide reference for physicians in decision making.

WARNING: The eMAC function does not consider the pre-medication of patients with drugs other than those specified in the instructions for use. The eMAC function is not applicable to manual drug administration or heart-lung machine use.

CAUTION: The eMAC function should be used by anesthetists familiar with this function principle, and users should be fully aware of the available literature on drug-related models.

NOTE: The eMAC function of this device is calculated based on the public model and does not represent the comprehensive efficacy indication of compound anesthesia for the patient.

The eMAC function displays the equivalent MAC value of the combined effects of multiple anesthesia drugs. Based on the public pharmacokinetic model and pharmacodynamic model, this function calculates the comprehensive anesthesia effect under the interaction of intravenous anesthesia drugs and inhalation anesthesia drugs, and equivalents the MAC value under pure inhalation anesthesia, so as to directly understand the drug effect under current drug administration.

Perform the following operations to get eMAC values:

1. Enter the standby mode.
2. Connect the infusion supervision system, infusion pump or syringe pump. For more information. See section 3.13 (Pages 3-12) "Connect Anesthesia System with Infusion Supervision System, Infusion Pump or Syringe Pump".
3. Plug the AG module..

4. Start ventilation.
5. Select the [**AnaeSight**] key and the eMAC value will be displayed. When the patient information is within the following ranges, the eMAC value will be displayed.

The detailed parameters are displayed as follows.

Patient information	Physical status	ASA I-II
	Height	150 cm to 200 cm
	Weight	40 kg to 140 kg
	Age	18 to 90
Contraindications	For patients with nervous system diseases, endocrine diseases, cardiopulmonary diseases, severe hepatic and renal metabolic diseases, and BMI>30, the calculation results of this model have large deviation. The deviations mainly come from the effects of such diseases on the metabolism or efficacy of anesthetic drugs.	
Support drugs	Anesthesia agent	Isoflurane, Sevoflurane, and Desflurane
	Intravenous drugs	Propofol, Remifentanil, Alfentanil and Sufentanil

4.13 Ventilation Mode Tabs

Displays tabs for ventilation modes. Each tab displays the ventilation mode and its parameters.

The ventilation modes on the screen can be customized. Select ventilation mode custom key to open [**Vent Mode Setup**] menu. In the opened menu, set the ventilation modes to be displayed in the ventilation mode filed. The system will add the ventilation modes one at a time in the order of selection.

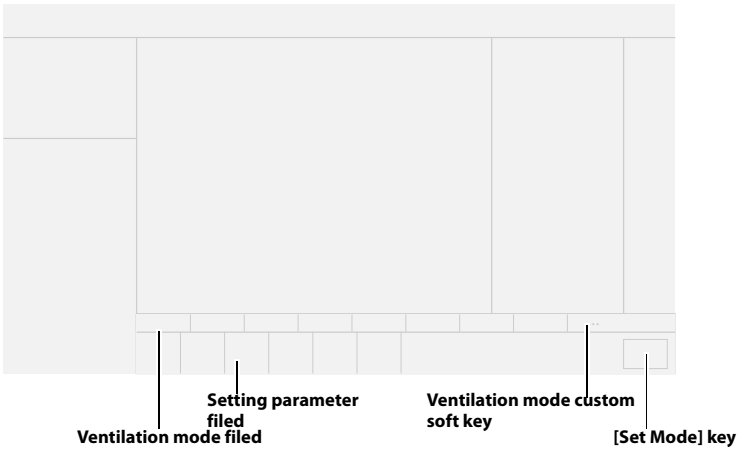


FIGURE 4-14 Auto Ventilation Mode Tabs

To change the ventilation mode:

1. Select the desired ventilation mode tab, the [**Set Mode**] key will turn green and start to flash.
2. Optionally, select one or more parameter buttons to change the parameter settings of the desired ventilation mode. Select ✔ in the pop-up dialog box of parameter settings to confirm the changes to the parameter.

3. Select the [**Set Mode**] key to finalize the ventilation mode.

NOTE: **If the [Set Mode] key is not selected after several seconds, the system will give audio alerts, and then the desired ventilation mode will be canceled.**

4.14 Functional Keys Field

Functional keys are provided on the right side of the Main Screen.

FIGURE 4-15 Functional Keys Field

4.14.1 Audio Pause

See section 11.4 (Pages 11-5) "Pause Alarm Audio".

4.14.2 Alarm Reset

See section 11.5 (Pages 11-5) "Alarm Reset".

4.14.3 Alarms

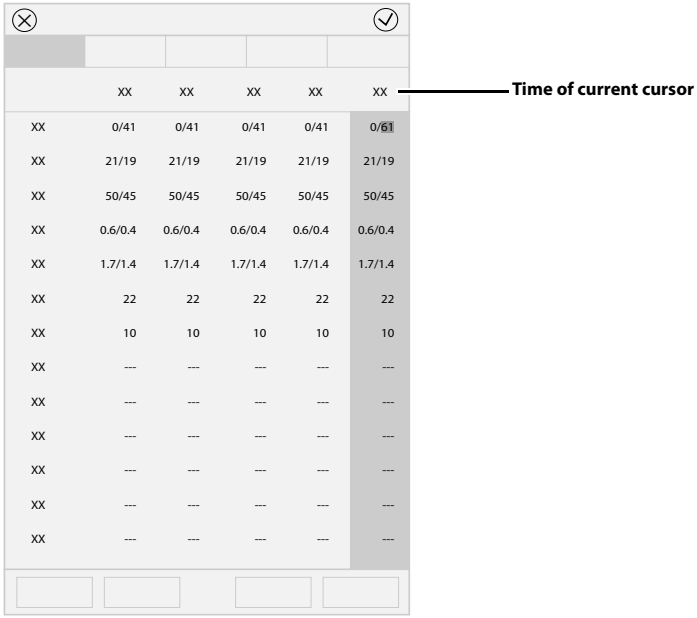
Select the [**Alarms**] key on the Main Screen to open the [**Alarms**] menu where you can set the alarm limits and view active alarms (See section 11.6 (Pages 11-5) "Set Alarm Limits").

4.14.4 History

Select the [**History**] key on the Main Screen to open the [**History**] menu. The menu contains the [**List Trends**], [**Graphic Trends**], [**Event Log**], [**Screen**] and [**Export**] tabs. The [**List Trends**], [**Graphic Trends**] and [**Event Log**] tabs on the [**History**] screen are associated. When you switch among the tabs, the cursor is automatically positioned to the record that is related to the previous page.

4.14.4.1 List Trends

On the [**List Trends**] screen, you can view the parameter data and events of a patient. If no display interval is set, the trends will be displayed based on the data with an interval of one minute by default.



	XX	XX	XX	XX	XX
XX	0/41	0/41	0/41	0/41	0/61
XX	21/19	21/19	21/19	21/19	21/19
XX	50/45	50/45	50/45	50/45	50/45
XX	0.6/0.4	0.6/0.4	0.6/0.4	0.6/0.4	0.6/0.4
XX	1.7/1.4	1.7/1.4	1.7/1.4	1.7/1.4	1.7/1.4
XX	22	22	22	22	22
XX	10	10	10	10	10
XX	---	---	---	---	---
XX	---	---	---	---	---
XX	---	---	---	---	---
XX	---	---	---	---	---
XX	---	---	---	---	---
XX	---	---	---	---	---

FIGURE 4-16 List Trends

4.14.4.1.1 About List Trends

- List Trends displays the time and date on the horizontal axis.
- List Trends displays the parameter data on the vertical axis.
- List Trends displays the trend records in descending order beginning with the most recent on the right side of the grid.
- List Trends are not stored when the machine is in the standby mode.
- List Trends can display the trend data of 48 consecutive hours.
- List Trends highlights the parameter data in the corresponding alarm color if an alarm condition existed for the parameter at the time of trend record storage.

4.14.4.1.2 List Trend Events Buttons

Drag the horizontal or vertical progress bar to view the updated trend data.

BUTTON	FUNCTION
Previous Event	The cursor moves from the current event to the previous event.
Next Event	The cursor moves from the current event to the next event.

TABLE 4-3 List Trend Events Buttons

4.14.4.1.3 Display Interval

In the List Trends menu, you can set the display interval to [**1 Min Interval**], [**5 Min Interval**], [**10 Min Interval**], [**15 Min Interval**], [**30 Min Interval**], [**1 Hour Interval**] and [**2 Hour Interval**].

4.14.4.1.4 Display Group

In the List Trends menu, you can set the display group to [**NMT**], [**BIS**], [**Gas**], [**Gas Flow**], [**Ventilation**] , [**eMAC**] and [**All**].

4.14.4.2 Graphic Trends

The [**Graphic Trends**] tab can record the trend of parameter values at specified time points and describe the changes in the measured results of parameters using a curve. Each dot on the curve matches the physiological parameter value at each time point. Graphic trends can also record standby and parameter alarm events. Graphic trend data automatically displays in one minute intervals unless the zoom is selected.

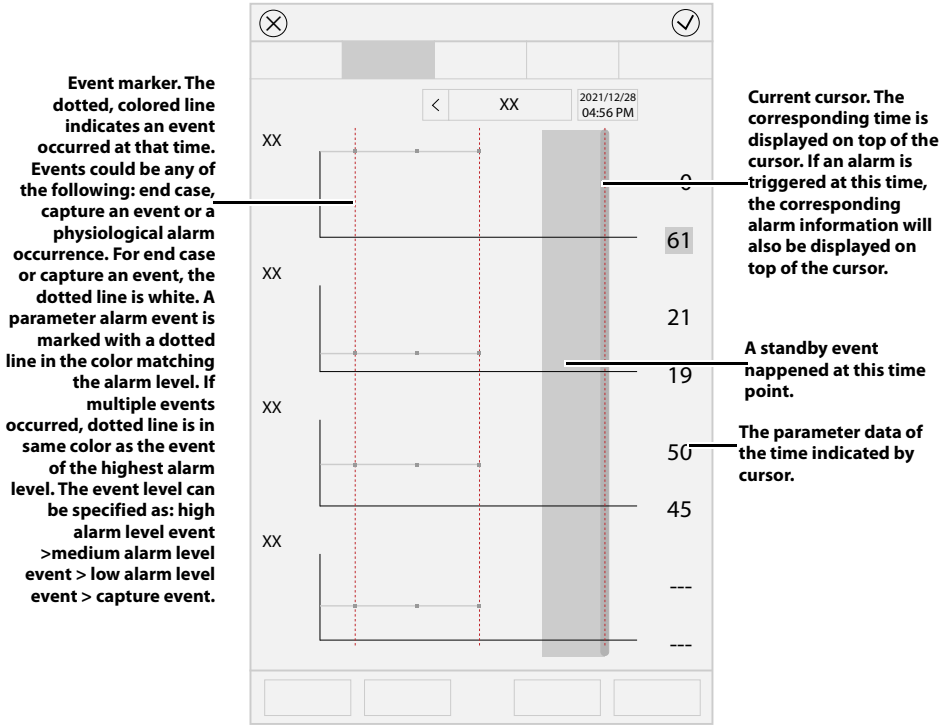


FIGURE 4-17 Graphic Trends

4.14.4.2.1 About Graphic Trends

- Graphic Trends store the data with the interval in one minute.
- Graphic Trends displays the trend records in descending order beginning with the most recent.
- Graphic Trends are not stored when the system is in standby status.
- The display period of data is a rolling 48 hours of continuous data.
- Graphic Trends highlights the parameter data in the corresponding alarm color if an alarm condition existed for the parameter at the time of trend record storage.

4.14.4.2.2 Graphic Trend Events Buttons

Drag the horizontal or vertical progress bar to view the updated trend data.

BUTTON	FUNCTION
Previous Event	The cursor moves from the current event to the previous event.
Next Event	The cursor moves from the current event to the next event.

TABLE 4-4 Graphic Trend Events Buttons

4.14.4.2.3 Zoom

In the Graphic Trends menu, you can set the zoom to [**1 Min Interval**], [**5 Min Interval**], [**10 Min Interval**], [**15 Min Interval**], [**30 Min Interval**], [**1 Hour Interval**] and [**2 Hour Interval**].

4.14.4.2.4 Display Group

In the Graphic Trends menu, you can set the display group to [**NMT**], [**BIS**], [**Gas**], [**Gas Flow**], [**Ventilation**] , [**eMAC**] and [**All**].

4.14.4.3 Event Log

The [**Event Log**] tab can record the system self-test event, leakage test event, entering and exiting the standby mode event, technical alarm information, physiological alarm information, operation event, shutdown delay event, etc.

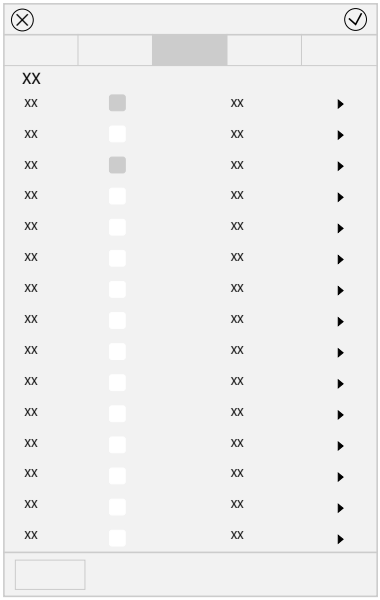


FIGURE 4-18 Event Log

NOTE: **Event logs will not be cleared after the anesthesia system powers off.**

NOTE: **The system can store up to 10,000 events. After the number of events exceeds 10,000, the earliest event will be overwritten by the latest event.**

4.14.4.3.1 Filter

In the Event Log menu, you can set [**Filter**] to [**High**], [**Medium**], [**Low**], [**Informational**], [**Activity**] and [**All On**].

4.14.4.4 Screen

You can select and delete captured screens.

4.14.4.5 Export

Insert a USB drive to the USB interface of the equipment as per the prompts on the screen. Select the [**Export**] key to export list trends, graphic trends, event logs and captured screens to the USB drive. The exported data is in the format of .html. Files in the format can be opened in Internet Explorer 8.0, 9.0, 10.0 and 11.0.

4.14.5 Capture Event/Screen

Select the [**Capture Event/Screen**] soft key, and the system will save the current screen as an image in the "png" format and log the current monitoring and event to the Event Log (See section 4.14.4.3 (Pages 4-24) "Event Log"). The anesthesia system can store up to 50 images.

4.14.6 Procedures

Select the [**Procedures**] key, and select [**Insp./Exp. Hold**], [**Multi-Step Recruitment**] or [**One-Step Recruitment**] in the opened screen.

4.14.7 Flow Pause

See section 6.6.12.4 (Pages 6-21) "Flow Pause".

4.14.8 Cardiac Bypass Mode (CPB)

See section 6.6.12.7 (Pages 6-22) "Cardiac Bypass Mode".

4.15 Setup Menu

Select the  icon and open the [**Setup**] menu.

4.15.1 Ventilation

MENU	DESCRIPTION
Vt/IBW	The system calculates the default tidal volume in the ventilation mode based on the [**Vt/IBW**] value.
Vt Source	Set [**Vt Source**] to [**IBW**] or [**Size**]. When the [**Vt Source**] is set to [**Size**], changes to [**IBW**] won't impact [**Vt**] setting. When the [**Vt Source**] is set to [**IBW**], changes to [**IBW**] will impact [**Vt**] and [**RR**] settings based on the Vt/IBW result.
Time Control	When [**Time Control**] is set to [**I:E**], the time control parameter in the VCV, PCV and PCV-VG ventilation modes is [**I:E**], and that in the PS and CPAP/PS ventilation modes is [**Apnea I:E**]. When [**Time Control**] is set to [**Tinsp**], the time control parameter in the VCV, PCV and PCV-VG ventilation modes is [**Tinsp**], and that in the PS and CPAP/PS ventilation modes is [**Apnea Ti**].
Pressure Display	Sets the pressure monitoring value on the Main Screen to [**PLAT**] or [**MEAN**].

TABLE 4-5 Ventilation Menu

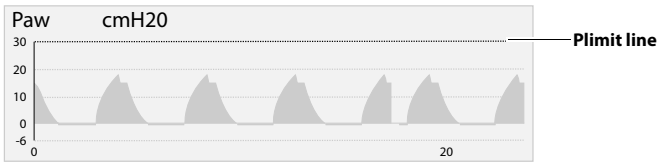
MENU	DESCRIPTION
Plimit Line	The [**Plimit Line**] can be set to (OFF) or (ON). The Plimit line function displays a dashed line in the Paw waveform area to indicate the Plimit position. The Plimit line can be displayed in VCV, SIMV-VC, PCV-VG, and SIMV-VG mode.  **NOTE:** **The Plimit line does not affect the auto-scaling algorithm. If the Plimit line is turned on but not visible, it may be because the line is positioned off the waveform scale.**
Breathing System Warmer	The [**Breathing System Warmer**] can be set to (OFF) or (ON). If the [**Breathing System Warmer**] is set to (OFF), or if AC power is not connected, the status screen displays an icon to indicate that the warmer is not active.  After cycling power, the Breathing System Warmer will return to the default state. **NOTE:** **The Breathing System Warmer is inactive when the equipment is powered by battery.**

TABLE 4-5 Ventilation Menu

4.15.2 O_2 Sensor

O_2 Sensor Monitoring

The [**O2 Sensor Monitoring**] can be set to (OFF) or (ON). If the [**O2 Sensor Monitoring**] is set to (ON), it indicates that the system can monitor the inhaled O_2 concentration of the patient. If the feature is not needed, you can set the [**O2 Sensor Monitoring**] to (OFF). After the [**O2 Sensor Monitoring**] is off, the system will block the alarms and prompt messages related to the O_2 sensor.

CAUTION: **The O_2 Sensor Monitoring feature is allowed to be turned off. However, to prevent potential hazards to the patient after the monitoring and alarming features are disabled, it is not recommended that you disable the O_2 Sensor Monitoring feature continuously.**

Calibrate O_2 Sensor

You can select the [**O2 Sensor Monitoring**] button to calibrate the O_2 sensor. Follow the prompts on the screen to perform the operation: See section 12.4.1 (Pages 12-4) "21% Oxygen Calibration" for more information.

4.15.3 CO2 (CO2 Module Configured)

See section 7.0 (Pages 7-1) "CO2 Monitoring" for more information.

4.15.4 AG (AG Module Configured)

See section 8.0 (Pages 8-1) "Anesthetic Gases and O2 Concentration Monitored" for more information.

4.15.5 BIS (BIS Module Configured)

See section 9.0 (Pages 9-1) "BIS Monitoring" for more information.

4.15.6 NMT (NMT Module Configured)

See section 10.0 (Pages 10-1) "NMT Monitoring" for more information.

4.15.7 Waveform

MENU	DESCRIPTION
Units&Limits	When this feature is enabled, the Main Screen will display the unit and alarm limit of the monitoring value. When this feature is disabled, the Main Screen will not display the unit and alarm limit of the monitoring value.
Waveform Type	Set the manner of drawing the waveform on the Main Screen to [**Fill**] or [**Draw**].
Sweep Speed	Set the waveform speed on the Main Screen.
CO2 Location	When the AG module or the CO_2 module is configured, the system will display the CO_2 waveform on the Main Screen. You can set [**CO2 Location**] to [**Top**] or [**Bottom**]. Based on the [**CO2 Location**] setting, the system displays the CO_2 waveform at the corresponding location on the Main Screen.
Color&Scale	You can not only set the colors of pressure, volume, flow rate, CO_2 waveform, trend waveform, and related monitoring values, but also you can set the scale of the pressure, volume, flow rate, or CO_2 waveform.

TABLE 4-6 Waveform Menu

4.15.8 Volume/Screen

MENU	DESCRIPTION
Volume	You can adjust the alarm volume, the system alert volume, the key click volume or the NMT beep volume. Indicates a lower volume, indictes a higher volume, and indicates that the volume is turned off.
Brightness	You can adjust the brightness of the Main Screen or Status Screen. Indicates a lower screen brightness, and indicates a higher screen brightness.
Bar Graph Display	You can set [**Bar Graph Display**] to [**Paw**] or [**Volume**] and the status screen will show related bar graph.

TABLE 4-7 Volume/Screen Menu

MENU	DESCRIPTION
Screen Saver	Set the delay time for entering the screen saver or disable the screen saver feature by setting it OFF. When the system enters the screen saver status, the status screen is displayed as blank, and the Main Screen displays Mindray at random locations as the screen saver. The system will exit from the screen saver when it detects the following operations: • A touch on the Main Screen • An operation on the master control knob • An operation on the flow control knob • The BFCS cover is opened/closed • The ACGO is enabled • The auxiliary O_2/air supply is enabled • The Auto/Manual switch location is changed • A module is inserted/withdrawn (AG module, BIS module or NMT module) • An alarm is issued
Clean Screen	When the [**Clean**] key is selected, the system will lock the screen for 10 seconds so that the display can be cleaned.

TABLE 4-7 Volume/Screen Menu

4.15.9 Information

It displays the software version, network and other related information of the equipment. The information is for view purpose only and does not support modifications.

4.15.10 Export System Data

The anesthesia system can export system data, including the equipment information, logs, monitoring data, system information, historical data, captured screens and network information.

To export data from the system, follow the steps below:

1. As per the instructions on the screen, insert a USB drive to the USB interface of the anesthesia system. The icon is displayed on the Main Screen.
2. Select the [**Export**] key, and the system will check the remaining space of the USB drive. If the remaining space is enough, the system will export the system data. The exported data is encrypted in the format of blg.
3. After the export is complete, select the icon.
4. Select [**Yes**] in the pop-up dialog box, and remove the USB drive.

4.15.11 Calibrate

Follow the prompts on the screen to calibrate the flow sensor. See section 12.3 (Pages 12-3) "Flow Sensor Calibration" for more information.

4.15.12 HFJV

See section 6.6.11 (Pages 6-15) "Set High Frequency Jet Ventilation (HFJV)" and 5.4.2 (Pages 5-6) "HFJV Test".

4.15.13 System

The [**System**] is accessible only by authorized administrative service personnel with password access. The [**System**] menu can only be accessed in Standby mode.

NOTE: The default password for accessing the System menu is "1234". The authorized administrator should change the default password immediately after the system is installed to prevent unauthorized access to the System menu. The password may contain up to 30 digits including numbers, letters (case sensitive) and special characters.

4.15.13.1 Calibrate

MENU	DESCRIPTION
O2 Sensor	Select [**Begin**] to calibrate the O_2 sensor as per the prompts on the screen. See section 12.4 (Pages 12-4) "O2 Sensor Calibration".
Zero Flow Meters	Select [**Begin**] to zero the flowmeter and follow the prompts on the screen. **NOTE: Before zeroing the flowmeter, make sure that the gas supply (O_2, N_2O and air) is disconnected.**
Zero Aux. O2/Air	This menu shows when you configure the auxiliary O_2/air function. Select [**Begin**] to zero the auxiliary O_2/air supply and follow the prompts on the screen.
Zero HFNC	This menu shows when you configure the HFNC function. Select [**Begin**] to zero the HFNC module and follow the prompts on the screen.
AG Module	This menu shows when you configure the AG module. See section 8.11 (Pages 8-9) "Calibrate the AG Module".
Internal AG module	This menu shows when you configure the internal AG module. See section 8.11 (Pages 8-9) "Calibrate the AG Module".
CO2 Module	This menu shows when you configure the CO_2 module. See section 7.9 (Pages 7-10) "Calibrate the Sensor".
Check NMT Sensor	This menu shows when you configure the NMT module. You can check the sensor when the sensor measurement is not accurate.

TABLE 4-8 Calibrate menu

4.15.13.2 Setup

MENU	OPTION	DESCRIPTION
Ventilation	**Insp Pressure**	When [**Insp Pressure**] is set to [**Pinsp**], the inspiration pressure parameter in the PCV and SIMV-PCV ventilation modes is [**Pinsp**]. When [**Insp Pressure**] is set to [**ΔPinsp**], the inspiration pressure parameter in the PCV and SIMV-PCV ventilation modes is [**ΔPinsp**].
	AMV Setting	When [**AMV Setting**] is set to [**MV%**], the setting parameter in the PCV ventilation modes is [**MV%**]. When [**AMV Setting**] is set to [**MV**], the setting parameter in the PCV ventilation modes is [**MV**].

TABLE 4-9 Setup Menu

MENU	OPTION	DESCRIPTION
Quick Key	**Alarm Reset**	When this feature is enabled, the Main Screen will display the [**Alarm Reset**] key. When this feature is disabled, the Main Screen will not display the [**Alarm Reset**] key.
	Capture Event/Screen	When this feature is enabled, the Main Screen will display the [**Capture Event/Screen**] key. When this feature is disabled, the Main Screen will not display the [**Capture Event/Screen**] key.
	Procedures	When this feature is enabled, the Main Screen will display the [**Procedures**] key. When this feature is disabled, the Main Screen will not display the [**Procedures**] key.
	Flow Pause	When this feature is enabled, the Main Screen will display the [**Flow Pause**] key. When this feature is disabled, the Main Screen will not display the [**Flow Pause**] key.
	Bypass in Auto mode	When this feature is enabled, the [**Bypass**] key on the Main Screen is available in both the Auto Ventilation mode and Manual Ventilation mode. When this feature is disabled, the [**Bypass**] key is only available in the Manual Ventilation mode.
AG (AG Module Configured)	**Null for 30s from zeroing**	When the feature is enabled, related parameters of AG module will be invalid within 30s of starting zeroing AG module. When the feature is disabled, related parameters of AG module will be normal within 30s of starting zeroing AG module.
	Types of Agent	Set the types of anesthetic agent which need automatic recognition.
CO2 (CO2 Module Configured)	**Null for 30s from zeroing**	When the feature is enabled, related parameters of CO_2 module will be invalid within 30s of starting zeroing CO_2 module. When the feature is disabled, related parameters of CO_2 module will be normal within 30s of starting zeroing CO_2 module.
Language/ Unit	**Language**	Set the language of the screen.
	Pressure Unit	Set the unit for pressure.
	CO2 Unit	Set the unit for CO_2.
	Gas Supply Pressure	Set the unit for gas supply pressure.
	Agent Cost Unit	Set the unit for anesthetic agent cost.
	Patient Height	Set the unit for patient height.
	Patient Weight	Set the unit for patient weight.
	HFJV Drive Pressure Unit	Set the unit for HFJV drive gas pressure.
Optimizer	**Optimizer**	Enable or disable the optimizer feature.
	Agent Usage	Enable or disable the agent usage calculation feature.
	Cost/ml of Liquid Agent	Set the cost of anesthetic agent per ml.
History	**Clear History**	Configure the Clear History setting at the end of the case. When this feature is enabled, the Standby Screen will display [**Clear History will delete all List Trends and Even Logs at the start of case!**].

TABLE 4-9 Setup Menu

MENU	OPTION		DESCRIPTION
Time/Date	**24 Hour Time**		Enable or disable the 24 Hour Time.
	Time Zone		Select to set the UTC time zone.
	Time		Set the current time.
	Date Format		Set the time format.
	Date		Set the current date.
	DayLight Savings	**DayLight Savings**	The [**DayLight Savings**] can be set to [**Auto**], [**ON**] or [**Off**]. When [**DayLight Savings**] is set to [**Auto**], the start time and end time of the daylight savings should be set. When [**DayLight Savings**] is set to [**ON**], the system time is automatically adjusted. If the region or country where the equipment is installed does not observe the daylight savings, set the [**DayLight Savings**] to [**Off**].
		Start	Set the start time of [**DayLight Savings**]. If [**DayLight Savings**] is set to [**ON**] or [**Off**], this setting cannot be selected.
		End	Set the end time of [**DayLight Savings**]. If [**DayLight Savings**] is set to [**ON**] or [**Off**], this setting cannot be selected.
Change Password	**Current Password**		Change the system password. After the system is installed, the authorized administrator should change the default password immediately to prevent unauthorized access to the System menu. The password may contain up to 30 digits including numbers, letters (case sensitive) and characters.
	New Password		
	Confirm Password		
Flow Control	**Quick Key 1**		The quick key for the [**Fresh Gas Control**] menu can be set here. The option can also be used to set the flow rate and O_2 concentration.
	Quick Key 2		
	Quick Key 3		
	Quick Key 4		
	Total Flow		Set the default fresh gas total flow when coming out of standby.
Internal Air Supply	**Enable Internal Air Supply**		When this function is enabled, the internal air supply is used for fresh gas supply. This function can be enabled only when the external air supply is insufficient.
Auth Code	**Create Auth Code**		An authorization code needs to be created when the remote control system interconnection function is enabled.

TABLE 4-9 Setup Menu

MENU	OPTION	DESCRIPTION
Infusion Device Connection	**Current Location**	Displays the location information of the anesthesia system, including the department, room number and bed number.
	Infusion device control auth operation	When this function is enabled, the syringe pump/ infusion pump/infusion supervision system needs to issue an authorization application. The anesthesia system can control the syringe pump/ infusion pump/infusion supervision system only after the authorization application is accepted. When this function is disabled, the above operations can be omitted.
	Connection Auth Code	You need to enter the authorization code when connecting the syringe pump/infusion pump/ infusion supervision system and the anesthesia system. The authorization code can be set on the syringe pump/infusion pump/infusion supervision system.
	Connection	When this function is enabled, the connection status of the syringe pump/infusion pump/ infusion supervision system and anesthesia system is displayed. To disconnect the collection, you can trun off this function.

TABLE 4-9 Setup Menu

4.15.13.3 Profiles

MENU	OPTION	DESCRIPTION
Edit	**Delete** **Rename** **Create**	10 factory profiles are displayed by default. In practical application, the operator may make some changes to some settings and these changes can be saved as user profiles. The anesthesia system saves the profiles in real time and the saved profiles are called recent profiles. Save User Profile: Select the [**Create**] key to set the profile name on the pop-up screen. After the profile is confirmed, the system will save the current profile as a user profile. Restore Factory Profile: Select a user profile, and select the [**Delete**] key. The system will delete the user profile and restore the factory profile. Load Profile Manually: In the standby mode, select the [**Current Profile: xxxx**] key and select the desired profile on the pop-up screen. When the anesthesia system restarts within 60 seconds after an abnormal power outage, the system can automatically restore the recent profile. If the power outage lasts longer than 120 seconds, the anesthesia system will automatically load the user profile before the shutdown. If the power outrage lasts between 60 to 120 seconds, the anesthesia system may automatically restore the recent profile or automatically load the user profile before the shutdown.

TABLE 4-10 Profiles Menu

MENU	OPTION	DESCRIPTION
Import	/	Insert a USB storage device into the USB interface of the anesthesia system and import the profile duplicate from the USB storage device as per the prompts on the screen.
Export	/	Insert a USB storage device into the USB interface of the anesthesia system and export the profile duplicate to the USB storage device as per the prompts on the screen.

TABLE 4-10 Profiles Menu

4.15.13.4 Network

CAUTION: Wireless network design, deployment, debugging and maintenance should be executed by Mindray service personnel or authorized technicians.

CAUTION: Always deploy the wireless network according to local wireless regulations.

CAUTION: Using 5G frequency band is recommended whenever possible. There are more interference sources in 2.4G frequency band.

CAUTION: Private APs and wireless routers are not allowed. These devices may cause radio interference and result in anesthesia system and CMS data loss.

CAUTION: To ensure network security and stability, data communication must be performed within a closed network or within a virtually isolated hospital network. The hospital is responsible for ensuring the security of the virtually isolated network.

CAUTION: WPA2-PSK and WPA2-Enterprise verification and encryption should be used if possible. Otherwise, the equipment may not be able to work or patient information may be leaked. WPA2-Enterprise and a long password are recommended.

CAUTION: Keep network authentication information, for example password, from being accessed by unauthorized users.

CAUTION: Do not connect non-medical devices to the anesthesia system network.

CAUTION: If wireless network signal is poor, there may be a risk of CMS data loss.

CAUTION: Maximum number of anesthesia systems connected to a single AP is 16 for this device. Too many anesthesia systems connected to the same AP may result in network disconnection.

CAUTION: RF interference may result in wireless network disconnection.

CAUTION: Disconnecting from the network may result in CMS data loss and function failure. Check the patient in case of network disconnection and reconnect the network as soon as possible.

CAUTION: Ensure that the anesthesia system IP address setting is correct. Changing the network settings may result in network disconnection. Contact your service personnel if you have any problems on setting the IP address.

CAUTION: To ensure proper network connection, do not modify the settings on the [Network] tab at random.

MENU	OPTION	DESCRIPTION
Network Type	**Network Type**	Set [**LAN**] or [**WLAN**].
	Shared Hotspot	This setting item is displayed when [**Network Type**] is set to [**LAN**]. When it is set to (ON), the anesthesia system is set as a hotspot. The patient location information (room, department, bed number) and hotspot password of the external device must be consistent with those of the anesthesia system before the hotspot can be accessed.
	Shared Hotspot Password	This setting item is displayed when [**Network Type**] is set to [**LAN**]. Set shared hotspot password. The hotspot password of the external device must be consistent with this password.
WLAN Setup	**Available Network List**	Select the desired wireless network from the list.
	Certificate Management	Manage wireless network certificate.
	Add WLAN	Add a new wireless network.
Ethernet1	**MAC Address**	Display the MAC address of the anesthesia system.
	Device Name	Set the device name.
	Obtain IP Address Automatically	Enable or disable the Obtain IP Address Automatically feature. When the feature is enabled, the [**IP Address**], [**Subnet Mask**] and [**Default Gateway**] cannot be manually changed. When the feature is disabled, the [**IP Address**], [**Subnet Mask**] and [**Default Gateway**] can be manually changed. In this case, the Obtain DNS Server Address Automatically and Obtain Default DNS Suffix Automatically features, and the Obtain IP Address Automatically feature in the SNTP menu are disabled.
	IP Address	Set the IP address.
	Subnet mask	Set the subnet mask.
	Default Gateway	Set the default gateway.
	Obtain DNS Server Address Automatically	Enable or disable the Obtain DNS the server Address Automatically feature. When the feature is enabled, the [**Preferred DNS Server**] and [**Alternate DNS Server**] cannot be manually changed. When the feature is disabled, the [**Preferred DNS Server**] and [**Alternate DNS Server**] need to be manually changed.
	Preferred DNS Server	Set the preferred DNS server.
	Alternate DNS Server	Set the alternate DNS server.

TABLE 4-11 Network Menu

MENU		OPTION	DESCRIPTION
Serial		Protocol	Set the serial communication protocol. **NOTE: If the System set to MR-WATO, the anesthesia system supports communications with a Mindray monitor with the Mindray Benelink module.**
		Baud Rate	Set the Baud rate.
		Data Bits	Set the data bits.
		Stop Bits	Set the stop bits.
		Parity	Set the parity.
		Data Interval	Set the data intervals.
		HL7 Protocol Version	Set the communication protocol version.
		Send Alarms	Enable or disable the Send Alarms feature.
		Send Alarm Ack	Enable or disable the Send Alarm Ack feature.
HL7	Data+Waveforms	Destination IP	Set the Destination IP address.
		Port	Set the port.
		Test Results	Select the [**Test**] key, and the system will start the network test and display the test results.
		Data Interval	Set the data intervals.
		HL7 Protocol Version	Set the communication protocol version.
		Send Waveforms	Enable or disable the Send Waveforms feature.
	Alarms	Destination IP	Set the Destination IP address.
		Port	Set the port.
		Test Results	Select the [**Test**] key, and the system will start the network test and display the test results.
		HL7 Protocol Version	Set the communication protocol version.
		Send Alarms	Enable or disable the Send Alarms feature.
		Send Alarm Ack	Enable or disable the Send Alarm Ack feature.
	Receiving Setting	Receiving Application	Input the receiving application.
		Receiving Facility	Input the receiving facility.
MD2		EUI	Display the EUI mark.
		Destination IP	Set the Destination IP address.
		Test Results	Select the [**Test**] key, and the system will start the network test and display the test results.

TABLE 4-11 Network Menu

MENU	OPTION	DESCRIPTION
Device Discover	**Multicast Address**	Set the multicast assembly address.
	Multicast TTL	Set the TTL.
	Master Server Address	Set the primary Server address.
	Master Server IP Address	Set the primary Server IP address.
	Connected Status	Display the current network connection status. Select [**Test**] to test the network and update connection status.
4G/5G	**4G/5G**	When it is set to (on), you can open the cellular mobile data of this system.
	CMS station	When it is set to (on), you can connect the CMS. When it is set to (off), you cannot connect the CMS.
SNTP	**Interval**	Set the time interval.
	Primary Server IP Address	Set the primary Server IP address.
	Secondary Server IP Address	Set the secondary Server IP address.
	Test Results	Select the [**Test**] key, and the system will start the network test and display the test results.
ADT	**ADT**	Enable or disable the ADT feature.
	Destination IP	Set the Destination IP address.
	Port	Set the port.
	Test Results	Select the [**Test**] key, and the system will start the network test and display the test results.
Endoscope	**IP Address**	Set the IP address of endoscopy.

TABLE 4-11 Network Menu

4.15.13.5 Information

It displays the device ID, MAC address and system features status. If you need to activate the function, please contact Mindray Technical Support for help.

4.15.14 Service Tab

Only authorized personnel by Mindray have access to the [**Service**] tab. Please contact Mindray Technical Support for help.

4.16 Status Screen

It displays the breathing system warmer status, bar graph and gas supply pressure.

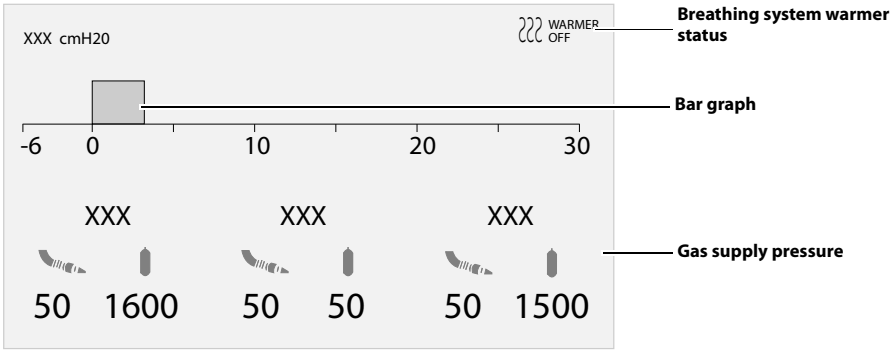


FIGURE 4-19 Status Screen

To change the gas supply pressure unit, perform the following settings:

1. Select the key > [**System**] key (system password needed) > [**Setup**] > [**Language/Unit**] tab.
2. Set [**Gas Supply Pressure**] to [**kPa**], [**psi**] or [**bar**].

Set the bar graph as follows:

1. Select the key > [**Volume/Screen**] tab.
2. Set [**Bar Graph Display**] to [**Paw**] or [**Volume**].

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5.0 Preoperative Tests

5.1 Requirements of Preoperative Tests

Preoperative tests on the equipment should be performed according to the test intervals listed below. Refer to special procedures or precautions in this manual.

NOTE: This is a guideline which can be modified to accommodate variations in local clinical practice. Such local modifications should have appropriate peer review.

NOTE: Ensure that the NO_2 cutoff and O_2/N_2O ratio are normal before use. Use an O_2 concentration tester to monitor the O_2 concentration in the gas output.

Perform the preoperative tests listed below at these events:

- **After the equipment is repaired or maintained, all test items should be tested.**
- **Every day before the equipment is used on the first patient:**
  - Inspect the System (Section 5.3)
  - System Check (Section 5.4)
  - Power Failure Alarm Test (Section 5.5)
  - Pipeline Test (Section 5.6)
  - Basic Ventilation Test (Section 5.7)
  - Backup Gas Cylinder Test (Section 5.8)
  - Flow Control System Test (Section 5.9)
  - Vaporizer Test (Section 5.10)
  - Breathing System Test (Section 5.11)
  - Alarm Test (Section 5.12)
  - Inspect the AGSS (Section 5.13)
  - Inspect the Negative Pressure Suction Device (Section 5.15)
  - Pre-operation Preparations (Section 5.16)
- **Before using the equipment on each patient:**
  - Inspect the System (Section 5.3)
  - System Check (Section 5.4)
  - Pipeline Test (Section 5.6)
  - Vaporizer Test (Section 5.10)
  - Breathing System Test (Section 5.11)
  - Inspect the AGSS (Section 5.13)
  - Inspect the Negative Pressure Suction Device (Section 5.15)
  - Pre-operation Preparations (Section 5.16)

NOTE: Read and understand the operation and maintenance of each component before using the anesthesia system.

NOTE: Do not use the anesthesia system if a test failure occurs. Please contact Mindray Technical Support for any additional assistance.

NOTE: Provide a checklist of the anesthetic system, including anesthetic gas delivery system, monitoring device, alarm system, and protective device, which are intended to be used for the anesthetic system, whether they are used alone or assembled together.

5.2 Preoperative Checklist

5.2.1 Introduction

The purpose of preoperative check is to detect potential system problems before use.

An effective method for detecting pneumatic circuit occlusions, leaks, and other system problems can be found in the procedures of preoperative checks. In addition, it is recommended that the breathing system should be tested for the ability to effectively deliver positive pressure ventilation before each ventilation begins. Test to see if the test lung can be properly ventilated and quickly identify an occluded circuit limb and other breathing system problems.

5.2.2 Suggested Preoperative Checklist

WARNING: To ensure the normal operation of the machine and the safety of both the user and the patient, please follow all check procedures established by the hospital before administering anesthesia to the patient.

Each day before administering anesthesia, the following should be done:

1. With the anesthesia system connected to an AC power supply, turn on the power switch and verify that the system is powered by the AC power supply. Follow the on-screen prompts to perform and complete the start-up test.
2. a. Check the O_2 Supply Failure safety messages and alarms.
   (See section 5.6.1 (Pages 5-6) "O2 Pipeline Test")
   b. Test low O_2 concentration alarms.
   (See section 5.12.2 (Pages 5-13) "O2 Concentration Monitoring and Alarm Test")
   c. Test high and low airway pressure alarms.
   (See section 5.12.6 (Pages 5-15) "Airway Pressure (Paw) Too High Alarm Test")
   (See section 5.12.7 (Pages 5-15) "Airway Pressure (Paw) Too Low Alarm Test")
   d. Test low minute ventilation and apnea alarms.
   (See section 5.12.3 (Pages 5-14) "Minute Volume (MV) Too Low Alarm Test")
   (See section 5.12.4 (Pages 5-14) "Apnea Alarm Test")
3. Verify that the O_2 sensor displays approximately 21% in room air and above 94% after exposure to 100% O_2.
   (See section 5.12.2 (Pages 5-13) "O2 Concentration Monitoring and Alarm Test").
4. Check that the vaporizers are properly installed and sufficiently filled and that filler ports are tightly closed. Verify that only one vaporizer can be turned ON at a time(See section 3.4 (Pages 3-2) "Vaporizer".).
5. Perform a vaporizer leak test for each vaporizer installed on the equipment (See section 5.10.2 (Pages 5-11) "Vaporizer Leak Test").
6. For an anesthesia system equipped with an AGSS, check whether the AGSS float position is between the Min and Max scale lines (See section 5.13 (Pages 5-16) "Inspect the AGSS").
7. Check the watertrap of the breathing system to ensure that there is no water collected.
8. Drain and wipe with a soft cloth any moisture from the absorber canister assembly.

Prior to administering anesthesia to each patient, the following should be done:

1. Check for any damage to or dangerous conditions in the equipment. Ensure all necessary equipment and supplies are present, e.g., drugs, CO_2 absorbent (not exhausted), breathing system and backup O_2 supply.

2. Check that the central O_2, N_2O and air supply pressure is within the specified range for pipelined gas supply (i.e., 280 to 600 kPa (40 to 87 psi)).
3. Perform the flow control system test(See section 5.9 (Pages 5-9) "Flow Control System Test").
4. Perform a vaporizer leak test for each vaporizer installed on the equipment (See section 5.10.2 (Pages 5-11) "Vaporizer Leak Test").
5. Verify that auxiliary O_2 and air supplies are available and functioning.
6. Verify that the Self-inflating Manual Ventilation device is available and functioning.
7. Check whether the backup O_2, N_2O and air cylinders (if applicable) have been installed onto the equipment and whether they have sufficient pressure without leakage under high pressure (See section 5.8 (Pages 5-8) "Backup Gas Cylinder Test").
8. Check whether the valves of the backup O_2, N_2O and air cylinders (if applicable) have been closed and not opened until needed to prevent unexpected use.
9. Connect the breathing system and manual bag and check the operation of unidirectional valves by visual inspection.
10. Check ventilation capability in Standby, Manual, VCV and PCV ventilation modes.
11. Check the negative pressure suction device to make sure it has sufficient pressure to clean the airway.
12. Verify the monitoring function and check alarms.

The following step is recommended to be performed when prompted by the equipment:

- Complete the 21% of O2 calibration (See section 12.4 (Pages 12-4) "O2 Sensor Calibration").

The following step is recommended when replacing an O_2 sensor:

- Complete the 21% and 100% of O2 calibration (See section 12.4 (Pages 12-4) "O2 Sensor Calibration").

The following steps are recommended for each replacement of CO_2 absorbent:

- Perform a leak test (See section 5.4.1 (Pages 5-5) "Leak and Compliance Test").

5.3 Inspect the System

NOTE: Ensure that the breathing system is correctly connected and not damaged.

Perform the following inspections before operating the equipment:

1. The equipment is correctly connected and it is in good condition.
2. Inspect the system for:
   a. Damage to flowmeters, vaporizers, gauges, supply hoses.
   b. Complete breathing system with adequate CO_2 Pre-Pak absorbent or or loose fill CO_2 absorbent.
   c. Backup gas cylinders are properly installed onto the yokes.
   d. Wrenches of backup gas cylinders are in place.
   e. Auxiliary O_2 supply is available and functioning.
3. All components are correctly attached.

4. The breathing system is correctly connected, the breathing tubes are undamaged. The self-inflating manual ventilation device is available and functioning.
5. The gas supply system has been connected and the pressure is normal.
6. The necessary emergency equipment is available and in good condition.
7. Equipment for airway maintenance and tracheal intubation is available and in good condition.
8. Inspect the color of the soda lime in the canister. Replace the soda lime immediately if obvious color change is detected.
9. Applicable anesthetic and emergency drugs are available.
10. The casters are not damaged or loose, the brake(s) is set and prevents movement.
11. Ensure that the breathing system is in proper position.
12. The AC mains indicator turns on when the power cord is connected to the AC power source. If the indicators are not displayed, the system does not have electrical power.
13. The anesthesia system can be switched on or off normally.
14. Check if the O_2 flush button is functioning properly.

5.4 System Check

1. When the system is turned on, it automatically initiates the Power On Self Test (POST). After the POST is over, the system check screen is displayed. Follow the instructions on the Main Screen for operations.
2. Select the [**Continue**] key and the system starts the check.
3. Select [**Test Details**] to view the test results of each test item.
4. Proceed to standby or troubleshoot the equipment based on the test results.
5. After the system check is over, the preoperative check screen is displayed. Perform desired preoperative checks as per the prompts on the screen.

SYSTEM CHECK ITEMS		DESCRIPTION	NOTE
1	Startup	When the system is turned on, it performs a self-test to ensure its alarm system (alarm light, speaker, and buzzer) and hardware are functioning properly.	Confirm that the buzzer plays the check sound when the power on self test is started. Otherwise, stop using the anesthesia system and contact your service personnel or Mindray.
2	System Check	Perform leak and compliance tests. Check the hardware, valves, sensors, flowmeters, gas supplies, power supplies and modules.	
3	Preoperative Check List	Display the checks to be performed before operating the system.	
4	HFJV test	Perform the jet branch and safety valve test. Check the hardware, valves, sensors and power supply.	

TABLE 5-1 System Check

5.4.1 Leak and Compliance Test

NOTE: **The system records the result of the last Circuit Leak Test on its standby screen, indicating whether the test was passed, failed, or skipped.**

1. *From system being turned on:*
   When the system is turned on, it automatically initiates the Power On Self Test (POST). After the POST is over, the system automatically enters the System Check screen. System Check includes leak and compliance tests.

   Alternatively, on the Main Screen:
   Enter the standby screen, and select the key > [**Leak Test**] key.
2. Follow the instructions on the screen.
3. Perform corresponding operation according to the test result and help information.

5.4.2 HFJV Test

NOTE: The system records the result of the last HFJV Test on its standby screen, indicating whether the test was passed, failed, or skipped.

1. *From system being turned on:*
   If the time since the last HFJV test exceeds the [**HFJV Test Interval**], when the system is turned on, it automatically initiates the Power On Self Test (POST). After the POST is over, the system automatically enters the System Check screen. System Check includes HFJV test. By selecting the icon> [**HFJV**] >[**HFJV Test Interval**], you can adjust the value of [**HFJV Test Interval**].

   Alternatively, on the Main Screen:
   Enter the standby screen, and select the key > [**HFJV Test**] key.
2. Follow the instructions on the screen.
3. Perform corresponding operation according to the test result and help information.

5.5 Power Failure Alarm Test

1. Connect the anesthesia system to an AC power supply, and turn on the power switch.
2. Disconnect the AC mains.
3. Make sure that the AC mains indicator is off. An audible alarm should sound and the alarm [**Battery in Use**] should be displayed on the main screen.
4. Reconnect the AC mains.
5. Make sure the audible alarm sound disappears and the AC mains indicator and battery charge indicator are illuminated. The alarm [**Battery in Use**] should not be displayed on the main screen.

5.6 Pipeline Test

5.6.1 O_2 Pipeline Test

1. Connect the O_2 pipeline supply.
2. If the anesthesia system has been configured with backup gas cylinders, turn off the valves of all the backup gas cylinders.
3. Set the system switch to the On position.
4. Set the O_2 flow to 6 L/min.

5. Ensure that the readings of O_2 pipeline pressure gauges are within the range of 280 to 600 kPa (40 to 87 psi).
6. Disconnect the O_2 pipeline supply.
7. As O_2 pressure decreases, the alarm of [**O2 Supply Failure**] and [**Drive Gas Pressure Low**] should occur.
8. Ensure that the O_2 gauge decreases to zero.

5.6.2 N_2O Pipeline Test

NOTE: To perform a N_2O pipeline test, connect the O_2 supply first to enable N_2O flow control.

NOTE: Different from O_2 pipeline supply, when N_2O supply is disconnected, the anesthesia system with no pressure sensor configured will issue no alarms related to N_2O pressure as N_2O pressure decreases.

1. Connect O_2 and N_2O pipeline supplies.
2. If the anesthesia system has been configured with backup gas cylinders, turn off the valves of all the backup gas cylinders.
3. Set the system switch to the On position.
4. Select the fresh gas flow display zone, and open the [**Fresh Gas Control**] menu. Set the [**Control Mode**] to [**Direct Flow**].
5. Set [**Balance Gas**] to [**N2O**].
6. Set the N_2O flow to 6 L/min.
7. Check whether the readings of the N_2O pipeline pressure gauges are within the range of 280 to 600 kPa (40 to 87 psi).
8. Disconnect the N_2O pipeline supply.
9. With the N_2O pressure decreases, the O2 flow remains unchanged and the N_2O flow becomes zero. Meanwhile, the anesthesia system with a pressure sensor configured will issue the alarm of [**N2O Supply Failure**].
10. Ensure that the N_2O gauge reading decreases to zero.

5.6.3 Air Pipeline Test

NOTE: Different from O_2 pipeline supply, when air supply is disconnected, the anesthesia system with no pressure sensor configured will issue no alarms as air pressure decreases.

1. Connect the pipelined Air supply.
2. If the anesthesia system has been configured with backup gas cylinders, turn off the valves of all the backup gas cylinders.
3. Set the system switch to the On position.
4. Select the fresh gas flow display zone, and open the [**Fresh Gas Control**] menu. Set the [**Control Mode**] to [**Direct Flow**].
5. Set [**Balance Gas**] to [**Air**].
6. Set the Air flow to 6 L/min.
7. Check whether the readings of the air pipeline pressure gauges are within the range of 280 to 600 kPa (40 to 87 psi).
8. Disconnect the pipelined Air supply.

9. With the air pressure decreases, the anesthesia system with a pressure sensor configured will issue the alarm of [**Air Supply Failure**].
10. Ensure that the Air gauge decreases to zero.

5.7 Basic Ventilation Test

1. Attach the breathing system and the manual bag.
2. Attach an adult test lung or manual bag to the patient end of the Y-piece of the breathing system.
3. Set the O_2 flow to 3 L/min and set the N_2O and air flows to zero.
4. Set the ventilator controls according to the following table:

VENTILATOR CONTROLS	VENTILATOR SETTINGS
Patient size	Adult
Ventilation Modes	PCV
Target Pressure - **Pinsp**	20
Respiratory Rate - **RR**	8
I:E Ratio - **I:E**	1:2
PEEP - **PEEP**	Off
Time of Pressure Rising - **Tslope**	0.5

5. Select **PCV** and begin ventilation.
6. Verify that the manual bag at the patient end of the Y-piece of the breathing system inflates and deflates and that the PLAT monitoring on the display and the PAW gauge reading are consistent with the Pinsp setting.

5.8 Backup Gas Cylinder Test

NOTE: No backup gas cylinder test is required for an anesthesia system not configured with backup gas cylinders.

5.8.1 Check Cylinder Pressure

1. Set the System switch to the OFF position and connect the gas cylinder to check.
2. Open the valve of each gas cylinder using the attached wrench.
3. Make sure that each gas cylinder has adequate pressure. In case of inadequate pressure discovered in any gas cylinder, close the valve for the specific cylinder and replace the cylinder with a fully-inflated one.

- Input range of O_2 cylinder: 6.9 to 20 MPa (1000 to 2900 psi)
- Input range of N_2O cylinder: 4.2 to 6 MPa (600 to 870 psi)
- Input range of air cylinder: 6.9 to 20 MPa (1000 to 2900 psi)

4. Close the valves of all cylinders.

5.8.2 High Pressure Leak Test of O_2 Cylinders

1. Set the System switch to the OFF position and disconnect the O_2 pipeline supply.
2. Open the valve of the O_2 cylinder.
3. Record the current pressure of the cylinder.
4. Close the valve of the O_2 cylinder.

5. Record the cylinder pressure after one minute.

If the pressure reduction of the backup gas cylinder exceeds 1.25 MPa, install a new cylinder gasket. Repeat Steps 1 to 5. If the leak persists, stop using the backup gas cylinder supply system.

5.8.3 High Pressure Leak Test of N_2O Cylinders

1. Set the System switch to the OFF position and disconnect the N_2O pipeline supply.
2. Open the valve of the N_2O cylinder.
3. Record the current pressure of the cylinder.
4. Close the valve of the N_2O cylinder.
5. Record the cylinder pressure after one minute.

If the pressure reduction of the backup gas cylinder exceeds 0.5 MPa, install a new cylinder gasket. Repeat Steps 1 to 5. If the leak persists, stop using the backup gas cylinder supply system.

5.8.4 High Pressure Leak Test of Air Cylinders

1. Set the System switch to the OFF position and disconnect the air pipeline supply.
2. Open the valve of the air cylinder.
3. Record the current pressure of the cylinder.
4. Close the valve of the air cylinder.
5. Record the cylinder pressure after one minute.

If the pressure reduction of the backup gas cylinder exceeds 1.25 MPa, install a new cylinder gasket. Repeat Steps 1 to 5. If the leak persists, stop using the backup gas cylinder supply system.

5.9 Flow Control System Test

WARNING: If N_2O is available and flows through the system during this test, use a safe and approved procedure to collect and remove N_2O gas.

WARNING: Incorrect gas mixtures can cause patient injury. If the O_2: N_2O ratio system does not supply O_2 and N_2O in the correct proportions, do not use the system.

CAUTION: Open the gas cylinder valve slowly to avoid damage to it. Do not rotate the flow control knob hard. If a backup gas cylinder is not used after a backup gas cylinder test, close its valve.

CAUTION: When the electronic flow control system is disabled, the backup flow control system will be enabled. The initial O_2 flow of backup flow control system is 1 L/min. The BFCS display only has a total flowmeter.

CAUTION: 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 you turn a flow control knob clockwise to decrease flow, the flowmeter should reach 1L/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 counterclockwise increases flow.

The flow control system includes Electronic Flow Control System (hereinafter referred to as EFCS) and Backup Flow Control System (hereinafter referred to as BFCS). Normally, EFCS is used. Perform EFCS and BFCS tests before any case:

1. Connect the pipeline supplies or slowly open the cylinder valves.
2. Set the system switch to the On position.
3. Select the fresh gas flow display zone, and open the [**Fresh Gas Control**] menu. Set the [**Control Mode**] to [**Direct Flow**].
4. Set [**Balance Gas**] to [**Air**].
5. Adjust the Air flow. Make sure that the displayed reading of electronic flowmeter is consistent with the setting.
6. Set [**Balance Gas**] to [**N2O**].
7. Adjust the N_2O flow gradually. Make sure that the O_2 flow increases with the increase of N_2O flow and that the O_2 and N_2O flows are in the proportion of 1 to 3.
8. Set both O_2 flow and N_2O flow to 5 L/min.
9. Turn off the O_2 pipeline supply.
10. Push the O_2 Flush button to release the pressure inside the system.
11. Make sure that the technical alarm of [**O2 Supply Failure**] appears, and the N_2O flow is zero.
12. Make sure that a N_2O flow value is read and finally stabilized at 5 L/min after the O_2 pipeline supply is turned on.
13. Open the BFCS cover, start the BFCS and make sure that a prompt message of [**Backup Flow Control is enabled**] appears.
14. Make a visual check to ensure that the total flowmeter shows a basal flow of approximately 1L/min.
15. Adjust the O_2 needle valve to increase the O_2 flow gradually and make sure that the total flow can rise to more than 10L/min.
16. Close the O_2 needle valve.
17. Rotate the O_2 needle valve for half a circle.
18. Close the BFCS cover, and the Main Screen will prompt a menu to confirm disabling the flow control system. Select [**Yes**] and ensure that the [**Manual valves must be closed!**] prompt message appears.
19. Close the Oxygen needle valve and close the BFCS cover again. The Main Screen prompts a menu to confirm disabling the flow control system. Select [**Yes**], and the prompt message disappears.

NOTE: **In the event that the BFCS needle valve fails to be closed when you have closed the BFCS cover, the system will prompt [Manual valves must be closed!] if you proceed with other operations. In this case, check if the needle valves are fully closed.**

NOTE: **When checking the readings on the total flowmeter, keep your visual angle at the same level of the float. The reading of the scale may vary when viewed at a different angle.**

20. Disconnect the pipelined gas supply or close the cylinder valve.
21. Set the System switch to the OFF position.

5.10 Vaporizer Test

WARNING: During the vaporizer test, the anesthetic agent comes from the fresh gas outlet. Use a safe and approved procedure to remove and collect the agent.

Before the test, ensure that the vaporizers are correctly installed. For detailed steps, see section 3.4 (Pages 3-2) "Vaporizer".

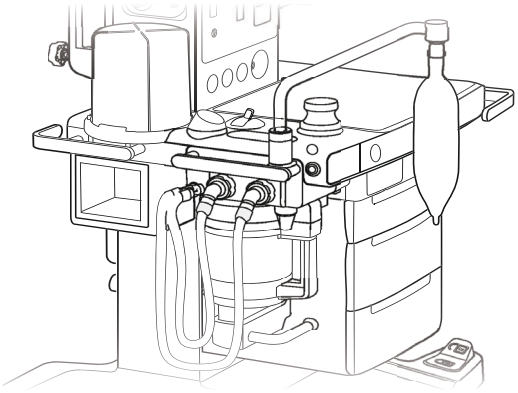
5.10.1 Vaporizer Back Pressure Test

1. Connect the O_2 pipeline supply or open the O_2 cylinder valve.
2. Set the O_2 flow to 6 L/min.
3. Ensure that the O_2 flow stays constant.
4. Adjust the vaporizer concentration from 0 to 1%. Ensure that the O_2 flow does not decrease by more than 1 L/min throughout the process. Otherwise, install a different vaporizer and repeat this step. If the problem persists, the malfunction is in the anesthesia system. Do not use this system.
5. Test each vaporizer as per 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] (zero) as the amount of anesthetic drug outputted is very small within this range.

5.10.2 Vaporizer Leak Test

1. Set the Auto/Manual switch to the Manual position.
2. Set the ACGO to the patient circuit (if ACGO function is configured).
3. Set the APL valve to the SP position.
4. Connect the manual bag to the bag arm port.
5. Connect the Y-piece on the breathing system to the leak test port.



6. Mount and lock the vaporizer onto the vaporizer mount. (Certain vaporizers need to be set to at least 1% for correct testing. See the vaporizer manufacturer's manual for details.)
7. Set the fresh gas flow to 0.2 L/min.
8. Set the APL valve to the 70 cmH_2O position.
9. Push the O_2 Flush button until the airway pressure gauge value is about 30 cmH_2O.

10. Release the O_2 Flush button. Make sure that there is no pressure decrease on the airway pressure gauge.
11. Turn off the vaporizer.
12. Repeat Steps 6 to 11 for another vaporizer.

5.11 Breathing System Test

WARNING: Objects in the breathing system can stop gas flow to the patient. This can cause injury or death. Ensure that there are no test plugs or other objects in the breathing system.

WARNING: Do not use a test plug that is small enough to fall into the breathing system.

5.11.1 Inspiratory and Expiratory Check Valve Tests

1. Ensure that the breathing system is correctly connected and not damaged.
2. Ensure that the check valves in the breathing system are operating normally.
   a. If the inspiratory check valve opens during inspiration and closes at the start of expiration, then the inspiratory check valve is operating normally.
   b. If the expiratory check valve opens during expiration and closes at the start of inspiration, then the expiratory check valve is operating normally.

5.11.2 Bellows Test

1. Enter the standby mode.
2. Set the Auto/Manual switch to the Auto position.
3. Set all the flow to zero.
4. Connect the Y piece on the breathing system to the leak test port to occlude the patient end of the breathing system.
5. Press the O2 Flush button to inflate the bellows so that the bellows reaches to the bellows top.
6. Ensure that the reading on the airway pressure gauge does not exceed 15 cmH_2O.
7. The bellows must fall no faster than about 300 mL/min. If the leakage rate is high, perform troubleshooting to find the leakage source. If the leakage source is the bellows, replace the bellows.

5.11.3 APL Valve Test

1. Enter the standby mode.
2. Set the Auto/Manual switch to the Manual position.
3. Connect the manual bag to the bag arm port.
4. Connect the Y-piece on the breathing system to the leak test port.
5. Turn APL valve control knob to the 30 cmH_2O position.
6. Press the O_2 Flush button to inflate the manual bag.
7. Ensure that the reading on the airway pressure gauge is within the range of 25cmH_2O to 40 cmH_2O.
8. Turn the APL valve control to the fully open position.
9. Set the O_2 flow to 3 L/min. Turn any other gases off.
10. Ensure that the reading on the airway pressure gauge is less than 5 cmH_2O.

11. Push and hold the O_2 flush button. Ensure that the reading on the airway pressure gauge does not exceed 10 cmH_2O.
12. Set the O_2 flow to zero. Ensure that the reading on the airway pressure gauge does not fall below 0 cmH_2O.

5.12 Alarm Test

Alarms also can be verified by creating an alarm condition on the equipment and verifying the corresponding alarm indicators are present on the anesthesia system.

5.12.1 Prepare for Alarm Tests

1. Connect the test lung or manual bag to the Y-piece of the breathing system.
2. Set the Auto/Manual switch to the Auto position.
3. Set the system switch to the ON position.
4. Set the system to the Standby mode.
5. Set Patient Size to Adult.
6. Set the ventilator controls as follows:
   - Ventilation Mode: VCV
   - **Vt**: 500 mL
   - **RR**: 12 bpm
   - **I:E**: 1:2
   - **Tpause**: 10%
   - **PEEP**: Off
   - **Plimit**: 30 cmH_2O
7. Set the Auto/Manual switch to the Manual position.
8. Set the O_2 flow to 0.5 to 1 L/min.
9. Set the Auto/Manual switch to the Auto position.
10. Press the O_2 Flush button to inflate the bellows so that the bellows reaches to the bellows top.
11. Ensure that:
    - The Main Screen displays the correctly set data. The measured values should be within the tolerances specified in the specifications (See section 13.12 (Pages 13-26) "Ventilator Specifications").
    - The bellows are normally inflated and deflated during mechanical ventilation.

5.12.2 O_2 Concentration Monitoring and Alarm Test

NOTE: For the anesthesia system with the Gas module installed, disconnect the sample line from the Y-piece and breathe into it until you see a CO_2 reading on the screen. Then reconnect the sample line to the Y-piece. This will activate the gas module alarms.

1. Set the Auto/Manual switch to the Manual position and exit Standby mode.

2. If the system has an AG module configured with O_2 monitoring functionality, make sure that the pre-heating of the module has been complete. Keep the sampling port on the watertrap of the AG module facing the air and check the FiO_2 value on the Main Screen to make sure that approximately 21% O_2 is measured in room air. If the system has no AG module configured with O_2 monitoring functionality available or has no AG module configured, make sure that the system is using the O_2 sensor and the O_2 sensor has been calibrated. Remove the O_2 sensor from the breathing system, but do not disconnect the cable of the O_2 sensor. After three minutes, check the FiO_2 value on the Main Screen to make sure that the approximately 21% O_2 is measured in room air.
3. On the Main Screen, select the [**Alarms**] soft key > [**Limits**] tab. Set the FiO_2 low alarm limit to 50%.
4. Ensure that the [**FiO2 Too Low**] alarm occurs.
5. Set the FiO_2 low alarm limit back to a value lower than the measured O_2 value and make sure that the alarm cancels.
6. Put the O_2 sensor back in the breathing system.
7. Select the [**Alarms**] key > [**Limits**] tab. Set the FiO_2 High alarm limit to 50%.
8. Connect the manual bag to the manual bag port. Press the O_2 Flush button to inflate the manual bag. Ensure that the sensor measures at least 90% O2.
9. Ensure that the [**FiO2 Too High**] alarm occurs.
10. Set the FiO_2 High alarm limit to 100% and make sure that the alarm cancels.

5.12.3 Minute Volume (MV) Too Low Alarm Test

1. Connect the test lung or manual bag to the Y-piece of the breathing system.
2. Set the Auto/Manual switch to the Auto position.
3. Set the ventilator controls as follows:
   - Ventilation Mode: VCV
   - **Vt**: 500 mL
   - **RR**: 12 bpm
   - **I:E**: 1:2
   - **Tpause**: 10%
   - **PEEP**: Off
   - **Plimit**: 30 cmH_2O
4. Select the [**Alarms**] key > [**Limits**] tab. Set the MV low alarm limit to 15.0 L/min.
5. Ensure that a [**MV Too Low**] alarm occurs after approximately 60 seconds.
6. Select the [**Alarms**] key > [**Limits**] tab. Set the MV low alarm limit back to a value lower than the measured MV value and ensure that the alarm cancels.

5.12.4 Apnea Alarm Test

1. Connect the manual bag to the manual bag port.
2. Set the Auto/Manual switch to the Manual position.
3. Turn the APL valve control knob to set the APL valve to the 10 cmH_2O position.
4. Push the O_2 Flush button to inflate the bag. Squeeze the manual bag to ensure that a complete breathing cycle occurs on the screen.

5. Stop squeezing the manual bag and wait for at least 30 seconds to make sure that [**Apnea**] alarm occurs.
6. Inflate and squeeze the manual bag to ensure that the [**Apnea**] alarm cancels.

5.12.5 Continuous Airway Pressure Too High Alarm Test

1. Connect the manual bag to the manual bag port.
2. Set the O_2 flow to the minimum value.
3. Turn the APL valve control knob to set the APL valve to the 30 cmH_2O position.
4. Set the Auto/Manual switch to the Manual position.
5. Connect the Y-piece on the breathing system to the leak test port to occlude the patient end of the breathing system.
6. Push the O_2 Flush button for approximately 15 seconds. Ensure that [**Continuous Airway Pressure**] alarm occurs.
7. Disconnect the breathing system and ensure that the alarm cancels.
8. Reconnect the breathing system.

5.12.6 Airway Pressure (Paw) Too High Alarm Test

1. Connect the test lung or manual bag to the Y-piece of the breathing system.
2. Set Patient Size to Adult, and start the automatic ventilation.
3. On the Main Screen, select the [**Alarms**] key > [**Limits**] tab.
4. Set the lower limit of PEAK alarm to 0 cmH_2O and the upper limit of PEAK alarm to 5 cmH_2O lower than the monitoring of the anesthesia system.
5. Ensure that a [**Paw Too High**] alarm occurs.
6. Set the PEAK high alarm limit to 40 cmH_2O.
7. Ensure that the alarm cancels.

5.12.7 Airway Pressure (Paw) Too Low Alarm Test

1. Connect the test lung or manual bag to the Y-piece of the breathing system.
2. Set Patient Size to Adult, and start the automatic ventilation.
3. On the Main Screen, select the [**Alarms**] key > [**Limits**] tab.
4. Set the PEAK Low alarm limit to 10 cmH_2O.
5. Disconnect the test lung or manual bag from the Y-piece of the breathing system.
6. Wait for 20 seconds. Check the alarm area and ensure that the [**Paw Too Low**] alarm occurs.
7. Connect the test lung or manual bag to the Y-piece of the breathing system.
8. Ensure that the alarm cancels.

5.12.8 AG Module Alarm Test

1. Install the AG module and see section 8.6 (Pages 8-5) "AG Measurement Preparation".
2. Remove the gas sampling tube from the anesthesia system and connect the standard gas bag filled with anesthetic gas AA. AA stands for one of the following anesthetic agents: Des (Desflurane), Iso (Isoflurane), Enf (Enflurane), Sev (Sevoflurane), or Hal (Halothane).

3. On the Main Screen, select the [**Alarms**] key > [**Limits**] tab.
4. Set the EtAA upper limit to be lower than the standard gas concentration.
5. Ensure that the [**EtAA Too High**] alarm appears on the screen.
6. Set the EtAA lower limit to be higher than the standard gas concentration.
7. Ensure that the [**EtAA Too Low**] alarm appears on the screen.

5.13 Inspect the AGSS

1. Connect the O2 supply.
2. Connect the waste gas outlet of the anesthesia system to the EVAC port or the vacuum port of the medical institution and enable the waste gas scavenging system.
3. Check whether the float is located between the MIN and MAX scale lines.

NOTE: **Do not block the AGSS pressure compensation openings during the inspection. If the float fails to move up to above the MIN scale line, possible reasons include the following:**
1. The float is sticky. Turn over the AGSS and check if the float moves up and down freely.
2. The waste gas scavenging system is not working or the pump rate is less than the minimum flow value of the AGSS specification.

5.14 Inspect the Passive AGSS

1. Connect the waste gas outlet of the anesthesia system to the passive AGSS.
2. Seal the Y-piece and install the manual bag. Set the Auto/Manual switch to the Manual position and rotate the APL valve to the SP position.
3. Set the fresh gas flow to 2 L/min and then exit to the standby mode. Observe the changes in airway pressure for one minute and confirm that the airway pressure does not exceed 5 cmH_2O.

5.15 Inspect the Negative Pressure Suction Device

1. Assemble the negative pressure suction device.
2. Occlude the suction tube inlet at the patient end.
3. Turn on the negative pressure pipeline supply.
4. For the venturi negative pressure suction device, set its switch to **ON**.
5. Set the selector switch to **REG**.
6. Turn the negative pressure adjustment knob to the maximum position and check if the reading on the pressure gauge increases gradually.

5.16 Pre-operation Preparations

1. Ensure that the ventilator parameters and alarm limits are set to applicable clinical levels.
2. Ensure that the system is in Standby mode.
3. Ensure that the equipment for airway pressure maintenance, manual ventilation and tracheal intubation, and applicable anesthetic and emergency drugs are available.
4. Set the Auto/Manual switch to the Manual position.

5. Connect the manual bag to the manual bag port.
6. Turn off all vaporizers.
7. Turn the APL valve control to the SP position to fully open the APL valve.
8. Set all gas flows to zero.
9. Ensure that the breathing system is correctly connected and not damaged.

WARNING: Before connecting the equipment to the patient, flush the device with O_2 at a flow of 8 L/min for at least two minutes. This removes unwanted mixtures and by-products from the system.

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6.0 Operations

WARNING: Before using the anesthesia system on the patient, ensure that the system is correctly assembled and in good condition, and that all the tests described in the Preoperative Tests are already completed. In case of test failure, do not use the system. Contact a qualified Mindray service representative to repair the system.

6.1 Powering On the Anesthesia System

1. Connect the pipelined gas supply and backup gas cylinders of the equipment.
2. Connect the power cord to the AC power source. Ensure that the AC power LED is illuminated.
3. Set the system switch to the ON position.
4. The Main Screen shows the start-up screen.
5. The alarm LED flashes red, yellow, and cyan once in turn and then a beep is given. This verifies that audible and visual alarms are operational.
6. After several seconds, the system self-test screen is displayed and the equipment runs its system self-test.

6.2 Power Off the Anesthesia System

The system provides a powering off function with the following features:

- A prompt sound is given when the user turns off the system. If the system switch is turned off in Standby mode, the system will wait 3 seconds to power off completely.
- If the power switch is turned off in Manual mode or in any of the Automatic ventilation modes, the system will wait 12 seconds until it is completely powered off. In the 12-second power off delay period, the screen will display a 10-second countdown timer. If the equipment is performing Automatic ventilation, the ventilator will continue ventilating the patient in the current ventilation mode.
- The system beeps once every second during the countdown from 10 seconds to 1 second. When the timer turns to zero, a two-second power-off sound is played.
- When the user turns on the equipment during the power off delay period, the countdown timer will disappear, and the anesthesia system will resume its previous state.

NOTE: The delayed power-off feature is not available when the equipment is in the standby mode. The delayed power-off feature is only available when the equipment is in an active ventilation mode.

6.3 Patient Setup

6.3.1 Standby Mode

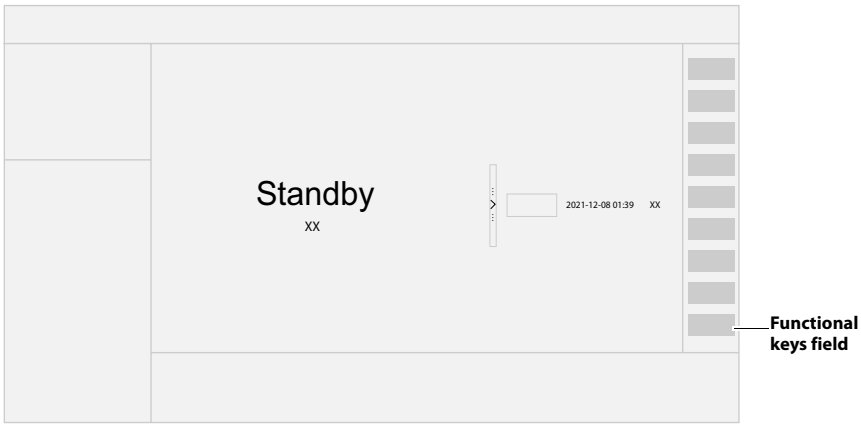

FIGURE 6-1 Standby Mode

NOTE: **Check whether the functional key area on the main screen displays [End Case] or [Start Case] key, which must be set by authorized service personnel. If you need to display this key, please contact Mindray Technical Support for help.**

6.3.1.1 Enter Standby Mode

When the [**End Case**] key is displayed on the functional key field of the main screen:

1. Select [**End Case**] on the Main Screen.
2. Follow the on-screen prompts to enter Standby mode.

When the [**End Case**] is not displayed on the functional key field of the main screen:

1. Set the Auto/Manual switch to the Manual position.
2. When using the EFCS, skip to Step 3.
   When using the BFCS, turn the flow control knob of the BFCS clockwise to the mechanical stop position.
3. Select the [**End Case**] key in the Manual mode.
4. Follow the on-screen prompts to enter Standby mode.

NOTE: **After selecting the [End Case] key, you can set whether to [Restore current profile settings] in the pop-up dialog box.**

NOTE: **When the system is in Standby mode and the Auto/Manual Switch is in Manual position, the [Bypass] button in the [Manual] tab is disabled. However, the [Alarms] button remains enabled and can be toggled to On or Off.**

WARNING: **Entering Standby mode will stop ventilation and parameter monitoring. Do not select Standby mode if the patient requires continuous ventilation.**

6.3.1.2 Exit Standby Mode

When the [**Start Case**] key is displayed on the functional key field of the main screen:

Touch the standby zone or select the [**Start Case**] key on the screen, and follow the on-screen prompts to exit the standby mode.

When the [**Start Case**] is not displayed in the functional key field of the main screen:

1. Set the Auto/Manual switch to the Manual position.

2. Touch the waveform zone on the screen or turn on the fresh gas, or select the [**Start Case**] key, and follow the on-screen prompts to exit standby mode.

6.3.2 Set Patient Information

See section 4.2 (Pages 4-4) "Patient Information Field".

6.4 O_2 Sensor Calibration

If O_2 sensor calibration is needed, please see section 12.4 (Pages 12-4) "O2 Sensor Calibration".

6.5 Set Fresh Gas

6.5.1 Set O_2, N_2O and Air Inputs

You can set the O_2 and balance gas through EFCS or set the O_2 and air flow through BFCS.

The Security System in the equipment is intended to prevent delivering low-O_2 gas mixtures to patients. N_2O cannot be delivered without O_2.

The equipment maintains a safe O_2 to N_2O ratio by keeping the N_2O flow in a proper ratio to the preconditioned O_2 flow. N_2O flow is subject to the limitation of O_2 flow to make sure that O_2 remains in a safe ratio of not lower than 25%.

Auto cut-off of N_2O:

When the O_2 pressure is lower than the threshold, N_2O is automatically cut off to zero the N_2O flow rate.

O_2 pressure loss alarm:

When the O_2 pressure is lower than 220 kPa (32 psi), the O_2 pressure failure alarm is triggered.

O_2 ratio controller:

The O_2 ratio controller ensures that the O_2 concentration in the fresh gas is always not lower than 25% when the N_2O valve is fully opened.

WARNING: If BFCS is used, ensure that O_2 flow controller is fully closed at the beginning and at the end of each case.

NOTE: The float flowmeter is calibrated based on 100% O_2. For other gas, the accuracy of the flowmeter may degrade.

NOTE: When checking the readings on the float flowmeter, keep the visual angle at the same level of the float. The reading of the scale may vary when viewed at a different angle.

NOTE: If the readings shown on the electronic flowmeters differ from that on the total flowmeter, the electronic flowmeter will prevail and the total flowmeter is an approximate value.

6.5.2 Set Anesthetic Agent

NOTE: **You do not need to perform this operation if inspiratory anesthetic agent is not used.**

NOTE: **The anesthesia system can be installed with vaporizers of Isoflurane, Halothane, Sevoflurane and Desflurane. Only one vaporizer can be opened at a time.**

6.5.2.1 Select the Desired Anesthetic Agent

1. Determine the anesthetic agent to be used and then fill the vaporizer.

NOTE: **Only vaporizers compliant with ISO 80601-2-13 and with Selectatec® Interlock Systems can be installed to this equipment. Refer to the vaporizer manufacturer's instructions for filling, draining and other information of the vaporizer.**

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

2. Install the vaporizer filled with anesthetic agent onto the anesthesia system.

6.5.2.2 Adjust the Concentration of Anesthetic Agent

Push and turn the concentration control on the vaporizer to set the appropriate concentration of anesthetic agent. For details about how to use the anesthetic agent, refer to the Vaporizer Instructions for Use.

6.5.3 Internal Air Supply

If the anesthesia system is equipped with an internal air supply, select the icon > [**System**] (system password needed) > [**Setup**] > [**Internal Air Supply**], [**Enable Internal Air Supply**] is set to (OFF) by default. When the pressure of air pipeline supply or air cylinder is insufficient, set [**Enable Internal Air Supply**] to (ON), and then select [**Yes**] from the pop-up dialog box to use the internal air supply. When the pressure of air pipeline supply or air cylinder is restored, the system automatically use the pipelined air supply or air cylinder for gas supply, and set [**Enable Internal Air Supply**] to (OFF).

NOTE: **The maximum output flow of the internal air supply is 5 L/min. If the original fresh gas flow is higher than 5 L/min, the fresh gas flow changes after you switch to the internal air supply.**

NOTE: **Do not use the internal air supply in the environment with Relative Humidity greater than 70%.**

When the internal air supply is used for gas supply, the system prompts [**Internal Air Supply in Use**]. To disable this prompt message, perform the following operations.

- Select the icon > [**System**] (system password needed) > [**Setup**] > [**Internal Air Supply**], and set [**Disable the "Internal Air Supply in Use" prompt**] to (ON).

6.6 Set Ventilation

NOTE: **In all ventilation modes, when inspiration pressure reaches the upper limit of PAW alarms, the system switches to expiration immediately and airway pressure is released.**

NOTE: When the drive gas supply fails, the automatic ventilation mode will not function normally.

6.6.1 Change Ventilation Mode

To change ventilation mode to Manual:

Use the Auto/Manual switch on the breathing system to enter and exit Manual ventilation mode.

To change ventilation mode to VCV, SIMV-VC, PCV, PCV-VG, SIMV-PC, SIMV-VG, CPAP/PS, APRV, AMV, or HFJV:

1. Select the tab of the desired ventilation mode. The [**Set Mode**] button (or [**Preset Mode**] button in manual mode) will flash.
2. Select the [**Set Mode**] button (or [**Preset Mode**] button in manual mode) to confirm the change. If the [**Set Mode**] button is not selected after several seconds, an audio reminder will sound for several seconds and then the system will return to the previous ventilation mode.
3. Optionally, select each available ventilation parameter to edit the parameter setting.
4. Move the Auto/Manual switch to the Auto position.

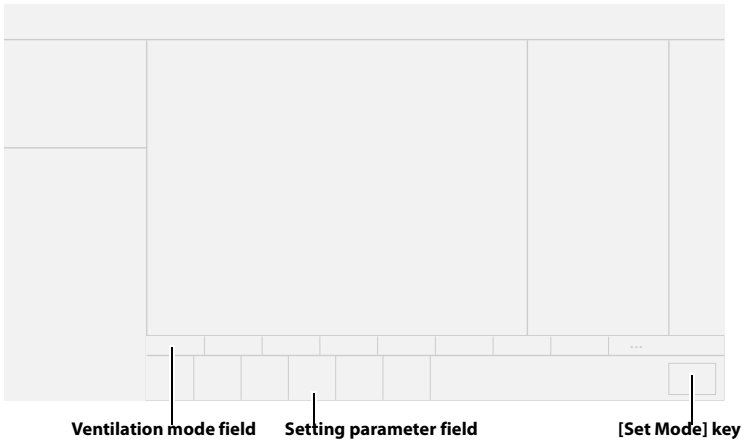

FIGURE 6-2 Auto Ventilation Mode Tabs

6.6.2 Set Manual Ventilation Mode

Manual ventilation mode is the operating mode used to manually ventilate the patients or allow patients to breathe spontaneously. To use the manual ventilation mode, you must first set the APL to the desired pressure value and then use the Auto/Manual switch on the breathing module to enter and exit Manual mode. Push the O_2 Flush button to inflate the bag if necessary.

FIGURE 6-3 Manual Ventilation Mode Tab

Set the APL Valve for Manual Ventilation

Rotate the APL valve adjustment knob to the desired pressure. The number on the knob that lines up with the index mark on the bottom section of the valve indicates the approximate pressure setting.

NOTE: Clockwise rotation increases the pressure, and counterclockwise rotation decreases the pressure.

The patient can be ventilated manually using the breathing bag. The pressure will be limited to the value set on the APL valve.

Set the APL Valve for Spontaneous Breathing

Rotate the APL valve adjustment knob fully counter clockwise until the SP marking on the knob lines up with the index mark on the bottom section of the valve. The valve will then be open for the patient to breathe spontaneously.

NOTE: In the manual ventilation mode, you can use the APL valve to adjust the pressure limit of breathing system and gas volume in the manual bag. When the pressure in the breathing system reaches the pressure limit set for the APL valve, the valve opens to release excess gas.

NOTE: The APL valve adjusts the breathing system pressure limit during manual ventilation. Its scale shows approximate pressure.

Set Alarms

In the manual ventilation mode, when the [**Alarms**] key is set to [**Off**], the pressure, volume and apnea alarms are disabled, and the related alarm limits will be displayed as [**Off**]. Pressure, volume and apnea alarms can be turned on by setting the [**Alarms**] button key to [**On**]. The related alarm limits will be restored to their original settings.

Set CO_2 Alarms

In the manual ventilation mode, the CO_2 and the CO_2 apnea alarms can be turned off by setting the [**CO2 Alarms**] soft key to [**Off**], and the related alarm limits will be displayed as [**Off**]. The [**CO2 and CO2 Apnea Alarms are OFF**] prompt will be displayed in the alarm area. The CO_2 and the CO_2 apnea alarms can be turned on by setting the [**CO2 Alarms**] key to [**On**] by turning the Auto/Manual Switch to the Auto position. The related alarm limits will be restored to their original settings.

NOTE: In the Auto ventilation mode, CO_2 alarms are turned on by default and cannot be turned off.

When the system exits the standby mode and enters the Manual ventilation mode, if the [**CO2 Alarms**] soft key is [**On**], the system will not enable the CO_2 and the CO_2 apnea alarms until three continuous respiratory waves are monitored.

In the following two cases, the system will disable the CO_2 alarms or CO_2 apnea alarms for 30 seconds. After 30 seconds, the CO_2 and the CO_2 apnea alarms will be enabled even if no respiratory wave has been monitored.

- If the [**CO2 Alarms**] key is set to [**On**] from the [**Off**] status.
- Set the Auto/Manual switch from the Manual position to the Auto position.

WARNING: Risk of inadequate monitoring. National standards require a minimum monitoring with some basic alarm functions. These standards may not be met if the alarm function of the CO_2 monitoring parameter is disabled. Disable the CO_2 parameter alarms feature only after you check the standard.

6.6.3 Settings Before Starting the Automatic Ventilation Mode

1. Enter Standby mode.
2. Select the desired ventilation mode tab.
3. Set the desired ventilation parameters.
4. Select the [**Set Mode**] key (flashing green) on the right of the ventilation tab to confirm the ventilation mode.
5. Push the O_2 Flush button to inflate the bellows if necessary.
6. If in Standby, exit Standby by touching the main screen.
7. To begin automatic ventilation, set the Auto/Manual switch to the Auto position.

6.6.4 Set Volume Control Ventilation (VCV)

Volume Control Ventilation (VCV) mode is a fully automatic ventilation mode. In the VCV mode, each time automatic ventilation starts, gas is delivered to the patient at a constant flow, which reaches the preset Vt within the gas delivery time. To ensure a certain amount of Vt, the resulted airway pressure (Paw) changes based on patient pulmonary compliance and airway resistance.

In the VCV mode, you need to set the Plimit to prevent harm to patients because of the overhigh airway pressure. Set Tpause to improve patient pulmonary gas distribution and PEEP to improve expiration of end-tidal carbon dioxide and to increase oxygenation of breathing process.

To ensure the set tidal volume gas delivery, the ventilator adjusts gas flow based on the measured inspiratory volume, dynamically compensates for the loss of tidal volume arising from breathing system compliance and system leakage and eliminates the effect of fresh gas as well. This is called tidal volume compensation.

In the VCV mode, if tidal volume compensation fails, the system can continue to deliver gas in a stable manner but cannot compensate for the effects of fresh gas flow and breathing system compliance losses.

In VCV and SIMV-VC modes, when inspiration pressure reaches Plimit, respectively, the inspiration pressure is held.

Set VCV mode:

1. Select the VCV tab on the Main Screen.
2. Select the parameter key and assign an appropriate value on the pop-up screen.
3. Check that all VCV parameters are set appropriately.
4. Select the [**Set Mode**] key to confirm the settings.

VCV parameters:

- **Vt**: tidal volume
- **RR**: respiratory rate
- **I:E** or **Tinsp**: ratio of inspiratory time to expiratory time or time of inspiration
- **Tpause**: percentage of inspiratory pause time in inspiratory time
- **PEEP**: positive end-expiratory pressure
- **Plimit**: pressure limit level

NOTE: Before activating a new automatic ventilation mode, ensure that all related parameters are set appropriately.

6.6.5 Set Pressure Control Ventilation (PCV)

Pressure control ventilation (PCV) mode is a basic fully-automatic ventilation mode. In the PCV mode, each time automatic ventilation starts, airway pressure rises rapidly to the preset Pinsp. Then the feedback system will slow down the output flow and maintain a constant airway pressure until the end of the inspiration time. The tidal volume delivered in the PCV mode changes based on patient pulmonary compliance and airway resistance.

In the PCV mode, you can set PEEP to improve expiration of carbon dioxide and to increase oxygenation of breathing process.

Set PCV mode:

1. Select the PCV tab on the Main Screen.
2. Select the parameter key and assign an appropriate value on the pop-up screen.
3. Check that all PCV parameters are set appropriately.
4. Select the [**Set Mode**] key to confirm the settings.

PCV parameters:

- **Pinsp** or **ΔPinsp**: peak inspiratory airway pressure or relative inspiratory pressure.
- **RR**: respiratory rate
- **I:E** or **Tinsp**: ratio of inspiratory time to expiratory time or time of inspiration
- **PEEP**: positive end-expiratory pressure
- **Tslope**: rise time

NOTE: Before activating a new automatic ventilation mode, ensure that all related parameters are set appropriately.

6.6.6 Set Pressure Control Ventilation - Volume Guarantee (PCV-VG)

Pressure Control Ventilation - Volume Guarantee (PCV-VG) mode implements volume-guaranteed ventilation in a pressure-controlled manner. In this mode, the pressure level should be kept as low as possible during the inspiration phase, and meanwhile the gas supply volume should be equal to the preset tidal volume. The pressure control level will vary according to the tidal volume setting, resistance and compliance of the patient's lungs.

Set PCV-VG mode:

1. Select the PCV-VG tab on the Main Screen.
2. Select the parameter key and assign an appropriate value on the pop-up screen.
3. Check that all PCV- VG parameters are set appropriately.
4. Select the [**Set Mode**] key to confirm the settings.

PCV-VG parameters:

- **Vt**: tidal volume
- **Plimit**: pressure limit level with volume guarantee
- **RR**: respiratory rate
- **I:E** or **Tinsp**: ratio of inspiratory time to expiratory time or time of inspiration
- **PEEP**: positive end-expiratory pressure
- **Tslope**: rise time

NOTE: Before activating a new automatic ventilation mode, ensure that all related parameters are set appropriately.

6.6.7 Set Synchronized Intermittent Mandatory Ventilation (SIMV)

The equipment supports three modes of SIMV: SIMV-volume control (SIMV-VC), SIMV-pressure control (SIMV-PC) and SIMV-volume guarantee (SIMV-VG).

6.6.7.1 Set Synchronized Intermittent Mandatory Ventilation - Volume Control (SIMV-VC)

SIMV-VC means to deliver synchronized intermittent mandatory volume controlled ventilation to the patient. In the SIMV- VC mode, the ventilator waits for patient's next inspiration based on the specified time interval. The sensitivity depends on Trigger. If Trigger is reached within the trigger waiting time (called synchronous trigger window), the ventilator delivers volume controlled ventilation synchronously with the preset tidal volume and inspiratory time. If the patient does not inspire within the trigger window, the ventilator delivers volume controlled ventilation to the patient at the end of trigger window. Spontaneous breathing outside trigger window can acquire pressure support.

In VCV and SIMV-VC modes, when inspiration pressure reaches Plimit, the inspiration pressure is held.

6.6.7.2 Set Synchronized Intermittent Mandatory Ventilation - Pressure Control (SIMV-PC)

SIMV-PC means to deliver synchronized intermittent mandatory volume controlled ventilation to the patient. In the SIMV-PC mode, the ventilator waits for patient's next inspiration based on the specified time interval. The sensitivity depends on Trigger. If Trigger is reached within the trigger waiting time (called synchronous trigger window), the ventilator delivers pressure controlled ventilation synchronously with the preset Pinsp and Tinsp. If the patient does not inspire within the trigger window, the ventilator delivers pressure controlled ventilation to the patient at the end of trigger window. Spontaneous breathing outside trigger window can acquire pressure support.

6.6.7.3 Set Synchronized Intermittent Mandatory Ventilation - Volume Guarantee (SIMV-VG)

SIMV-VG means to deliver synchronized intermittent mandatory pressure control volume guarantee ventilation to the patient. In the SIMV-VG mode, the ventilator waits for patient's next inspiration based on the specified time interval. The sensitivity depends on F-Trig (or P-Trig). If F-Trig (or P-Trig) is reached within the trigger waiting time (called synchronous trigger window), the ventilator delivers pressure controlled volume guarantee ventilation synchronously with the preset tidal volume and inspiratory time. If the patient does not inspire within the trigger window, the ventilator delivers pressure controlled volume guarantee ventilation to the patient at the end of trigger window. Spontaneous breathing outside trigger window can acquire pressure support.

Set SIMV-VC, SIMV-PC or SIMV-VG Mode:

1. Select the SIMV-VC, SIMV-PC or SIMV-VG tab on the Main Screen.
2. Select the parameter key and assign an appropriate value on the pop-up screen.
3. Check that all the SIMV-VC, SIMV-PC or SIMV-VG parameters are set appropriately.
4. Select the [**Set Mode**] key to confirm the settings.

SIMV-VC parameters:

- **Vt**: tidal volume
- **RR**: respiratory rate
- **Tinsp**: time of inspiration
- **F-Trig**/**P-Trig**: flow trigger level/pressure trigger level
- **ΔPsupp**: support pressure
- **PEEP**: positive end-expiratory pressure
- **Plimit**: pressure limit level
- **Tpause**: inspiratory pause
- **Trig Window**: trigger window (supports buffer time of synchronous inspiration of patients, in the later expiratory stage in the Auto ventilation mode, with its duration being a percent of the set breathing cycle)
- **Tslope**: rise time
- **Exp%**: expiration trigger level (change to the expiratory stage when the expiration trigger level (peak flow * expiration trigger level) is reached.)

SIMV-PC parameters:

- **Pinsp** or **ΔPinsp**: peak inspiratory airway pressure or relative inspiratory pressure
- **RR**: respiratory rate
- **Tinsp**: time of inspiration
- **F-Trig**/**P-Trig**: flow trigger level/pressure trigger level
- **Tslope**: rise time
- **ΔPsupp**: support pressure
- **PEEP**: positive end-expiratory pressure
- **Trig Window**: trigger window
- **Exp%**: expiration trigger level

SIMV-VG parameters:

- **Vt**: tidal volume
- **RR**: respiratory rate
- **Tinsp**: Inspiration time
- **F-Trig**/**P-Trig**: flow trigger level/pressure trigger level
- **ΔPsupp**: support pressure
- **PEEP**: positive end-expiratory pressure
- **Plimit**: pressure limit level
- **Trig Window**: trigger window
- **Tslope**: rise time
- **Exp%**: expiration trigger level

NOTE: Before activating a new automatic ventilation mode, ensure that all related parameters are set appropriately.

6.6.8 Set Continuous Positive Airway Pressure/Pressure Support Ventilation (CPAP/PS)

In the Pressure Support (PS) mode (when ΔPsupp is not 0 cmH_2O, PS is displayed in the current ventilation mode area), the equipment provides support to the patient's effort at a preset inspiratory pressure level. Inspiration is triggered and cycled by patient's effort.

In the Continuous Positive Airway Pressure (CPAP) mode (when ΔPsupp is 0 cmH_2O, CPAP is displayed in the current ventilation mode area), the system maintains the airway pressure at the user-defined positive pressure level throughout the ventilation cycle. The patient breathes spontaneously and determines his own breathing frequency, timing and tidal volume.

You can set the F-Trig (or P-Trig), ΔPapnea, PEEP, allowed Min RR, and Tslope. If the Min RR (minimum respiratory rate) is exceeded, and there is no spontaneous breathing or spontaneous breathing is too weak to reach F-Trig (or P-Trig), the equipment will give an Apnea Ventilation breath to ensure that the ventilation is occurring.

Set CPAP/PS mode:

1. Select the CPAP/ PS tab on the Main Screen.
2. Select the parameter key and assign an appropriate value on the pop-up screen.

3. Check that all CPAP/PS parameters are set appropriately.
4. Select the [**Set Mode**] key to confirm the settings.

CPAP/PS parameters:

- **ΔPsupp**: support pressure (the ventilation mode is CPAP when ΔPsupp=0 cmH_2O)
- **Tslope**: rise time
- **PEEP**: positive end-expiratory pressure
- **F-Trig**/**P-Trig**: flow trigger level/pressure trigger level
- **Exp%**: expiration trigger level
- **Min RR**: minimum respiratory rate, applies to apnea backup breaths only
- **ΔPapnea**: apnea pressure
- **Apnea Ti** or **Apnea I:E**: apnea inspiration time or ratio of inspiratory time to expiratory time in apnea ventilation cycle

NOTE: **Before activating a new automatic ventilation mode, ensure that all related parameters are set appropriately.**

6.6.9 Set Airway Pressure Release Ventilation (APRV)

APRV is airway pressure release ventilation mode. It can be seen as periodical, short period airway pressure release in CPAP mode.

Set APRV mode:

1. Select the APRV tab on the Main Screen.
2. Select the parameter key and assign an appropriate value on the pop-up screen.
3. Check that all APRV parameters are set appropriately.
4. Select the [**Set Mode**] key to confirm the settings.

APRV parameters:

- **Phigh**: high pressure level
- **Plow**: low pressure level
- **Thigh**: time of high pressure
- **Tlow**: time of low pressure
- **Tslope**: rise time

NOTE: **Before activating a new automatic ventilation mode, ensure that all related parameters are set appropriately.**

6.6.10 Set Adaptive Minute Ventilation (AMV)

AMV refers to adaptive minute ventilation, which is a ventilation mode that adjusts the patient's ventilation parameters based on minimum work of breathing (WOB). Users can adjust the target minute ventilation by setting the patient's ideal body weight and minute ventilation percentage. Based on the Otis formula, the Ventilator will calculate the respiratory rate and tidal volume that minimize the work of breath under the minute ventilation, and adjust the inspiration/expiration ratio based on the measured lung time constant. AMV is only suitable for adult and pediatric ventilation.

Otis formula:

$$f = \frac{\sqrt{1 + 2a \cdot RC_{exp} \cdot \frac{MV - f \cdot V_d}{V_d}} - 1}{a \cdot RC_{exp}}$$

Where f indicates the minimum respiratory rate that minimizes the work of breath, MV indicates the target minute ventilation, V_d indicates the patient's physiological dead space volume and RC_{exp} indicates the time constant of lung. a is a coefficient related to the respiratory waveform. For a sine wave, a=2π2/60.

Target minute ventilation volume is calculated by the following formula:

Target minute ventilation MV=Minute ventilation %×$f_{default}$×Vt/IBW×IBW/1000

Where, Vt/IBW is the tidal volume for the ideal body weight and IBW is the ideal body weight. $f_{default}$ is a group of default values related to the IBW. Its values are shown in the table below:

IBW (kg)	$f_{default}$ (/min)
[1.8, 3)	40
[3, 9)	35
[9, 13)	30
[13, 17)	25
[17, 23)	20
[23, 29)	15
[29, 36)	14
[36, 200)	12

The first three cycles of AMV is PCV experimental ventilation to calculate patient's lung resistance and compliance. Initial ventilation parameters are:

IBW (kg)	Pinsp(cmH_2O)	Tinsp(s)	$f_{default}$ (/min)
[1.8, 3)	15	0.4	40
[3, 6)	15	0.4	30
[6, 9)	15	0.6	25
[9, 12)	15	0.6	20
[12, 15)	18	0.7	20
[15, 21)	15	0.8	20
[21, 24)	15	0.9	15
[24, 30)	15	1	15
[30, 40)	15	1	14
[40, 60)	15	1	12
[60, 90)	15	1	10
[90, 100)	18	1.5	10
⩾ 100	20	1.5	10

TABLE 6-1 Experimental ventilation cycle setting parameters

After three experimental ventilations, enter the automatic adjustment stage. Based on the principle of minimum WOB, ensure that the actual minute volume is as close as possible to the preset minute volume value. If the patient has no spontaneous respiration, enable automatic ventilation. If the patient restores spontaneous respiration, enable support ventilation.

Set AMV mode:

1. Select the AMV tab on the Main Screen.
2. Select the parameter key and assign an appropriate value on the pop-up screen.
3. Check that all AMV parameters are set appropriately.
4. Select the [**Set Mode**] key to confirm the settings.

AMV parameters:

- **MV%**: Percentage of minute volume
- **PEEP**: positive end-expiratory pressure
- **Tslope**: rise time
- **F-Trig**/**P-Trig**: flow trigger level/pressure trigger level
- **Exp%**: expiration trigger level

NOTE: Before activating a new automatic ventilation mode, ensure that all related parameters are set appropriately.

6.6.11 Set High Frequency Jet Ventilation (HFJV)

WARNING: The HFJV mode is only used for ventilation support in the diagnosis and treatment of respiratory diseases through trachea and bronchus during laryngeal surgery and respiratory intervention.

WARNING: The HFJV mode is not applicable to emergency application in cardiopulmonary resuscitation, application of acute pulmonary edema, and application in treatment of chronic obstructive pulmonary disease (COPD) with multi-organ failure.

WARNING: During HFJV, routine mechanical ventilation modes must be readily available to provide ventilation to the patient at any time.

WARNING: Absolute contraindications include severe restrictive and obstructive pulmonary disease, extensive laryngeal or tracheal bleeding at the surgical site, and anticipated risk of severe bleeding in supraglottic and subglottic surgery, extreme obesity, inspiration disorder, and non-fasting patients.

CAUTION: Nasal intubation is not indicated in pediatric patients due to anatomical reasons.

CAUTION: HFJV is open ventilation and cannot be used with traditional inhalation anesthesia. Also, due to the nature of open ventilation, always use personal protective equipment (e.g. Face or eye protection, etc.) to avoid unnecessary droplet infection.

NOTE: Jet ventilation for 60 minutes results in cooling and dehydration; therefore, breathing gas should be used to heat and humidify the trapped gas when the expected operative time is long.

NOTE: Intermittent airflow and entrainment may produce noise during HFJV and may compromise your interests. You can increase the volume of other medical devices.

NOTE: Before activating a new automatic ventilation mode, ensure that all related parameters are set appropriately.

NOTE: When the pressure monitoring tube is not connected, the system will use intermittent pressure measurement to prevent the airway pressure from being too high. Intermittent pressure measurements are not available when single high-frequency jet ventilation is used and the frequency is greater than 200 bpm.

High Frequency Jet Ventilation (HFJV) is a ventilation mode used in the opened airway. HFJV is achieved through a separate module. You can set drive pressure, reapiratory rate and ratio of inspiratory time to expiratory time of the high-frequency unit and normal-frequency unit separately and FiO2 jet shared by the two units. Pdrive will affect the airway pressure at the patient end. HFJV mode can be divided into single high-frequency jet ventilation and high-frequency + normal-frequency jet ventilation.

Set HFJV Mode:

1. Select the HFJV tab on the Main Screen.
2. Select the parameter key and assign an appropriate value on the pop-up screen.
3. Check that all HFJV parameters are set appropriately.
4. Select the [**Set Mode**] key to confirm the settings.

HFJV parameters:

- **HF**: high frequency switch
- **f**: respiratory rate of high frequency
- **i:e**: ratio of inspiratory time to expiratory time of high frequency
- **P HF**: drive pressure of high frequency
- **NF**: normal frequency switch
- **F**: respiratory rate of normal frequency
- **I:E**: ratio of inspiratory time to expiratory time of normal frequency
- **P NF**: drive pressure of normal frequency
- **FiO2 Jet**: injected oxygen concentration
- **Laser Safe**: switch of laser safety mode

To avoid fire or burn during laser surgery, set [**Laser Safe**] to (ON). When the laser safety mode is switched on, if the current injected oxygen concentration is higher than [**FiO2 Jet Limit**], it automatically decreases to [**FiO2 Jet Limit**]; If the current injected oxygen concentration is equal to or lower than [**FiO2 Jet Limit**], the current injected oxygen concentration is retained. When the laser safe mode is switched off, the injected oxygen concentration automatically restores to the value before entering the laser safe mode. Set [**FiO2 Jet Limit**] according to the following procedure:

1. Select the key > [**HFJV**] key.
2. Set [**FiO2 Jet Limit**] to an appropriate value.

In HFJV mode, when the system is configured with the CO_2 or AG module, the CO_2 or AG module enters the spot measurement mode. In CO_2 spot measurement mode, CO_2 measurement or periodic measurement needs to be started manually. In addition, you can set the trend length of $EtCO_2$:

1. Select the key > [**HFJV**] key.
2. Set [**Trend Length**] to an appropriate value.

6.6.11.1 High-flow Nasal Cannula Oxygen (HFNC)

High-flow Nasal Cannula Oxygen (HFNC) refers to a method to increase the O_2 concentration in the airway at normal pressure through simple tube connections. HFNC refers a medical measure that increases the alveolar O_2 concentration by increasing the O_2 concentration in the inhaled gas to promote O_2 diffusion, thereby increasing the partial pressure and saturation of blood oxygen in arteries so as to ease or rectify hypoxia. HFNC is a hypoxia prevention or treatment means and the O_2 concentration it provides is higher than that in the air.

WARNING: HFNC can be applied to open or semi-open ventilations such as nasal cannula or mask ventilation, but it can not be applied to closed or semiclosed ventilations like tracheal intubation or laryngeal mask ventilation.

WARNING: Airway pressure and ventilation parameters related to respiration, such as flow rate, minute ventilation, apnea, are not monitored during HFNC.

WARNING: An SpO_2 monitoring device should be used to monitor SpO_2 during HFNC.

WARNING: Insufficient gas supply pressure may cause inaccurate control of oxygen concentration.

WARNING: Do not use antistatic or conductive breathing tubes. Using tubes made from such materials will expose the patient to electric shocks and may cause fires in an oxygen-enriched environment.

WARNING: The equipment must only be used under the supervision of qualified medical staff. If a fault occurs to the equipment or the patient fails to perform enough spontaneous respiration, professional medical personnel can give immediate help.

NOTE: Stop the automatic ventilation before starting the HFNC. Otherwise it may cause inaccurate accuracy of the automatic ventilation or limited flow adjustment of HFNC.

NOTE: HFNC can be started only when the oxygen supply is connected. If the gas supply is insufficient during ventilation, it may cause limited flow adjustment. If the gas supply returns to normal, you need to restart the anesthesia system to get rid of the limitation of flow adjustment.

To start the HFNC:

1. Connect the HFNC tube, see section 3.7 (Pages 3-6) "High-flow Nasal Cannula (HFNC) Tube".
2. Press the HFNC switch to start the HFNC.
3. Adjust the oxygen concentration and total flow.
4. Press the HFNC switch to turn off the HFNC after use.

6.6.12 Other Features

6.6.12.1 Lung Recruitment Ventilation

Lung recruitment is a lung-protective ventilation strategy. The ventilator intermittently supplies gases of a pressure higher than the mean airway pressure, and sustains the pressure for a period of time during the automatic ventilation. In this way, the lung recruitment maneuvers open more collapsed pulmonary alveoli and prevent the secondary pulmonary atelectasis caused by the low tidal volumes ventilation.

For the safety of the ventilation and observing the effect of the lung recruitment ventilation, the anesthesia system needs to perform real-time monitoring over **PEAK**, **PEEP**, **Compl**, and **Vte** during the lung recruitment ventilation.

NOTE: **Lung recruitment can only be used in automatic ventilation modes.**

NOTE: **Generally, 100% O_2 or high concentration O_2 is used for ventilation during lung recruitment.**

NOTE: **It is not recommended to use lung recruitment where patients may spontaneously breath.**

NOTE: **Terminate the lung recruitment ventilation when the physiological state of the patient is abnormal.**

6.6.12.1.1 One-Step Recruitment

NOTE: **Before activating the lung recruitment ventilation, ensure that all related parameters are set appropriately.**

1. On the Main Screen, select the [**Procedures**] key > [**One-Step Recruitment**].
2. Set the lung recruitment parameters in the pop-up menu.
3. Select the [**Start**] key after setup is completed. [**Recruitment**] is displayed in the current ventilation mode area.

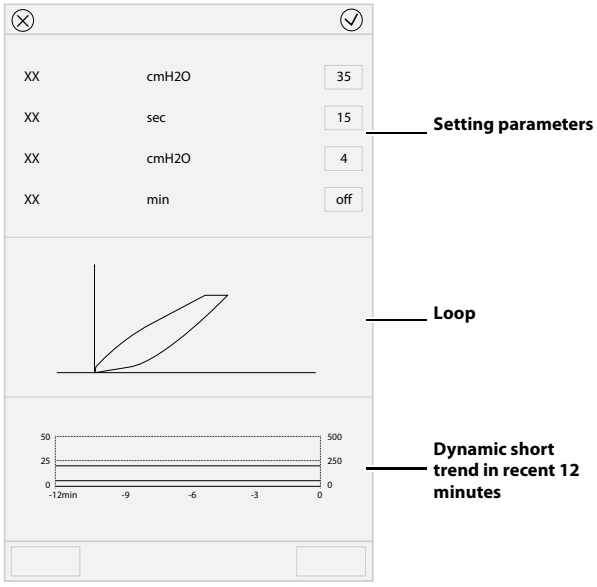

FIGURE 6-4 One-Step Recruitment

Recruitment parameters:

- **Pressure Hold**: the lung recruitment ventilation pressure.
- **Duration**: the lung recruitment ventilation duration.
- **PEEP On Exit** or **Plow On Exit**: the positive end-expiratory pressure or low pressure level upon exit from the lung recruitment ventilation mode.
- **Cycle Interval**: the interval of starting lung recruitment ventilation.

6.6.12.1.2 Multi-Step Recruitment

1. On the Main Screen, select [**Procedures**] key > [**Multi-Step Recruitment**].
2. Select [**Procedures**] in the pop-up menu. If necessary, you can edit the current procedure.
3. Select the [**Start**] key after setup is completed. [**Recruitment**] is displayed in the current ventilation mode area.

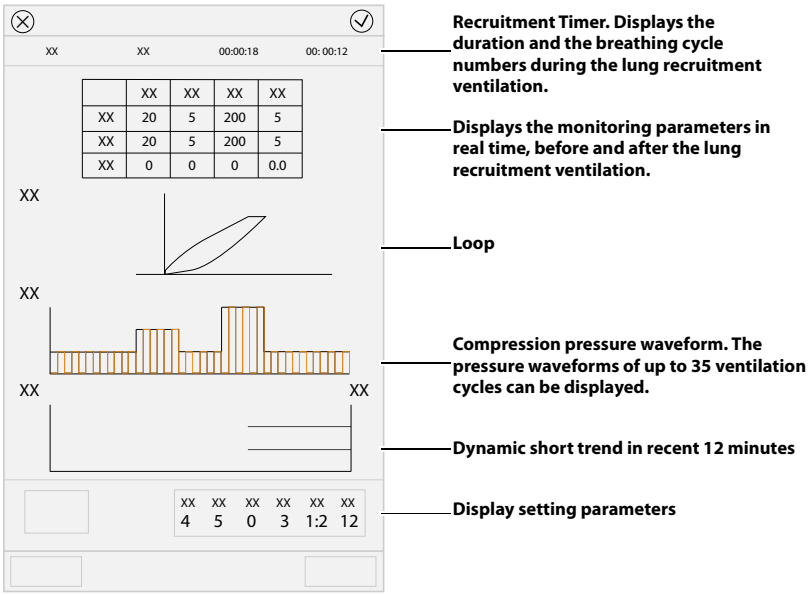

FIGURE 6-5 Multi-Step Recruitment

Recruitment parameters:

- **Steps**: Step of the lung recruitment ventilation. You can set 7 steps.
- **ΔP**: support pressure in a certain step of lung recruitment ventilation.
- **PEEP**: positive end-expiratory pressure in a certain step of lung recruitment ventilation.
- **Breaths**: breath cycle numbers in a certain step of the lung recruitment ventilation.
- **I:E**: ratio of inspiratory time to expiratory time in a certain step of lung recruitment ventilation.
- **RR**: respiratory rate in a certain step of lung recruitment ventilation.
- **PEEP On Exit** or **Plow On Exit**: positive end-expiratory pressure or low pressure level upon exit from the lung recruitment ventilation mode.

6.6.12.1.3 Parameter Monitoring

During the lung recruitment ventilation, the anesthesia system monitors **PEAK**, **PEEP**, **Vte** and **Compl**.

6.6.12.1.4 Freeze Trend

Freeze the trend waveforms by selecting the[**Freeze Trend**] key in [**Recruitment**] menu.

In freeze status, select the[**Unfreeze Trend**] key to exit the frozen status.

6.6.12.2 Inspiration Hold

Inspiration Hold means to extend the patient's time of inspiratory phase manually and to prevent the patient from expiration for a certain period of time.

On the Main Screen, select the [**Procedures**] key > [**Insp./Exp. Hold**]. Push and hold the [**Insp. Hold**] key in the opened screen. The anesthesia system will start the inspiration hold. When you release the [**Insp. Hold**] key, the anesthesia system terminates the inspiration hold. Inspiration Hold is active for a maximum of 30 seconds (for adults and pediatric) or 5 seconds (for neonates). If the [**Insp. Hold**] key is pushed and exceeds the maximum time, the anesthesia system will terminate the inspiration hold automatically.

During Inspiration Hold, the anesthesia system calculates Cstat, Pplat and Ri automatically. The last 4 measurements are saved.

NOTE: There is at least one expiratory phase between two inspiration holds.

NOTE: The system will not respond to inspiration hold key operation in standby or manual ventilation mode.

NOTE: The inspiration hold function is disabled in CPAP mode. When apnea ventilation occurs, the expiration hold function is supported.

6.6.12.3 Expiration Hold

Expiration Hold means to extend the patient's time of expiratory phase manually and to prevent the patient from inspiration for a certain period of time.

On the Main Screen, select the [**Procedures**] key > [**Insp./Exp. Hold**]. Push and hold the [**Exp. Hold**] key in the opened screen. The anesthesia system will start the expiratory hold. When you release the [**Exp. Hold**] key, the anesthesia system terminates the expiratory hold. Expiration Hold is active for a maximum of 30 seconds (for adults and pediatric) or 5 seconds (for neonates). If the [**Exp. Hold**] key is pressed and held for more than the maximum time or is released, the anesthesia system terminates the expiration hold automatically.

During Expiration Hold, the anesthesia system calculates PEEPi and PEEPtot automatically. The last 4 measurements are saved.

NOTE: There is at least one inspiratory phase between two expiration holds.

NOTE: The system will not respond to expiratory hold key operation in standby or manual ventilation mode.

NOTE: The expiration hold function is disabled in CPAP mode. When apnea ventilation occurs, the expiration hold function is supported.

6.6.12.4 Flow Pause

Use [**Flow Pause**] to temporarily suspend the flow of gas during the ventilation. Using [**Flow Pause**] while the breathing system is disconnected prevents the flow of gas into the room. [**Flow Pause**] is available during automatic ventilation and manual ventilation.

To enter [**Flow Pause**] state:

1. Select the [**Flow Pause**] key on the Main Screen.
2. Select [**Yes**] on the pop-up screen to confirm the change. The system will enter [**Flow Pause**] status.

When the system is in the [**Flow Pause**] state:

- The fresh gas flow is turned off.
- The mechanical ventilation is suspended.
- Physiological alarms related to ventilation and gas are disabled.
- The countdown timer is enabled. The default countdown time is 60 seconds. You can select [**+30 sec**] button to add 30 seconds to the current countdown time. The maximum countdown time is 2 minutes.

To exit the [**Flow Pause**] state:

- The system exits the [**Flow Pause**] state automatically when the countdown time is 00:00.
- Select [**End Flow Pause**] button to exit the [**Flow Pause**] state.
- The system exits the [**Flow Pause**] state automatically when the system enters Standby mode or when the BFCS is enabled.

After the system exits the [**Flow Pause**] state:

- The fresh gas flow resumes at the settings before entering the [**Flow Pause**] state.
- Ventilation resumes in the same ventilation mode and with the same parameter settings as before entering the [**Flow Pause**] state.
- Physiological alarms related to ventilation and gas are enabled.

6.6.12.5 Auxiliary Common Gas Outlet (ACGO) Mode

If the equipment is configured with an ACGO switch, the system enters or exits ACGO mode by turning on or off the ACGO switch.

Preset Ventilation Mode after Exit from ACGO

For example, if the current ventilation mode is VCV, enable ACGO and the system will enter the ACGO mode. Under such circumstances:

- If the ventilation mode remains unchanged, the system will enter the VCV mode upon its exit from the ACGO mode.
- If another ventilation mode other than VCV has been selected, such as PCV, select [**Preset Mode**], and the system will enter the PCV mode upon exit from the ACGO mode.

NOTE: **If the system is currently in Standby or Manual mode, the system enters ACGO mode when ACGO is enabled. Under such circumstances, the [Preset Mode] feature is invalid. At this point, the system will enter the corresponding Standby or Manual mode upon exit from the ACGO mode.**

FIGURE 6-6 Press the [**Preset Mode**] Key to Set PCV as the Ventilation Mode upon Exit from the ACGO Mode

6.6.12.6 Monitor

When the anesthesia system has an external AG module configured, the system supports the Monitor mode. In the Manual ventilation mode, select the [**Monitor**] key to enable the Monitor mode. [**Monitor**] is displayed in the current mode area. The mode disables all ventilation related alarms.

6.6.12.7 Cardiac Bypass Mode

The Bypass mode turns off pressure, volume and apnea alarms when they are not appropriate (e.g., during heart/lung bypass).

Set whether to enter the Bypass mode in the automatic ventilation mode:

1. Enter the standby mode.
2. Select the icon > [**System**] key > enter and confirm the system password > [**Setup**] > [**Quick Key**] tab.
3. The [**Bypass in Auto mode**] can be set to (off) or (on).
   - When the [**Bypass in Auto mode**] is set to (off), the Bypass mode is only available in the Manual ventilation mode (not available in the Auto ventilation mode). Start the ventilation, if you select the [**Bypass**] key in the manual mode and select [**Yes**] in the pop-up dialog box, the system will enter the Bypass mode.
   - When the [**Bypass in Auto mode**] is set to (on), the Bypass mode is available in both the Manual and Auto ventilation modes. Start the ventilation, if you select the [**Bypass**] key on the Main Screen and select [**Yes**] in the pop-up dialog box, the system will enter the Bypass mode.

NOTE: When the Bypass mode is enabled, the [Alarms] button is disabled and automatically set to [Off].

When the system exits the Byapss mode, the [**Alarms**] button returns to its setting before the Byapss mode is enabled.

6.7 Start Automatic Ventilation

NOTE: Before starting a new automatic ventilation mode, ensure that all related ventilation parameters are set appropriately.

NOTE: Turn off the HFNC before starting the automatic ventilation to avoid affecting the accuracy of the automatic ventilation.

To start automatic ventilation from Standby mode:

1. Set the Auto/Manual switch to the Manual position.
2. Exit Standby by touching the Main Screen or by turning on the fresh gas.

3. Set the Auto/Manual Switch to the Auto position. The system will start automatic ventilation.

6.8 Stop Automatic Ventilation

To stop automatic ventilation:

1. Ensure that the breathing system is set up and the APL valve is set properly before stopping automatic ventilation.
2. Set the Auto/Manual switch to the Manual position to stop automatic ventilation.

6.9 Relationships of Ventilation Parameters

Different ventilation modes may share the same ventilation parameters and values. For example, SIMV-VC and VCV both include Vt, Plimit, RR, Tpause, and PEEP. Therefore, these parameter values that are linked may be passed from the previous ventilation mode to the current mode. B.11 (Pages B-12) "Ventilation Linkage Parameters" includes a table that lists how the linked parameter values are set when ventilation modes are changed.

Ventilation parameter values that are linked are set according to relationship equations. B.12 (Pages B-16) "Constraints Among Ventilation Parameters" includes a table of equations to show how linked parameter values are set when ventilation modes are changed.

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7.0 CO_2 Monitoring

7.1 Introduction

CO_2 monitoring is a continuous, non-invasive technique for determining the concentration of CO_2 in the patient's airway by measuring the absorption of infrared (IR) light of specific wavelengths. The CO_2 has its own absorption characteristic and the amount of light passing the gas probe depends on the concentration of the measured CO_2. When a specific band of IR light passes through respiratory gas samples, some of IR light will be absorbed by the CO_2 molecules. The amount of IR light transmitted after it has been passed through the respiratory gas sample is measured with a photodetector. From the amount of IR light measured, the concentration of CO_2 is calculated.

CO_2 measurement is used to monitor the respiratory status of the patient and guide the patient's ventilation. There are two methods for measuring CO_2 in the patient's airway:

- Mainstream measurement: Use a CO_2 sensor attached to an airway adapter directly inserted into the patient's breathing system.
- Sidestream measurement: Sample expired patient gas at a constant sample flow from the patient's airway, and analyze it with a CO_2 sensor built into the CO_2 module.

The rated respiration rate of the CO_2 module of the anesthesia system is 0 to 150 bpm, and the data sample rate is 50Hz. Besides, the $EtCO_2$ gas reading is subject to the peak value of the CO_2 waveform of the corresponding respiratory cycle.

The rated respiration rate range of the mainstream CO_2 module of the anesthesia system is 0 to 150 bpm, and the data sample rate is 100Hz. The $EtCO_2$ gas reading is subject to the peak value of the exhaled CO_2 waveform (settable items: the peak value of one respiratory cycle, the peak value within 10 seconds, and the peak value within 20 seconds).

The method used to determine the rated respiration rate range: utilize a valve to permit switching between the two sampling gases at different frequencies (simulating the range of specified respiration rates). Record the $EtCO_2$ value presented for each frequency. By drawing the coordinate diagram which indicates the corresponding relationship between end-tidal value and breathing frequency, the range of breathing frequency can be obtained, with $EtCO_2$ measurement accuracy complying with the specification.

CO_2 measurement provides:

1. CO_2 waveform.
2. End-tidal CO_2 ($EtCO_2$) value: the CO_2 value measured at the end of the expiration phase.
3. Fraction of inspired CO_2 ($FiCO_2$): the CO_2 value measured during the inspiration phase.
4. Respiratory rate (awRR): the breaths per minute.

7.2 Identify CO_2 Modules

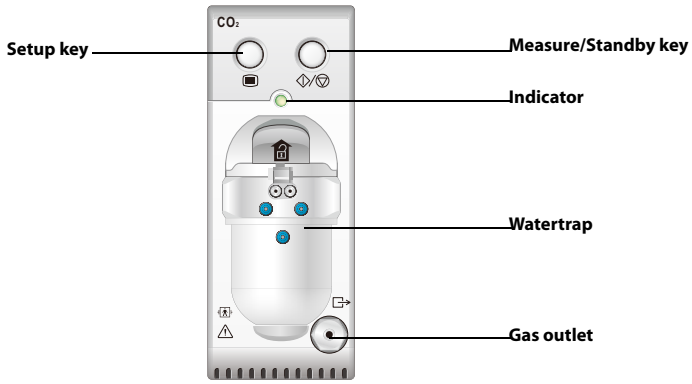

FIGURE 7-1 Sidestream CO2 Module

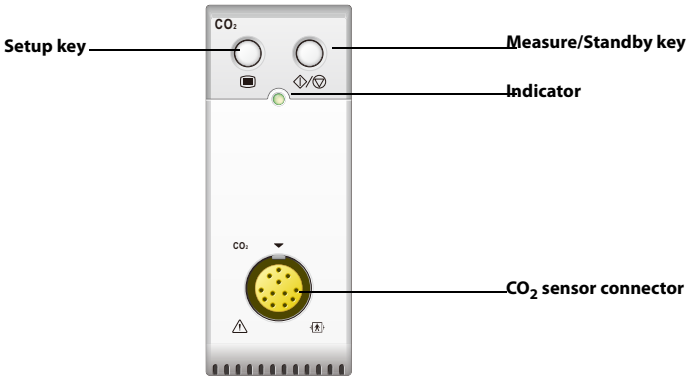

FIGURE 7-2 Mainstream CO_2 module

NOTE: The buttons on the CO_2 module have been disabled.

7.3 Prepare to Measure CO_2

7.3.1 Using a Sidestream CO2 Module

1. Select the appropriate watertrap according to patient type and attach it to the watertrap socket.
2. Connect one end of the gas sampling tube to the watertrap.
3. Connect the other end of the gas sampling tube to the patient.
4. Connect one end of the exhaust tube to the gas outlet on the module and the other end to the the sample gas return port on the anesthesia system to return the sample gas to the patient circuit.

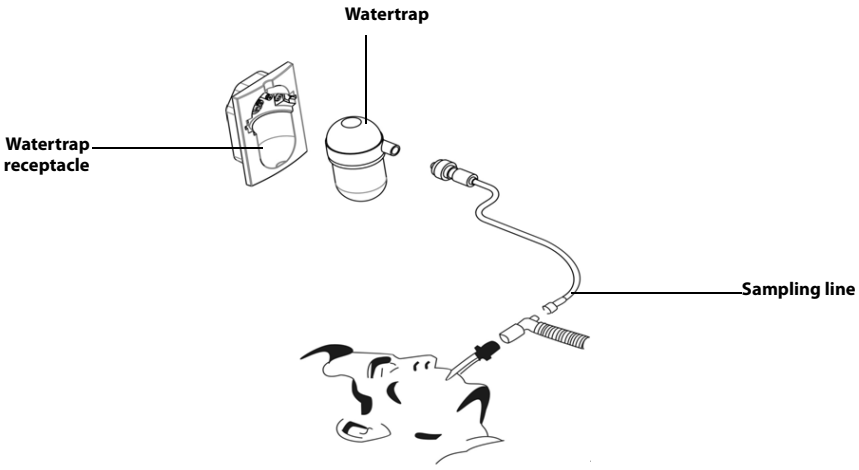

FIGURE 7-3 Prepare to Measure CO_2 (Sidestream CO_2 module)

5. By default, the sidestream CO_2 module is in measure mode. The [**CO2 Startup**] message appears on the screen when the CO_2 module is plugged in.
6. After start-up is finished, the [**CO2 Warm-up**] message is displayed. The CO_2 module is in ISO accuracy mode. If you perform CO_2 measurements during warm-up, the measurement accuracy may be compromised.
7. After warm-up is finished, the module enters full accuracy measure mode.

CAUTION: The watertrap collects water drops condensed in the sampling line, and therefore it prevents water drops from entering the module. When the water collected reaches a certain amount, pour it out to avoid blocking the airway.

CAUTION: The watertrap has the filter material, preventing bacterium, vapor and patient's secretions from entering into the module. After a long-term use, dust or other substances may compromise the air permeability of the filter material or even block the airway. In this case, the watertrap must be replaced. Replacing the watertrap every other month is recommended. Or, replace the watertrap when it is found leaky, damaged or contaminated.

7.3.2 Using a Mainstream CO_2 module

1. Connect the sensor to the CO_2 module.
2. By default, the mainstream CO_2 module is in measure mode. The [**CO2 Startup**] message appears on the screen when the CO_2 module is plugged in.
3. After warm-up is finished, connect the sensor to the airway adapter.
4. Perform a zero calibration. See section 7.8 (Pages 7-9) "Zero the Sensor".
5. After the zero calibration is finished, connect the airway as shown below.

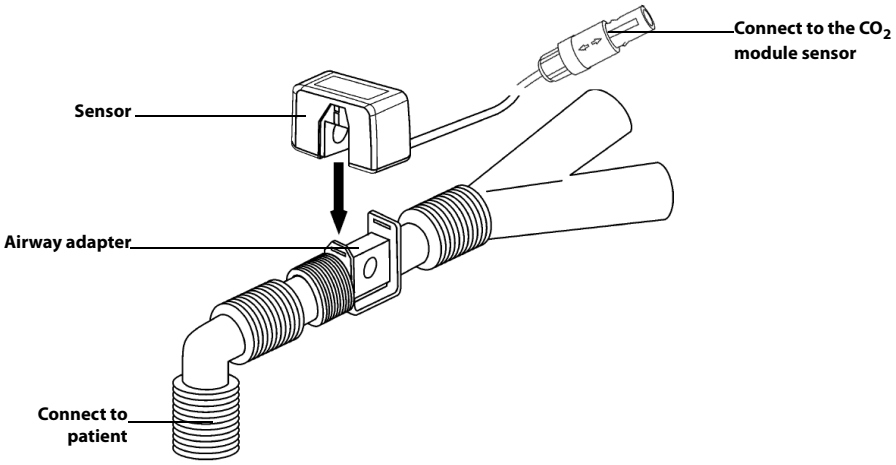

FIGURE 7-4 Prepare to Measure CO_2 (Mainstream CO_2 Module)

6. Make sure there are no leakages in the airway and then start a measurement.

NOTE: **Please install the sensor on the top of the adapter to avoid fluids accumulation on the windows of the adapter. High concentration of fluids accumulated at this position will obstruct gas analysis.**

7.4 CO_2 Setup

Perform the settings below when the anesthesia system configured with the CO_2 module.

7.4.1 Set Operating Mode

When the anesthesia system enters standby mode, then the CO2 module will also enter its standby mode. When the anesthesia system exits from standby mode, the CO2 module will also exit from its standby mode and enter measure mode.

For sidestream CO_2 module, the working components of the CO2 module such as gas pump are automatically turned off to extend the service life of the module in standby mode.

7.4.2 Set Flow Rate

For the sidestream CO_2 module, you can change the sampling rate of respiratory gas in the patient's airway by setting the flow rate.

1. Select the key > [**CO2**] key.
2. Select the [**Flow Rate**] tab.
3. Select an appropriate flow rate.
4. Select to confirm the changes.

WARNING: **Take the patient's physical endurance into consideration to set an appropriate flow rate.**

NOTE: **The flow rate is fixed at 50 ml/min for low-rate accessories.**

7.4.3 Set Max Hold

The $EtCO_2$ and $FiCO_2$ values in the CO_2 parameter area are refreshed in real time. For mainstream CO_2 module, you can set the method to calculate the $EtCO_2$ and $FiCO_2$.

1. Select the key > [**CO2**] key.
2. Select the [**Max Hold**] tab.
3. Set an appropriate value.

- [**Single Breath**]: $EtCO_2$ and $FiCO_2$ are calculated for every breath.
- [**10 Seconds**] or [**20 Seconds**]: The highest CO_2 concentration in the selected range of time is regarded as the $EtCO_2$, and the lowest CO_2 concentration is regarded as the $FiCO_2$.

4. Select to confirm the changes.

7.4.4 Set Barometric Pressure

The sidestream CO_2 module has the function of automatic barometric pressure compensation (the system automatically measures the barometric pressure of the environment which the anesthesia system is exposed to). However, the mainstream CO_2 module, with the default barometric pressure of 760 mmHg, does not have such function. You must modify the barometric pressure manually based on the actual situation. The method is as follows:

1. Select the key > [**CO2**] key.
2. Select the [**Barometric Press.**] button.
3. Enter the value of barometric pressure which the anesthesia system is exposed to.
4. Select to confirm the changes.

WARNING: Set the barometric pressure properly before using the mainstream CO_2 module. Improper settings will result in erroneous CO_2 readings.

7.4.5 Set Humidity Compensation

There are two types of gases that the CO_2 module will measure:

1. ATPD: Ambient Temperature and Pressure, Dry Gas.
2. BTPS: Body Temperature and Pressure, Saturated, that is, the damp gas at a body temperature of 37℃, with a relative humidity of 95% and a moisture partial pressure of 47 mmHg.

Moisture may lead to a higher CO2 reading. The module uses different formulas to calculate the CO2 partial pressure in the two circumstances:

ATPD: $P_{CO2}(mmHg) = CO_2(vol\%) \times P_{amb} / 100$

BTPS: $P_{CO2}(mmHg) = CO_2(vol\%) \times (P_{amb} - 47) / 100$

Where: P_{CO2} = CO_2 partial pressure, $vol\%$ = CO_2 concentration, P_{amb} =ambient pressure, and the unit is mmHg.

As the mainstream CO_2 module has a built-in heating component to prevent water vapor from condensing, setting humidity compensation is not needed. For the sidestream CO_2 module, humidity compensation can be switched on or off based on the actual situations. The settings method is as follows:

1. Select the key > [**CO2**] key.
2. Set [**BTPS Compen.**] to (off) or (on).
3. Select to confirm the changes.

7.4.6 Set Gas Compensations

WARNING: The various compensations should be set based on the actual situations. Otherwise, the measurement results may deviate significantly from the actual value, resulting in misdiagnoses.

For the sidestream CO_2 module:

1. Select the key > [**CO2**] key.
2. Select the [**O2 Compen.**], [**N2O Compen.**] or [**Des Compen.**] key.
3. Set the appropriate value.
4. Select to confirm the changes.

The total of the concentrations of the above three gas compensations can not be greater than 100 %.

For the mainstream CO_2 module:

1. Select the key > [**CO2**] key.
2. Set the following compensation based on actual circumstances:

- Select the [**Balance Gas**] key and set an appropriate value.
  - Air: When the respiratory gas of the patient is dominated by air.
  - N2O: When the respiratory gas of the patient is dominated by N2O.
- Select the [**O2 Compen.**] key and set an appropriate value.
  - Off: When the O_2 content in the measured gas is less than 30%.
  - Other options: Select appropriate values based on the O_2 content in the measured gas.
- Select the [**AG Compen.**] key and enter an appropriate value. When the patient's respiratory gas contains anesthetic gas, enter the content of the anesthetic gas to compensate the impact of the anesthetic gas on the measuring result.

3. Select to confirm the changes.

7.4.7 Set CO_2 Unit

To change the CO_2 Unit:

1. Select the key > [**System**] key (system password needed) > [**Setup**] > [**Language/Unit**] tab.
2. Select the [**CO2 Unit**] tab.
3. Choose [**mmHg**], kPa or %.
4. Select to confirm the changes.

7.4.8 Set CO_2 Scale

To change the CO_2 scale:

1. Select the key > [**Waveform**] key.
2. Choose the appropriate scale.

3. Select ✓ to confirm the changes.

7.4.9 Set Alarm Limits

You can set the high and low alarm limits of CO_2 to create alarm conditions consistent with patient needs. The alarm is then triggered when the parameter value is greater than the High Limit or lower than the Low Limit.

NOTE: When using the anesthesia system, ensure that the alarm limits of each parameter are set to the appropriate values for the patient.

To set the alarm limits:

1. On the Main Screen, select the [**Alarms**] key > [**Limits**] tab.
   Or, select the monitoring area to display the alarm limits settings menu.
2. Select a parameter key.

NOTE: When the monitoring value on the main screen flashes due to an alarm, select the flashing area to open the corresponding Alarm Limits setting menu.

3. Enter the desired parameter value using the keyboard on the screen. For each parameter, the range of values is displayed above the keypad.
4. You can select [**Load Alarm Defaults**] to restore the default values and restore the upper and lower limits of parameter alarms to the user default values.
5. Select ✓ to save the changes (or select ✗ to discard the changes).

7.5 Measurement Limitations

Measurement accuracy may be compromised due to:

- Leakage or internal sample gas leakage
- Mechanical shock
- Cyclic pressure which is greater than 10 kPa (100 cmH_2O)
- Other interference source (if available)

Measurement accuracy may be affected by the respiratory rate and I/E ratio as follows:

- EtCO2 is within specification for respiratory rate $\leqslant$ 60 bpm and I/E ratio $\leqslant$ 1:1;
- EtCO2 is within specification for respiratory rate $\leqslant$ 30 bpm and I/E ratio $\leqslant$ 2:1.

Measurement accuracy is unspecified for respiratory rate larger than 60 bpm.

7.6 Troubleshooting

When the sampling system of the sidestream CO_2 module works incorrectly, check if the sampling tube is kinked. If not, remove the sampling tube from the watertrap. Then, if a prompt message indicating airway malfunction appears on the screen, it means that the watertrap is occluded. In this case, you must replace the watertrap. If no such prompt message is displayed, it means that the sampling tube is occluded. Then you must replace the sampling tube.

7.7 Sample Gas Recirculation

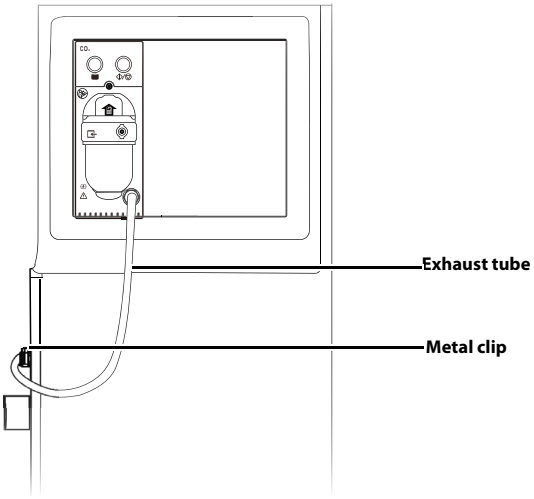

FIGURE 7-5 Sample Gas Recirculation (Sidestream CO2 Module)

To return the sample gas to the patient circuit, plug the exhaust tube into the sample gas return port marked . A click indicates that the connector of the exhaust tube is installed in place, as shown above. Depress the metal clip to pull out the exhaust tube. When using sidestream CO_2 module to perform CO_2 measurements on the patient who is receiving or has recently received anesthetic agents, connect the gas outlet on the module to the sample gas return port to prevent the medical staff from breathing in the anesthetic agent.

WARNING: When the sample gas recirculation feature is enabled, please install a breathing system filter compliant with the ISO 23328-1 and ISO 23328-2 standards on the patient end.

NOTE: The sample gas recirculation will not impact the testing precision.

7.8 Zero the Sensor

Zeroing the sensor aims to eliminate the effect of baseline drift on the readings during the measurement so as to ensure measurement accuracy.

For sidestream CO_2 module, a zero calibration is carried out automatically when necessary. You can also start a manual zero calibration when deemed necessary. You do not need to disconnect the sensor from the breathing system when performing the zeroing.

1. Ensure that the system is in Standby mode. If not, select [**End Case**] button on the main screen and follow the on-screen prompts to enter Standby mode.
2. Select the key > [**System**] key (system password needed).
3. Select the [**Calibrate**] key > [**CO2 Module**] key.
4. Select the [**Zero**] tab. The system will display the results of the zero status when the process is completed.
5. If zeroing fails, you can select the [**Retry**] key to zero again. If zeroing is completed successfully, you can select [**Continue**] to enter the calibration screen.

6. If there is no need to zero, you can select ✓ to close the window.

For mainstream CO_2 modules, zero the sensor whenever:

- A new adapter is used;
- The sensor is connected to the module again;
- The prompt message [**CO2 Zero Required**] is displayed on the screen when the sensor is not in the best Measure status. In this case, check the airway adapter for any blockage, e.g. mucus, etc. If it is occluded, clear or replace the adapter.

To zero the sensor, do as follows:

1. Connect the sensor to the CO_2 module. The message [**CO2 Warm-up**] is displayed.
2. After warm-up is finished, connect the sensor to a clean, dry airway adapter. The adapter should be vented to the air and isolated from CO_2 sources, such as anesthesia system, the patient's breathing, your own breathing, etc.
3. Select the ⚙ key > [**System**] key (system password needed).
4. Select the [**Calibrate**] key > [**CO2 Module**] key.
5. Select the [**Zero**] tab. The system will display the results of the zero status when the process is completed.
6. Select ✓ to close the window.

WARNING: When zeroing the sensor during the measurement, disconnect the sensor from the patient's airway first.

WARNING: Please do not rely on the readings during zeroing.

7.9 Calibrate the Sensor

For sidestream CO_2 module, a daily calibration is not required, but a calibration should be performed every other year or when the measured value has a great deviation. For mainstream CO_2 modules, no calibration is required.

Prepare the following before doing the calibration:

- Gas cylinder: one or more cylinders filled with 3%, 4%, 5%, 6%, or 7% CO_2
- T-shape connector
- Sampling tube

Follow the steps below to calibrate the CO_2 module:

1. Use the T-shape connector to connect the gas cylinder, gas bag and sampling tube as follows.

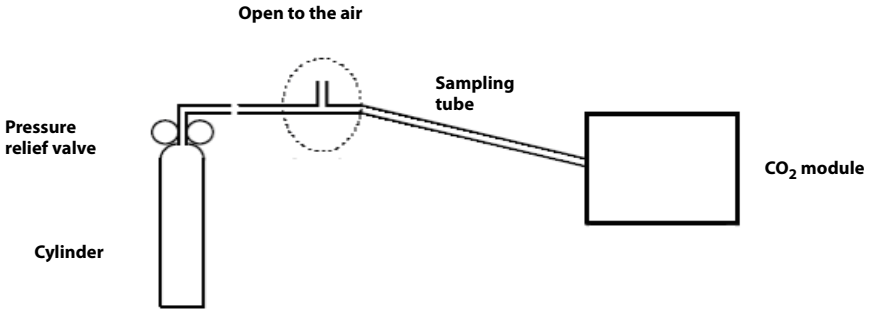

FIGURE 7-6 Calibrate the CO_2 Module

2. Ensure that the system is in Standby mode. If not, select [**End Case**] button on the main screen and follow the on-screen prompts to enter Standby mode.
3. Select the key > [**System**] key (system password needed).
4. Select the [**Calibrate**] tab.
5. Select the [**CO2 Module**] tab.
6. Wait for the CO_2 module to enter the full accuracy mode.
7. Enter the actual concentration of the calibration gas.
8. Turn on the calibration gas cylinder and the system will display the real-time concentration of calibration gas. Wait for the real-time concentration of calibration gas to become stable.
9. Select the [**Begin**] or [**Calibrate**] key to start calibrating the CO_2 module. The system will display the results of the calibration status when the process is completed.
10. If the calibration fails, you can select [**Retry**] to calibrate again or select [**Cancel**] to cancel the calibration. If the calibration is completed successfully, you can select [**Done**] to close the calibration screen.
11. Select to close the window.

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8.0 Anesthetic Gases and O_2 Concentration Monitored

8.1 Introduction

The anesthetic gas (AG) module measures the patient's anesthetic and respiratory gases, and incorporates the features of the O2 module as well.

The AG (anesthesia gas) module determines the concentrations of certain gases using the infrared (IR) light absorption measurement. The gases that can be measured by the AG module absorb IR light. Each gas has its own absorption characteristic. The gas is transported into a sample cell, and an optical IR filter selects a specific band of IR light to pass through the gas. For multiple gas measurement, there are multiple IR filters. This means that higher concentration of IR absorbing gas causes a lower transmission of IR light. From the amount of IR light measured, the concentration of gas present can be calculated.

Oxygen does not absorb IR light as other breathing gases and is therefore measured relying on its paramagnetic properties. Inside the O_2 sensor are two nitrogen-filled glass spheres hung on a torsion device in a symmetrical magnetic field. This assembly is suspended in a symmetrical non-uniform magnetic field. In the presence of paramagnetic oxygen, the glass spheres are pushed further away from the strongest part of the magnetic field. The strength of the torque acting on the suspension is proportional to the oxygen concentration. From the strength of the torque, the concentration of oxygen is calculated.

AG measurement provides:

1. Waveforms: CO_2, N_2O, O_2 and AA waveforms.
2. Measurement parameters: $EtCO_2$, $FiCO_2$, EtN_2O, FiN_2O, FiO_2, EtO_2, EtAA, FiAA and MAC.

Specifically, AA stands for any of the following anesthetic agents: Des (Desflurane), Iso (Isoflurane), Enf (Enflurane), Sev (Sevoflurane), or Hal (Halothane).

The rated respiration rate for AG module is 2 to 100 bpm. The data sample rate is 25 Hz. The peak value of the CO_2 waveform in the corresponding breathing cycle applies as the $EtCO_2$ gas reading. The peak value of the O_2 waveform in the corresponding breathing cycle applies as the O_2 gas reading. The EtN_2O and EtAA values at the time of the recorded CO_2 waveform apply as the EtN_2O and EtAA gas readings.

8.2 MAC Values

The minimum alveolar concentration (hereinafter referred to as MAC) can be displayed on the screen when the anesthesia system is configured with external AG module.

MAC is a basic index indicating the depth of inhaled anesthesia. The ISO 80601-2-55 defines MAC as follows: alveolar concentration of an inhaled anesthetic agent that, in the absence of other anesthetic agents and at equilibrium, prevents 50% of subjects from moving in response to a standard surgical stimulus.

The following table lists 1 MAC of various inhaled anesthetic agents.

Anesthetic agent	Des	Iso	Enf	Sev	Hal	N_2O
1 MAC	6.65 %	1.15 %	1.70 %	2.10 %	0.77 %	105%*

** 1 MAC of nitrous oxide can only be reached in a hyperbaric chamber.*

TABLE 8-1 1 MAC of Various Inhaled Anesthetic Agents

NOTE: The data shown in this table are from ISO 80601-2-55, which are published by the U.S. Food and Drug Administration for a healthy 40-year-old male patient.

NOTE: In actual applications, although the gas module accounts for patient age, the effects of weight and other factors on the inhaled anesthetic agent should be considered.

When one or more anesthetic agents are used, the formula for calculating MAC is as follows:

$$MAC = \sum_{i=0}^{N-1} \frac{EtAgent_i}{AgentVol_{age}i}$$

Where, N stands for the number of all anesthetic agents (including N_2O) which the AG module can measure, $EtAgent_i$ stands for the end-tidal concentration of each kind of inhaled anesthetic agent, and $AgentVol_{age}i$ stands for the 1 MAC value corresponding to the each kind of inhaled anesthetic agent after age correction.

The formula for calculating age correction of 1 MAC is as follows:

$$MAC_{age} = MAC_{40} \times 10^{(-0.00269 \times (age - 40))}$$

NOTE: The formula above is only available for patients who are older than one year old. If the patient is less than one year old, the system will use one year old to do age correction.

For example, the AG module measures that a 60-year-old patient's end-expiratory concentrations of Iso is 0.9% and that of N2O is 50%. Based on the above age correction formula, the 1 MAC value of Iso is 1.01% and that of N_2O is 92.7% for the 60-year-old patient, and the MAC value is:

$$MAC = \frac{0.9\%}{1.01\%} + \frac{50\%}{92.7\%} = 1.4$$

8.3 Agent Usage Calculation

CAUTION: The Agent Usage Calculation feature is intended for management purposes only and shall not be used as a basis for clinical decision-making.

The agent usage is displayed on the standby screen. The agent usage accumulates from 0 when the anesthesia system exits the standby mode. When the anesthesia system enters standby, the agent usage stops accumulating.

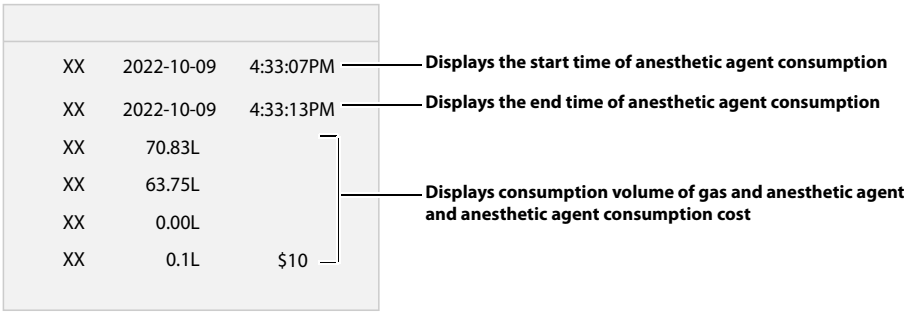

图 8-1 Agent Usage Calculation

Enable or disable the Agent Usage Calculation feature following the steps below:

1. Select the key > [**System**] key (system password needed) > [**Setup**] > [**Optimizer**] tab.
2. The [**Agent Usage**] can be set to (off) or (on). If the [**Agent Usage**] is set to (off), no agent usage data is displayed on the Main Screen. If the [**Agent Usage**] is set to (on), the agent usage is displayed on the Main Screen.

8.4 Agent Consumption Speed

CAUTION: The Agent Consumption Rate feature is intended for management purposes only and shall not be used as a basis for clinical decision-making.

The anesthesia system supports calculation of the agent consumption speed and cost.

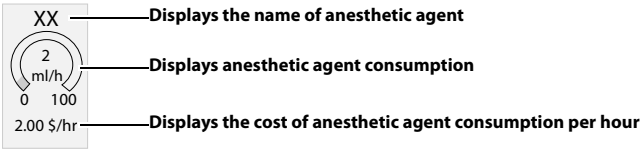

FIGURE 8-2 Agent Consumption Speed

Enable or disable the Agent Consumption Rate feature following the steps below:

1. Select the key > [**System**] key (system password needed) > [**Setup**] > [**Optimizer**] tab.
2. The [**Agent Usage**] can be set to (off) or (on). If the [**Agent Usage**] is set to (off), no agent consumption speed is displayed on the Main Screen. If the [**Agent Usage**] is set to (on), the agent consumption speed is displayed on the Main Screen.
3. Set the cost of anesthetic agent per ml. When the [**Agent Usage**] is set to (on), the cost of used agent is displayed on the Main Screen.

8.5 Identify External AG Module

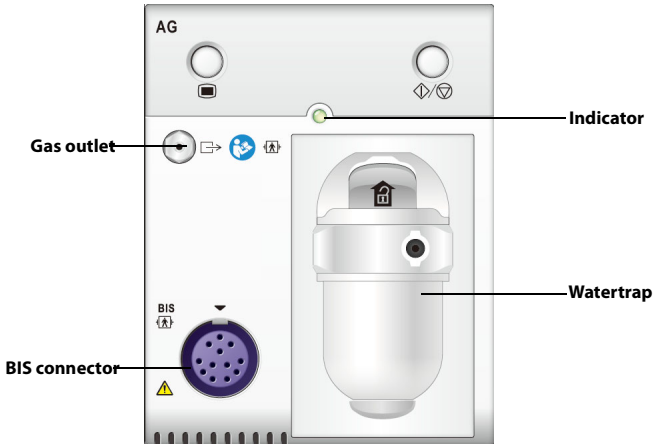

FIGURE 8-3 AG Module

NOTE: **The AG module is configured with the automatic barometric pressure compensation feature.**

NOTE: **The buttons on the AG module have been disabled.**

NOTE: **The indicator will flash when the module performs a self-test or when the communication between the module and the system is abnormal. The indicator is on when the communication between the module and the system is normal.**

8.6 AG Measurement Preparation

1. Select the appropriate watertrap according to patient type and attach it to the watertrap socket.
2. Connect one end of the gas sampling tube to the watertrap.
3. Connect the other end of the gas sampling tube to the patient via the airway adapter.
4. Connect one end of the exhaust tube to the gas outlet on the module and the other end to the the sample gas return port on the anesthesia system to return the sample gas to the patient circuit.

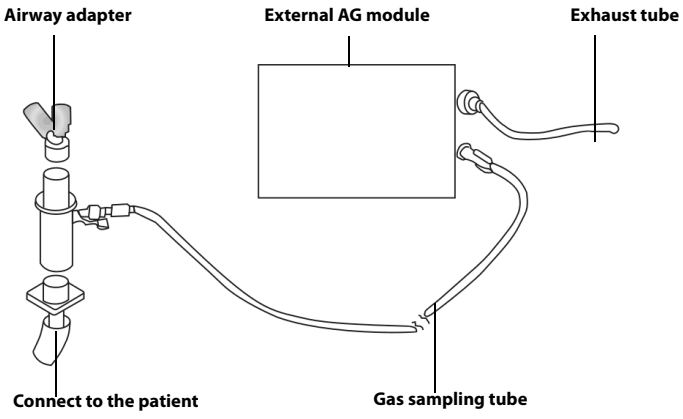

FIGURE 8-4 AG Measurement Preparation

CAUTION: **Position the airway adapter properly so that the part connecting to the gas sampling tube is pointing upwards. This prevents condensed water from entering the gas sampling tube and causing an occlusion as a result.**

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

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

WARNING: **Do not use the watertraps designed for adults/pediatric patients on infant patients. Otherwise it may cause injuries to the patients.**

WARNING: **Make sure that all connections are reliable. Any leak in the system can result in erroneous readings due to patient breathing gas mixed with ambient air.**

8.7 AG Module Settings

You can do the following settings when the anesthesia system is configured with an external AG module.

8.7.1 Set Operating Mode

When the anesthesia system enters standby mode, then the AG module will also enter its standby mode. When the anesthesia system exits from standby mode, the AG module will also exit from its standby mode and enter measurement mode.

8.7.2 Set AG Flow Rate

1. Select the key > [**AG**] tab.
2. Select the [**Flow Rate**] tab.
3. Select an appropriate flow rate.
4. Select to close the dialog box and confirm the changes.

8.7.3 Set CO_2 Unit

1. Select the key > [**System**] key (system password needed) > [**Setup**] > [**Language/Unit**] tab.
2. Select the [**CO2 Unit**] tab.
3. Choose [**mmHg**], [**kPa**] and [**%**].
4. Select to close the dialog box and confirm the changes.

8.7.4 Set CO_2 Scale

1. Select the key > [**Waveform**] tab.
2. Choose the appropriate scale.
3. Select to close the dialog box and confirm the changes.

8.7.5 Set O_2 Scale

1. Select the key > [**AG**] tab.
2. Select the [**O2 Scale**] tab.
3. Choose the appropriate scale.
4. Select to close the dialog box and confirm the changes.

8.7.6 Set N_2O Scale

1. Select the key > [**AG**] tab.
2. Select the [**N2O Scale**] tab.
3. Choose the appropriate scale.
4. Select to close the dialog box and confirm the changes.

8.7.7 Set AA Scale

1. Select the key > [**AG**] tab.
2. Select the [**AA Scale**] key. Specifically, AA stands for any of the following anesthetic agents: Des (Desflurane), Iso (Isoflurane), Enf (Enflurane), Sev (Sevoflurane), or Hal (Halothane).
3. Choose the appropriate scale.
4. Select to close the dialog box and confirm the changes.

8.7.8 Set Types of Agent

1. Select the key > [**System**] key (system password needed) > [**Setup**] > [**AG**] tab.
2. Select the [**Types of Agent**] tab.
3. Select the appropriate anesthetic agent. The system will automatically identify related types of anesthetic agent based on the settings.
4. Select to close the dialog box and confirm the changes.

8.7.9 Set Alarm Limits

You can set the high and low alarm limits of N_2O, CO_2, O_2 and agents to keep alarm conditions consistent with patient needs. The alarm is then triggered when the parameter value is greater than the High Limit or lower than the Low Limit.

NOTE: **When using the anesthesia system, ensure that the alarm limits of each parameter are set to the appropriate values for the patient.**

1. On the Main Screen, select the [**Alarms**] soft key > [**Agents**] tab.
   Or, select the monitoring area to display the alarm limits settings menu.
2. Select a parameter key that needs to be changed.

NOTE: **When the monitoring value on the main screen flashes due to an alarm, select the flashing area to open the corresponding Alarm Limits setting menu.**

3. Enter the desired parameter value using the keyboard on the screen. For each parameter, the range of values is displayed above the keypad.

4. You can select [**Load Alarm Defaults**] to restore the default values and restore the upper and lower limits of parameter alarms to the user default values.
5. Select ✓ to save the changes (or select ✗ to discard the changes).

8.8 Measurement Limits

The following factors may reduce measurement accuracy:

- Leakage or internal leakage of sample gas
- Mechanical shock
- Humidity or condensate
- Cyclic pressure greater than 10 kPa (100 cmH_2O)
- Other interference source (if available)

NOTE: The output gas data of the anesthesia module will be zero if the measured concentration is below the defined threshold for more than 3 seconds.

NOTE: Inaccuracy is specified at 10-55 °C operating temperature and default compensated for an H_2O partial pressure of 11mBar (i.e. 22 °C @40% RH conditions) and using a DRYLINE™ sampling system. Any other ambient H_2O partial pressure will dilute the gas sample to a different extent, causing a measurement error. Under the typical operating conditions, this effect is negligible. An increase of the ambient H_2O partial pressure to 30mBar (i.e. 28 °C @80% RH or 33 °C @60% RH) will cause a general error for all measured gases of 2% REL. For automatic compensation of the ambient humidity effect on the gas sample composition, the actual ambient H_2O partial pressure can be input to AION™ from the host via the communication interface.

8.9 Troubleshooting

If the gas inlet (including watertrap, sampling tube and airway adapter) is occluded by condensed water, airway occlusion will be prompted on the screen.

To remove the occlusion:

- Check the airway adapter for occlusion and replace it if necessary.
- Check the sampling tube for occlusion or kinking and replace it if necessary.
- Check the watertrap for water accumulation. Empty the watertrap. If the problem persists, replace the watertrap.

If the problem persists, internal occlusions may exist. Contact your service personnel.

If the exhaled O_2 concentration is higher than the inhaled O_2 concentration, it may be because of an overly low pump rate. It is recommended to increase the [**Flow Rate**].

8.10 Sample Gas Recirculation

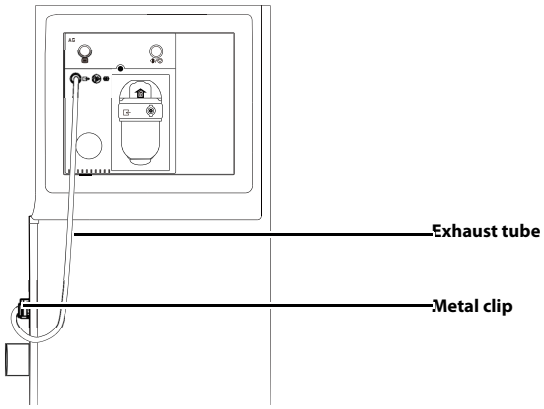

FIGURE 8-5 Sample Gas Recirculation

To return the sample gas to the patient circuit, plug the exhaust tube into the sample gas return port marked. A "snap" indicates that the connector of the exhaust tube is installed in place, as shown above. Depress the metal clip to pull out the exhaust tube.

WARNING: When using AG module to perform AG measurements on the patient who is receiving or has recently received anesthetic agents, you must connect the gas outlet on the module to the sample gas return port to prevent the medical staff from breathing in the anesthetic agent.

WARNING: When the sample gas recirculation feature is enabled, please install a breathing system filter compliant with the ISO 23328-1 and ISO 23328-2 standards on the patient end.

NOTE: The sample gas recirculation will not impact the measuring precision.

8.11 Calibrate the AG Module

Prepare the following before doing the calibration:

- Gas cylinder: The gas cylinder contains a standard or mixed gas. The gas concentration should meet the following requirements: AA>1.5%, CO_2>1.5%, N_2O >40%, and O_2>40%. AA represents an anesthetic gas.
- T-shape connector
- Breathing tubes

Follow the steps below to calibrate the AG module:

1. Use the T-shape connector to connect the gas cylinder, gas bag and sampling tube as follows.

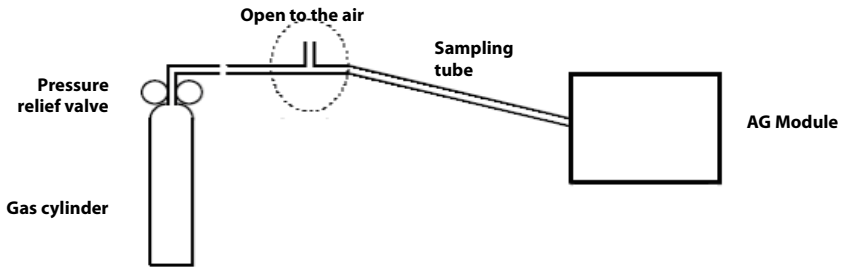

FIGURE 8-6 Calibrate the AG Module

2. Ensure that the system is in Standby mode.
3. Select the key > [**System**] key (system password needed).
4. Select the [**Calibrate**] tab.
5. Select the [**AG Module**] or [**Internal AG Module**] key.
6. Wait for the AG module to be fully warmed up.
7. Enter the actual concentration of the calibration gas.
8. Turn on the calibration gas canister. The system displays the real-time concentration of calibration gas.
9. Select the [**Begin**] key to start calibrating the AG module. The system will display the results of the calibration status when the process is completed.
10. If the calibration failed, select the [**Retry**] key to calibrate the module again.
11. Select to close the window.

9.0 BIS Monitoring

9.1 Introduction

Bispectral Index (BIS) monitoring is designed to monitor the hypnotic state of the brain based on acquisition and processing of EEG signals. Use of BIS monitoring to help guide anesthetic administration may be associated with the reduction of the incidence of awareness with recall during general anesthesia or sedation.

There are two BIS solutions available for use with the BIS module: using the BISx or using the BISx4. The BISx is for single side BIS monitoring, and the BISx4 is for both single side and bilateral BIS monitoring. The BISx4 provides bilateral BIS monitoring only when the BIS Bilateral Sensor is connected.

The BIS component using on this monitor is purchased from Medtronic. It is important to recognize this index is derived using solely that company's proprietary technology. Therefore, it is recommended that clinicians have reviewed applicable information on its utility and/or risks in published articles and literature/web site information from Medtronic, or contact Medtronic for clinical-based BIS questions. Failure to do so could potentially result in the incorrect administration of anesthetic agents and/or other potential complications of anesthesia or sedation. We recommend that clinicians also review the following practice advisory (that includes a section on BIS monitoring): The American Society of Anesthesiologists, Practice Advisory for Intraoperative Awareness and Brain Function Monitoring (Anesthesiology 2006;104:847-64). Clinicians are also recommended to maintain current knowledge of FDA or other federal-based regulatory, practice or research information on BIS and related topics.

To make it easier for the operator to understand what is being measured and any limitations. Some technical details of the BIS module are provided, including:

- Input dynamic range: ±1Mv
- EEG bandwidth: 0.25 to 100Hz
- Noise (RTI): <0.3 μV (0.25 to 50 Hz)
- Patient leakage current: <10 μA

BIS monitoring is intended for adult and pediatric patients.

9.2 Identify BIS Module

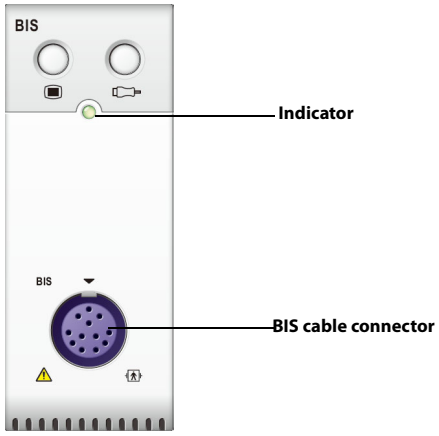

FIGURE 9-1 BIS Module

9.3 Safety Information

WARNING: BIS monitoring is not intended for neonatal patients.

WARNING: Ensure the conductive parts of sensors and connectors do not contact any other conductive parts, including earth.

WARNING: When using the electrosurgical unit, do not place the BIS sensor between the surgical site and the negative electrode plate of the electrosurgical unit to avoid burns.

WARNING: Using brain stimulation devices, such as transcranial electrical stimulation of motor-evoked potentials, keep stimulation electrodes as far away from the BIS sensor as possible and ensure that the electrodes and sensor are placed in accordance with the instructions on the package to avoid burns.

WARNING: When defibrillation is performed on a patient under BIS monitoring, the BIS sensor cannot be placed between the defibrillation electrode plates or pads.

WARNING: The clinical performance, risks/benefits and application of the BIS feature for pediatric patients are not fully verified and assessed.

WARNING: For patients with neurological disorders, patients taking psychoactive medication and children under one year old, BIS values should be interpreted cautiously due to the limited clinical experience.

WARNING: The BIS monitoring is a complex technology, intended for use only as an adjunct to clinical judgment and training. Clinical judgment should always be used when interpreting BIS in conjunction with other available clinical signs. Reliance on BIS alone for intraoperative anesthetic management is not recommended.

WARNING: Misinterpretation of BIS can result in incorrect administration of anesthetic agents and/or other potential complications of anesthesia or sedation.

WARNING: BIS values should be interpreted cautiously with certain anesthetic combinations, such as those relying primarily on either ketamine or nitrous oxide/narcotics to produce unconsciousness.

WARNING: Use the BIS accessories specified in A.0 (Pages A-1) "Accessories" to ensure that the defibrillation protection requirements are met.

CAUTION: Ensure that the BISx or BISx4 does not come into prolonged contact with the patient's skin, as it may generate heat and cause discomfort.

CAUTION: Do not use the BIS sensor if the sensor gel is dry. To avoid dryout, do not open the pack until you are ready to use the sensor.

CAUTION: When using electro-convulsive therapy (ECT) equipment during BIS monitoring, place ECT electrodes as far as possible from the BIS sensor to minimize the effect of interference. Certain ECT equipment may interfere with the proper function of the BIS monitoring system. Check for compatibility of equipment during patient setup.

CAUTION: The BIS measurement based on measuring the EEG signal is inherently very sensitive. Do not use electrical radiating equipment close to the BISx or BISx4.

CAUTION: Artifact may lead to inappropriate BIS values. Potential artifact may be caused by unusual or excessive electrical interference or high EMG activity like shivering, muscle activity or rigidity, sustained eye movements, head and body motion. Also, improper sensor placement and poor skin contact (high impedance) may cause artifact and interfere with the measurement.

CAUTION: External radiating devices may disturb the measurement.

CAUTION: Poor signal quality may lead to inappropriate BIS values.

9.4 Monitoring Steps

1. Connect the BISx or BISx4 device to the BIS module.

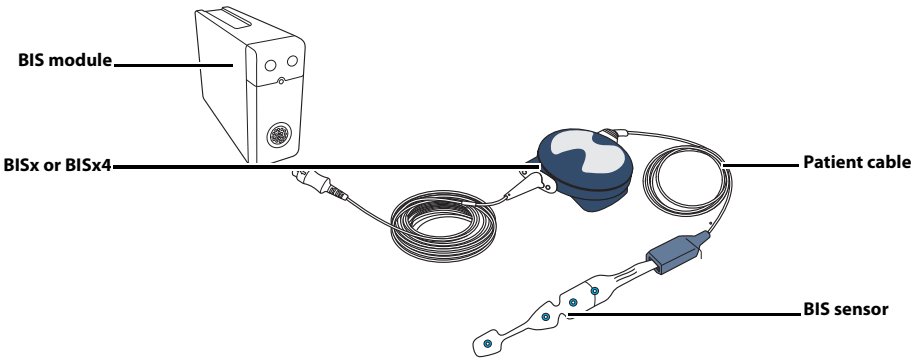

FIGURE 9-2 Device Connection

2. Use the attachment clip on the back of BISx or BISx4 equipment to keep the equipment fixed at an appropriate position near near the patient, but not above the level of the patient's head.
3. Connect the BISx or BISx4 device to the patient cable.
4. Attach the BIS sensor to the patient following the instructions supplied with sensor.
5. Connect the BIS sensor to the patient cable. Once the equipment detects an effective sensor, it automatically measures the impedance values of all electrodes and displays the results on the screen.

WARNING: Be careful not to wrap the patient cables around the patient.

NOTE: Make sure that the patient's skin is dry. A wet sensor or a salt bridge could result in erroneous BIS and impedance values.

NOTE: Do not use the BIS sensor if the sensor gel is dry. To avoid dry out, do not open the pack until you are ready to use the sensor.

NOTE: Due to intimate skin contact, reuse may pose risk of infection. If skin rash or other unusual symptom develops, stop using and remove the sensor.

9.5 BIS Parameters

If the anesthesia system is configured with BIS module, there will be an area displaying BIS related monitoring parameters in parameter display area on the screen.

For BIS monitoring of unilateral cerebral hemisphere, the BIS parameter area includes the following parameters:

1. Bispectral index (**BIS**)

The BIS numeric value reflects the patient's level of consciousness. Typically, it ranges from 40 to 60 for a patient under general anesthesia during surgery.

BIS NUMERIC VALUE	DESCRIPTION
100	The patient is totally conscious.
70	The patient is in light hypnotic state but still unlikely to be awakened.
60	The patient is under general anesthesia, loses consciousness and is in moderate hypnotic state.
40	The patient loses consciousness and is in deep hypnotic state.
0	The EEG waveform is displayed as a flat line, and the patient has no electrical brain activity.

TABLE 9-1 BIS numeric value

2. Signal Quality Index (**SQI**)

The SQI numeric value reflects signal quality and provides information about the reliability of the BIS, SEF, TP, and SR numeric values during the last minute period. Generally, the higher the level, the better the signal. If signal quality is too low to accurately calculate a BIS value, the BIS value and other trend variables are affected by artifact will not display. SQI bar chart is filled evenly based on SQI values. It ranges from 0 to 100%.

1 bar represents that SQI is in the range of 1% to 20%.

2 bars represents that SQI is in the range of 21% to 40%.

3 bars represents that SQI is in the range of 41% to 60%.

4 bars represents that SQI is in the range of 61% to 80%.

5 bars represents that SQI is in the range of 81% to 100%.

- 0 to 15%: the numeric values cannot be derived.
- 15 to 50%: the numeric values cannot be reliably derived.
- 50 to 100%: the numeric values are reliable.

3. Electromyograph (**EMG**)

EMG numeric value reflects the electrical power of muscle activity and high frequency artifacts. Low EMG indicates that EMG activity is low. EEG monitoring conditions are optimal when the bar is empty: EMG < 30 dB.

- 1 to 4 bars: EMG 30 to 55 dB. EEG monitoring conditions are acceptable.
- 5 bars: EMG > 55 dB. EEG monitoring conditions are unacceptable.

4. Suppression Ratio (**SR**)

SR is the percentage of time over the last 63-second period in which the EEG is considered to be in the suppressed state. For example, if SR = 10, it indicates that 10% of the signals are suppressed within the last 63 seconds, and the suppression time is 6s. If SR= 100%, the EEG signal is a straight line. It has certain application value for brain injury, coma, hypoxia, hypothermia, premature infant and anesthesia.

5. Spectral edge frequency (**SEF**)

SEF is the frequency below which 95% of the total power can be measured.

6. Total Power (**TP**)

TP numeric number which monitors the state of the brain indicates the power in the frequency band ranging from 0.5 to 30 Hz. The available range is 40 to 100dB.

7. Burst count (**BC**)

A burst means a train of EEG burst pulse and there is no electrical activity of the brain followed and preceded by the period of burst activity (at least 0.5 second). The BC numeric value reflects the number of EEG bursts per minute, helping you quantify the suppression level of EEG. This parameter is only available for the BIS module of the Extend Sensor. BC value is valid only when SQI $\geqslant$ 15% and SR $\geqslant$ 5%.

For BIS monitoring of bilateral cerebral hemisphere, the BIS parameter area includes the following parameters:

1. **BIS L**: bispectral index of left brain
   BIS R: bispectral index of right brain
2. **EMG L**: electromyograph of left brain
   EMG R: electromyograph of right brain
3. **SR L**: suppression ratio of left brain
   SR R: suppression ratio of right brain
4. **SEF L**: spectral edge frequency of left brain
   SEF R: spectral edge frequency of right brain
5. **SQI L**: signal quality index of left brain
   SQI R: signal quality index of right brain
6. **TP L**: total power of left brain
   TP R: total power of right brain
7. **BC L**: burst count of left brain
   BC R: burst count of right brain
8. BIS variability index (**sBIS**)
   BIS variability index represents the standard deviation of BIS value in the last three minutes.
   sBIS L: BIS variability index of the left brain
   sBIS R: BIS variability index of the right brain
9. EMG variability index (**sEMG**)
   EMG variability index represents the standard deviation of EMG value in the last three minutes.
   sEMG L: EMG variability index of the left brain
   sEMG R: EMG variability index of the right brain
10. Asymmetry (**ASYM**)
    Asymmetry represents the asymmetry in EEG powers of bilateral cerebral hemispheres and is the difference for percentages of EEG power present in left or right hemisphere with respect to total EEG power present in total brain. ASYM value with the prefix of "L" indicates the total power of left brain is greater than right brain. ASYM value with the suffix of "R" indicates the total power of right brain is greater than left brain.

9.6 BIS Screen

The waveforms related to BIS are shown in the split split screen field.

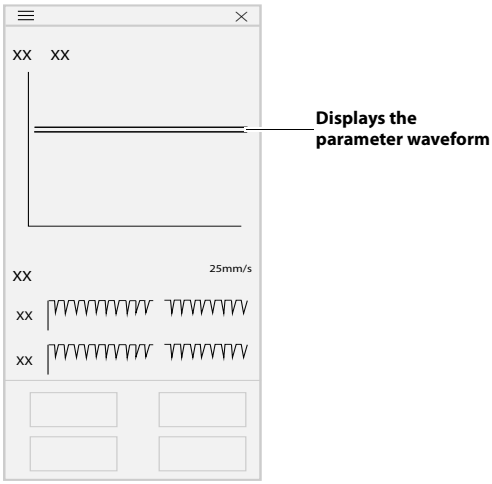

FIGURE 9-3 BIS Screen (Taking BISx4 as an Example)

9.6.1 View Waveforms

Select [**Views**] key, and select the waveform to be viewed as needed.

9.6.2 Set Trend Length

Select [**Trend Length**] key, and set [**Trend Length**] to [**6 min**], [**12 min**], [**30 min**] or [**60 min**].

9.6.3 Set EEG Size

If you view EEG waveform, you can set the EEG size of this waveform. Select [**EEG Size**] key, and set [**EEG Size**] to [**50 μV**], [**100 μV**], [**200 μV**] or [**500 μV**].

9.6.4 Set ECG Speed

If you view EEG waveform, you can set the EEG speed of this waveform. Select [**EEG Speed**] key, and set [**EEG Speed**] to [**6.25 mm/sec**], [**12.5 mm/sec**], [**25 mm/sec**] or [**50 mm/sec**]. The larger the numeric value is, the faster the scanning speed is.

9.7 Automatic Impedance Check

By default, this check is switched on.

The Impedance Check will continuously check the impedance of the signal electrodes and the reference electrode. This check does not affect the EEG waveform. As long as the impedances are within the valid range, no prompt message or result about this check will be given.

The Impedance Check checks the impedance of ground electrode once every ten minutes and takes approximately four seconds each time. An artifact in EEG waveform will be caused during this check, and the message [**BIS Ground Checking**] will be prompted. If the ground electrode does not pass this check, another impedance check is initiated. This continues until the ground electrode passes the check.

If the automatic impedance check interferes with other monitors or measurements, it can be switched off.

1. Select the key > [**BIS**] key.
2. Set [**Impedance Check**] to (Off) on the pop-up screen.

CAUTION: Automatic sensor check may need to be disabled if the 1 nA 128 Hz Impedance check signal interferes with other equipment.

CAUTION: After switching off the automatic impedance check, the user will not be notified about the impedance value changes, which may lead to incorrect BIS values. Therefore, Auto Check should only be switched off if the check interferes with other measurements.

9.8 Sensor Impedance Check

Sensor impedance check measures the exact impedance of each individual electrode, and it causes a disturbed EEG waveform. During the check, the message [**Sensor Check In Progress**] will be displayed on the screen.

The check can be started by the following ways:

- The sensor impedance check is automatically initiated when a sensor is connected.
- Select the [**Views**] key on the BIS screen, and select [**Sensor**] in the opened options. And then select the [**Check Sensor**] key.

The check can be stopped by the following ways:

- The sensor impedance check stops automatically if the impedances of all electrodes are within the valid range.
- Select the [**Views**] key on the BIS screen, and select [**Sensor**] in the opened options. And then select the [**Stop Check Sensor**] key.

Depending on the different sensors used, the sensor check interfaces may slightly be different. This system can automatically identify the type of the used sensor, and show the corresponding electrode on the sensor check interface.

The impedance status of the sensor is marked by a color. The color of each electrode indicates its status:

COLOR	STATUS	DESCRIPTION	ACTION THAT SHOULD BE TAKEN
Red	Lead off	Electrode falls off and has no skin contact.	Press the sensor edge down to ensure good skin contact. Check the connection of the sensor. If the problem persists, remove the sensor, thoroughly clean the skin, and allow the skin to dry before repositioning the sensor or replacing it with a new one.
Grey	Noise	The noise is too loud. Impedance cannot be measured.	Check sensor contact with skin. Press the sensor edge down to ensure good skin contact.
Yellow	High	The impedance is above the high limit.	
Green	Pass	The impedance is within valid range.	No action necessary.

COLOR	STATUS	DESCRIPTION	ACTION THAT SHOULD BE TAKEN
Blue	Unknown	In check or not performed yet	No action necessary.

TABLE 9-2 Result of sensor check

Although BIS can still be measured when the electrode status is [**Noise**] or [**High**]. However, to achieve the best performance, all electrodes should be in [**Pass**] status.

The sensor check may fail for the following reasons:

- Impedance too high
- Incorrect sensor application
- Poor sensor connection
- Defective sensor or patient cable

To correct the situation:

- Check the sensor
- Relocate the sensor according to instructions
- Check sensor connection
- Replace sensor or patient cable

9.9 View DSA

Select the [**Views**] key on the BIS screen, and select [**DSA**] in the opened options to call out the DSA screen.

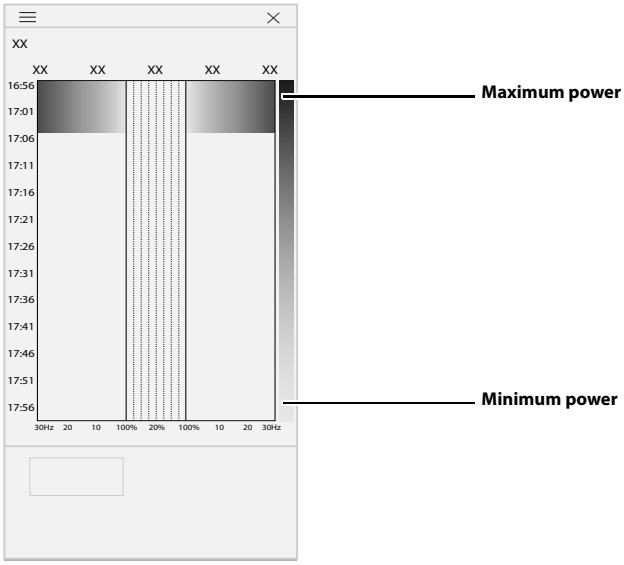

FIGURE 9-4 DSA

The Density Spectral Array (DSA) can visually show changes in the power spectrum distribution of bilateral cerebral hemispheres over a certain time period. DSA window shows the following information:

- y-axis: time scale
- x-axis: signal frequency scale from 0 to 30 Hz

- Color bar: shows range of power by color. Red indicates maximum power and blue indicates minimum power.
- Spectral edge frequency (SEF) trend: The white curve on the graph represents the changes in Spectral Edge Frequency (SEF). 95% of the total power lies on the side with lower frequency; 5% of total power lies on the side with higher frequency.
- The current SEF value: displays on top of the DSA window.
- ASYM graph: displays in the center of the DSA window. It shows the degree of asymmetry in EEG power between the left and right hemispheres. The ASYM scale begins at 20% at the center line and runs left or right to 100%. Asymmetry data less than 20% are not displayed on the graph, but are available in the tabular trends.

9.10 BIS Module Settings

9.10.1 BIS Module Switch

1. Select the key > [**BIS**] key.
2. Set [**BIS Module**] to (on) or (off) to turn on or turn off the BIS module.

9.10.2 Impedance Check

1. Select the key > [**BIS**] key.
2. Set [**Impedance Check**] to (on) or (off) to turn on or turn off the automatic impedance check.

9.10.3 EEG Filter

1. Select the key > [**BIS**] key.
2. Set [**EEG Filter**] to (on) or (off) to turn on or turn off the EEG filter function.

9.10.4 Smoothing Rate

1. Select the key > [**BIS**] key.
2. Set [**Smoothing Rate**] to [**10 Sec**], [**15 Sec**] or [**30 Sec**].

The smoothing rate defines how the anesthesia system calculates the BIS data on average. A smaller smoothing rate indicates increased responsiveness by the anesthesia system to changes in the patient's state. A larger smoothing rate indicates a smoother BIS trend with smaller variation, and decreased sensitivity to artifacts.

9.10.5 Monitored Parameters

1. Select the key > [**BIS**] key.
2. Set the monitored parameters to (on) or (off) to show or hide the monitored parameters.

9.10.6 Set Alarm Limits

You can set the high and low alarm limits of BIS to create alarm conditions consistent with patient needs. The alarm is then triggered when the parameter value is greater than the High Limit or lower than the Low Limit.

NOTE: **When using the anesthesia system, ensure that the alarm limits of each parameter are set to the appropriate values for the patient.**

To set the alarm limits:

1. On the Main Screen, select the [**Alarms**] soft key > [**Limits**] tab.
   Or, select the monitoring area to display the alarm limits settings menu.
2. Select a parameter key.

NOTE: **When the monitoring value on the main screen flashes due to an alarm, select the flashing area to open the corresponding Alarm Limits setting menu.**

3. Enter the desired parameter value using the keyboard on the screen. For each parameter, the range of values is displayed above the keypad.
4. You can select [**Load Alarm Defaults**] to restore the default values and restore the upper and lower limits of parameter alarms to the user default values.
5. Select ✓ to save the changes (or select ✗ to discard the changes).

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10.0 NMT Monitoring

10.1 Introduction

NMT (neuromuscular transmission) module quantitatively evaluates the degree of muscle relaxation of patients under neuromuscular blockage by imposing controllable electrical stimulation to a specific motor nerve, using acceleromyography (AMG) to implement motion capture on corresponding muscle responses and extracting the features of the response signals obtained.

10.2 Identify NMT Module

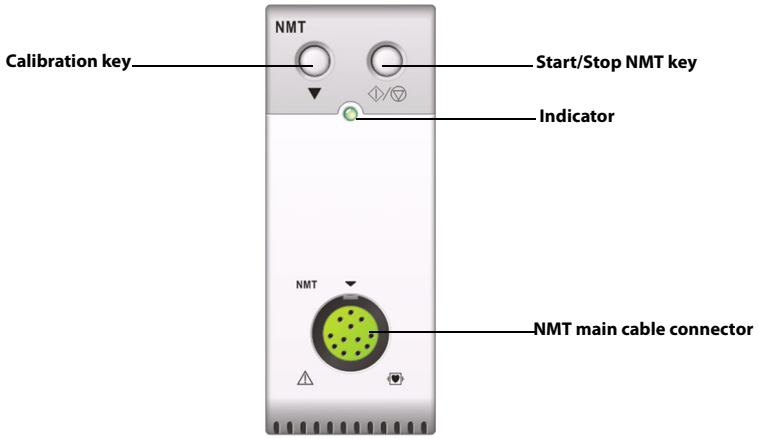


FIGURE 10-1 NMT Module

10.3 Safety Information

WARNING: The NMT measurement is only intended for adult and pediatric patients, not intended for neonatal patients.

WARNING: The NMT stimulation should not be applied directly on the eyes, mouth and the front of the neck (especially the carotid sinus) or the stimulation should not be applied from electrodes placed on the chest and the upper back or placed cross over the heart.

WARNING: Application of electrodes near the thorax may increase the risk of cardiac fibrillation.

WARNING: Never place the electrodes in body areas where inflammation or injury is evident.

WARNING: When you are connecting the electrodes or the patient cable, make sure that the connectors do not touch any other electrically conductive materials or ground.

WARNING: Patients with nerve damage or other neuromuscular problems may not respond properly to stimulation. The NMT measurement may show abnormal results when monitoring the status of muscle paralysis in these patients.

WARNING: NMT stimulation current pulses may interfere with other sensitive equipment, for example, implanted cardiac pacemakers. Do not use the NMT measurement on patients with implanted medical devices unless directed by a medical specialist.

WARNING: Simultaneous use of the NMT measurement with electrosurgical equipment may result in burns at the stimulation site in rare cases and can also adversely affect measurement accuracy. Make sure the negative plate of electrosurgical equipment is properly connected to the patient in order to avoid the burn at the NMT stimulation electrode.

WARNING: Do not use the NMT measurement in close proximity to shortwave or microwave therapy devices, otherwise, the measurement result may be adversely affected.

WARNING: Never touch the stimulation electrodes during the electrical stimulation unless the stimulation has been stopped.

WARNING: Always check if the insulating barrier of the NMT sensor and the stimulation cable is in good condition and does not show signs of wear and tear before using.

CAUTION: NMT monitoring can only used as an auxiliary method in patient assessment. When you use it, you must observe the clinical signs and symptoms of the patient.

CAUTION: NMT monitoring can be painful to a non-sedated patient. It is recommended not to stimulate before the patient is adequately sedated.

CAUTION: Only use applicable electrodes as per doctors' advice.

CAUTION: Pay special attention to current densities exceeding 2 mA r.m.s/cm^2 for any electrodes.

10.4 Stimulation Modes

The NMT measurement provides the following four stimulation modes. Some NMT stimulation modes require a little neurophysiological recovery time and during this recovery phase, no new measurement and calibration can be started.

10.4.1 TOF mode

The TOF (Train-Of-Four) mode is the most common mode for clinical purposes.

In TOF mode, the module generates four stimulation pulses at 0.5 second intervals while measures the patient's reaction, and calculates the ratio of the fourth to the first response of the TOF sequence (TOF-Ratio).

When muscle relaxation continues to deepen, the TOF-Ratio declines until the fourth response disappears and no TOF-Ratio is calculated. When T1 is too low, the TOF-Ratio cannot be calculated. At this point, the degree of muscle relaxation of the patient can be estimated from the number of responses detected (TOF-Count). The count of TOF-Count indicates how many times the response is detected in relation to 4 stimulations. The fewer the response count is detected, the deeper is the muscle relaxation.

If the proper reference response value is obtained during the calibration process, the first response amplitude T1 of each TOF measurement as percentage of the reference response value is calculated resulting in T1 %.

In TOF mode, the measurement recovery time is 10 seconds. If the calibration and measurement are initiated during this period, the module will automatically delay the calibration and measurement.

10.4.2 ST Mode

In single twitch stimulation (ST) mode, the module sends a single electrical pulse and measures the response of the patient. If the proper reference response value is obtained during the calibration process, the response value of each TOF measurement as percentage of the reference response value is calculated by the module, resulting in ST-Ratio.

When using depolarizing muscle relaxants, the ST mode is practical if TOF-Ratio does not give any additional information about the patient status. Additionally, when the doctor needs to observe the fast change of patient's muscle relaxation level, ST stimulation at a frequency of 1 Hz can provide more precise measurement and provide the muscle relaxation changes in a more real-time way.

10.4.3 PTC Mode

When muscle relaxation deepens, different parameters are needed to measure the response. When the response to the fourth stimulation disappears or the first stimulation response is very weak, the TOF-Ratio cannot be obtained and only the number of responses TOF-Count can be observed. When stimulation pulses no longer give any stimulation response, the TOF-Count cannot be obtained either. To monitor the muscle relaxation level, you can start the PTC mode.

PTC stimulation mode starts with a sequence of four current pulses delivered at 2 Hz. If a muscle response is detected, the PTC sequence will be stopped and the response will be recorded as TOF result. If there is no muscle response, the tetanic stimulation continues to be delivered for 5 seconds with a frequency of 50 Hz, followed by a pause of 3 seconds, followed by 20 pulses delivered at interval of 1 second. The number of detected responses is counted and expressed as PTC. The fewer responses are detected, the deeper is the muscle relaxation.

After exiting the PTC mode, NMT measurements and calibration will be disabled for 20 seconds, and PTC mode can only be entered again in 2 minutes.

10.4.4 DBS Mode

Double Burst Stimulation (DBS) enables better visual observing for the fading in the responses. DBS consists of two separate trains of impulses, where each train of impulse consists of certain pulses at a frequency of 50 Hz. The response ratio of the second response to the firs response is calculated and expressed as DBS-Ratio, while the number of responses is detected and counted as DBS-Count.

The module supports DBS 3.2 mode and DBS 3.3 mode.

- DBS 3.2 mode: consists of two consecutive bursts of pulses at an interval of 750ms. The first burst consists of three consecutive pulses, and the second burst consists of two consecutive pulses. The interval between the pulses in the same burst is 20ms.
- DBS 3.3 mode: consists of two consecutive bursts of pulses at an interval of 750ms. Each burst consists of three consecutive pulses, and the interval between the pulses in the same burst is 20ms.

In DBS mode, the measurement recovery time is 15 seconds. If the calibration or the measurement is initiated during this period, the module will automatically delay the calibration and measurement.

10.5 NMT Measurement Preparation

Before taking NMT measurement, connect the NMT cable to the NMT module. The following picture shows NMT cable is connected with patient.

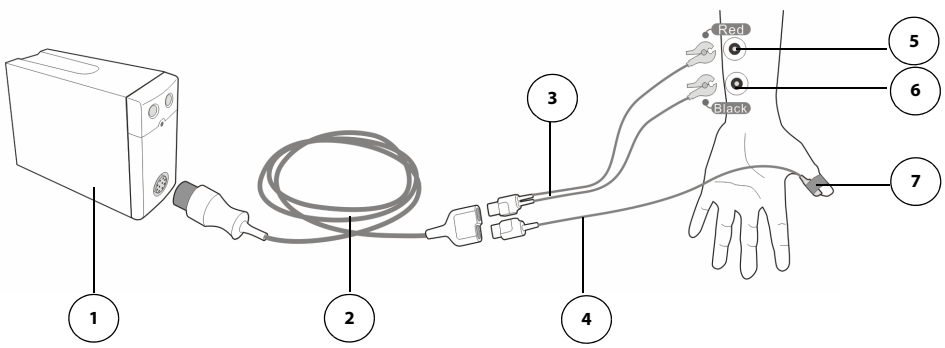


FIGURE 10-2 Device Connection

1. NMT Module
2. NMT main cable
3. NMT stimulation cable
4. NMT sensor cable
5. Proximal electrode
6. Distal electrode
7. NMT sensor

10.5.1 Skin Preparation

Good electrode-to-skin contact is important for good stimulation quality. Before applying the electrodes, clean the application site of oil and dirt and avoid placing the electrodes over the site where there is excessive body hair or lesion. Insufficient cleaning of the skin can cause high skin impedance which could cause the stimulation to stop.

1. Select sites with intact skin and without lesion of any kind to place the electrodes.
2. Clip or shave the body hair of the application sites as necessary.
3. Gently rub the skin surface at the electrode to remove dead skin cells.
4. Thoroughly clean the sites where the electrode will be placed with mild soap and water.
5. Dry the skin thoroughly, leaving no soap residue.

10.5.2 Place Electrodes and Sensor

It is suggested that you place the two stimulating electrodes to along the course of the ulnar nerves on the patient's wrist for NMT measuring. ECG electrodes for pediatric or neonatal patients are recommended. It is required to use CE-certified electrodes. Make sure that the patient's thumb can move freely before installing the electrodes and sensor.

Follow the steps below to place the electrodes and sensor:

1. Place the distal electrode close to the wrist.

2. Place the proximal electrode 2 to 3 cm away from the distal electrode.
3. Attach the black electrode clamp to the distal electrode.
4. Attach the red electrode clamp to the proximal electrode.
5. Attach the sensor with its large flat side facing towards the palmar side of the thumb with adhesive tape. The cable should be attached in such a way that it does not 'pull' at the sensor and that movement of the thumb is not obstructed.

CAUTION: Pay attention not to make the two electrodes contact each other.

CAUTION: Incorrect placement of electrodes may stimulate the wrong nerves, leading to wrong muscle responses.

CAUTION: When multiple nerves are stimulated, the measured responses may be affected by other muscular activity.

CAUTION: If the stimulating electrodes are placed to near to the palm, the stimulating pulses may directly stimulate the muscle.

CAUTION: A too strong stimulation current may produce a too strong stimulus to the muscle.

CAUTION: Moving or touch the patient during measurement may lead to inaccurate measurement results.

CAUTION: Make sure that the NMT stimulation cable is not in contact with an external pacemaker or vessel lines.

CAUTION: To avoid electrical shocks, do not touch the electrodes before the NMT stimulation is stopped.

CAUTION: Take care to handle the NMT sensor, avoiding forcefully striking the sensor.

CAUTION: After repositioning the patient, check that the NMT sensor is still placed properly and that the thumb can move freely.

NOTE: Correct positioning of the electrodes is important. Even slight displacement may result in considerable changes in stimulation current that the patient receives. Furthermore, the electrodes must be positioned in such a way that avoids direct stimulation to the muscle.

NOTE: It is observed that applying slight pressure on the electrodes may improve the stimulation considerably, so we recommend that fix the electrodes to the skin with tapes.

NOTE: The further the sensor is placed on the thumb, the stronger the acceleration signal is. The signal strength can be adjusted by adjusting the placement of the sensor.

NOTE: The arm where the electrodes and sensors are attached should be kept immobile during the whole NMT measurement procedure.

10.6 NMT Calibration

The strength of the sensor signal received varies from patient to patient. The reference response amplitude is determined through NMT calibration. The reference response amplitude is the twitch occurred from the supramaximal stimulation current when the muscle of patient is not paralyzed.

CAUTION: Start calibration before the administration of a muscle relaxant drug to prevent voluntary muscle contraction and tension from interfering with the reference search.

The stimulation current for calibration can be defined by the user, or searched by the module. The current searched by the module is the supra current. If the [**Stimulation Current**] is set to [**Supra (60mA)**], the module will automatically search for the supra current to identify the reference response amplitude. If the [**Stimulation Current**] is set to a value between 1 mA and 60 mA, the module will use this setting value to determine the reference response amplitude. For adults, the supramaximal current amplitude is usually between 35 mA and 55 mA.

The calibration procedure is as follows:

1. Select the key > [**NMT**] key to confirm that [**Stimulation Current**] and [**Pulse Width**] are correctly set.
2. Open the NMT view in the split screen field, and select the [**Calibrate**] key or press the calibrate key on the module to start calibration.

If calibration fails, the NMT module will automatically use the default value as the reference amplitude.

NOTE: Nerve stimulation may cause pain, so it is recommended that perform the calibration after administration of anesthetics.

NOTE: Changing the stimulation current or pulse width invalidates the reference response amplitude value, and recalibration is required before the measurement due to the changes in stimulation energy.

10.7 NMT Measurement

NMT measurement can be started in the following approach:

- Press the Start/Stop key on NMT module, or
- Select [**Start NMT**] in the NMT view of the split screen field.

Press the Start/Stop Button on the NMT module again, or select [**Stop NMT**] in the the NMT view of the split screen field to stop the NMT measurement immediately.

NOTE: If you need to change the NMT settings during the measurement, stop the measurements, change the settings, and then restart the measurements.

NOTE: Take care when removing the sensor from the patient after measurement is complete. Do not pull on the cable.

10.8 NMT Setup

10.8.1 Set Stimulation Mode

The NMT measurement provides four stimulation modes: TOF, ST, DBS, and PTC. Select the [**Settings**] key in the NMT view of the split screen field and set the stimulation mode in the pop-up menu. For the DBS mode, select the key > [**NMT**] key to set the [**DBS Mode**] to [**DBS 3.3**] or [**DBS 3.2**].

10.8.2 Set Measurement Interval

Measurement interval is the time interval between two NMT measurements. This function is not available in the PTC mode. Select the [**Settings**] key in the NMT view of the split screen field and set the intervals in the pop-up menu.

10.8.3 Set Stimulated Current

Before performing the NMT calibration and measurement, confirm that the desired stimulus current value is selected.

You can use supramaximal current or set a current value between 1 and 60 mA. For adults, the supramaximal current amplitude is usually between 35 mA and 55 mA. Smaller currents may be desirable for children.

Changing stimulation current invalidates the reference response amplitude value obtained during the calibration, and recalibration is required.

Select the key > [**NMT**] key and select the [**Stimulation Current**] button to assign an appropriate value.

10.8.4 Set Pulse Width

You can increase the pulse width to increase the effect of the stimulation to help finding the supramaximal stimulation current.

Changing pulse width invalidates the reference response amplitude value obtained during the calibration, and recalibration is required.

Select the key > [**NMT**] key and select the [**Pulse Width**] button to assign an appropriate value.

10.8.5 Set Block Recovery

Block recovery indicates that the patient is responding more sensitive to the stimulation and the degree of neuromuscular block is decreasing. The block recovery note alerts you when the patient reaches the set block recovery threshold. The note can be used to help maintain a certain muscle relaxation level of the patient.

Select > [**NMT**] key and set [**Block Recovery**]. If [**Block Recovery**] is set to [**Off**], the anesthesia system will not give an alert.

10.8.6 Set Stimulation Beep Volume

Select the key [**Volume/Screen**] to adjust [**NMT Beep Volume**] on the opened interface. The anesthesia system gives a beep at the selected volume at each stimulation pulse if [**NMT Beep Volume**] is set to a value other than 0.

10.9 NMT Parameters

The following table provides the NMT measurement parameters in different stimulation modes:

STIMULATION MODE	PARAMETER	PARAMETER UNIT	MAXIMUM BARS
TOF	TOF ratio	%	4
	TOF count	/	4
ST	ST ratio	%	1
	ST count	/	1
PTC	PTC	/	/
DBS	DBS ratio	%	2
	DBS count	/	2

TABLE 10-1

If the anesthesia system is configured with the NMT module, the waveform/parameter/spirometry/trend display field and split screen field can display the monitoring parameters related to NMT respectively.

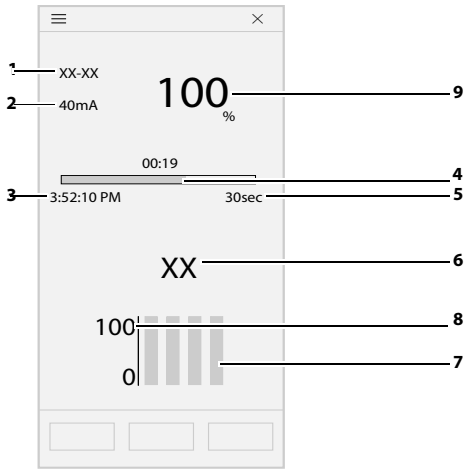


FIGURE 10-3 NMT Parameters (Split Screen Field, Taking TOF Mode as an Example)

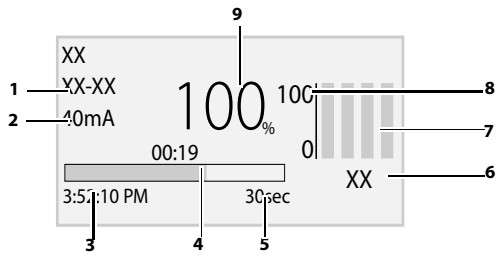


FIGURE 10-4 NMT Parameters (Waveform/Parameter/Spirometry/Trend Field, Taking TOF Mode as an Example)

1. Parameter name
2. Stimulation current

3. Time of last finished measurement
4. Measurement countdown: time to start the next measurement. The measurement countdown will not be shown if [**Intervals**] is set to [**Manual**].
5. Intervals: If [**Intervals**] is set to [**Manual**], [**Manual**] is displayed here.
6. T1 %: response to first stimulus as percentage of the reference response amplitude TOF mode. This value will not be shown if calibration is not completed successfully.
7. Stimulation response bar graph: amplitude of response to the stimulation. The maximum height of the bar graphs is 120 %.
8. Scale: displays the scale of the amplitude of response to stimulation. The scale will not be shown if calibration is not completed successfully.
9. Parameter value

10.10 Recover NMT Calibration Information

In the event of a brown-out of the NMT module, or when the NMT module is transferred to another equipment together with the patient, you can use the recovery feature if you want to continue with the measurement and use the obtained calibration information including stimulation current, pulse width, and reference response amplitude.

Select the [**Settings**] button in the right view of the NMT and select the [**Reload Value**] button in the pop-up menu to restore the calibration information.

11.0 Alarms and Messages

11.1 Introduction

The system provides alarms and messages that are indicated to the user by visual and audible alerts. The alarm messages are displayed in the top graph area of the main screen.

11.1.1 Alarm System Self-test

The system performs a self-test of its alarm system when powered on. The self-test is described as follows:

- During the self-test, the alarm LED will illuminate in sequence with the colors red, yellow, and cyan for approximately 1 second each color.
- The system speaker produces one tone after the alarm light is in self-test.

11.1.2 Types of Alarms and Messages

The equipment provides the following types of alarms and prompt messages. See section 11.8 (Pages 11-8) "Alarms and Prompt Messages" for the list of alarms and prompt messages.

- **Physiological Alarms:**
  Patient-related variables cause physiological alarms. These alarms require a user response. Physiological alarms can have the following priorities: high, medium, and low.
- **Technical Alarm:**
  Machine-related variables cause technical alarms. These alarms require a user response and may have a high, medium, or low priority. Technical alarms can have the following priorities: high, medium and low.
- **Prompt Message:**
  This is a message to the user. They do not require an immediate user response. These messages always have the lowest priority, below physiological and technical alarms. It is displayed in white.

11.1.3 Alarm Indicators

The equipment provides the following alarm indicators:

- **An Alarm LED located on top of the LCD monitor.** The LED can illuminate in red, yellow, cyan, or OFF, depending on the alarm condition.
  TABLE 11-1 describes the alarm behavior of different alarm types and different alarm priority levels. If multiple alarms occur simultaneously, the audio and LED behavior will follow the active alarm with the highest priority.
- **Colored alarm messages displayed on the Main Screen.** High priority messages are red. Medium priority messages are yellow. Low priority messages are cyan. Prompt messages are white. Messages display according to priority and time. (See section 11.2.1 (Pages 11-4) "Display Rules of Alarm Messages".)
- **Alarm audio from the system alarm speaker.** TABLE 11-1 lists the audio behavior for each type of alarm.

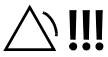
ALARM TYPE	ALARM PRIORITY	AUDIO BEHAVIOR	MESSAGE BEHAVIOR	ALARM LED COLOR
Physiological alarm	High	Play high priority alarm sounds at an interval of 5 ± 1 seconds.	White text on red background, high priority icon. 	Red
	Medium	Play medium priority alarm sounds at an interval of 5 ± 1 seconds.	Black text on yellow background, medium priority icon. 	Yellow
	Low	Play low priority alarm sounds at an interval of 17 ± 1 seconds.	White text on cyan background, low priority icon. 	Cyan
Technical Alarm	High	Play high priority alarm sounds at an interval of 5 ± 1 seconds.	White text on red background, high priority icon. 	Red
	Medium	Play medium priority alarm sounds at an interval of 5 ± 1 seconds.	Black text on yellow background, medium priority icon. 	Yellow
	Low	Play low priority alarm sounds at an interval of 17 ± 1 seconds.	White text on cyan background, low priority icon. 	Cyan
Prompt Message	None	None	Black text on white background.	Off

TABLE 11-1 Alarm Indicators (Audio and On-screen Messages)

11.2 Alarm Display

Alarm messages are automatically displayed on the top of the Main Screen when alarm conditions are met. Additionally, a list of all active alarms can be found in the Alarms window.

Each message is displayed with an associated priority symbol as follows:

- High priority 
- Medium priority 
- Low priority 

To display a list of all active alarms:

1. On the Main Screen, select the [**Alarms**] softkey or touch the Alarm Message area on the top of the screen.
   The Alarms window is displayed.
2. Select [**Active**] tab.
   A list of all active alarm messages is displayed.
   Alarms are displayed in order of priority and time.

11.2.1 Display Rules of Alarm Messages

Alarm messages are displayed in order of priority and time of occurrence.

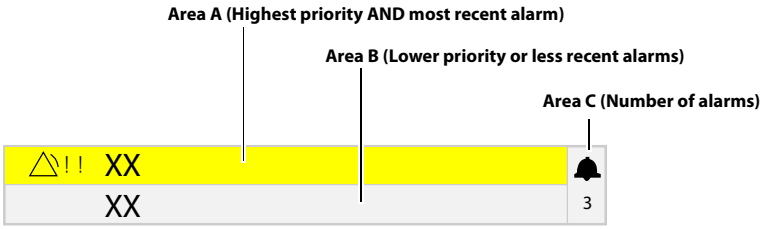


FIGURE 11-1 Display Rules of Alarm Messages

Alarm messages are displayed in Area A, Area B and Area C, according to the following rules:

- To be in Area A, an alarm must be both the highest priority and the most recent (Area A does not cycle). The remaining active alarms and prompt messages cycle in Area B.
- New Alarms with lower priority than alarms in Area A are displayed directly in Area B, and the cycle proceeds from that position in the list.
- Alarms cycling in Area B are grouped and displayed in the following order: high, medium, low, and prompt messages. In each group, the most recent alarm displays first.
- If the alarm in Area A is removed, then the most recent alarm with the highest priority from Area B is moved to Area A.
- Area C displays the number of active alarms.

11.3 Set Alarm Volume

The Alarms Volume settings adjust the audio level of all high, medium, and low priority sounding alarms. The System Alert Volume settings adjust the audio level of all sounding pop-up prompts and non-confirmed ventilation mode alerts.

To set the Alarm Volume:

1. On the Main Screen, select the [ ] soft key > [**Volume/Screen**] tab.
2. Adjust the volume on the pop-up screen.

WARNING: Do not rely exclusively on the audible alarm system when using the anesthesia system. Adjustment of alarm volume to a low level may result in a hazard to the patient. Always keep the patient under close surveillance.

NOTE: The auditory alarm signal A-weighted sound pressure level which is measured in 2.5 m of radius shall be no less than 45 dB and no more than 85 dB.

11.4 Pause Alarm Audio

Clicking the [**Audio Pause**] key will pause the alarm audio for 120 seconds, no matter whether the anesthesia system has active alarms. All the other alarming indicators work normally except the alarm audio. The alarm audio pause icon and 120 seconds countdown are displayed on the top of the screen. When [**Audio Pause**] is enabled, the audio of new alarms is also paused. After the 120 second countdown, the system will exit from the audio pause state. When [**Audio Pause**] is enabled, click the [**Audio Pause**] key again to exit from the audio pause state.

11.5 Alarm Reset

When an alarm condition occurs and triggers an audio alarm, select the [**Alarm Reset**] soft key to pause the audio of all active alarms. If the reset alarms contain medium or high priority alarms, the alarm audio will be paused for 120 seconds. The Alarm Reset icon and the 120-second countdown timer are displayed on the top of the screen. Select the key again to resume the alarm audio. When the alarms are reset, all the alarming indicators work normally except the alarm audio.

NOTE: If a new alarm occurs, the new alarm will ring even when the system is in an alarm reset status. In this case, you can select the [Alarm Reset] soft key again to pause the new alarm audio and reset the countdown to 120 seconds.

If the reset alarms contain only low priority alarms, the alarm will be turned off. The alarm audio off icon and 120 seconds countdown are displayed on the top of the screen. If a new alarm occurs, the new alarm will sound.

NOTE: If a new alarm occurs, the new alarm will sound if the new alarm is a low priority one even when the alarm audio is turned off. In this case, you can select the [Alarm Reset] soft key again to turn off the alarm audio. If the new alarms occurred contain medium or high level alarms, then the new alarm audio will sound. In this case, you can select the [Alarm Reset] soft key again to pause the new alarm audio and start a 120-second countdown.

11.6 Set Alarm Limits

You can set the alarm limits of PEAK, MV, Vte, RR, FiO_2, EtO_2, $EtCO_2$ and $FiCO_2$. When the anesthesia system is configured with HFJV mode, you can also set the alarm limits of PEAK(HFJV) and PP(HFJV). The alarm is then triggered when the parameter value is greater than the High Limit or lower than the Low Limit.

WARNING: During equipment use, pay frequent attention to the alarm limits parameters to ensure that they are appropriately set. Setting the alarm limits to limiting values will render the alarming system unhelpful.

NOTE: When using the anesthesia system, ensure that the alarm limits of each parameter are set to the appropriate values for the patient.

NOTE: When the anesthesia system restarts within 60 seconds after an abnormal power outage, the system can automatically restore the recent profile. If the power outage lasts longer than 120 seconds, the anesthesia system will automatically load the user profile before the shutdown. If the power outrage lasts between 60 to 120 seconds, the anesthesia system may automatically restore the recent profile or automatically load the user profile before the shutdown.

NOTE: **If the equipment is powered off for less than 30 seconds and then powered on, the alarming settings will be restored to the status before the system was powered off.**

NOTE: **If the airway pressure monitoring stays lower than the lower limit of alarm for 20 seconds or one automatic ventilation cycle (depending on which one is longer), a corresponding alarm will be triggered.**

NOTE: **If the Vte monitoring stays higher than the upper limit of alarm for three consecutive cycles, a corresponding alarm will be triggered.**

NOTE: **If the Vte monitoring stays lower than the lower limit of alarm for three consecutive cycles, a corresponding alarm will be triggered.**

NOTE: **In the manual ventilation mode, the system will disable the [Paw Too Low] alarm, and the PEAK low alarm limit in monitoring parameters area will display [Off].**

To set the alarm limits:

1. On the Main Screen, select the [**Alarms**] soft key > [**Limits**] tab.
   Or,
   select the monitoring area to display the alarm limits settings menu.
2. Select a parameter key.

NOTE: **When the monitoring value on the main screen flashes due to an alarm, select the flashing area to open the corresponding Alarm Limits setting menu.**

3. Enter the desired parameter value using the keyboard on the screen. For each parameter, the range of values is displayed above the keypad.
4. You can select [**Load Alarm Defaults**] to restore the default values and restore the upper and lower limits of parameter alarms to the factory defaults.
5. Repeat Steps 3 to 4 for each parameter.
6. Select ✓ to save the changes (or select ✗ to discard the changes).
7. To save an alarm limit to a user profile:
   Select the ⚙ key > [**System**] key (system password needed) > [**Profiles**] tab. Select a profile, and select the [**Create**] key. Set the profile name on the pop-up screen. After the profile is confirmed, the system will save the current profile as a user profile.
8. To load a user profile:
   In the standby mode, select the [**Current Profile: xxxx**] key and select the desired profile on the pop-up screen.

11.6.1 Auto Alarm Limits

The Auto Alarm Limits function uses an algorithm based on measured values. The relationship is shown in the table below.

When the System is in Standby mode or Manual mode, the [**Auto Alarm Limits**] button will be disabled. The [**Auto Alarm Limits**] key is also disabled when the current mode is PS, SIMV- VC, or SIMV- PC.

ALARM LIMIT	ADJUSTMENT FORMULA
PEAK High	PEAK+5 cmH_2O or PLAT+10 cmH_2O, whichever is greater. Minimum: 35 cmH_2O.
PEAK Low	(PLAT-PEEP) x 0.6 + PEEP - 1 cmH_2O Minimum: 3 cmH_2O. Maximum: PEAK High - 1 cmH_2O
MV High	MV x 1.4 Minimum: 2.0 L/min
MV Low	MV x 0.6 Minimum: 0.1 L/min Maximum: MV High - 0.1 L/min
Vte High	Vte x 1.4
Vte Low	Vte x 0.6
RR High	RR x 1.4
RR Low	RR x 0.6

TABLE 11-2 Auto Alarm Limits

The parameters in the formula are all measured parameters.

The alarm limits for PEAK are calculated on the basis of the average value for PEAK, PLAT, and PEEP. The value used for average uses the value of the last four ventilation cycles or the value in one minute, whichever is smaller. Spontaneous breaths by the patient are not taken into account.

The alarm limits for Vt and RR are calculated on the basis of the average value. The value used for average uses the value of the last four ventilation cycles or the value in one minute, whichever is smaller. Spontaneous breaths by the patient are not taken into account.

If there is no valid MV, Vte or RR measurement value, the corresponding alarm limits will not be adjusted.

If the average value of PEAK, PLAT, and PEEP cannot be calculated, the corresponding alarm limits will not be adjusted.

If the calculated alarm limit is more than the high threshold of setting range or less than the low threshold, the corresponding threshold is used as the auto alarm limit.

11.7 View Active Alarms

To display a list of all active alarms:

On the Main Screen, select the [**Alarms**] softkey or touch the Alarm Message area on the top of the screen. The Alarms window is displayed.

1. Select [**Active**] tab.
   A list of all active alarm messages is displayed.

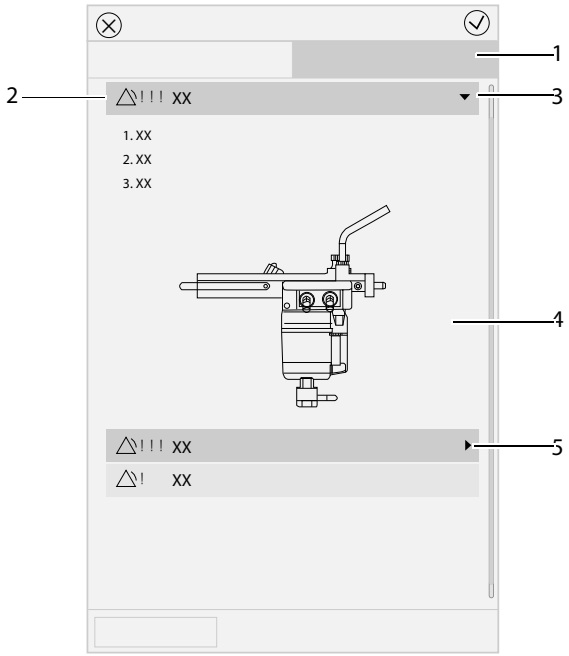


FIGURE 11-2[**Active**] Alarms List in the Alarms Window

2. Alarm messages
   - Red: indicates high priority alarm.
   - Yellow: indicates medium priority alarm.
   - Cyan: indicates low priority alarm.
   - White: indicates prompt message.
3. Help information soft key
   Select this key to display help information in the expanded interface. Select key again to close the help information interface. Only the alarms with high priority have help information.
4. Help information
5. Scroll bar
   Scroll the bar to view more alarm information.

11.8 Alarms and Prompt Messages

This section lists the following alarms and messages:

- Physiological Alarm Messages
- Technical Alarm Messages
- Prompt Message

For each alarm message, the system has provided corresponding troubleshooting measures. If the problem persists, contact your service personnel.

NOTE: The "Disable in Cardiac Bypass Mode" column indicates whether the physiological alarm is blocked in the Cardiac Bypass mode.

NOTE: The "Disable in Standby Mode" column indicates whether the physiological alarm is blocked in the standby mode.

NOTE: You can view past alarms in the [History] menu.

NOTE: The Alarm Delay time between the anesthesia system and the external interconnected device or system is smaller than or equal to 3s.

11.8.1 Physiological Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
Apnea	No breath has been detected within the apnea time.	1. Check alarm limit: Tapnea. 2. Check whether the breathing system is leaking or disconnected. 3. Ensure the position of Auto/manual switch is correct.	Medium
Apnea>2 min	No breath has been detected within the last 120 seconds.	1. Check whether ventilation starts. 2. Check whether the breathing system is leaking or disconnected. 3. Ensure the position of Auto/manual switch is correct.	High
Paw Too High	PEAK > high alarm limit setting.	1. Check alarm limit: PEAK High. 2. Check ventilation settings: Pinsp/ ΔPinsp, Vt, PEEP, etc. 3. Check whether the breathing system is kinked or blocked.	High
Paw Too Low	PEAK < low alarm limit setting for 20 seconds.	1. Check alarm limit: PEAK Low. 2. Check ventilation settings: Pinsp/ ΔPinsp, Vt, PEEP, etc. 3. Check whether the breathing system is leaking or disconnected.	High
Pressure Limiting	Paw ≥ Plimit.	Check ventilation settings: Plimit.	Low
MV Too High	MV > high alarm limit setting.	1. Check alarm limit: MV High. 2. Check ventilation settings: Pinsp/ ΔPinsp, Vt, RR, etc.	Medium
MV Too Low	MV < low alarm limit setting.	1. Check alarm limit: MV Low. 2. Check ventilation settings: Pinsp/ ΔPinsp, Vt, RR... 3. Check whether the breathing system is leaking or blocked.	Medium
Vte Too High	Vte > high alarm limit setting.	1. Check alarm limit: Vte High. 2. Check ventilation settings: Pinsp/ ΔPinsp, Vt, etc.	Medium
Vte Too Low	Vte < low alarm limit setting.	1. Check alarm limit: Vte Low. 2. Check ventilation settings: Pinsp/ ΔPinsp, Vt, etc. 3. Check whether the breathing system is leaking or blocked.	Medium
RR Too High	RR > high alarm limit setting.	1. Check alarm limit: RR High. 2. Check ventilation settings: RR, F-Trig/P-Trig, etc. 3. Check whether the breathing system is leaking or blocked.	Low

TABLE 11-3 Physiological Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
RR Too Low	RR < low alarm limit setting.	1. Check alarm limit: RR Low. 2. Check ventilation settings: RR, F-Trig, etc.	Low
Continuous Airway Pressure	Paw in the breathing system > continuous airway pressure alarm limit for 15 seconds.	1. Check APL valve setting in manual mode. 2. Check whether the breathing system is kinked or blocked.	High
Negative Pressure	Paw < -10 cmH_2O for 1 second.	1. Check the negative pressure suction. 2. Check whether AGSS works normally.	High
EtCO2 Too High	$EtCO_2$ > high alarm limit setting.	1. Check alarm limit: $EtCO_2$ High 2. Check whether it is necessary to replace soda lime of the CO_2 absorbent canister.	Medium
EtCO2 Too Low	$EtCO_2$ < low alarm limit setting.	1. Check alarm limit: $EtCO_2$ Low. 2. Check whether the sampling line of AG module is disconnected.	Medium
FiCO2 Too High	FiCO2 > high alarm limit setting.	1. Check alarm limit: FiCO2 High. 2. Check whether it is necessary to replace soda lime of the CO_2 absorbent canister.	Medium
FiN2O Too High	FiN_2O > high alarm limit setting.	Check fresh gas balance gas setting.	Medium
EtHal Too High	EtHAL > high alarm limit setting.	1. Check alarm limit: EtHal High. 2. Check AA% setting.	Medium
EtHal Too Low	EtHAL < low alarm limit setting.	1. Check alarm limit: EtHal Low. 2. Check AA% setting. 3. Check whether the sampling line of AG module is disconnected.	Medium
FiHal Too High	FiHAL > high alarm limit setting.	1. Check alarm limit: FiHal High. 2. Check AA% setting.	Medium
FiHal Too Low	FiHAL < low alarm limit setting.	1. Check alarm limit: FiHal Low. 2. Check AA% setting. 3. Check whether the sampling line of AG module is disconnected.	Medium
EtEnf Too High	EtENF > high alarm limit setting.	1. Check alarm limit: EtEnf High. 2. Check AA% setting.	Medium
EtEnf Too Low	EtENF < low alarm limit setting.	1. Check alarm limit: EtEnf Low. 2. Check AA% setting. 3. Check whether the sampling line of AG module is disconnected.	Medium
FiEnf Too High	FiENF > high alarm limit setting.	1. Check alarm limit: FiEnf High. 2. Check AA% setting.	Medium
FiEnf Too Low	FiENF < low alarm limit setting.	1. Check alarm limit: FiEnf Low. 2. Check AA% setting. 3. Check whether the sampling line of AG module is disconnected.	Medium
EtIso Too High	EtISO > high alarm limit setting.	1. Check alarm limit: EtIso High. 2. Check AA% setting.	Medium

TABLE 11-3 Physiological Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
EtIso Too Low	EtISO < low alarm limit setting.	1. Check alarm limit: EtIso Low. 2. Check AA% setting. 3. Check whether the sampling line of AG module is disconnected.	Medium
FiIso Too High	FiISO > high alarm limit setting.	1. Check alarm limit: FiISO High. 2. Check AA% setting.	Medium
FiIso Too Low	FiISO < low alarm limit setting.	1. Check alarm limit: FiIso Low. 2. Check AA% setting. 3. Check whether the sampling line of AG module is disconnected.	Medium
EtSev Too High	EtSEV > high alarm limit setting.	1. Check alarm limit: EtSev High. 2. Check AA% setting.	Medium
EtSev Too Low	EtSEV < low alarm limit setting.	1. Check alarm limit: EtSev Low. 2. Check AA% setting. 3. Check whether the sampling line of AG module is disconnected.	Medium
FiSev Too High	FiSEV > high alarm limit setting.	1. Check alarm limit: FiSev High. 2. Check AA% setting.	Medium
FiSev Too Low	FiSEV < low alarm limit setting.	1. Check alarm limit: FiSEV Low. 2. Check AA% setting. 3. Check whether the sampling line of AG module is disconnected.	Medium
EtDes Too High	EtDES > high alarm limit setting.	1. Check alarm limit: EtDes High. 2. Check AA% setting.	Medium
EtDes Too Low	EtDES < low alarm limit setting.	1. Check alarm limit: EtDes Low. 2. Check AA% setting. 3. Check whether the sampling line of AG module is disconnected.	Medium
FiDes Too High	FiDES > high alarm limit setting.	1. Check alarm limit: FiDes High. 2. Check AA% setting.	Medium
FiDes Too Low	FiDES < low alarm limit setting.	1. Check alarm limit: FiDes Low. 2. Check AA% setting. 3. Check whether the sampling line of AG module is disconnected.	Medium
MAC Too High	MAC > high alarm limit setting.	1. Check alarm limit: MAC High. 2. Check AA% setting.	Medium
MAC Too Low	MAC < low alarm limit setting.	1. Check alarm limit: MAC Low. 2. Check AA% setting. 3. Check whether the sampling line of AG module is disconnected.	Medium
EtO2 Too High	EtO_2 > high alarm limit setting.	1. Check alarm limit: EtO2 High. 2. Check fresh gas O_2 setting. 3. Check fresh gas balance gas setting, and the balance gas source is connected correctly.	Medium
EtO2 Too Low	EtO_2 < low alarm limit setting.	1. Check alarm limit: EtO2 Low. 2. Check fresh gas O_2 setting. 3. Check whether the breathing system is leaking.	Medium

TABLE 11-3 Physiological Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
FiO2 Too High	FiO_2 > high alarm limit setting.	1. Check alarm limit: FiO2 High. 2. Check fresh gas O_2 setting. 3. Check fresh gas balance gas setting, and the balance gas source is connected correctly.	Medium
FiO2 Too Low	FiO_2 < low alarm limit setting.	1. Check alarm limit: FiO2 Low. 2. Check fresh gas O_2 setting. 3. Check whether the breathing system is leaking.	High
BIS Too High	BIS > high alarm limit setting.	Check alarm limit: BIS High.	Medium
BIS Too Low	BIS < low alarm limit setting.	Check alarm limit: BIS Low.	Medium
BIS L Too High	BIS L> high alarm limit setting.	Check alarm limit: BIS L High.	Medium
BIS L Too Low	BIS L< low alarm limit setting.	Check alarm limit: BIS L Low.	Medium
BIS R Too High	BIS R> high alarm limit setting.	Check alarm limit: BIS R High.	Medium
BIS R Too Low	BIS R< low alarm limit setting.	Check alarm limit: BIS R Low.	Medium
Apnea CO2	No breath is detected and Apnea time ⩾ Apnea alarm time.	1. Check whether ventilation starts. 2. Check whether the sampling lines of the AG module are correctly connected to the breathing system. 3. Check patient's breathing ability.	High
Paw Too High	PEAK (in HFJV mode) > high alarm limit setting.	1. Check the patient airway. 2. Check whether the pressure monitoring tubing is kinked or clogged. 3. Check alarm limit: PEAK High in HFJV mode. 4. Adjust the ventilation parameters.	High
Paw Too Low	PEAK (in HFJV mode) < Low alarm limit setting.	1. Check alarm limit: PEAK Low in HFJV mode. 2. Check the ventilation paramenters: P HF and P NF. 3. Check if the pressure monitoring tube is disconnected.	High
PP Too High	PP (intermittent pressure in HFJV mode) > high alarm limit setting.	1. Check the patient airway. 2. Check whether the injection catheter is kinked or clogged. 3. Check alarm limit: PP High in HFJV mode. 4. Adjust the ventilation parameters.	High

**Not applicable. The alarm message does not exist within this mode and therefore it cannot be disabled or enabled.*

TABLE 11-3 Physiological Alarm Messages

11.8.2 Technical Alarm Messages

11.8.2.1 Startup Alarm Messages

NOTE: Startup alarms will not trigger the alarm audio and alarm light.

NOTE: The priority of startup alarms is only displayed in the alarm log.

NOTE: "Startup result if fail" column indicates the result when this startup phase alarm is triggered, which may be [All], [Manual Only], and [Non-Functional].

NOTE: **[All] indicates that all Automatic Ventilation, Manual Ventilation, and Cardiac Bypass modes are enabled.**

[Manual Only] indicates that only Manual Ventilation and Cardiac Bypass modes are enabled.

[Non-Functional] indicates that the anesthesia system cannot be used.

MESSAGE	CAUSE	CORRECTIVE ACTION	ALARM PRIORITY
Bundle Version Error	The incompatible firmware version is installed.	Please contact Mindray Technical Support.	High
Bundle Version: Time out	The self-test result cannot be obtained due to the internal communication error.		High
Incompatible Version Found	Software Version is incompatible.		High
Flowmeter Selftest Error	1. Board self-test error. 2. Valve self-test error. 3. Branch leakage, etc.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	High
Flowmeter Selftest: Time out	The self-test result cannot be obtained due to the internal communication error.		High
BFCS Selftest Error	BFCS self-test error.	1. Restart machine to repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	High
BFCS Selftest: Time out	The self-test result cannot be obtained due to the internal communication error.		High
Aux Control Module Selftest Error	1. Board self-test error. 2. The CPU board cannot communicate with the auxiliary monitoring board.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	High
Aux Control Module Selftest: Time out	The self-test result cannot be obtained due to the internal communication error.		High
Ventilator Selftest Error	1. Board self-test error. 2. The CPU board cannot communicate with the monitoring board.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	High
Ventilator Selftest: Time out	The self-test result cannot be obtained due to the internal communication error.		High
Ventilator Voltage Error	Ventilator voltage error.		High
PEEP Valve Failure	1. The PEEP valve voltage error. 2. The PEEP valve pressure error.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	Medium
Insp Valve Failure	1. Inspiratory valve voltage error. 2. Inspiratory valve flow error.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	Medium
Safety Valve Failure	Safety valve voltage error.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	Medium

TABLE 11-4 Power-on Self-Test Alarm Messages

MESSAGE	CAUSE	CORRECTIVE ACTION	ALARM PRIORITY
Flow Sensor Failure	The flow on the ventilator is out of range.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	Low
Calibrate Flow Sensor and Insp Valve	1. The calibration table is not found on the EEPROM. 2. The checksum of the calibration table does not match.	1. Calibrate flow sensors through Service menu after entering Standby. 2. Please contact Mindray Technical Support if the problem persists.	Low
Calibrate Pressure Sensor and PEEP Valve	1. The calibration table is not found on the EEPROM. 2. The checksum of the calibration table does not match.	Please contact Mindray Technical Support for pressure calibration.	Low
Perform 21% and 100% O2 Sensor Calibration	1. The calibration table is not found on the EEPROM. 2. The checksum of the calibration table does not match.	1. Calibrate O_2 sensors through System menu after entering Standby. 2. Please contact Mindray Technical Support if the problem persists.	Low
Ventilator Initialization Error	The CPU board cannot send parameter settings to the monitoring board.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	High
Ventilator Initialization: Time out	The self-test result cannot be obtained due to the internal communication error.		High
Drive Gas Pressure Low	The drive gas pressure is low.	1. Connect the drive gas pipeline. 2. Check that until drive gas pressure become normal.	High
O2 Supply Failure	O_2 Supply Failure.	1. Connect the O_2 pipeline. 2. Check the O_2 pressure until it returns to normal.	High
Power Supply Voltage Error	Power supply voltage error.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	High
RT Clock Needs Battery	The system does not have the button cell, or the button cell is exhausted.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	High
RT Clock Failure	The RT clock chip is faulty.		High
Keyboard Selftest Error	Keyboard selftest error.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	High
Keyboard Selftest:Time out	The keyboard self-test result cannot be obtained due to the communication error.		High
Drive Gas Valve Selftest Error	Drive gas valve failure.	Please contact Mindray Technical Support.	Low
Internal Air Supply Selftest Error	Internal air supply selftest error.	Please contact Mindray Technical Support.	Low
HFJV Selftest Error	HFJV selftest error.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	Low
HFJV Selftest : Time Out	The self-test result cannot be obtained due to the internal communication error.		Low

TABLE 11-4 Power-on Self-Test Alarm Messages

MESSAGE	CAUSE	CORRECTIVE ACTION	ALARM PRIORITY
Calibrate HFJV Module	1. The calibration table is not found on the EEPROM. 2. The checksum of the calibration table does not match.	Please contact Mindray Technical Support.	Low
Blower Failure (only applicable to the anesthesia system configured with blower)	Blower failure.	Please contact Mindray Technical Support.	High
Blower Temp Sensor Failure (only applicable to the anesthesia system configured with blower)	Blower temperature sensor failure.	Please contact Mindray Technical Support.	Medium
Blower Fan Failure (only applicable to the anesthesia system configured with blower)	Blower fan failure.	Please contact Mindray Technical Support.	Medium
Replace Blower HEPA Filter (only applicable to the anesthesia system configured with blower)	The HEPA filter is occluded and the resistance increases.	Please contact Mindray Technical Support.	Low
Internal Air Supply Fan Failure	Internal air supply fan failure.	Please contact Mindray Technical Support.	Medium
AG Selftest Error	AG module selftest error.	1. Re-plug or replace the AG module. 2. Repeat the test. 3. Please contact Mindray Technical Support if the problem persists.	Low
AG Selftest: Time out	External AG selftest result cannot be obtained due to communication error.		Low
Internal AG Error 02	Internal AG module selftest error.	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	Low
Internal AG: Time out	Internal AG self test result cannot be obtained due to communication error.		Low
BIS Selftest Error	BIS selftest error.	1. Re-plug or replace the BIS module. 2. Restart machine to repeat the test. 3. Please contact Mindray Technical Support if the problem persists.	Low
BIS Selftest: Time out	BIS selftest result can not be obtained due to communication error.	1. Check BISx/BISx4 host cable connection. 2. Restart machine to repeat the test. 3. Please contact Mindray Technical Support if the problem persists.	Low

TABLE 11-4 Power-on Self-Test Alarm Messages

MESSAGE	CAUSE	CORRECTIVE ACTION	ALARM PRIORITY
CO2 Selftest Error	CO_2 selftest failure.	1. Re-plug or replace the CO_2 module. 2. Restart machine to repeat the test. 3. Please contact Mindray Technical Support if the problem persists.	Low
CO2 Selftest: Time out	CO2 selftest result can not be obtained due to communication error.		Low
NMT Selftest Error	NMT selftest error.	1. Re-plug or replace the NMT module. 2. Restart machine to repeat the test. 3. Please contact Mindray Technical Support if the problem persists.	Low
NMT Selftest: Time out	NMT selftest result can not be obtained due to communication error.		Low

TABLE 11-4 Power-on Self-Test Alarm Messages

11.8.2.2 CPU Board Runtime Alarm

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
IP Address Conflict	The IP address of the anesthesia system is the same as the IP address of another device in the local network.	Check the IP address setting.	Medium
Manual Only	POST test failed and the result is [**Manual Only**].	1. Repeat the test. 2. Please contact Mindray Technical Support if the problem persists.	Medium
Manual Only - Leak Test Failed	Circuit leakage test failed and the result is [**Manual Only**].		Medium
Auto Ventilation is Non-Functional	The system's Auto Ventilation mode is not available.		High
Status Screen Comm Stop	The CPU board lost communication with the status screen.	Please contact Mindray Technical Support.	High
Aux O2/AIR Comm Stop	The CPU board lost communication with the auxiliary O_2/air module.	Please contact Mindray Technical Support.	High
HFNC Module Comm Stop	The CPU board lost communication with the High-flow Nasal Cannula (HFNC) module.	Please contact Mindray Technical Support.	High
Storage Error	Data service is interrupted.	Please contact Mindray Technical Support.	Low
Infusion Device Disconnected	The infusion device is disconnected from the anesthesia system.	1. Reconnect the infusion device and the anesthesia system. 2. Please contact Mindray Technical Support if the problem persists.	Low

TABLE 11-5 CPU Board Runtime Alarm Messages

11.8.2.3 Power Supply Board Runtime Alarm

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
Power System Comm Stop	Lost communication with CPU board for 10 seconds.	Please contact Mindray Technical Support.	High
Power Supply Voltage Error	Power supply voltage error.		High
Low Battery Voltage!	Battery voltage is low.	1. Check the power supply. 2. Connect AC power immediately.	High
System shutting down, Battery depleted!	Battery voltage is too low.	1. Connect AC power immediately. 2. In emergency, please use Manual ventilation.	High
Battery Undetected	Battery undetected.	Please contact Mindray Technical Support.	Medium
Battery in Use	AC power fail.	Connected to AC power source.	Low
Battery Failure	Battery failure.	Please contact Mindray Technical Support.	High
Battery Temp High. Syst maybe Down	Battery temperature is too high during discharge. The system may be down.	Connect to the external power supply.	High
Battery 1 Charge Failure	Battery 1 charging failure.	Please contact Mindray Technical Support.	High
Battery 2 Charge Failure	Battery 2charging failure.	Please contact Mindray Technical Support.	High
Battery 1 Aging	Battery 1 Aging.	Please contact Mindray Technical Support.	High
Battery 2 Aging	Battery 2 Aging.	Please contact Mindray Technical Support.	High
Battery 1 Comm Error	Battery 1 communication error.	Please contact Mindray Technical Support.	High
Battery 2 Comm Error	Battery 2 communication error.	Please contact Mindray Technical Support.	High
Battery 1 Failure	Battery 1 Failure.	Please contact Mindray Technical Support.	High
Battery 2 Failure	Battery 2Failure.	Please contact Mindray Technical Support.	High
Battery Temp. High. Connect Ext. Pwr.	Battery temperature is too high.	Connect to the external power supply.	High
Power Board Selftest Error	Power board self-test error.	Please contact Mindray Technical Support.	High
Batteries are unbalanced.Please charge.	The battery level is not balanced.	Connect to the external power supply.	Low
Insert the Second Battery	The anesthesia system with two standard batteries is equipped with only one battery.	Please contact Mindray Technical Support.	Medium

TABLE 11-6 Power Supply Board Runtime Alarm Messages

NOTE: **If the power supply board loses communication with the CPU board for 10 seconds, the alarm buzzer will be turned on.**

11.8.2.4 Flow Control System Runtime Alarm

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
Electronic Flow Control Error	Power supply voltage abnormality, valve fault, flow sensor fault, flow abnormality of output fresh gas, etc.	Please contact Mindray Technical Support.	Medium
No Fresh Gas	The flow rate of O_2 and balance gas is zero continuously for five seconds.	1. Check the O_2 source and the balance gas source are connected correctly. 2. Check fresh gas setting.	Medium
O2 Branch Flow Not Achieved	The measured flow of the O_2 branch exceeds the target flow threshold for the O_2 branch.	1. Check O_2 source is connected correctly. 2. Please contact Mindray Technical Support if the problem persists.	Low
Balance Gas Branch Flow Not Achieved	The measured flow of the balance gas branch exceeds the target flow threshold for the balance gas branch.	1. Check balance gas source is connected correctly. 2. Please contact Mindray Technical Support if the problem persists.	Low
Flowmeter Comm Stop	Lost communication with CPU board for 10 seconds.	Please contact Mindray Technical Support.	Medium
Total Flow Sensor Selftest Time Out	The automatic flow sensor self-test times out.	Please contact Mindray Technical Support.	Medium
Backup Flow Control is enabled	The backup flow control system is in use.	Please contact Mindray Technical Support.	Low
Backup Flow Control Error	1. BFCS two-way valve is faulty. 2. The micro switches at the two locations of the mechanical gate are in inconsistent status.	Please contact Mindray Technical Support.	Medium

**Not applicable. The alarm message does not exist within this mode and therefore it cannot be disabled or enabled.*

TABLE 11-7 Flow Control System Runtime Alarm Messages

11.8.2.5 Ventilator Control Board Runtime Alarm

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
Aux Control Module Comm Stop	Lost communication with CPU board for 10 seconds.	Please contact Mindray Technical Support.	High
Ventilator Voltage Error	Ventilator voltage error.	Please contact Mindray Technical Support.	High
PEEP Valve Failure	1. The PEEP valve voltage error. 2. The PEEP valve pressure error.	Please contact Mindray Technical Support.	Medium
Insp Valve Failure	1. Inspiratory valve voltage error. 2. Inspiratory valve flow error.	Please contact Mindray Technical Support.	Medium
Safety Valve Failure	Safety valve voltage error.	Please contact Mindray Technical Support.	Medium
Flow Sensor Failure	1. Inspiratory flow is out of range. 2. Expiratory flow is out of range.	Please contact Mindray Technical Support.	Low

TABLE 11-8 Ventilator Control Board Runtime Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
Check Flow Sensors	1. Inspiratory reverse flow. 2. Expiratory reverse flow.	1. Check whether the check valves are OK. 2. Please contact Mindray Technical Support if the problem persists.	High
Pinsp Not Achieved	The Pinsp failed to reach the Pinsp setting in the pressure mode.	1. Check ventilation settings: Pinsp/ ΔPinsp, ΔPsupp, PEEP... 2. Check whether the breathing tube is leaking. 3. Clear the [**Continuous Airway Pressure**] alarm.	Low
Vt Not Achieved	The Vt does not reach the Vt setting in volume mode.	1. Check ventilation settings: Vt, Plimit… 2. Check whether the breathing system is leaking or blocked. 3. Clear the [**Pressure Limiting**] and [**Continuous Airway Pressure**] alarms.	Low
ACGO 3-way Valve Failure	ACGO three-way valve status error.	Please contact Mindray Technical Support.	Medium
Pressure Monitoring Channel Failure	For auxiliary control module: 1. The monitoring value of the PEEP sensor or pressure sensor is out of range. For ventilator control board: 1. The monitoring value of the PEEP sensor or pressure sensor is out of range. 2. The zero point of the PEEP sensor or pressure sensor is abnormal.		Medium
Aux Control Module Voltage Error	Auxiliary control module voltage error.		Low
Breathing System Not Mounted	The breathing system is not mounted.	Please Mount the breathing system.	High
Flow Pause Valve Error	Flow pause valve failure.	Please contact Mindray Technical Support.	Low
Patient Circuit Leak	1. Circuit leak. 2. The patient is not connected.	Check whether the patient circuit is leaking or disconnected.	Medium
Tube Disconnected?	Tube is disconnected.	1. Check the breathing tube for any leakage. 2. Perform System Check to test the leakage.	High
CO2 Absorber Canister Not Locked	CO_2 absorbent canister is not installed.	1. Check whether CO_2 absorber canister is correctly installed and locked. 2. Re-install the CO_2 absorber canister. 3. Please contact Mindray Technical Support if the problem persists.	High
O2 Sensor Disconnected	The AG module and the O_2 sensor are not connected.	Connect O_2 cell or plug in the external AG module.	Low
Replace O2 sensor	O_2 sensor is exhausted.	Replace the O_2 sensor.	Medium

TABLE 11-8 Ventilator Control Board Runtime Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
Perform 21% and 100% O2 Sensor Calibration	O_2 value is greater than 110% or between 5% and 15% for 4 seconds.	Calibrate the O_2 sensor.	Low
Ventilator Comm Stop	Lost communication with CPU board for 10 seconds.	Please contact Mindray Technical Support.	High
Drive Gas Pressure Low	The drive gas pressure is low.	1. Connect the drive gas pipeline. 2. In emergency, please use Manual ventilation.	High
O2 Supply Failure	O_2 supply failure.	Connect the O_2 pipeline.	High
Air Supply Failure	Air supply pressure low.	Connect the air pipeline.	Medium
N2O Supply Failure	N2O supply pressure is low.	Connect the N_2O pipeline supply.	Medium
Fresh Gas Flow Too High	In VCV and SIMV-VC modes, the flow rate of fresh gas is greater than or equal to the desired flow rate.	1. Check fresh gas flow setting. 2. Check ventilation settings: Vt, Tinsp…	Low
AMV: Cannot Meet Target	The ventilation failed to reach the target MV% setting in the AMV mode.	1. Check the ventilation parameter settings. 2. Check the alarm limits settings.	Low
Heating Module Failure	1. The temperature difference between the two resistances is large. 2. The temperature of one of the resistances is too high.	Please contact Mindray Technical Support.	Low
O2 Branch Pressure Sensor Failure	The O2 branch pressure sensor is not connected.	Please contact Mindray Technical Support.	High
Air Branch Pressure Sensor Failure	The air branch pressure sensor is not connected.	Please contact Mindray Technical Support.	Medium
Drive Gas Switch Valve Failure (only applicable to anesthesia system without blower)	Drive gas swtich valve failure.	Please contact Mindray Technical Support.	High

**Not applicable. The alarm message does not exist within this mode and therefore it cannot be disabled or enabled.*

TABLE 11-8 Ventilator Control Board Runtime Alarm Messages

11.8.2.6 Blower Alarm Messages (Only Applicable to Anesthesia System Configured with Blower)

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
Replace Blower HEPA Filter	HEPA filter occluded and resistance increased.	Please contact Mindray Technical Support.	Low
Blower Temperature High	Blower temperature exceeds the threshold.	1. Check if the operating ambient temperature of the machine exceeds the maximum operating temperature specified by the vendor. 2. Check whether the gas inlet is occluded. If yes, clear the foreign substance and dust.	High

TABLE 11-9 Blower Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
Blower Temp Sensor Failure	Blower temperature sensor failure.	Please contact Mindray Technical Support.	Medium
Blower Failure	Blower failure.	Please contact Mindray Technical Support.	High
Blower Temp Too High	Blower temperature too high.	Please contact Mindray Technical Support.	High
Blower Fan Failure	Blower fan failure.	Please contact Mindray Technical Support.	Medium

TABLE 11-9 Blower Alarm Messages

11.8.2.7 CO2 Module Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
CO2 Module Error	1. CO_2 module communication stops. 2. CO_2 module hardware malfunctions. 3. CO2 module system error. 4. CO_2 module initialization error.	1. Re-plug the CO_2 module. 2. Replace the CO_2 module or contact Mindray Technical Support.	High
CO2 Module High Temp	The CO_2 sensor temperature is greater than 63°C.	1. Drop ambient temperature. 2. Re-plug the module. 3. Please contact Mindray Technical Support if the problem persists.	Low
CO2 Module Low Temp	The CO_2 sensor temperature is less than 5°C.	1. Raise ambient temperature. 2. Re-plug the module. 3. Please contact Mindray Technical Support if the problem persists.	Low
CO2 High Airway Press.	Airway pressure is higher than 790 mmHg.	1. Check the airway pressure setting of anesthesia system. 2. Disconnect with the anesthesia system. 3. Re-plug the CO_2 module. 4. Please contact Mindray Technical Support if the problem persists.	Low
CO2 Low Airway Press.	Airway pressure is lower than 400 mmHg.		Low
CO2 High Barometric	Barometric pressure is higher than 790 mmHg.	1. Re-plug the CO_2 module. 2. Replace the CO_2 module or contact Mindray Technical Support.	Low
CO2 Low Barometric	Barometric pressure is lower than 428 mmHg.		Low
CO2 Sampleline Occluded	The sampling line is occluded.	1. Check if the sampling line of the CO_2 module is kinked or blocked. 2. Replace the airway. 3. Re-plug the CO_2 module. 4. Please contact Mindray Technical Support if the problem persists.	Low
CO2 No Watertrap	The CO_2 watertrap is off or disconnected.	Check the watertrap connections.	Low
EtCO2 Over Range	The monitoring value exceeds the measurable range.	1. Zero the CO_2 module. 2. Please contact Mindray Technical Support if the problem persists.	Low
FiCO2 Over Range			
EtO2 Over Range			
FiO2 Over Range			

TABLE 11-10 CO2 Module Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
CO2 Zero Failed	CO_2 module failure.	1. Re-plug the CO_2 module. 2. Please contact Mindray Technical Support if the problem persists.	Low
CO2 Replace the O2 Sensor	O_2 sensor is exhausted or O_2 sensor error	Replace the O_2 sensor.	High
CO2 Oxygen Module Failure	Paramagnetic O_2 module error.	Please contact Mindray Technical Support.	High
CO2 Change Watertrap	The watertrap should be changed.	Check the connections of the watertrap and re-connect it.	Low
CO2 No Sensor	The mainstream CO_2 module is not connected to the sensor or there is a communication error.	1.Ensure that the CO_2 sensor is connected. 2. Please contact Mindray Technical Support if the problem persists.	Low
CO2 Sensor Error	The sensor of the mainstream CO_2 module is faulty.	Please contact Mindray Technical Support.	Low

TABLE 11-10 CO2 Module Alarm Messages

11.8.2.8 AG Module Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
AG Module Error	AG Module Error.	1. Replace the AG module. 2. Please contact Mindray Technical Support if the problem persists.	High
O2 Sensor Error	Paramagnetic O_2 sensor error.		High
AG No Watertrap	The AG module watertrap is mounted improperly or not mounted.	Check the connections of the watertrap and re-connect it.	Low
AG Change Watertrap	Replace the AG watertrap.	Replace the AG watertrap.	Low
AG Airway Occluded	Flow rate is lower than 20 ml/min for 1 second.	1. Check if the sampling line of AG module is kinked or blocked. 2. Replace the airway. 3. Re-plug the module. 4. Please contact Mindray Technical Support if the problem persists.	Low
AG Zero Failed	Gas measurements is of poor accuracy during zeroing.	1. Check for external interference sources. 2. Check whether there is a [**AG Airway Occluded**] alarm, and remove the occlusion. 3. Re-plug the module. 4. Please contact Mindray Technical Support if the problem persists.	Low
Mixed Agent	MAC < 3.	Please use the purge agent function to purge the residual anesthetic gas in the circuit	Low
	Mixed anesthetic gases are detected, but MAC is an invalid value.		Medium
Mixed Agent and MAC ⩾ 3	MAC ⩾ 3.		Medium

TABLE 11-11 AG Module Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
CO2 Over Range	The monitored value exceeds the measurement range.	1. Calibrate the AG module. 2. Replace the AG module. 3. Please contact Mindray Technical Support if the problem persists.	Low
N2O Over Range			
Hal Over Range			
Enf Over Range			
Iso Over Range			
Sev Over Range			
Des Over Range			
O2 Over Range			
awRR Over Range			
Internal AG Error 01	1. Internal AG hardware error. 2. Internal AG self-test error. 3. Internal AG hardware fault. 4. Internal AG initialization error. 5. Internal AG communication stopped.	Please contact Mindray Technical Support.	Low
Internal AG Error 02	Internal AG zero failed.		
Internal AG Error 03	Internal AG no watertrap.		
Internal AG Error 04	Internal AG airway occluded.		
Internal AG Error 05	Internal AG change watertrap.		

TABLE 11-11 AG Module Alarm Messages

11.8.2.9 BIS Module Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
BIS Module Error	1. BIS module initialization error. 2. BIS Module communication abnormality. 3. BIS module selftest error.	1. Re-plug the BIS module. 2. Replace the BIS module or contact Mindray Technical Support.	High
BIS Electrode Poor Contact	BIS electrode impedance is too high.	Check and reconnect the BIS sensor.	Low
BIS Sensor Off	BIS sensor is off.	Please check whether the connect of the electrodes are firm and reconnect the electrode if necessary.	Low
BIS Electrode 1 Poor Contact	Electrode impedance is high.	Check and reconnect the BIS sensor.	Low
BIS Electrode 1 Lead Off	Electrode lead is off.	Please check whether the connect of the electrodes are firm and reconnect the electrode if necessary.	Low
BIS Electrode 2 Poor Contact	Electrode impedance is high.	Check and reconnect the BIS sensor.	Low
BIS Electrode 2 Lead Off	Electrode lead is off.	Please check whether the connect of the electrodes are firm and reconnect the electrode if necessary.	Low

TABLE 11-12 BIS Module Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
BIS Electrode 3 Poor Contact	Electrode impedance is high.	Check and reconnect the BIS sensor.	Low
BIS Electrode 3 Lead Off	Electrode lead is off.	Please check whether the connect of the electrodes are firm and reconnect the electrode if necessary.	Low
BIS Electrode 4 Poor Contact	Electrode impedance is high.	Check and reconnect the BIS sensor.	Low
BIS Electrode 4 Lead Off	Electrode lead is off.	Please check whether the connect of the electrodes are firm and reconnect the electrode if necessary.	Low
BIS Electrode G Poor Contact	Electrode impedance is high.	Check and reconnect the BIS sensor.	Low
BIS Electrode G Lead Off	Electrode lead is off.	Please check whether the connect of the electrodes are firm and reconnect the electrode if necessary.	Low
BIS Electrode C Poor Contact	Electrode impedance is high.	Check and reconnect the BIS sensor.	Low
BIS Electrode C Lead Off	Electrode lead is off.	Please check whether the connect of the electrodes are firm and reconnect the electrode if necessary.	Low
BIS Electrode LE Poor Contact	Electrode impedance is high.	Check and reconnect the BIS sensor.	Low
BIS Electrode LE Lead Off	Electrode lead is off.	Please check whether the connect of the electrodes are firm and reconnect the electrode if necessary.	Low
BIS Electrode LT Poor Contact	Electrode impedance is high.	Check and reconnect the BIS sensor.	Low
BIS Electrode LT Lead Off	Electrode lead is off.	Please check whether the connect of the electrodes are firm and reconnect the electrode if necessary.	Low
BIS Electrode RE Poor Contact	Electrode impedance is high.	Check and reconnect the BIS sensor.	Low
BIS Electrode RE Lead Off	Electrode lead is off.	Please check whether the connect of the electrodes are firm and reconnect the electrode if necessary.	Low
BIS Electrode RT Poor Contact	Electrode impedance is high.	Check and reconnect the BIS sensor.	Low
BIS Electrode RT Lead Off	Electrode lead is off.	Please check whether the connect of the electrodes are firm and reconnect the electrode if necessary.	Low
BISx Error	1. BIS DSC Error. 2. BIS DSC failure.	Re-plug the module. Please contact Mindray Technical Support if the problem persists.	High

TABLE 11-12 BIS Module Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
BIS No Cable	BIS cable is not connected.	Check the BIS cables.	Low
BIS No Sensor	Sensor is off from patient.	1. Check the BIS sensor. 2. Re-plug the BIS module. 3. Replace the BIS main cable. 4. Replace the BISx or BISx4.	Low
BIS Sensor Too Many Uses	The number of sensor usage is exceeded.	Replace the sensor.	Low
BIS Signal Quality Too Low	SQI measurement value <15%.	1. Check the patient. 2. Check whether the sensor placement is correct and whether it is in good contact with the patient's skin. 3. Check whether the BISx or BISx4 is far away from the electric radiation equipment.	Low
BIS Low Signal Quality	SQI measurement value <50%.		Low
BIS L Signal Quality Too Low	SQI L measurement value <15%.		Low
BIS L Low Signal Quality	SQI L measurement value <50%.		Low
BIS R Signal Quality Too Low	SQI R measurement value <15%.		Low
BIS R Low Signal Quality	SQI R measurement value <50%.		Low
BIS Sensor Expired	Sensor expired.	Replace the BIS sensor.	Low
BISx Disconnected	BIS cable is not connected to module or the communication error.	1. Check BISx or BISx4 connection. 2. Re-plug the BIS module. 3. Replace the BIS main cable. 4. Replace the BISx or BISx4.	Low
BIS Wrong Sensor Type	The BIS sensor is non-specification type.	Check and use the right sensor.	Low
BIS Sensor Fault	Sensor failure or electrode failure.	Replace the BIS sensor.	Low
Disconnect/ Reconnect BIS	The BIS module should be re-mounted.	Re-plug the BIS module.	Low

TABLE 11-12 BIS Module Alarm Messages

11.8.2.10 NMT Module Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
NMT Module Error	1. NMT Module communication abnormality. 2. NMT module communication stopped. 3. NMT module communication error. 4. NMT module initialization error. 5. NMT module power failure. 6. NMT module selftest error.	1. Re-plug the NMT module. 2. Replace the NMT module or contact Mindray Technical Support.	High
NMT No Main Cable	The NMT main cable is disconnected.	Check that NMT main cable is properly connected to the NMT module.	Low

TABLE 11-13 NMT Module Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
NMT No Sensor	The NMT sensor is disconnected.	1. Check that NMT sensor is properly connected to the NMT main cable. 2. If the alarm persists, replace the sensor.	Low
NMT Stimulation Electrode Off	The NMT stimulation electrode falls off.	1. Check that NMT stimulation cable is properly connected to the NMT patient cable. 2. If the alarm persists, check the application of electrodes.	Low
NMT Sensor Error	The NMT sensor error.	Please contact Mindray Technical Support.	Low
NMT Stimulation Current Over Limit	NMT stimulation current exceeds limits.		Low
ST-Ratio Overrange	The monitored value exceeds the measurement range.	Please contact Mindray Technical Support.	Low
TOF-Ratio Overrange			
DBS-Ratio Overrange			

TABLE 11-13 NMT Module Alarm Messages

11.8.2.11 Auxiliary O2/Air Module Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
Aux O2/AIR Failure	1. O2 branch flow sensor error. 2. Air branch flow sensor error. 3. O2 branch switch valve error. 4. Air branch switch valve error.	Please contact Mindray Technical Support.	Medium
Aux O2/AIR Selftest Error	1. EEPROM self-test error. 2. O2 proportional valve self-test error. 3. Air proportional valve self-test error. 4. Zero reading error.	1. Restart the auxiliary O2/air feature. 2. Please contact Mindray Technical Support if the problem persists.	Medium
Calibrate Aux O2/ AIR Module	1. The calibration table is not found on the EEPROM. 2. The checksum of the calibration table does not match.	Please contact Mindray Technical Support.	Low

TABLE 11-14 Auxiliary O2/Air Module Alarm Messages

11.8.2.12 HFNC Module Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
HFNC Module Failure	1. O2 branch flow sensor error. 2. Air branch flow sensor error. 3. HFNC flow control range error.	Please contact Mindray Technical Support.	Medium
HFNC Selftest Error	1. EEPROM self-test error. 2. O2 proportional valve self-test error. 3. Air proportional valve self-test error. 4. Zero reading error.	1. Restart HFNC. 2. Please contact Mindray Technical Support if the problem persists.	Medium
Calibrate HFNC Module	1. The calibration table is not found on the EEPROM. 2. The checksum of the calibration table does not match.	Please contact Mindray Technical Support.	Low

TABLE 11-15 HFNC Module Alarm Messages

11.8.2.13 HFJV Module Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
HF Pressure Not Achieved	The drive pressure of the high frequency branch does not reach the set value.	Please contact Mindray Technical Support.	Medium
NF Pressure Not Achieve	The drive pressure of the normal frequency branch does not reach the set value.	Please contact Mindray Technical Support.	Medium
HF Pressure Too High	The drive pressure of the high frequency branch is too high.	Please contact Mindray Technical Support.	Medium
NF Pressure Too High	The drive pressure of the normal frequency branch is too high.	Please contact Mindray Technical Support.	Medium
HFJV Module Error: 01	The 3-way valve or purge valve failure.	Please contact Mindray Technical Support.	Medium
HFJV-HF Module Failure: 01	The high frequency air branch failure.	Please contact Mindray Technical Support.	High
HFJV-HF Module Failure: 02	The high frequency oxygen branch failure.	Please contact Mindray Technical Support.	High
HFJV-HF Module Failure: 03	The high frequency pressure sensor failure.	Please contact Mindray Technical Support.	High
HFJV-HF Module Failure: 04	The high frequency safety valve failure.	Please contact Mindray Technical Support.	High
HFJV-HF Module Failure: 05	High frequency module self-test error.	Please contact Mindray Technical Support.	High
HFJV-HF Module Failure: 06	The internal voltage is abnormal.	Please contact Mindray Technical Support.	High
HFJV-HF Module Failure: 07	Auxiliary module communication failure or VCM communication failure.	Please contact Mindray Technical Support.	High
HFJV-NF Module Failure: 01	The normal frequency air branch failure.	Please contact Mindray Technical Support.	High

TABLE 11-16 HFJV Module Alarm Messages

HFJV-NF Module Failure: 02	The normal frequency oxygen branch failure.	Please contact Mindray Technical Support.	High
HFJV-NF Module Failure: 03	The normal frequency pressure sensor failure.	Please contact Mindray Technical Support.	High
HFJV-NF Module Failure: 04	The normal frequency safety valve failure.	Please contact Mindray Technical Support.	High
HFJV-NF Module Failure: 05	Normal frequency module self-test error.	Please contact Mindray Technical Support.	High
HFJV-NF Module Failure: 06	The internal voltage is abnormal.	Please contact Mindray Technical Support.	High
HFJV-NF Module Failure: 07	Auxiliary module communication failure.	Please contact Mindray Technical Support.	High
NF Jet Tube is Kinked or Occluded	The tube of the normal frequency limb is kinked or blocked.	1. Check whether the tube of the normal frequency limb is kinked or clogged. 2. Please contact Mindray Technical Support if the problem persists.	High
HF Jet Tube is Kinked or Occluded	The tube of the high frequency limb is kinked or blocked.	1. Check whether the tube of the high frequency limb is kinked or clogged. 2. Please contact Mindray Technical Support if the problem persists.	High
NF Jet Tube Disconnected?	Normal frequency limb accessories at the device end are disconnected.	1. Check whether the normal frequency limb accessories at the device end are disconnected. 2. Please contact Mindray Technical Support if the problem persists.	High
HF Jet Tube Disconnected?	High frequency limb accessories at the device end are disconnected.	1. Check whether the high frequency limb accessories at the device end are disconnected. 2. Please contact Mindray Technical Support if the problem persists.	High
Jet Ventilation is stopped	1. During HFJV ventilation, the laser safety mode is switched on. 2. When O2 concentration is lower than 40%, the air branch failure or the air supply pressure is insufficient.	1. Check if the air branch supply is sufficient. 2. Please contact Mindray Technical Support if the problem persists.	High
HFJV Aux Module Failure: 01	In the single high frequency configuration, the module power-on self-test fails.	Please contact Mindray Technical Support.	High
HFJV Aux Module Failure: 02	In the single high frequency configuration, the internal power supply is abnormal.	Please contact Mindray Technical Support.	High
HFJV Aux Module Failure: 03	In the single high frequency configuration, the protection module communication fails.	Please contact Mindray Technical Support.	High

TABLE 11-16 HFJV Module Alarm Messages

11.8.2.14 Internal Air Supply Alarm Messages

MESSAGE	CAUSE	ACTION	ALARM PRIORITY
Internal Air Supply Error	The internal air supply cannot output pressure properly.	1. Check if the filter at the air pump inlet is contaminated. 2. Please contact Mindray Technical Support if the problem persists.	Medium
Internal Air Supply Fan Failure	The internal air supply fan failure.	Please contact Mindray Technical Support.	Medium

TABLE 11-17 Internal Air Supply Alarm Messages

11.8.3 Prompt Message

11.8.3.1 Prompt Messages Displayed in Alarms Area

INFORMATION	NOTE
Volume and Apnea Alarms are OFF	This message appears when the [**Alarms**] is set to [**Off**] in the Manual mode.
CO2 and CO2 Apnea Alarms are OFF	This message appears when the [**CO2 Alarms**] is set to [**Off**] in the Manual mode.
Load Profile Failure	This message appears when loading user or latest configuration failed.
Save Profile Failure	This message appears when an error occurs during saving user profiles.
Demo Mode - Not for Clinical Use	This message appears when the system works in the demo mode.
Service Mode- Not for Clinical Use	This message appears when the machine is working in Service Mode.
Mainboard Reset	This message appears when the mainboard is restarted abnormally.
Ventilator Reset	This message appears when the ventilator is restarted abnormally.
Aux Control Module Reset	This message appears when the auxiliary monitoring board is restarted abnormally.
Apnea Ventilation	This message appears when Apnea Ventilation is triggered in the PS/CPAP mode.
Calibrate O2 sensor for 21%	This message appears when more than 72 hours have elapsed since the last successful calibration.
Calibrate O2 sensor for 100%	This message appears when the O_2 Sensor 100% Calibrate data is not revised correctly after 21% O_2 sensor calibration is successful.
Auto-zero in process	This message appears when auto-zeroing of the pressure sensors is in process.
New functions activated, please restart!	This message appears when function activation completes successfully.
Restart to activate new service configurations	This message appears when Flowmeter Standard is changed.
Could not locate time server	This message appears when the SNTP Protocol is set to On but has not communicated with the time server for 5 intervals.
Total Flow Sensor Selftest in Progress	This message appears when an automatic total flow sensor self-test is in progress.

TABLE 11-18 Prompt Messages Displayed in Alarms Area

INFORMATION	NOTE
Leak Test Not Performed	This message appears when the Auto Leak Test or Manual Leak Test is skipped after system startup, or 24 hours has elapsed since last leak test.
Ventilation and Fresh Gas Flow Paused	This message displays when the Flow Pause is active..
All Physiological Alarms are OFF	This message displays when the Flow Pause is active..
CO2 Data is Unavailable for Optimizer	This message appears when the optimizer indicator feature for fresh gas is enabled and when the CO2 data is invalid.
AG Loaded Successfully	External AG loaded successfully.
AG Unloaded Successfully	External AG unloaded successfully.
AG Startup	AG module is starting up.
AG Warmup	AG module is warming up.
AG Zeroing	AG module zeroing in progress.
Hal is detected.	With the AG monitoring switch off, this message appears when the system detects halothane.
Enf is detected.	With the AG monitoring switch off, this message appears when the system detects enflurane.
Iso is detected.	With the AG monitoring switch off, this message appears when the system detects isoflurane.
Sev is detected.	With the AG monitoring switch off, this message appears when the system detects sevoflurane.
Des is detected.	With the AG monitoring switch off, this message appears when the system detects desflurane.
BIS Sensor Checking	BIS sensor impedance check is being performed.
BIS Ground Checking	BIS ground check is being performed.
BIS Sensor Check Failed	BIS sensor check failed or some electrode impedance checks failed.
BIS in Demo	BIS module is connected with simulator.
BIS Interference	BIS signal is interfered.
CO2 Warm-up	CO_2 module is working in warmup status.
CO2 Startup	CO_2 module is starting up.
CO2 Zero Running	CO_2 zero is running
CO2 Loaded Successfully	CO_2 module is loaded successfully.
CO2 Unloaded Successfully	CO_2 module is unloaded successfully.
CO2 Zero Required	The CO_2 module needs to be zeroed.
CO2 Sensor Warmup	The mainstream CO_2 sensor is warming up.
CO2 Check Adapter	Mainstream CO_2 module airway adapter error.
Block Recovery	The tested value exceeds the block recovery threshold.
NMT Loaded Successfully	NMT module is loaded successfully.
NMT Unloaded Successfully	NMT module is unloaded successfully.
Drive Gas Switched to O2 (only applicable to anesthesia system without blower)	The drive gas has been successfully switched to O_2.
Drive Gas Switched to AIR (only applicable to anesthesia system without blower)	The drive gas has been successfully switched to air.

TABLE 11-18 Prompt Messages Displayed in Alarms Area

INFORMATION	NOTE
Drive Gas Switched Back to O2 (only applicable to anesthesia system without blower)	The drive gas has been successfully restored to O_2.
Drive Gas Switched Back to AIR (only applicable to anesthesia system without blower)	The drive gas has been successfully restored to air.
Drive Gas Switch Valve Failure (only applicable to anesthesia system without blower)	This message appears when drive gas switch valve is failed, but current drive gas pressure is normal.
Internal Air Supply in Use	The air supply is switched to the internal air supply.
Switched Back to External Air Supply	The air supply is switched back to the external air supply.
Internal Air Supply Need Maintenance	The operating time of the internal air supply exceeds the maintenance time.
Blower Need Maintenance (only applicable to anesthesia system configured with blower)	Blower has exceeded maintenance time.
Jet Ventilation is Off	This message appears when both the high frequency jet ventilation switch and the normal frequency jet ventilation switch are turned off in HFJV mode.

TABLE 11-18 Prompt Messages Displayed in Alarms Area

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12.0 Maintenance

WARNING: Do not use a malfunctioning anesthesia system. Have all repairs and service done by an authorized service representative.

WARNING: 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.**

WARNING: Only use lubricants approved for anesthesia or O_2 equipment.

WARNING: Do not use lubricants that contain oil or grease. They can burn or explode in the presence of high O_2 concentrations.

WARNING: Abide by disinfection control and safety procedures as used equipment may be contaminated by blood or body fluids.

WARNING: Movable parts and removable components may present a pinch or a crush hazard. Use care when moving or replacing system parts and components.

WARNING: Do not use O3 for disinfection. Otherwise, the breathing system may be damaged.

CAUTION: 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.**

NOTE: Personnel with no servicing experience for such a type of equipment shall not engage in servicing of the equipment. Replace damaged parts with components manufactured or sold by Mindray. Then test the unit to ensure that it complies with the manufacturer's published specifications.

NOTE: If necessary, contact Mindray for the circuit diagram, list of parts and calibration instructions of products or other information related to equipment maintenance.

12.1 Maintenance Schedule

The schedules listed below are the minimum frequency based on 2,000 hours of usage per year. The equipment should be serviced more frequently if used more than this yearly usage. Maintenance should be performed by a trained technician.

NOTE: During cleaning and setup, inspect the parts and seals for damage. Replace or repair as necessary.

MINIMUM MAINTENANCE FREQUENCY	MAINTENANCE
Every day	Clean the external surfaces.
Every 72 hours	Perform the 21% O_2 calibration (O_2 sensors in breathing system). The system will prompt the user for 21% O_2 calibration.
Every month or as necessary	Check the internal air supply inlet dust filter for dust condensation. Clean or replace it as necessary. For anesthesia system configured with blower, check the blower air inlet dust filter for dust condensation. Clean or replace it as necessary.
Every year	Gas module calibration. Regular maintenance by trained technical personnel. Please contact Mindray Technical Support for details.
Annually, or every 5000 hours, or as necessary	Replace the HEPA filter at the internal air supply inlet. or replace it as necessary. For anesthesia system configured with blower, replace HEPA filter at the blower air inlet.
On-demand	• Perform the 21% oxygen calibration and 100% oxygen calibration after replacing the O_2 sensor or when there is a larger error in O_2 concentration monitoring. • Replace the O_2 sensor if it cannot be calibrated. • Replace the soda lime in the canister if the soda lime color changes. Follow the manufacturer's instructions. • Replace the flow sensor if the seal for the flow sensor is damaged, the membrane inside the flow sensor is cracked or distorted, or the flow sensor is cracked or distorted. • Calibrate the flow sensor after re-installing the cleaned or disinfected flow sensor, after replacing with a new flow sensor, or when tidal volume measurement is inaccurate. • Clear the water gathered in the watertrap and the gas module watertrap. • Replace the gas supply hose if it is damaged. • Before installing the cylinder, check whether the cylinder gasket at the yoke is damaged. If it is damaged, replace the gasket.

TABLE 12-1 Maintenance Schedule

12.2 Breathing System Service

When cleaning the breathing system, replace any parts that are visibly cracked, chipped, distorted or worn. See section 5.4 (Pages 5-5) "System Check" and 12.10 (Pages 12-10) "Cleaning and Disinfection" for specific operations.

12.3 Flow Sensor Calibration

WARNING: Do not calibrate the flow sensor when the system is connected to a patient.

NOTE: During calibration, do not operate the pneumatic parts. Do not move or press the breathing tubes.

NOTE: **Calibrate the flow sensor after re-installing the cleaned or disinfected flow sensor, after replacing with a new flow sensor, or when tidal volume measurement is inaccurate.**

Calibrate the flow sensor every time the flow exceeds the specification or the flow sensor is replaced.

To calibrate the flow sensor:

1. Ensure that the gas supply pressure is normal.
2. Turn off all fresh gas inputs.
3. Set the Auto/Manual switch to the Auto position.
4. Remove the bellows, and reinstall the bellows housing.
5. Connect the Y piece on the breathing system to the leak test port to close the breathing system.
6. Remove the watertrap.
7. Ensure that the system is in Standby mode.
8. Select the icon and open the [**Setup**] menu.
9. Select the [**Calibrate**] tab.
10. Operate following the on-screen prompts. Select the [**Begin**] key to calibrate the flow sensor. The calibration may take several minutes. The system will display the results of the calibration status after the process is completed.
11. Select to close the menu.
12. After calibration is completed, reinstall the bellows and the watertrap.

NOTE: **In case of repeated calibration failure, contact Mindray Technical Support.**

12.4 O_2 Sensor Calibration

WARNING: **Do not perform the calibration when the system is connected to a patient.**

WARNING: **To calibrate an O_2 sensor, the ambient pressure must be identical with the ambient pressure for O_2 transport monitoring of the breathing system. Otherwise, the monitoring may exceed the specified range.**

WARNING: **Prior to the O_2 sensor calibration, remove the O_2 sensor. Make sure there is no water on the O_2 sensor or where it is installed before installing the O_2 sensor.**

WARNING: **No O_2 calibration is required if O_2 sensor is not equipped or not used.**

WARNING: **Observe related biohazard regulations during disposal of discarded O_2 sensors. Do not burn O_2 sensors.**

12.4.1 21% Oxygen Calibration

It is required to check the 21% O_2 calibration once around every 72 hours to keep O_2 sensor accuracy for the anesthesia system not connected to the air supply.

NOTE: **The breathing system automatically seals off the O_2 sensor port when the O_2 sensor is removed.**

1. Select the icon > [**O2**] key.

2. Remove the O_2 sensor from the O_2 sensor port on the breathing system. Allow three (3) minutes for the sensor to acclimate to the environment.
3. Carefully follow the on-screen prompts to prepare for calibration.
4. Select the [**Begin**] key to start the O_2 sensor calibration. The system will display the calibration status after calibration has completed.
5. If an error code (such as 00 00 00 10) is displayed in red, see Table 12-2, "O2 Sensor Calibration Error Codes," on page 5 to learn more about troubleshooting. When the 21% O_2 calibration is complete, reinstall the O_2 sensor to the O_2 sensor port on the breathing system.

12.4.2 100% Oxygen Calibration

When the measured O_2 concentration evidently diverges from other reference values, or when the O_2 sensor is replaced, the sensor should be calibrated again. When the O_2 sensor is replaced, 100% O_2 calibration is required.

1. Make sure that the anesthesia system is in the standby mode.
2. Select the icon > [**System**] (system password needed) > [**Calibrate**] > [**O2 Sensor**] key.
3. Make sure that no alarm appears.
4. Carefully follow the on-screen prompts to prepare for calibration.
5. Select the [**Begin**] key to start the O_2 sensor calibration. The system will display the calibration status after calibration has completed.
6. If the error code (such as 00 00 00 10) is displayed in red, see Table 12-2, "O2 Sensor Calibration Error Codes," on page 5 to learn more about troubleshooting.
7. After the calibration is complete, select to close the menu.

NOTE: **If the 100% O_2 calibration failed, check for any technical faults and alarms. After the fault is cleared, calibrate the sensor again.**

NOTE: **If the calibration failed for several times, replace the O_2 sensor and calibrate the sensor again. If the calibration failure persists, contact Mindray Technical Support.**

12.4.3 O2 Sensor Calibration Error Codes

ERROR CODE	DESCRIPTION	RECOMMENDED COUNTERMEASURES
1	21% calibration value is small	1. Check that the O_2 sensor is connected to the cable correctly. 2. Check that the O_2 sensor is in 21% O_2. 3. Check that the O_2 sensor output voltage in the calibration menu is steady. 4. Replace the O_2 sensor.
2	21% calibration value is great	1. Check that the O_2 sensor is connected to the cable correctly. 2. Check that the O_2 sensor is in 21% O_2. 3. Check that the O_2 sensor output voltage in the calibration menu is steady. 4. Replace the O_2 sensor.

TABLE 12-2 O2 Sensor Calibration Error Codes

ERROR CODE	DESCRIPTION	RECOMMENDED COUNTERMEASURES
3	100% calibration value is small	1. Check that the O_2 sensor is connected to the cable correctly. 2. Check that the O_2 sensor is in 100% O_2. 3. Check that the O_2 sensor output voltage in the calibration menu is steady. 4. Replace the O_2 sensor.
4	100% calibration value is great	1. Check that the O_2 sensor is connected to the cable correctly. 2. Check that the O_2 sensor is in 100% O_2. 3. Check that the O_2 sensor output voltage in the calibration menu is steady. 4. Replace the O_2 sensor.
5	Difference between 21% calibration value and 100% calibration value exceeds the threshold	Replace the O_2 sensor.
6	Error in correcting 100% calibration value using 21% calibration value	1. Replace the O_2 sensor. 2. Perform the calibration again. 3. Replace the CPU board.
7	System in BFCS status	Set the machine to the EFCS state.
33	O2 supply pressure low	1. Replace or connect the gas supply. 2. If the gas supply functions normally, check the gas supply pressure switch.
35	Air supply pressure low	1. Replace or connect the gas supply. 2. If the gas supply functions normally, check the gas supply pressure switch.
37	O2 sensor disconnected	1. Check for any [**O2 Sensor Disconnected**] alarm on the screen. If you see the alarm, check whether the O_2 sensor cable is connected correctly. 2. Check that the O_2 sensor output voltage in the calibration menu is steady. 3. Replace the O_2 sensor.
38	O_2 sensor failure	1. Check for any [**Replace O2 sensor**] alarm on the screen. If you see the alarm, check whether the O_2 sensor cable is connected correctly. 2. Check that the O_2 sensor output voltage in the calibration menu is steady. 3. Replace the O_2 sensor.
39	Failure to save table	1. Perform the calibration again. 2. Replace the CPU board.
3B	The ACGO switch is turned on.	Turn off the ACGO switch.

TABLE 12-2 O2 Sensor Calibration Error Codes

12.5 Zero Flow Meters

1. Select the icon > [**System**] (system password needed) > [**Calibrate**] > [**Zero Flow Meters**] key.
2. Select [**Begin**] to zero the flowmeter and follow the prompts on the screen.

NOTE: Before zeroing the flowmeter, make sure that the gas supply (O_2, N_2O and air) is disconnected.

12.6 Zero Aux. O2/Air

1. Select the icon > [**System**] (system password needed) > [**Calibrate**] > [**Zero Aux. O2/Air**] key.
2. Select [**Begin**] to zero the auxiliary O_2/air supply and follow the prompts on the screen.

12.7 Zero HFNC

1. Select the icon > [**System**] (system password needed) > [**Calibrate**] > [**Zero HFNC**] key.
2. Select [**Begin**] to zero the HFNC module and follow the prompts on the screen.

12.8 Handling of Water Condensation

12.8.1 Avoid Water Condensation

Water comes from the condensation of exhaled gas and a chemical reaction between CO_2 and the soda lime in the CO_2 absorbent canister. Water condensation is inevitable during use of the anesthesia system. At lower fresh gas flows more water builds up because of the following:

- More CO_2 stays in the CO_2 absorbent canister to react and produce water.
- More moist, exhaled gas stays in the breathing system and CO_2 absorbent canister to produce condensed water.

When the anesthesia system is in use, water condesation inside the flow sensor, watertrap, gas module watertrap, and patient tube could result in abnormal flow waveform, unstable tidal volume or inaccurate measured value of gas. If there is water condensation, clear it immediately before use.

To avoid water condensation:

- Increase the fresh gas flow as appropriate. More water may be gathered when the fresh gas flow is lower than the optimizer, and less water is gathered when the fresh gas flow is higher than the optimizer.
- Turning off the breathing circuit heating can help reduce the gathered water in the breathing tube, but the water gathered in the circuit may increase on the contrary.
- Use a filter between the flow sensor and the patient to limit water condensation in the flow sensor.

12.8.2 Clear Gathered Water

Water condensation inside the flow sensor, watertrap, gas module watertrap, CO_2 absorbent canister, and patient tube results in abnormal flow waveform, unstable tidal volume or inaccurate measured value of gas. If there is water condensation inside these parts, clear the water, and then reinstall the parts for use.

WARNING: Check water build-up inside the flow sensor before every system use. Accumulated water in the flow sensor causes erroneous readings.

WARNING: Ensure that all breathing system parts are completely dried after the breathing system is cleaned and disinfected.

WARNING: Water may gather in the patient's breathing tube if the Auto Ventilation mode is used for a long time (such as longer than four hours). Clear the gathered water in time to avoid impact on the ventilation or ingress of water into the patient circuit.

12.9 Electrical Safety Inspection

NOTE: Perform an electrical safety inspection after servicing or routine maintenance. Before performing the electrical safety inspection, ensure that all the covers, panels, and screws are correctly installed.

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

12.9.1 Auxiliary Outlet Test

Verify that the mains power voltage appears on each auxiliary outlet when the anesthesia system is connected to the mains power.

12.9.2 Electrical Safety Test

Connect the anesthesia system and the electrical safety analyzer according to the electrical safety analyzer operator's manual. If the BIS module is configured, connect the BIS module to the potential column of the electrical safety analyzer. The test results shall meet the requirements of IEC60601-1.

1. Perform protective earth resistance test:
   a. Connect the probe of the electrical safety analyzer to its null terminal for zeroing before testing. Select the earth resistance (Ω) mode and test the earth resistance between the protective grounding terminal of the AC power supply and the equipotentiality.
   b. Test the grounding impedance using a 25A testing current.
   c. Verify the resistance is less than 0.1ohms (100 mohms).
   d. Test the earth resistance of the safety analyzer to the protective grounding terminal of the AC power supply and the protective grounding terminal of any auxiliary outlet respectively, and repeat Steps b and c.
   e. If the impedance value is greater than 0.1ohms (100 mohms) but smaller than 0.2ohms (200 mohms), remove the AC power cable, and connect the probe that was originally connected to the protective grounding terminal of the AC power supply to the protective grounding terminal of the AC power outlet. Then repeat steps a to d.
2. Select the current (μA) mode, Perform the following earth leakage current tests:
   - Normal polarity
   - Reverse polarity
   - Normal polarity with open neutral
   - Reverse polarity with open neutral

   Verify that the maximum leakage current does not exceed 500 μA (0.5 mA) in the first two tests. While for the last two tests, verify that the maximum leakage current does not exceed 1000 μA (1 mA).

3. If the BIS module is configured, test the patient leakage current in the following circumstances.Select the current (μA) mode and select the potential column connected to BIS from the menu. Press the polarity button to select positive and negative polarity, the neural button to select neutral wire connection or disconnection, the earth button to select ground wire connection or disconnection, and mains on AP can be found in the menu.
   - 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
   - Reverse polarity with mains on AP

   Verify that the maximum leakage current in the first two circumstances does not exceed 100μA (0.1mA), that in the middle four circumstances does not exceed 500μA (0.5mA), and that in the last two circumstances does not exceed 5000μA (5mA).
4. If the BIS module is configured, test the patient auxiliary current between each electrode and the rest ones in the following circumstances in sequence.Select the current (μA) mode and select the potential column connected to BIS from the menu. Press the polarity button to select positive and negative polarity, the neural button to select neutral wire connection or disconnection, the earth button to select ground wire connection or disconnection.
   - Normal polarity
   - Reverse polarity
   - Normal polarity with open neutral
   - Reverse polarity with open neutral
   - Normal polarity with open earth
   - Reverse polarity with open earth

   Verify that the maximum auxiliary current in the first two circumstances does not exceed 100 μA (0.1 mA), and that in the last four circumstances does not exceed 500 μA (0.5 mA).

NOTE: Please use a certified safety analyzer (such as UL, CSA or AAMI) and perform related tests following their respective instructions.

NOTE: Open neutral or earth is called single fault mode.

WARNING: Leakage current tests are required when the normal saline or blood spills and after the start of each monitoring. A leakage current test is required immediately after a major surge appears in the residential electrical system.

WARNING: Keep in mind that liquids similar to normal saline and Ringer's solution and blood are excellent conductors. Avoid touching any part of the system using a wet hand. Always operate using clean and dry hands.

12.10 Cleaning and Disinfection

ISO 17664 compliance:

The process for autoclave sterilization of the Anesthetic Breathing System has been tested and found to be in compliance with ISO 17664-1: 2021. Compliance to ISO 17664-1: 2021 only applies when bacterial/ viral filters are used to filters air coming in from the patient and returning air to the patient. Filters must be properly installed. Refer to 12.10.3.5 (Pages 12-19) "Reassembly" and 12.10.1 (Pages 12-10) "Cleaning and Disinfecting Agents / Autoclaving".

WARNING: 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. See section 5.4.1 (Pages 5-5) "Leak and Compliance Test".

Observe all the "WARNINGs" and "NOTEs" at the beginning of this chapter. Before use, identify the cleaning and disinfecting frequencies and levels for the system following the infection control stipulations of the medical institution. If disinfection is required, make sure to follow the methods described in the following sections to clean and dry all parts.

12.10.1 Cleaning and Disinfecting Agents / Autoclaving

The cleaning agents and disinfectors listed have been tested and found to not cause harm to the Anesthesia System parts. Read the material safety data sheet (MSDS) for each cleaning agent and disinfector.

The cleaning agents and disinfectors listed may not be available or approved for use in all countries or regions. Follow hospital guidelines for cleaning and cleaning agent use, disinfecting and disinfector use.

NOTE: Cleaning and disinfecting solutions not shown in the cleaning agents and disinfectors listed must have a pH of 7.0 to 10.5. Organic, halogenated or petroleum-based solvents, anesthetic agents, glass cleaners, acetone, or other harsh cleaning agents and disinfectors are not recommended.

Clean and disinfect the system before its first use. After the system has been used, clean or disinfect it on a daily basis or regularly at a desired interval. See Table 12-1, “Maintenance Schedule,” on page 3 for reference.

Table 12-3 to Table 12-5 introduces the cleaning agents and disinfectors, as well as the possible high-temperature and high-pressure processing procedures for the anesthesia system.

CLEANING AGENT
Green soap tincture

TABLE 12-3 Cleaning Agent

	DISINFECTOR
Surface disinfection	Ethanol (75%)
	Sodium hypochlorite solution 0.5%
	Isopropanol (70%)
	Alpet® D2 Surface Sanitizing Wipes
	PDI Super Sani-Cloth® Germicidal Disposable Wipe
	Metrex™ Cavi Wipes™
	PDI Sani-Cloth® Plus Germicidal Disposable Cloth
Suction tubes and liquid collection bottles of the negative pressure suction device	Glutaraldehyde (2%)
	CIDEX® OPA
Blower air inlet dust filter (only applicable to anesthesia system configured with blower) and internal air supply inlet dust filter	Ethanol (75%)
	Isopropanol (70%)
	Glutaraldehyde (2%)
	CIDEX® OPA

TABLE 12-4 Disinfector

AUTOCLAVING PROCESS
Autoclaving process*

** Except O_2 sensor, O_2 sensor support and airway pressure gauge, all the components of the breathing system are resistant to autoclaving process. The components can be autoclaved up to a maximum temperature of 134°C (273°F) for 4 minutes (recommended time of using dynamic-air-removal steam sterilizer). Suction tubes and liquid collection bottles of the negative pressure suction device are not autoclavable.*

TABLE 12-5 Autoclaving Process

12.10.2 Exterior

Clean all exteriors (including the external surface of the Anesthesia System, the external surface of the breathing system, the external surface of the gas monitoring module, the external surface of the BIS module, the external surface of the NMT module, the external surface of the gas supply hose assembly, the external surface of the scavenging hose assembly and the external surface of the bracket, etc.) and cables using soft cloths moistened with an authorized cleaning agent (See Table 12-3 on page 10).

Disinfect all exteriors (including the external surface of the Anesthesia System, the external surface of the breathing system, the external surface of the gas monitoring module, the external surface of the BIS module, the external surface of the NMT module, the external surface of the gas supply hose assembly, the external surface of the scavenging hose assembly and the external surface of the bracket, etc.) and cables using soft cloths moistened with an authorized disinfectors (See Table 12-4 on page 11).

After the cleaning or disinfection is complete, use dry and lint-free cloths to remove the residual cleaning agent and disinfector solution.

12.10.3 Breathing System

WARNING: **Use extreme care while handling the CO2 absorbent as it is a caustic irritant.**

CAUTION: **Never immerse the oxygen sensor or its connector into any type of liquid. Dispose the O2 sensor according to the manufacturer's specifications.**

CAUTION: **Do not wash the inner surface of the oxygen sensor.**

CAUTION: **Do not perform soaking or high-temperature processing on the O2 sensor.**

NOTE: **Do not use water or high pressure gas to flush the inside of the flow sensor; otherwise, the flow sensor will be damaged.**

NOTE: **Do not insert any object into the flow sensor for cleaning; otherwise, the flow sensor will be damaged.**

NOTE: **Please disassemble and clean the bottom of the CO2 absorbent canister regularly.**

12.10.3.1 Disassembly

Disassemble the Breathing System at the point of use or at the designated cleaning area.

12.10.3.1.1 Breathing Tube

NOTE: **When removing a breathing tube, hold the joints at both ends of the tube to prevent damage to the tube.**

NOTE: **Do not reuse the bacterial filter to prevent cross infection.**

1. Pull the bacteria filter off the Y-piece.

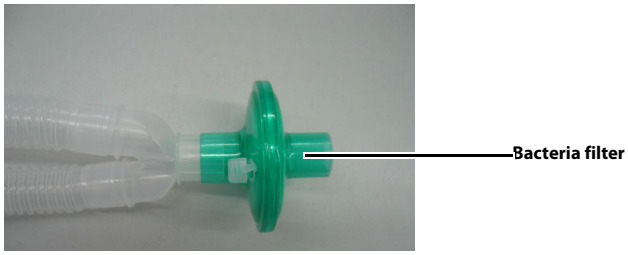


FIGURE 12-1 Remove the Bacteria Filter

2. Disconnect the expiratory tube and inspiratory tube from the expiration connector and the inspiration connector of the breathing system, respectively.

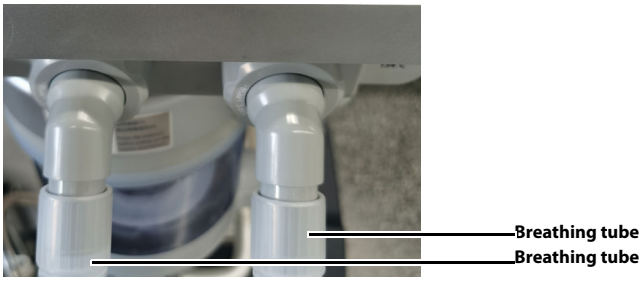


FIGURE 12-2 Remove the Breathing Tubes

12.10.3.1.2 Manual Bag

Directly draw out the manual bag to disassemble it.

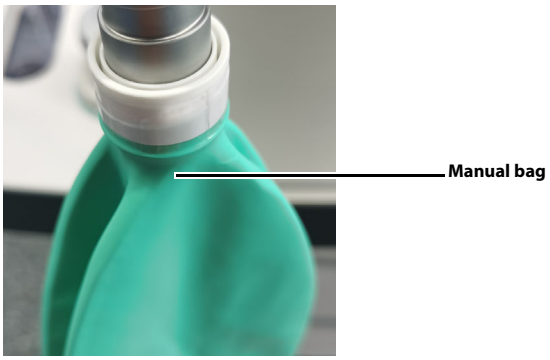


FIGURE 12-3 Remove the Manual Bag

12.10.3.1.3 O_2 Sensor

1. Press the O_2 sensor cover switch to open the O_2 sensor cover.

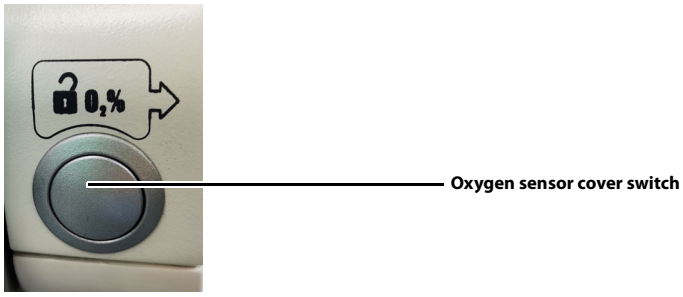


FIGURE 12-4 Open the O_2 Sensor Cover

2. Pull straight out the O_2 sensor cable.

FIGURE 12-5 Pull Out the O_2 Sensor Cable

3. Press the buckle to pull out the O_2 sensor support from the breathing system.

FIGURE 12-6 Disassemble the O_2 Sensor Support

4. Rotate the O_2 sensor anticlockwise to remove it from the support.

FIGURE 12-7 Remove the O_2 Sensor from the Support

5. Close the O_2 sensor cover.

12.10.3.1.4 CO_2 Absorbent Canister

1. Rotate the locking mechanism handle clockwise to the unlocked position.

FIGURE 12-8 Canister Unlocking

FIGURE 12-9 Canister Locking

2. Remove the CO_2 absorbent canister.

3. Remove the absorber from the CO_2 absorbent canister.

WARNING: Please dispose of discarded absorbent following the requirements of absorbent manufacturers.

12.10.3.1.5 Bypass

Press and hold the buckle on the bypass assembly to take out the bypass assembly downward.

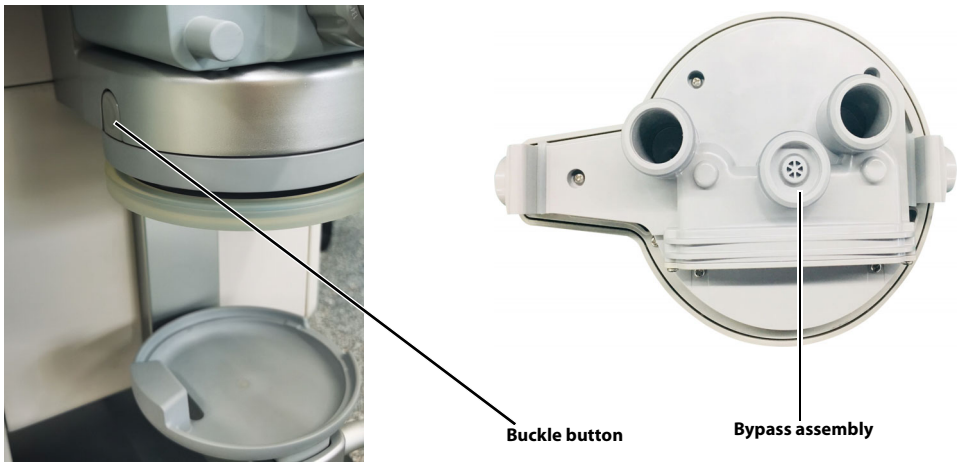


FIGURE 12-10 Remove the Bypass

WARNING: When removing the bypass assembly, hold the bypass assembly with one hand to prevent it from falling, and press the buckle on the bypass assembly with the other hand.

12.10.3.1.6 Bellows Assembly

1. Rotate the bellows housing counterclockwise and lift it upwards to remove it.

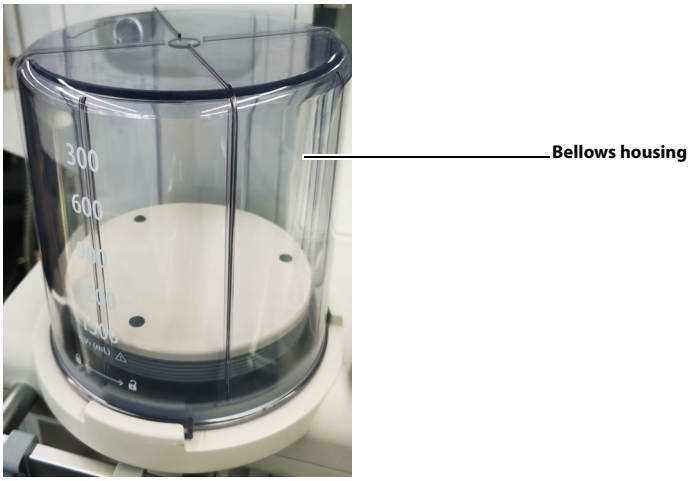


FIGURE 12-11 Remove the Bellows Housing

2. Pull the bellows and the upper and lower cover assembly upward.

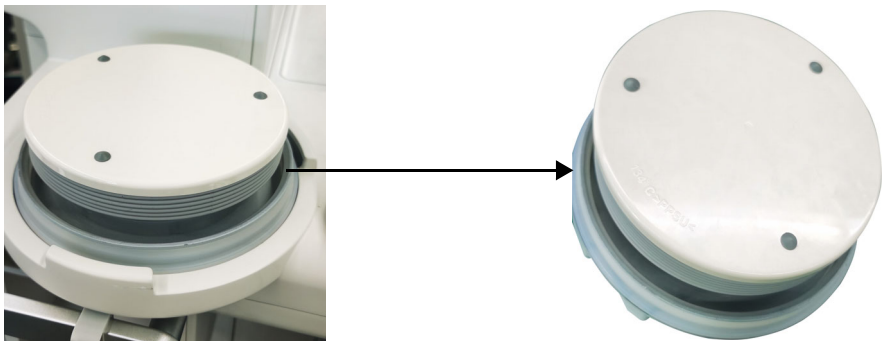


FIGURE 12-12 Remove the Bellows and the Upper and Lower Cover Assembly

3. Pull the bellows from the upper and lower cover assembly.

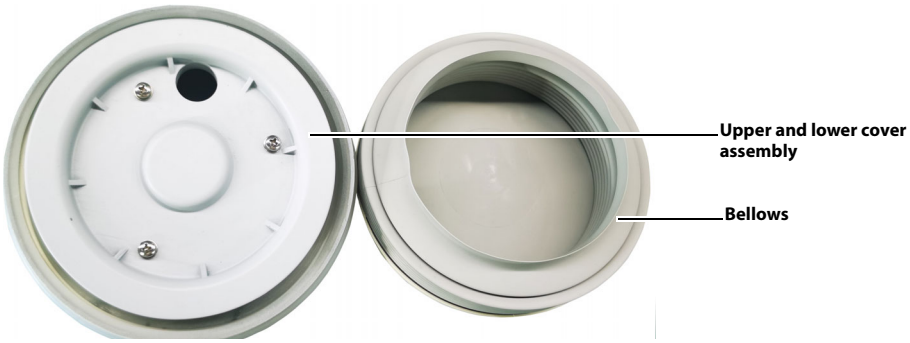


FIGURE 12-13 Bellows and Upper and Lower Cover Assembly

12.10.3.1.7 Flow sensor

1. Twist the locking nut counterclockwise and remove the inspiratory and expiratory connector.

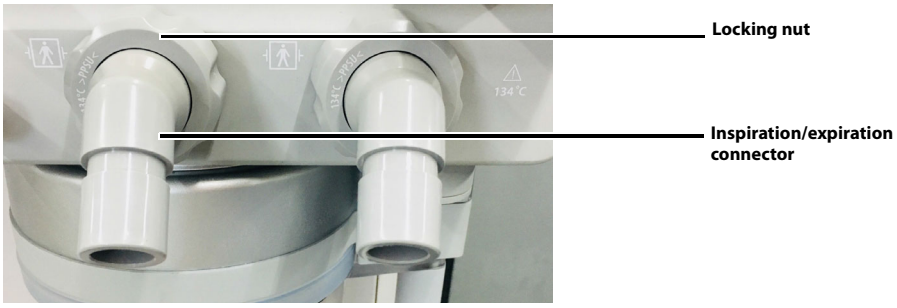


FIGURE 12-14 Remove the Inspiratory and Expiratory Connector and Locking Nut

2. Pull out the flow sensor horizontally.

FIGURE 12-15 Remove the Flow Sensor

12.10.3.1.8 Bag Arm

Rotate the retaining ring counterclockwise until it is fully loosened. Lift the bag arm upward.

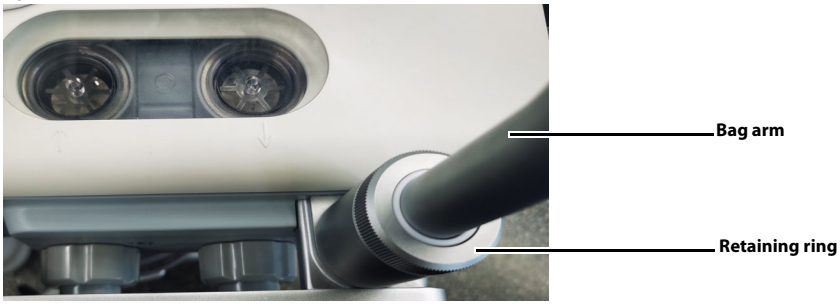
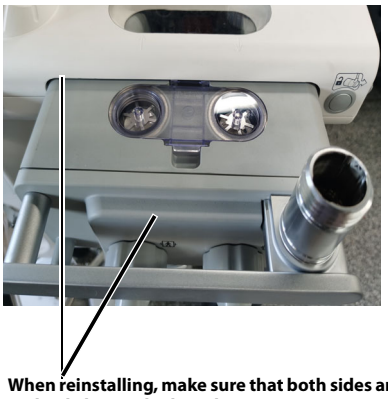


FIGURE 12-16 Remove the Bag Arm

12.10.3.1.9 Breathing System Body

Hold the handrails on one body side of the breathing system and pull the breathing system out.



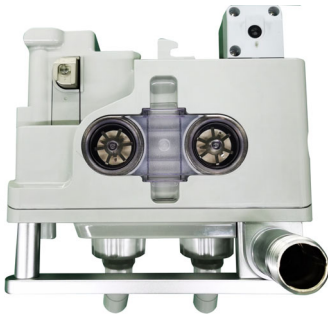


FIGURE 12-17 Remove the Breathing System Body

12.10.3.1.10 Inspiratory and Expiratory Check Valves

1. Press the buckle and pull out the cover of the inspiratory and expiratory check valves.

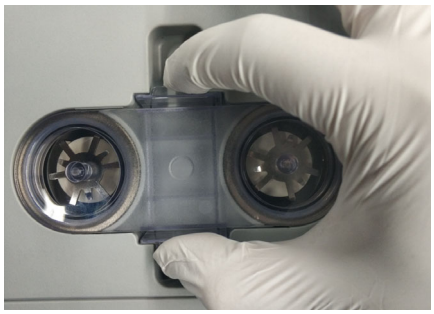


FIGURE 12-18 Remove the Check Valve Cover

2. Remove the inspiratory and expiratory check valves from the breathing system body.

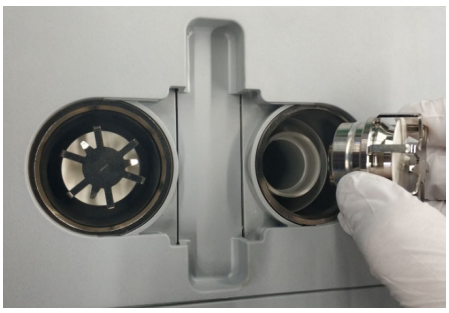
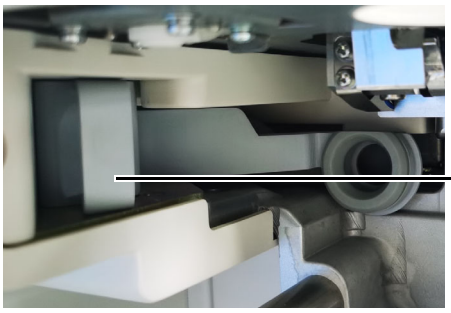


FIGURE 12-19 Remove the Inspiratory and Expiratory Check Valves

12.10.3.1.11 Bellows Connection Tube

Hook the pull ring with your finger and pull out the bellows connection tube.



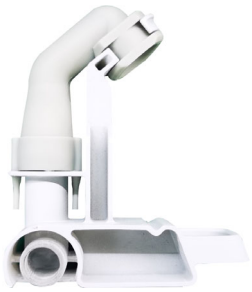


FIGURE 12-20 Bellows Connection Tube

12.10.3.1.12 Visual Inspection

Check if the following components are damaged, worn out and deformed. If yes, contact Mindray Technical Support.

- Bellows housing
- Bellows and upper and lower cover assembly
- Bellows connection pipe
- Breathing system body
- Bag arm
- O_2 sensor support
- Bypass assembly
- CO_2 absorbent canister
- Inspiratory port
- Expiratory port
- Flow sensor
- Inspiratory check valve
- Expiratory check valve
- Gasket

12.10.3.2 Cleaning

Cleaning processing (except oxygen sensor exterior and PAW gauge):

1. Soak or flush the breathing system with an approved cleaning agent (see TABLE 12-3 (Pages 12-10) "Cleaning Agent") for a period defined by the cleaning agent manufacturer.
2. Flush the breathing system with clean water.
3. If disinfection of the breathing system is required, proceed to 12.10.3.3 (Pages 12-19) "Disinfection/Autoclaving". Otherwise, skip to 12.10.3.4 (Pages 12-19) "Drying".

Cleaning processing (oxygen sensor exterior and PAW gauge):

1. Clean the oxygen sensor exterior or PAW gauge with a soft, lint-free cloth, and a recommended cleaning agent (see TABLE 12-3 (Pages 12-10) "Cleaning Agent").
2. If disinfection is required, proceed to 12.10.3.3 (Pages 12-19) "Disinfection/Autoclaving". Otherwise, skip to 12.10.3.4 (Pages 12-19) "Drying".

12.10.3.3 Disinfection/Autoclaving

CAUTION: Do not autoclave the following components: PAW gauge and oxygen sensor. These components cannot withstand immersion or the heat and pressure of sterilization.

NOTE: Before disinfection, make sure that the components have been cleaned (See section 12.10.3.2 (Pages 12-18) "Cleaning").

Disinfecting processing (except oxygen sensor exterior and PAW gauge):

1. Autoclaving the breathing system with an approved autoclaving method (see TABLE 12-5 (Pages 12-11) "Autoclaving Process"), that is, at 134 °C for 4 minutes (recommended time of using dynamic-air-removal steam sterilizer).
2. Allow the breathing system to cool and dry thoroughly before use, see section 12.10.3.4 (Pages 12-19) "Drying".

Disinfecting processing (oxygen sensor exterior and PAW gauge):

1. Disinfect the oxygen sensor exterior or PAW gauge with a soft, lint-free cloth, and a recommended disinfecting agent (see TABLE 12-4 (Pages 12-11) "Disinfector").
2. Allow to dry thoroughly before use, see section 12.10.3.4 (Pages 12-19) "Drying".

12.10.3.4 Drying

CAUTION: If moisture remains in the bellows after cleaning, the bellows surface folds may become tacky and prevent the bellows from properly expanding. Ensure all moisture is removed from the bellows after cleaning.

Drying processing (except oxygen sensor exterior and PAW gauge):

1. Drain the water from the Breathing System components.
2. Dry for 100 minutes at 90°C in a drying cabinet.
3. Cool the Breathing System components.
4. If Breathing System components are to be stored or transported, they should be wrapped in non woven fabric.

Drying processing (oxygen sensor exterior and PAW gauge):

After the cleaning or disinfection is complete, use dry and lint-free cloths to remove the residual cleaning agent and disinfecting agent.

12.10.3.5 Reassembly

NOTE: Before reinstallation, make sure that the assembly has been handled and dried.

NOTE: Reinstall the breathing system at the point of use and at the designated clean area.

Check if the following components are damaged, worn out and deformed. If yes, contact Mindray Technical Support.

- Bellows housing
- Bellows and upper and lower cover assembly
- Bellows connection pipe
- Breathing system body
- Bag arm
- O_2 sensor support
- Bypass assembly
- CO_2 absorbent canister
- Inspiratory port
- Expiratory port
- Flow sensor
- Inspiratory check valve
- Expiratory check valve
- Gasket

12.10.3.5.1 Bellows Connection Tube

Hook the pull ring with your finger and push the bellows connection tube in place.

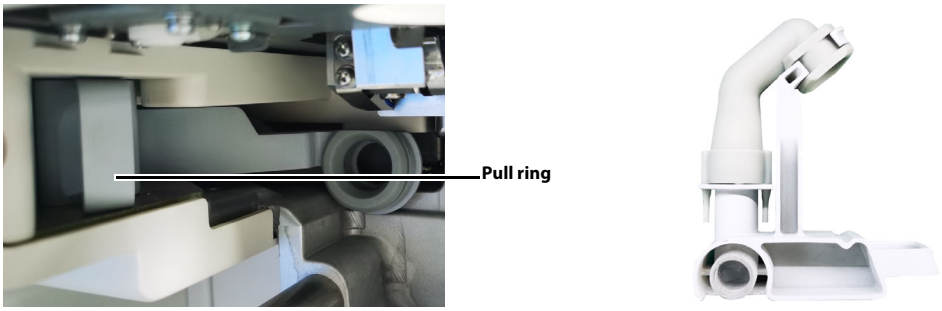


FIGURE 12-21 Bellows Connection Tube

12.10.3.5.2 Inspiratory and Expiratory Check Valves

1. Insert the inspiratory and expiratory check valves into the breathing system body.

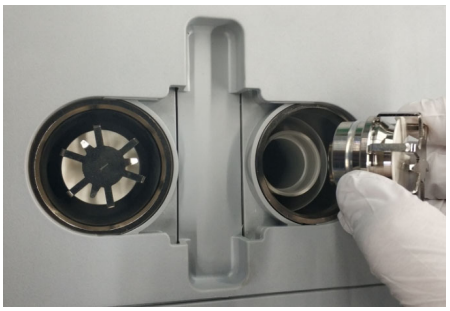


FIGURE 12-22 Insert the Inspiratory and Expiratory Check Valves

2. Push the check valve cover downward. You will hear a snap when the it is installed in place.

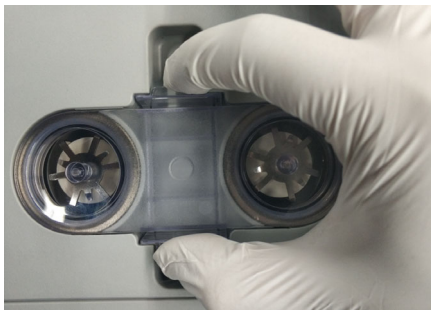
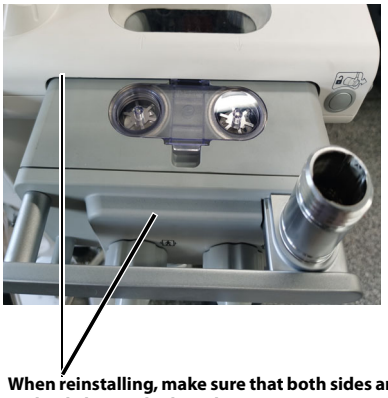


FIGURE 12-23 Install the Check Valve Cover

12.10.3.5.3 Breathing System Body

Hold the handrails on one side of the breathing system body and push the breathing system body into the anesthesia system. Make sure that the two surfaces in the following figure are level and a click sound is heard.



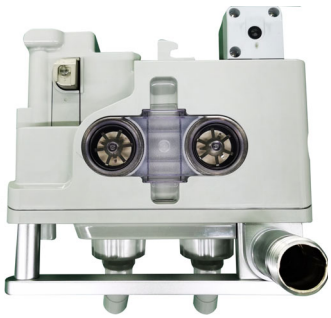


FIGURE 12-24 Install the Breathing System Body

12.10.3.5.4 Bag Arm

To install the bag arm, align it with the slot on the breathing system and screw the retaining ring clockwise until it is tightened..

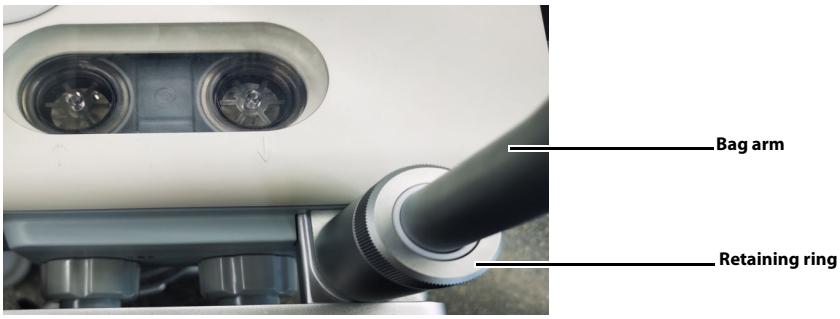


FIGURE 12-25 Install the Bag Arm

12.10.3.5.5 Flow sensor

WARNING: Exercise caution when moving the anesthesia system to avoid damage to the flow sensor because of collision at the inspiratory and expiratory connector.

WARNING: Tighten the locking nut of the screw cap at the inspiratory and expiratory connector when reinstalling the flow sensor. Otherwise it may cause a failure of the flow sensor.

WARNING: Keep the breathing tube end that is connected to the inspiratory and expiratory heading downward when reinstalling the flow sensor. Otherwise the water formed by condensed vapor may flow into the inspiratory and expiratory connector and affect measurement of the flow sensor.

1. Insert the flow sensor in the direction shown in the figure and keep the side with the screen printing upward.

FIGURE 12-26 Install the Flow Sensor

2. Insert the flow sensor horizontally to the end.
3. Align the inspiration/expiration connector with the flow sensor slot, and tighten up the locking nut clockwise.

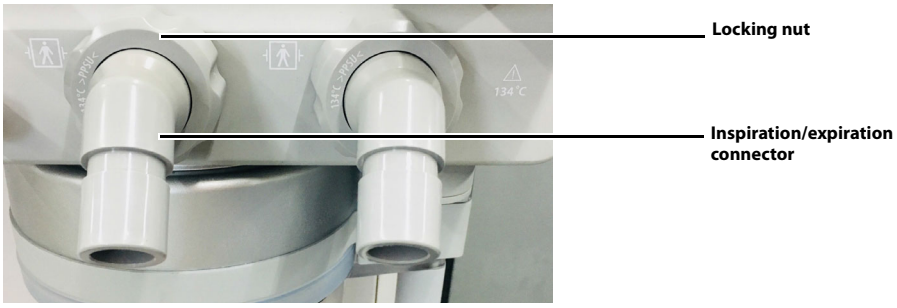


FIGURE 12-27 Install the Inspiratory and Expiratory Connector and Locking Nut

12.10.3.5.6 Bellows Assembly

1. Attach the bottom ring of the bellows to the upper and lower cover assembly. Ensure that the bellows is tightly connected to the upper and lower cover assembly.

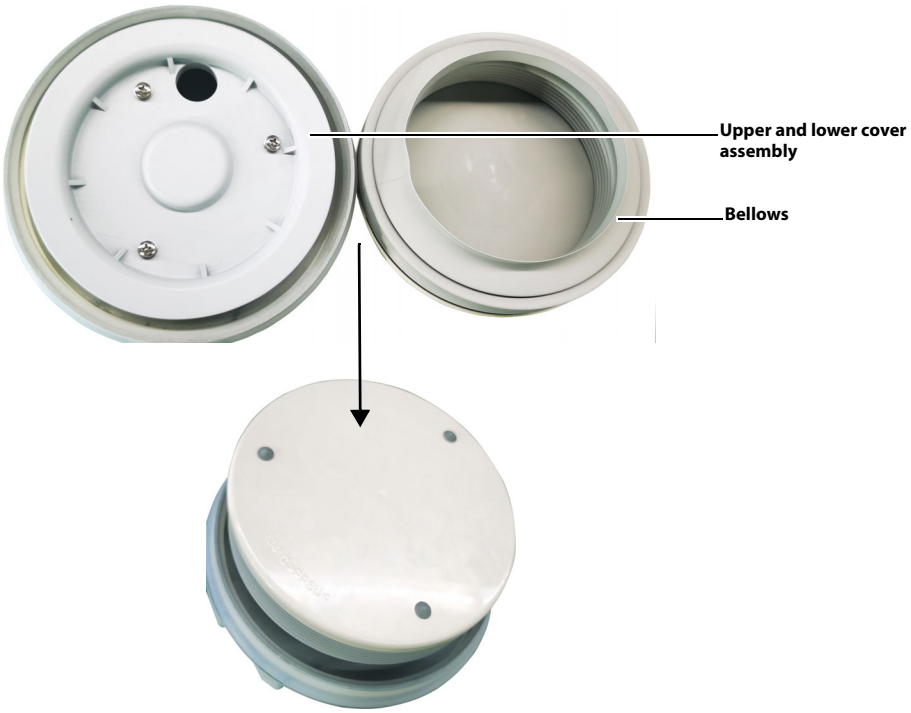


FIGURE 12-28 Install the Bellows

2. Pull the lower cover assembly downward.

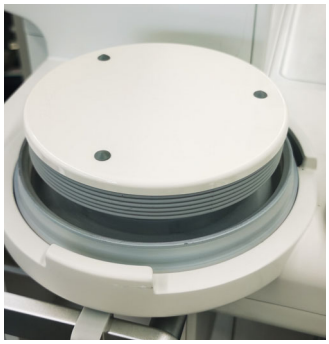


FIGURE 12-29 Install the Upper and Lower Cover Assembly

3. Hold the bellows housing tightly and turn it clockwise until it stops. Ensure that the side of the housing marked with scale is facing the operator..

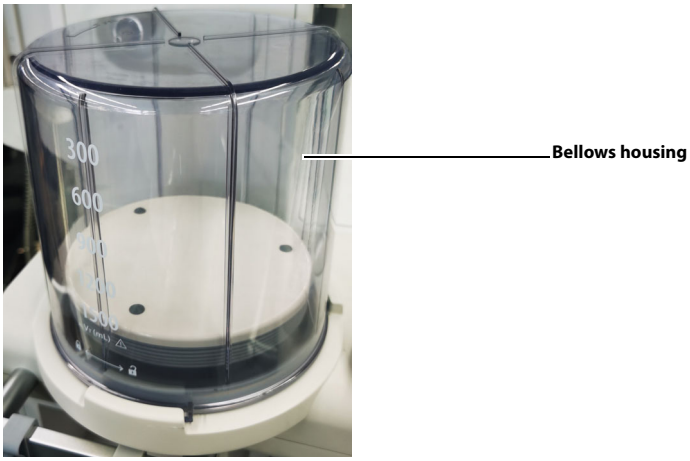


FIGURE 12-30 Install the Bellows Housing

12.10.3.5.7 Bypass

Press and hold the buckle on the bypass assembly and align it with the mounting plate of the bypass assembly. Then, push the bypass assembly upwards to install it in place. You will hear a snap when the bypass is installed in place.

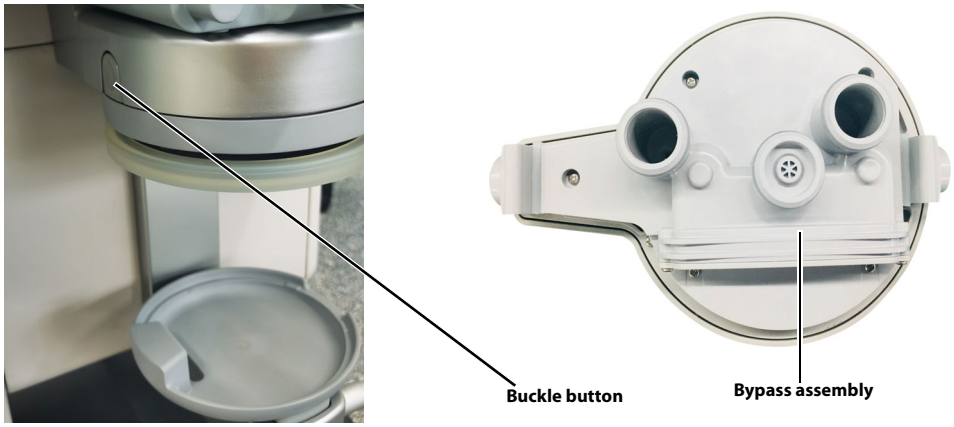


FIGURE 12-31 Install the Bypass

NOTE: **When the bypass is enabled, gases in the breathing system do not go through the CO_2 absorbent canister.**

12.10.3.5.8 CO_2 Absorbent Canister

Load absorbent into the canister and place the canister onto the underpan assembly. Rotate the handle counter clockwise to the horizontal position to lock the canister.

FIGURE 12-32 Canister Unlocking

FIGURE 12-33 Canister Locking

WARNING: **Use extreme care while handling the CO_2 absorbent as it is a caustic irritant.**

WARNING: **Check if the gasket is properly installed in place while re-installing the canister. If the gasket is not properly installed, it may cause breathing system leaks.**

WARNING: **Before locking the canister, make sure that the gasket on the bypass assembly has no residual absorbent particles or powder. Otherwise it may cause breathing system leaks.**

NOTE: **Before adding the absorbent, make sure that the canister is fully dry. The absorbent poured in should not surpass the Max mark on the CO_2 absorbent canister.**

12.10.3.5.9 O_2 Sensor

1. Press the O_2 sensor cover switch to open the O_2 sensor cover.

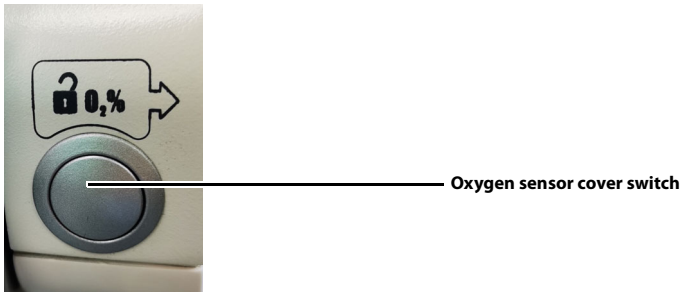


FIGURE 12-34 Open the O_2 Sensor Cover

2. Rotate the O_2 sensor clockwise to install it to the support.

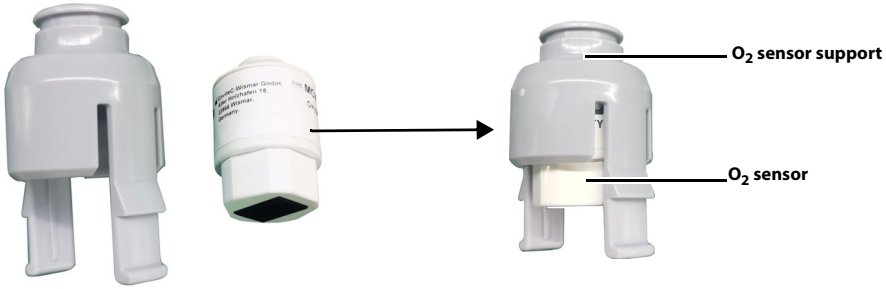


FIGURE 12-35 Install the O_2 Sensor to the Support

3. Push the O_2 sensor support into the breathing system.

FIGURE 12-36 Install the O_2 Sensor Support

4. Insert the O_2 sensor cable into the O2 sensor.

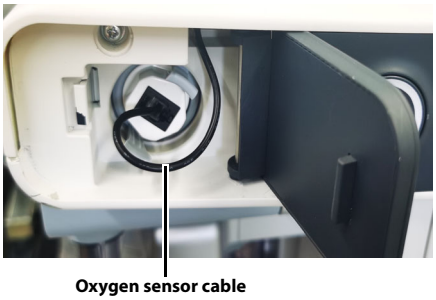


FIGURE 12-37 Insert the O_2 Sensor Cable

5. Close the O_2 sensor cover.

12.10.3.5.10 Manual Bag

Directly insert the manual bag to install it.

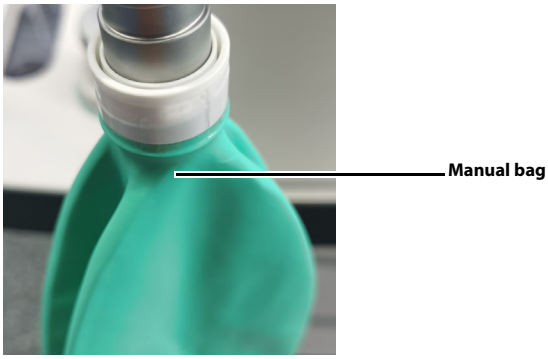


FIGURE 12-38 Install the Manual Bag

12.10.3.5.11 Breathing Tube

NOTE: **When installing a breathing tube, hold the joints at both ends of the tube to prevent damage to the tube.**

NOTE: **Do not reuse the bacterial filter to prevent cross infection.**

NOTE: **Install the filter following the instructions in this manual to prevent dust or particles from entering the patient's lungs and prevent cross infection.**

CAUTION: **The bacteria filters shall comply with the requirements of ISO 23328-1 and ISO 23328-2.**

1. Install the expiratory tube and inspiratory tube to the expiration connector and the inspiration connector of the breathing system, respectively.

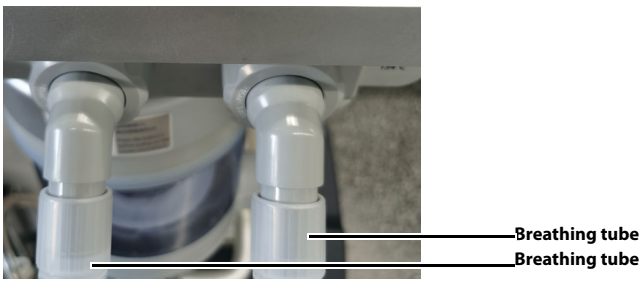


FIGURE 12-39 Install the Breathing Tubes

2. Install the bacteria filter onto the Y-piece.

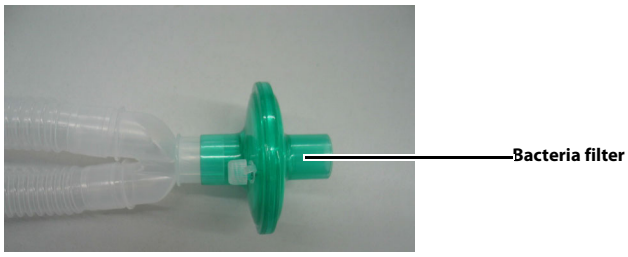


FIGURE 12-40 Remove the Bacteria Filter

12.10.3.6 Inspection and Test

After reassemble the components, power on the system and follow the on-screen prompts to perform leak and compliance test (See section 5.4.1 (Pages 5-5) "Leak and Compliance Test").

12.10.4 Negative Pressure Suction Device

12.10.4.1 Disassembly

Disassemble the Negative Pressure Suction Device at the point of use or at the designated cleaning area.

Pull out the suction tubes, take out the liquid collection bottles and discard the filter.

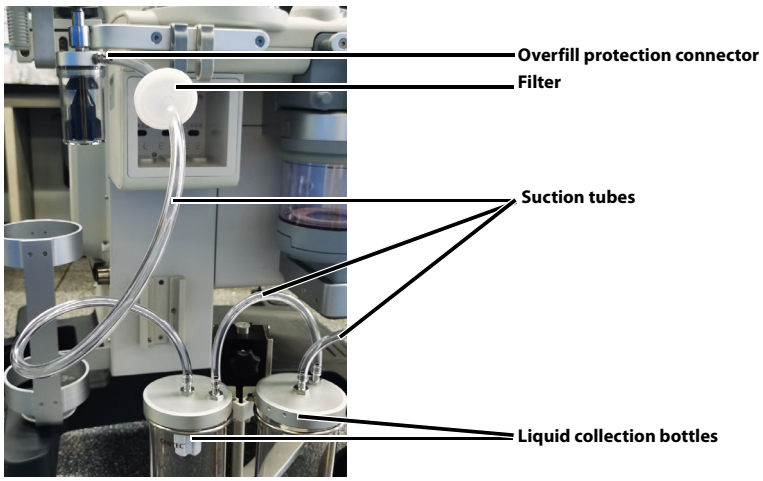


FIGURE 12-41 Remove the Liquid Collection Bottles, Filter and Suction Tubes

NOTE: **Filter is disposable accessory. Please follow local regulations to dispose of discarded filter.**

12.10.4.2 Cleaning

1. Soak or rinse the negative pressure suction tubes and liquid collection bottles with an approved cleaning agent (see TABLE 12-3 (Pages 12-10) "Cleaning Agent") for a period defined by the detergent manufacturer.
2. Use clean water to flush the negative pressure suction tubes and the liquid collection bottles.
3. To disinfect the suction tubes and the liquid collection bottles, proceed to 12.10.4.3 (Pages 12-28) "Disinfection". Otherwise, jump to 12.10.4.4 (Pages 12-28) "Drying".

12.10.4.3 Disinfection

NOTE: Ensure that the suction tubes and liquid collection bottles have been cleaned as described before the disinfection.

1. Soak or rinse the negative pressure suction tubes and liquid collection bottles with an approved disinfector (see TABLE 12-4 (Pages 12-11) "Disinfector") for a period defined by the disinfection agent manufacturer.
2. Use clean water to flush the negative pressure suction tubes and the liquid collection bottles.
3. Allow the negative pressure suction tubes and the liquid collection bottles to dry completely before use.

12.10.4.4 Drying

After the cleaning or disinfection is complete, use dry and lint-free cloths to remove the residual cleaning agent and disinfecting agent.

12.10.4.5 Reassembly

NOTE: Before the reassembly, make sure that the assembly has been reprocessed and dried.

NOTE: Reassemble the Negative Pressure Suction Device at the point of use and at the designated cleaning area.

NOTE: When install the filter to the suction tube, pay attention to keeping the side printed with IN facing the liquid collection bottle.

NOTE: Avoid twisting or bending suction tubes during use.

Check if the components are damaged, worn out and deformed. If yes, contact Mindray Technical Support.

Place the liquid collection bottles to the bracket. Connect the suction tubes, filter and the liquid collection bottles by following the printed instructions on the bottle. Insert the suction tube to the overfill protection connector.

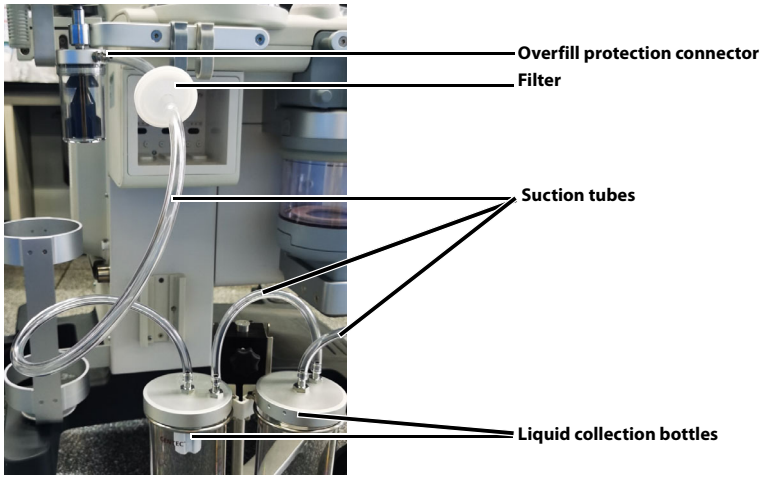


FIGURE 12-42 Install the Liquid Collection Bottles, Filter and Suction Tubes

12.10.4.6 Inspection and Test

After reassemble the components of the negative pressure suction device, check the negative pressure suction device before use.. See section 5.15 (Pages 5-16) "Inspect the Negative Pressure Suction Device".

12.10.5 AGSS

12.10.5.1 Disassembly

Disassemble the AGSSat the point of use or at the designated cleaning area.

1. Remove the AGSS waste gas transfer hose.

FIGURE 12-43 Remove the Waste Gas Transfer Hose

2. Remove the AGSS cover. Check the AGSS filter, shake it over a waste container, and if necessary, clean it. If the filter must be replaced, dispose of the old one in accordance with local regulations.

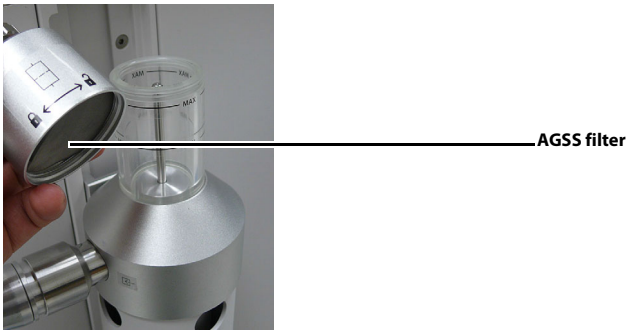


FIGURE 12-44 Remove the AGSS Upper Cover/Check the AGSS Filter

12.10.5.2 Cleaning

1. Clean the outer surface of the AGSS and Transfer Hose with a soft, lint-free cloth and a recommended cleaning agent (see TABLE 12-3 (Pages 12-10) "Cleaning Agent").
2. If disinfection is required, proceed to 12.10.5.3 (Pages 12-29) "Disinfection". Otherwise, skip to 12.10.5.4 (Pages 12-30) "Drying".

12.10.5.3 Disinfection

NOTE: Ensure that the AGSS and Transfer Hose have been cleaned as described before the disinfection.

Disinfect the outer surface of the AGSS and Transfer Hose with a soft, lint-free cloth and a recommended disinfecting agent (see TABLE 12-4 (Pages 12-11) "Disinfector"). Allow to dry thoroughly.

12.10.5.4 Drying

After the cleaning or disinfection is complete, use dry and lint-free cloths to remove the residual cleaning agent and disinfecting agent.

12.10.5.5 Reassembly

NOTE: Before the reassembly, make sure that the assembly has been reprocessed and dried.

NOTE: Reassemble the AGSS at the point of use and at the designated cleaning area.

Check if the components are damaged, worn out and deformed. If yes, contact Mindray Technical Support.

1. Reinstall the AGSS filter and cover.

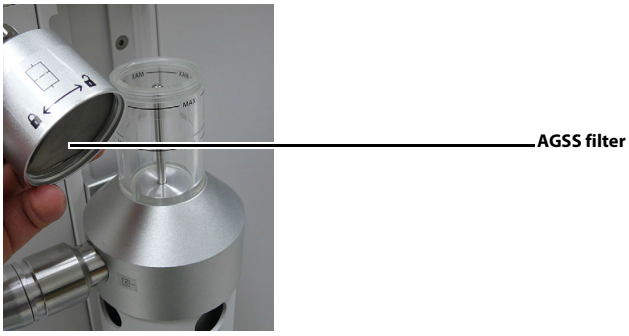


FIGURE 12-45 Install the AGSS Upper Cover/Check the AGSS Filter

2. Connect the gas inlet of AGSS to the waste gas scavenging connector of the anesthesia system through the waste gas transfer hose. The gas outlet of AGSS is connected to the waste gas scavenging system of the hospital through the AGSS tube.

FIGURE 12-46 Install the Waste Gas Transfer Hose

12.10.5.6 Inspection and Test

After reassemble the components of the AGSS, check the AGSS before use. See section 5.13 (Pages 5-15) "Inspect the AGSS".

12.10.6 HEPA Filter and Dust Filter

12.10.6.1 Disassembly

Disassemble the HEPA Filter and Dust Filter at the point of use or at the designated cleaning area.

Pull the buckle on the baffle to remove the baffle. Pull the buckle on the HEPA filter to take it out. If it is necessary to remove the dust filter, pinch the dust filter with two fingers and take it out.

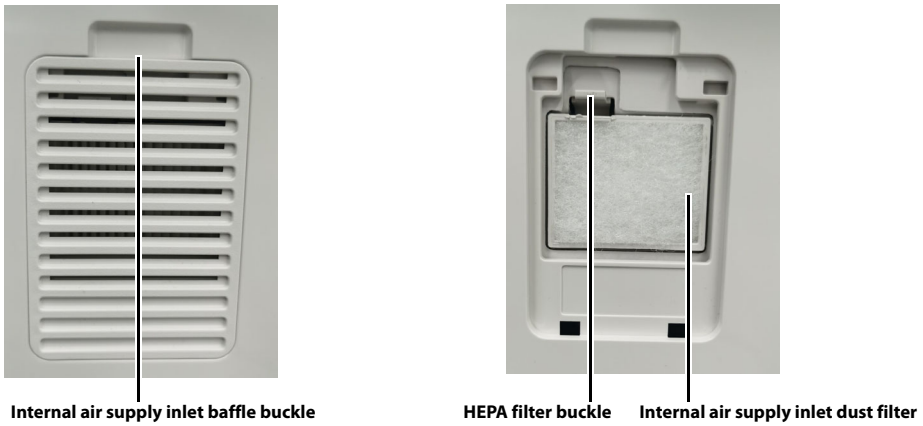


FIGURE 12-47 Remove the HEPA Filter and Dust Filter at Internal Air Supply Inlet

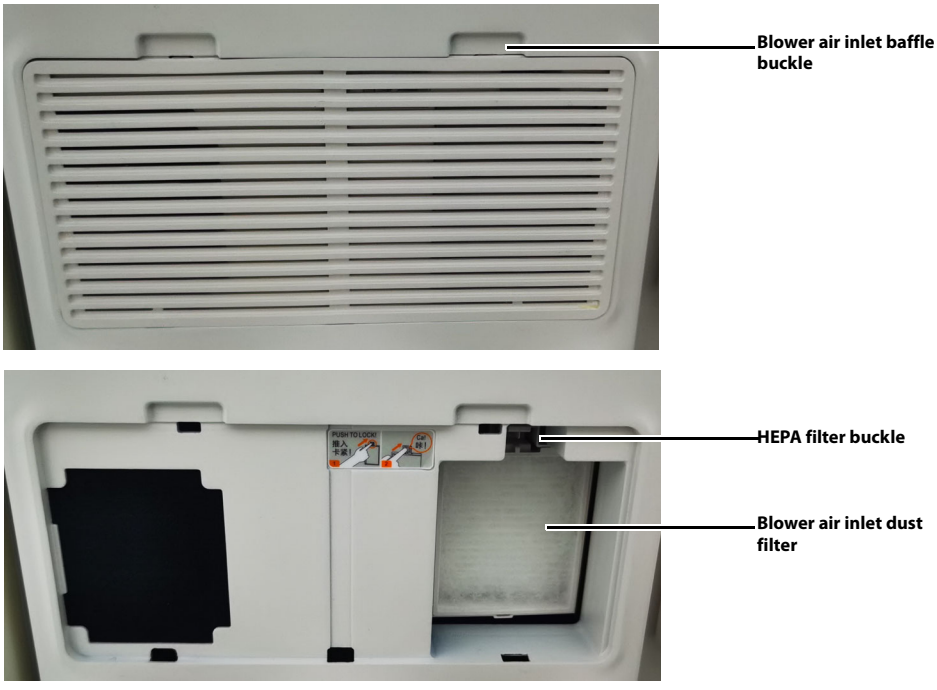


FIGURE 12-48 Remove the HEPA Filter and Dust Filter at Blower Air Inlet (Only Applicable to the Anesthesia System Configured with Blower)

12.10.6.2 Cleaning

1. Soak or flush the dust filter with an approved cleaning agent (see TABLE 12-3 (Pages 12-10) "Cleaning Agent") for a period defined by the cleaning agent manufacturer.
2. Flush the dust filter with clean water.
3. To disinfect the dust filter, proceed to 12.10.6.3 (Pages 12-32) "Disinfection". Otherwise, jump to 12.10.6.4 (Pages 12-32) "Drying".

12.10.6.3 Disinfection

NOTE: Ensure that the dust filter has been cleaned as described before the disinfection.

1. Use an approved disinfector (see TABLE 12-4 (Pages 12-11) "Disinfector") to soak the dust filter, the soaking and flushing time shall be defined by the disinfectant manufacturer.
2. Flush the dust filter with clean water.
3. Allow the dust filter to dry completely before use.

12.10.6.4 Drying

After the cleaning or disinfection is complete, use dry and lint-free cloths to remove the residual cleaning agent and disinfecting agent.

12.10.6.5 Reassembly

NOTE: Before the reassembly, make sure that the assembly has been reprocessed and dried.

NOTE: Reassemble the HEPA Filter and Dust Filter at the point of use and at the designated cleaning area.

Check if the components are damaged, worn out and deformed. If yes, contact Mindray Technical Support.

1. Align the HEPA filter with the corresponding slot, and push in the direction the HEPA filter is installed. Fasten the HEPA filter buckle.
2. Place the dust filter in the corresponding position.
3. Insert the protruding supports at the bottom of the baffle into the corresponding grooves to fasten the buckle.

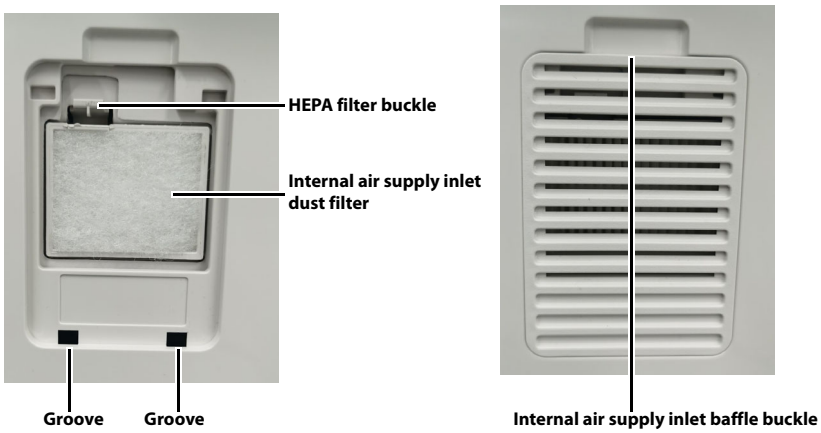


FIGURE 12-49 Remove the HEPA Filter and Dust Filter at Internal Air Supply Inlet

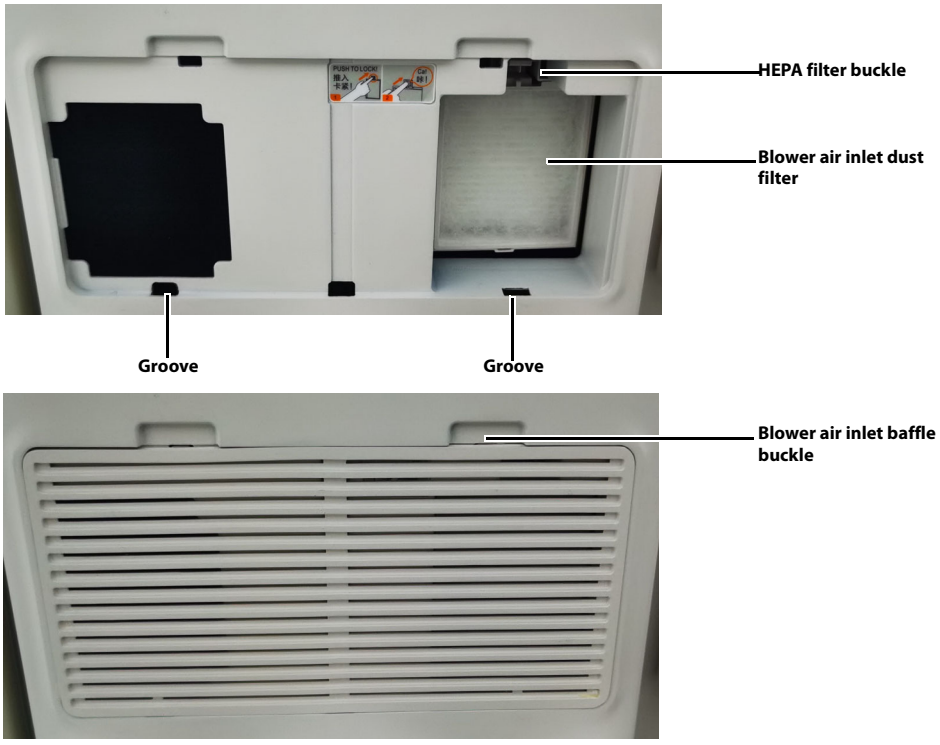


FIGURE 12-50 Remove the HEPA Filter and Dust Filter at Blower Air Inlet (Only Applicable to the Anesthesia System Configured with Blower)

12.10.7 HFJV (HFJV Tube, Needle and Bronchoscope Adapter)

12.10.7.1 Disassembly

NOTE: Disassemble the HFJV Tube, Needle and Bronchoscope Adapter at the point of use or at the designated cleaning area.

Remove the HFJV tube, needle and bronchoscope adapter.

12.10.7.2 Cleaning

1. Soak or flush the HFJV tube, needle and bronchoscope adapter with an approved cleaning agent (see TABLE 12-3 (Pages 12-10) "Cleaning Agent") for a period defined by the cleaning agent manufacturer.
2. Flush the HFJV tube, needle and bronchoscope adapter with clean water.
3. To disinfect the HFJV tube, needle and bronchoscope adapter, proceed to 12.10.7.3 (Pages 12-33) "Disinfection". Otherwise, jump to 12.10.7.4 (Pages 12-34) "Drying".

12.10.7.3 Disinfection

NOTE: Ensure that the HFJV tube, needle and bronchoscope adapter have been cleaned as described before the disinfection.

1. Use an approved disinfector (see TABLE 12-4 (Pages 12-11) "Disinfector") to soak the HFJV tube, needle and bronchoscope adapter, the soaking and flushing time shall be defined by the disinfectant manufacturer.
2. Flush the HFJV tube, needle and bronchoscope adapter with clean water.
3. Allow the HFJV tube, needle and bronchoscope adapter to dry completely before use.

12.10.7.4 Drying

After the cleaning or disinfection is complete, use dry and lint-free cloths to remove the residual cleaning agent and disinfecting agent.

12.10.7.5 Reassembly

Check if the components are damaged, worn out and deformed. If yes, contact Mindray Technical Support.

Refer to 3.8 (Pages 3-7) "High Frequency Jet Ventilation (HFJV) Tube" to reinstall the HFJV tube, needle and bronchoscope adapter.

12.10.7.6 Inspection and Test

After cleaning or disinfection, power on the anesthesia system and perform HFJV test before using the HFJV ventilation mode. For details, see the 5.4.2 (Pages 5-6) "HFJV Test".

12.11 Periodic Maintenance

WARNING: Do not maintain the equipment when it is used on a patient.

Visual inspection should be performed every 30 days to ensure timely replacement of worn or damaged parts. Check the air intake dust filter for dust build-up. Clean or replace as necessary.

1. Power off the system.
2. Visually check the whole system.
3. Check the air intake dust filter for dust build-up. Clean or replace as necessary.
4. Power on the system and follow the on-screen prompts to perform leak test and compliance test. See section 5.4.1 (Pages 5-5) "Leak and Compliance Test".

13.0 Product Specifications

13.1 Standards Compliance

The anesthesia system shall be used together with the monitoring devices, alarm system and protective devices below:

- The pressure measurement device in compliance with ISO 80601-2-13;
- The pressure restriction device in compliance with ISO 80601-2-13;
- The expiratory volume monitor in compliance with ISO 80601-2-13;
- The breathing system with alarm system in compliance with ISO 80601-2-13;
- The anaesthetic vapour delivery system in compliance with ISO 80601-2-13;
- The anaesthetic gas scavenging system in compliance with ISO 80601-2-13;
- The anesthetic gas delivery device in compliance with ISO 80601-2-13;
- The anesthetic ventilator in compliance with ISO 80601-2-13;
- The O_2 monitor in compliance with ISO 80601-2-55;
- The CO_2 monitor in compliance with ISO 80601-2-55;
- The AG monitor in compliance with ISO 80601-2-55.

The anesthesia system is integrated with the pressure measurement device, pressure restriction device, expiratory volume monitor, anaesthetic breathing system with alarm system, anaesthetic gas delivery system, anaesthetic vapour delivery system, anaesthetic ventilator, AG monitor in compliance with the afore mentioned standards, where:

- The pressure restriction device, expiratory volume monitor and breathing system with alarm system also comply with ISO 80601-2-13.
- AG monitor in compliance with ISO 80601-2-55.

13.2 Safety Designations

Type of Protection against Electric Shock:	Class I equipment with internal electric power supply. Where the integrity of the external protective earth (ground) in the installation or its conductors is in doubt, the equipment shall be operated from its internal electric power supply (i.e., battery supply).
Degree of Protection against Electric Shock:	Type BF, defibrillation-proof (Type CF for NMT Module)
Rated voltage and frequency of equipment:	External electric power supply: 220V to 240 VAC, 50/60 Hz 100V to 240 VAC, 50/60 Hz 100V to 120 VAC, 50/60 Hz Internal battery supply: Lithium-ion, 14.4 VDC, 13.2 Ah (2 batteries installed) Lithium-ion, 14.4 VDC, 6.6 Ah (1 battery installed)
Input power of equipment:	220 to 240VAC, 8A 100 to 240VAC, 8A 100 to 120VAC, 8A
Mode of Operation:	Continuous

TABLE 13-1 Safety Designations

Degree of Protection against Hazards of Explosion:	Not for use with flammable anesthetics.
Degree of Protection against Harmful Ingress of Water:	IPX1 (IPX4 for BIS Module)
Electrical Connection between Equipment and Patient:	Electrical connections
Degree of Mobility:	Mobile (including the base and casters)
Disinfection methods:	Recommended by manufactures
Application parts with protection against electric shock:	All application parts
Signal input or output part:	Both signal input and output parts
Permanent or non-permanent installation:	Non-permanent installation

TABLE 13-1 Safety Designations

13.3 Physical Specifications

Dimensions:	Standard anesthesia system: Height: 1495 mm Width: 763 mm Depth: 766 mm Anesthesia system with large backup cylinder: Height: 1495 mm Width: 763 mm Depth: 850 mm Pendant-mounted Anesthesia System (Professional Version): Height: 1265 mm Width: 763 mm Depth: 874 mm
Weight:	Standard anesthesia system: Approximately 140 kg (Standard configured mass) Approximately 260 kg (Maximum configured mass) Anesthesia system with large backup cylinder: Approximately 160 kg (Standard configured mass) Approximately 290 kg (Maximum configured mass) Pendant-mounted Anesthesia System (Professional Version): Approximately 140 kg (Standard configured mass) Approximately 260 kg (Maximum configured mass)

TABLE 13-2 Physical Specifications

Worktable (stainless steel):	Weight limit: 30kg Width: 462mm Depth: 352 mm Height: 830 mm
Auxiliary Work Surface:	Weight limit: 15kg Width: 303mm Length: 379 mm
Top Shelf:	Weight limit: 15kg Width: 478mm Depth: 310mm
Side Mounting Rails:	Supporting weight: 27 kg at a maximum distance of 0.41 m with a safety factor of 6 times the weight
Bag Arm:	Fixed Height Bag Arm: Length: 510 mm Height: 1108 mm Swiveling angle: ± 90 degrees Flexible Bag Arm: Length: 550mm The height and angle of the flexible bag arm can be adjusted freely.
Drawers (internal dimensions):	Weight limit: 5 kg Two drawers: Height: 123 mm Width: 275mm Depth: 340 mm Three drawers: Height: 72mm (only applicable to the first drawer); 123 mm (only applicable to the second and third drawer) Width: 275mm Depth: 340 mm
Caster:	Diameter: 125 mm Brake: central brake with lock/unlock indicator
System Noise (under the typical working mode):	≤45dB(A)

TABLE 13-2 Physical Specifications

13.4 Software Specifications

Host CPU:	IMX8M Plus
Primary programming language:	C++
Operating system:	Linux
AC power input:	1
Network connector:	1, standard RJ45 connectors, 100 Base-TX

TABLE 13-3 Software Specifications

Serial bus connector (MSB):	1
USB connector:	2, USB 2.0
Satellite module rack (SMR) connector:	3
Video output connector:	1, HDMI
Nurse call connector:	0
Equipotential grounding terminal:	1

TABLE 13-3 Software Specifications

13.5 Environmental Specifications

Operating Temperature:	+10°C to +40°C
Storage Temperature:	-20°C to +60°C (Oxygen Cell: -20°C to 50°C)
Operating Humidity:	15 to 95% RH, non-condensing
Storage Humidity:	10 to 95% RH, non-condensing
Operating Atmospheric Pressure:	70 kPa to 106.7 kPa
Storage Atmospheric Pressure:	50 kPa to 106.7 kPa

TABLE 13-4 Environmental Specifications

13.6 Electrical Specifications

13.6.1 Main Electrical Power Specifications

Power Supply Input Voltage:	220V to 240 VAC, 50/60 Hz 100V to 240 VAC, 50/60 Hz 100V to 120 VAC, 50/60 Hz
Power Supply Input Current:	8 A maximum
Length of Power Cord:	5 m
Grade of Power Cord:	Normal grade

TABLE 13-5 Main Electrical Power Specifications

13.6.2 Battery Power Specifications

Battery Type (only applicable to the anesthesia system without blower):	Lithium-ion battery, One (1) battery: 14.4 VDC, 6.6 Ah Two (2) batteries: 14.4 VDC, 13.2 Ah
Battery Type (only applicable to the anesthesia system configured with blower):	Lithium-ion battery, Two (2) batteries: 14.4 VDC, 13.2 Ah

TABLE 13-6 Battery Power Specifications

Battery Run-time (only applicable to the anesthesia system without blower):	≥ 90 minutes (powered by one piece new fully-charged battery under the typical condition) ≥ 180 minutes (powered by two pieces new fully-charged batteries under the typical condition) ≥ 60 minutes (powered by one piece new fully-charged battery under the worst power consumption condition) ≥ 120 minutes (powered by two pieces new fully-charged batteries under the worst power consumption condition)
Battery Run-time (only applicable to the anesthesia system configured with blower):	≥ 120 minutes (powered by two pieces new fully-charged batteries under the typical condition) ≥ 90 minutes (powered by two pieces new fully-charged batteries under the worst power consumption condition)
Time to Shutdown from Lower Battery Alarm:	5 minutes at least (powered by new fully-charged batteries after the first low-power alarm)
Battery Charge Time:	New Battery: ≤ 8 hours (powered by new depleted batteries at 25°C ambient temperature under typical working mode).

TABLE 13-6 Battery Power Specifications

13.6.3 Auxiliary Electrical Outlets

Number of Outlets:	4
Output Voltage:	Corresponds to power supply input voltage
Output Current of Each Auxiliary Outlet:	3 A max.
Output Current for Total Auxiliary Outlet:	5 A max.
Fuse Rating Current of Each Auxiliary Outlet:	3.15 A
Fuse Rating Current for Total Auxiliary Outlet:	5 A

TABLE 13-7 Auxiliary Electrical Outlets

13.6.4 Power Consumption

Power Consumption (only applicable to the anesthesia system without blower):	Power consumption during shutdown: < 8 W (powered by fully-charged batteries) Standby power consumption: < 65 W (powered by fully-charged batteries) Typical power consumption: < 80 W (powered by fully charged batteries under typical working mode) Maximum power consumption: < 120 W (powered by fully-charged batteries under the worst power consumption condition)
Power Consumption (only applicable to the anesthesia system configured with blower):	Power consumption during shutdown: < 8 W (powered by fully-charged batteries) Standby power consumption: < 65 W (powered by fully-charged batteries) Typical power consumption: < 90 W (powered by fully charged batteries under typical working mode) Maximum power consumption: < 155 W (powered by fully-charged batteries under the worst power consumption condition)

TABLE 13-8 Power Consumption

13.6.5 Communication Ports

RS-232 Communication Port:	One DB9 male connector.
Network Port:	One separate RJ-45 network ports.
USB Ports:	Two USB ports.
Video Signal Port:	One HDMI female port.
Radio Port:	Mobile Cellular Network. Connects with the external device and communicate with the external device.
WIFI：	Connects with the external device and communicate with the external device. Connects with the infusion supervision system, syringe pump or infusion pump.

TABLE 13-9 Communication Ports

13.7 Pneumatic Specifications

13.7.1 Pipeline Supply

Pipeline Input Pressure Range:	O_2: 280 to 600 kPa (40 to 87 psi) N_2O: 280 to 600 kPa (40 to 87 psi) Air: 280 to 600 kPa (40 to 87 psi)
Pipeline Input Flow Rate Range:	O_2: V'max. 190 L/min Air: V'max. 150 L/min N_2O: V'max. 20 L/min

TABLE 13-10 Pipeline Supply

Pipeline Connections:	DISS NIST
Gas Configuration:	N_2O, Air, O_2

TABLE 13-10 Pipeline Supply

13.7.2 Backup O_2 Supply

Backup O_2 Pressure Range:	280 to 600 kPa (40 to 87 psi)
Pipeline Input Flow Rate Range:	V'max. 190 L/min
Pipeline Connections:	DISS NIST

TABLE 13-11 Backup O_2 Supply

13.7.3 Cylinder Supply

O_2 Cylinder Input Pressure Range:	6.9 to 20.0 MPa (1000 to 2900 psi)
N_2O Cylinder Input Pressure Range:	PISS end: 4.2 to 6.0 MPa (600 to 870 psi) Anesthesia system end: 280 to 600 kPa (40 to 87 psi)
Air Cylinder Input Pressure Range:	6.9 to 20.0 MPa (1000 to 2900 psi)
Cylinder Input Flow Rate Range:	O_2: V'max. 190 L/min Air: V'max. 150 L/min N_2O: V'max. 20 L/min
Cylinder Connections:	Pin-Index Safety System (PISS)
Yoke Configuration:	Air, N_2O, O_2

TABLE 13-12 Standard Cylinder Supply

13.7.4 Auxiliary Common Gas Outlet (ACGO)

Control Type:	Mechanical
Connector:	Coaxial 22mm male/15mm female conical connector
Safety Pressure:	A relief valve limits fresh gas pressure at the ACGO outlet port to not more than 12.5 kPa.

TABLE 13-13 ACGO

13.7.5 Anesthetic Vaporizer

Vaporizer Positions:	Double (not including the vaporizer parking position mount)

TABLE 13-14 Anesthetic Vaporizer

Mounting Mode:	Selectatec®, with interlocking function (Selectatec® is registered trademark of Datex-Ohmeda Inc.) Plug-in®, with interlocking
Type:	Mindray V60 anesthetic vaporizers. Three types of vaporizers with anesthetic agents halothane, isoflurane, sevoflurane are available. Mindray V80 Desflurane anesthetic vaporizers.

TABLE 13-14 Anesthetic Vaporizer

13.7.6 Drive Gas (only Applicable to Anesthesia System without Blower)

Air or O_2.

13.7.7 O_2 Controls

O_2 supply failure alarm: ≤220.6 kPa.

13.8 Breathing System Specifications

13.8.1 Breathing System Volume

Mechanical Ventilation:	1800 mL
Manual Ventilation:	1950 mL

TABLE 13-15 Breathing System Volume

13.8.2 Bellows Volume

Bellows	1500 mL

TABLE 13-16 Bellows Volume

13.8.3 CO_2 Absorber Assembly

Absorber Capacity:	1 Pre-Pak (1500 ml)
Absorber Canister Contents:	1 Pre-Pak canister or Loose Fill absorbent

TABLE 13-17 CO_2 Absorber Assembly

13.8.4 Breathing System Connections

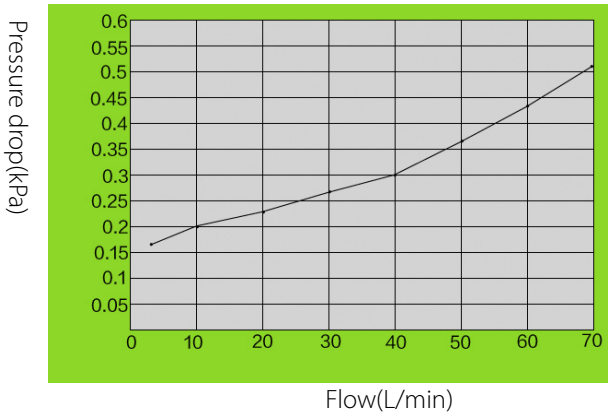
Exhalation Connection:	Coaxial 22 mm male/15 mm female conical connector
Inhalation Connection:	Coaxial 22 mm male/15 mm female conical connector
Manual Bag Connection:	Coaxial 22 mm male/15 mm female conical connector
Exhaust Port:	30 mm male conical connector

TABLE 13-18 Breathing System Connections

13.8.5 APL Valve

Range:	SP, 5 to 70 cmH_2O
Control Accuracy:	± 3 cmH_2O or ±15% of the setting value, whichever is greater, but is not more than +10 cmH_2O
Adjustable Range of Motion:	> 300 degrees
Tactile Knob Indication:	30 cmH_2O and above
Opening Pressure:	≤ 0.2 kPa (test gas flow of 20 mL/min in dry or wet conditions)

Resistance of APL valve in dry gas:



Resistance of APL valve in wet gas:

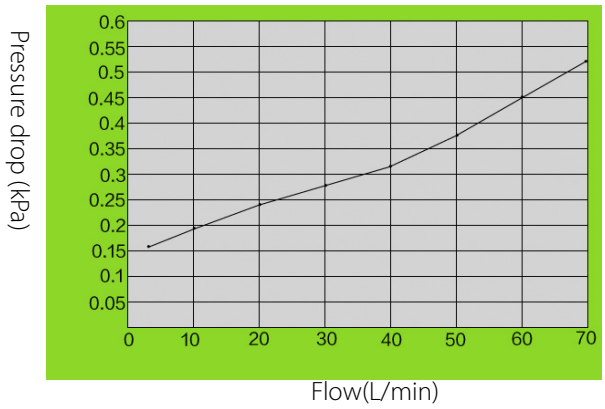
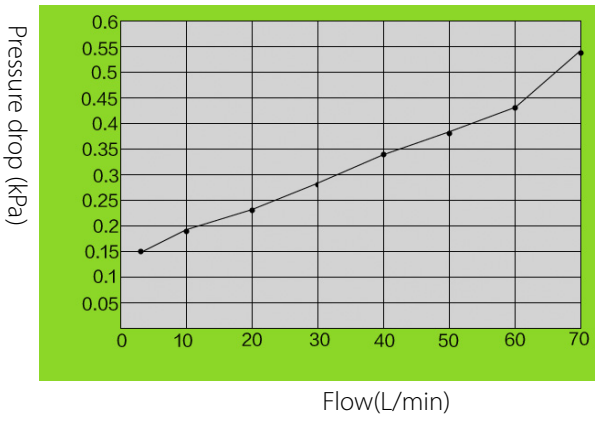


TABLE 13-19 Breathing System Connections

Resistance of APL valve in dry gas (Lift the APL Valve):



Resistance of APL valve in wet gas (Lift the APL Valve):

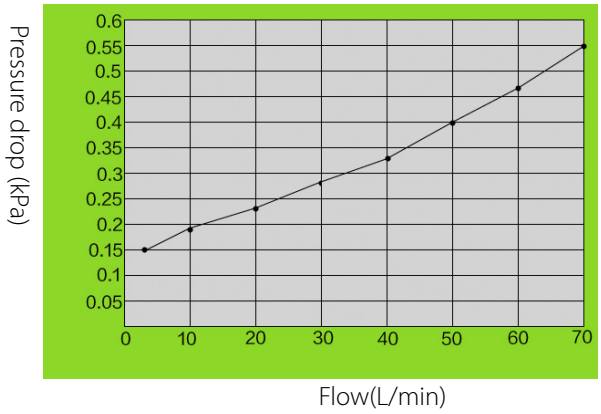


TABLE 13-19 Breathing System Connections

13.8.6 Resistance

Expiratory resistance in mechanical ventilation mode:

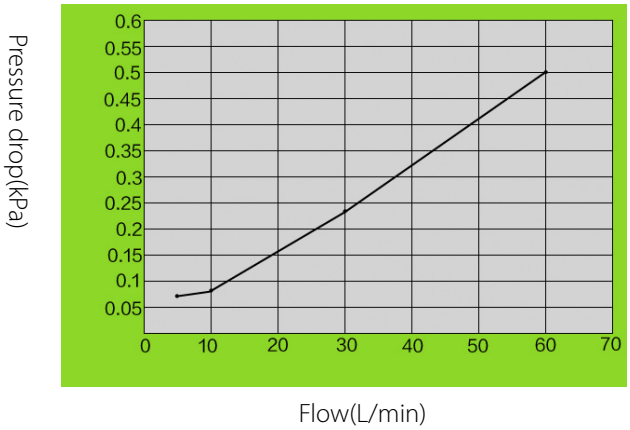
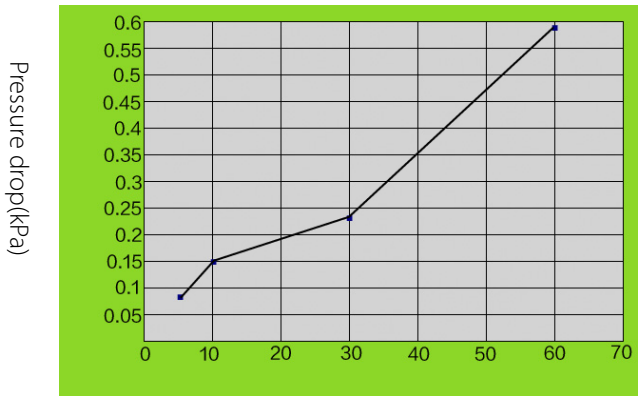
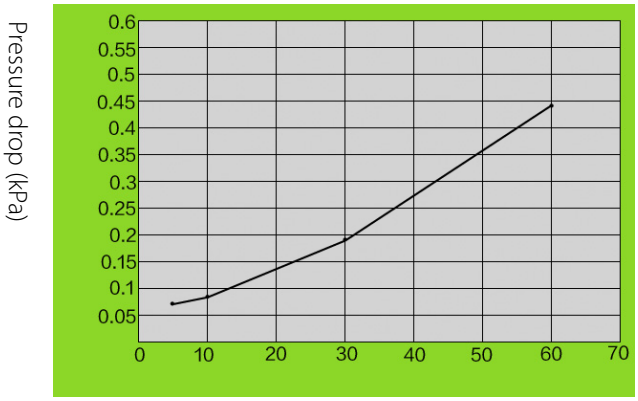


TABLE 13-20 Resistance

Inspiratory resistance in mechanical ventilation mode:



Expiratory resistance in manual mode:



Inspiratory resistance in manual mode:

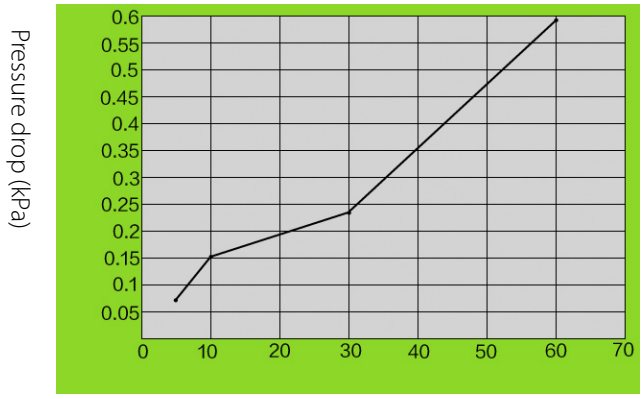


TABLE 13-20 Resistance

13.8.7 Breathing System Temperature Controller

10°C≤T(Ambient temperature)≤20°C:	ΔT=T (Temperature at metal test point of the pressure sampling body near the inspiratory check valve)-T (Ambient temperature)≥11°C
20°C≤T Ambient temperature)≤40°C	T (Temperature at metal test point of the pressure sampling body near the inspiratory check valve)≥31°C
10°C≤T(Ambient temperature)≤40°C	ΔT=|T (Temperature at test point of Y-piece patient connection)-T (Ambient temperature)|≤2°C and T (Temperature at test point of Y-piece patient connection)≤41°C
Single Fault Condition	T (Temperature at test point of Y-piece patient connection)≤41°C

Note: The block heater does not operate while the system is being powered by the internal battery supply.

TABLE 13-21 Breathing System Temperature Controller

13.8.8 Breathing Circuit Parameters

System Compliance:	≤ 2 ml/cm H_2O
Resistance:	≤ 0.6 kPa
Leakage:	≤ 50 ml/min @ 3.0 kPa (under BTPS condition)
System Safety Pressure on Breathing System:	110 cmH_2O

TABLE 13-22 Breathing Circuit Parameters

13.9 Anesthetic Gas Scavenging System (AGSS)

Type of the Applicable Disposable System:	Low flow
Extract Flow:	25 to 50 L/min
Resistance:	≤ 0.05 kPa @ 30 L/min ≤ 0.35 kPa @ 75 L/min
Size:	Height: 430 mm; Width: 132 mm; Depth: 114mm

TABLE 13-23 Anesthetic Gas Scavenging System with Low Flow (Active AGSS)

Type of the Applicable Disposable System:	High flow
Extract Flow:	75 to 105L/min
Resistance:	≤ 0.05 kPa @ 30 L/min ≤ 0.35 kPa @ 75 L/min
Size:	Height: 430 mm; Width: 132 mm; Depth: 114mm

TABLE 13-24 Anesthetic Gas Scavenging System with High Flow (Active AGSS)

13.10 Negative Pressure Suction device

13.10.1 Continuous Suction Regulator

Performance Category:	Pharyngeal Suction
Gas Supply:	Negative pressure of medical pipeline
Gas Supply Connections:	NIST, DISS
Gas Supply Pressure Range:	-72 kPa to -40 kPa
Maximum Vacuum:	≥ 65 kPa (gas supply pressure: -72 kPa)
Maximum Flow:	≥ 40 L/min (gas supply pressure: -72 kPa)
Vacuum Gauge Accuracy:	± 5% of full scale

TABLE 13-25 Continuous Suction Regulator

13.10.2 Venturi Suction Regulator

Performance Category:	Pharyngeal Suction
Gas Supply:	Medical compressed air
Gas Supply Connections:	NIST, DISS
Gas Supply Pressure Range:	280 kPa to 600 kPa
Drive Gas Consumption:	<35 L/min with drive gas at 280 kPa <55 L/min with drive gas at 600 kPa
Maximum Vacuum:	≥ 50kPa
Maximum Flow (without suction bottle and filter):	≥ 25 L/min
Vacuum Gauge Accuracy:	± 5% of full scale

TABLE 13-26 Venturi Suction Regulator

13.11 Monitor Module

13.11.1 AG Module

Warm-up Time:	ISO accuracy mode: < 45 s Full accuracy mode: <10 min
Sampling Rate:	Sampling rate: Adult/Pediatric AG watertrap and sample line: 150/180/200 ml/min Neonate AG watertrap and sample line: 100/110/120 ml/min Accuracy: ± 10 ml/min or ± 10% of the setting value, whichever is greater
Gas:	CO_2, O_2, N_2O, and any of the five anesthetic agents: DES, ISO, ENF, SEV and HAL.

TABLE 13-27 AG Module

Range:	CO2: 0.0 to 30% (0.0 to 30 kPa, 0.0 to 226 mmHg)
	O2: 0 to 100%
	N2O: 0 to 100%
	DES: 0.0 to 30%
	SEV: 0.0 to 30%
	ENF: 0.0 to 30%
	ISO: 0.0 to 30%
	HAL: 0.0 to 30%
Resolution:	CO2: 0.1%
	O2: 1%
	N2O: 1%
	DES: 0.1%
	SEV: 0.1%
	ENF: 0.1%
	ISO: 0.1%
	HAL: 0.1%
ISO Accuracy Mode:	Add ± 0.3%$_{ABS}$ to full accuracy for CO_2; Add ± 8%$_{REL}$ to full accuracy for all agents; N_2O accuracy is ± (8%$_{REL}$ + 2%$_{ABS}$).

TABLE 13-27 AG Module

Full Accuracy Mode:	Gas	Range (%)	Accuracy (vol.%)
	CO_2	0 to 1	± 0.1
		1 to 5 (not including 1)	± 0.2
		5 to 7 (not including 5)	± 0.3
		7 to 10 (not including 7)	± 0.5
		> 10	Unspecified
	N_2O	0 to 20	± 2
		20 to 100 (not including 20)	± 3
	O_2	0 to 25	± 1
		25 to 80 (not including 25)	± 2
		80 to 100 (not including 80)	± 3
	DES	0 to 1	± 0.15
		1 to 5 (not including 1)	± 0.2
		5 to 10 (not including 5)	± 0.4
		10 to 15 (not including 10)	± 0.6
		15 to 18 (not including 15)	± 1
		> 18	Unspecified
	SEV	0 to 1	± 0.15
		1 to 5 (not including 1)	± 0.2
		5 to 8 (not including 5)	± 0.4
		> 8	Unspecified
	ENF, ISO, HAL	0 to 1	± 0.15
		1 to 5 (not including 1)	± 0.2
		> 5	Unspecified

TABLE 13-27 AG Module

Rise Time:	**Gas**	**Measured by using adult/pediatric water trap and 2.5m sampling line**	**Measured by using neonatal water trap and 2.5m sampling line**
	CO_2	≤300ms@150ml/min ≤300 ms@180ml/min ≤250 ms@200ml/min	≤400 ms@100ml/min ≤400 ms@110ml/min ≤250 ms@120ml/min
	N_2O	≤300ms@150ml/min ≤300 ms@180ml/min ≤250 ms@200ml/min	≤400 ms@100ml/min ≤400 ms@110ml/min ≤250 ms@120ml/min
	O_2	≤600ms@150ml/min ≤600ms@180ml/min ≤500ms@200ml/min	≤800ms@100ml/min ≤800ms@110ml/min ≤600ms@120ml/min
	HAL	≤550ms@150ml/min ≤550ms@180ml/min ≤300ms@200ml/min	≤600ms@100ml/min ≤600ms@110ml/min ≤300ms@120ml/min
	ENF	≤400ms@150ml/min ≤400 ms@180ml/min ≤350 ms@200ml/min	≤500 ms@100ml/min ≤500 ms@110ml/min ≤350 ms@120ml/min
	DES, SEV, ISO	≤400ms@150ml/min ≤400 ms@180ml/min ≤350 ms@200ml/min	≤450 ms@100ml/min ≤450 ms@110ml/min ≤300 ms@120ml/min
System Total Response Time:	**Gas**	**Measured by using adult/pediatric water trap and 2.5m sampling line**	**Measured by using neonatal water trap and 2.5m sampling line**
	CO_2	≤5 s @150ml/min ≤5 s @180ml/min ≤5 s @200ml/min	<5 s @100ml/min <5 s @110ml/min <5 s @120ml/min
	N_2O	≤5 s @150ml/min ≤5 s @180ml/min ≤5 s @200ml/min	<5 s @100ml/min <5 s @110ml/min <5 s @120ml/min
	O_2	≤5 s @150ml/min ≤5 s @180ml/min ≤5 s @200ml/min	<5 s @100ml/min <5 s @110ml/min <5 s @120ml/min
	DES, SEV, ISO, HAL, ENF	≤6 s @150ml/min ≤6 s @180ml/min ≤6 s @200ml/min	<6 s @100ml/min <6 s @110ml/min <6 s @120ml/min
Primary Agent ID Threshold[1]:	0.15% (0.4% during ISO accuracy mode)		
Secondary Agent ID Threshold[2]:	0.3% (0.5% during ISO accuracy mode) or $5\%_{REL}$ ($10\%_{REL}$ for Isoflurane) of primary agent if Primary agent >10%		
Measurement Accuracy Drift:	Meets accuracy requirements within 6 hours		

TABLE 13-27 AG Module

Rate Measurement:	Measurement range: 2 bpm to 100 bpm Resolution: 1 bpm Measurement accuracy: 2 bpm to 60 bpm: ± 1 bpm > 60 bpm: unspecified
Watertrap Emptying Interval [3]:	Neonate AG watertrap: ≥24h@100ml/min [4] ≥22h@110ml/min ≥20h@120ml/min Adult/Pediatric AG watertrap: ≥19h@150ml/min ≥18h@180ml/min ≥17h@200ml/min

TABLE 13-27 AG Module

1. *For Halothane: Increase in threshold by 0.1%$_{ABS}$.*
2. *For Halothane: Increase in threshold by 0.1%$_{ABS}$.*
3. *Experiment condition: temperature of sampled gas is 37 °C, ambient temperature is 23 °C, relative humidity of sampled gas is 100%.*
4. *Cleaning time of watertrap ≥24h means that the liquid level will not exceed the MAX line within 24 hours.*

NOTE: Inaccuracy specifications are affected by the breath rate and I:E change. The end-tidal gas reading is within specification for breath rate below 15BPM and I:E ratio smaller than 1:1 relative to the gas readings without breath; Add ±6%$_{REL}$ to inaccuracy for HAL and O2 for breath rate larger than 15 BPM; Add ±6%$_{REL}$ to inaccuracy for all gases for breath rate larger than 30 BPM (inaccuracy for HAL and O2 are unspecified in this case); inaccuracy is unspecified for breath rate larger than 60 BPM.

NOTE: The ability to properly resolve end-tidal values can be measured by using the set-up described in ISO 80601-2-55:2011 figure 201.101. In short, the method consists of sampling gas from two different sources connected to an electrically controlled pneumatic valve to permit rapid switching between the two sources. During the test, the valve is set to switch gas source at a number of frequencies (simulating the range of specified breath rates) and for each frequency the end-tidal value presented by the gas analyzer is noted. From a diagram of end-tidal value over frequency, the frequency at which the gas analyzer is no longer able to resolve end-tidal values according to specification is identified. This ability to properly resolve end-tidal values is listed in the corresponding AION^{TM} Multigas Analyzer technical specification.

NOTE: Data sample rate 25 Hz. Data presentation is 50 Hz, every second data point is interpolated.

NOTE: Inspiratory and end tidal CO_2 concentration readings are identified by AION^{TM} Platinum Multigas Analyzers using the lowest and highest values respectively of the temporal CO_2-curve. Corresponding readings of N_2O and anesthetic agents are taken at the same point in time. Inspiratory and end-tidal O_2 concentration readings are identified by the O_2 mean value during the respiratory phase as identified by the temporal CO_2 curve. Once correctly identified, the highest and lowest O2 concentration readings during each part of the phase will be presented as inspiratory and end-tidal O_2 respectively.

NOTE: **The rated respiration rate measurement range for AG module is 2 to 100 bpm. The data sample rate is 25 Hz. The $EtCO_2$ concentration reading uses the highest value of the CO_2 waveform within the breathing cycle. The EtN_2O and EtAA concentration readings use the value measured at the moment when the $EtCO_2$ concentration is recorded. The FiO_2 concentration reading uses the highest value of the O_2 waveform within the breathing cycle.**

NOTE: **The rated respiration rate measurement range for AG module is calculated based on the CO_2 waveform. The test method used to determine the rated respiration rate range: Utilize the valves to switch the two sampling gases at different frequencies (simulating specified breath rates). Record the $EtCO_2$ value at each frequency. By drawing the coordinate diagram which indicates the corresponding relationship between end-tidal value and breathing frequency, the range of breathing frequency can be obtained.**

13.11.1.1 Alarms

AG ALARM LIMITS	RANGE	STEP	UNIT
$EtCO_2$ High Limit	Off, 2 to 99	1	mmHg (% and kPa should be optional)
$EtCO_2$ Low Limit	Off, 0 to 97		
$FiCO_2$ High Limit	Off, 1 to 99		
EtO_2 High Limit	Off, 12 to 100	1	%
EtO_2 Low Limit	Off, 10 to 98		
FiO_2 High Limit	20 to 100, off		
FiO_2 Low Limit	18 to 98		
FiN_2O High Limit	82	/	%
EtHal High Limit	Off, 0.2 to 5.0	0.1	%
EtHal Low Limit	Off, 0.0 to 4.8		
FiHal High Limit	Off, 0.2 to 5.0		
FiHal Low Limit	Off, 0.0 to 4.8		
EtEnf High Limit	Off, 0.2 to 5.0	0.1	%
EtEnf Low Limit	Off, 0.0 to 4.8		
FiEnf High Limit	Off, 0.2 to 5.0		
FiEnf Low Limit	Off, 0.0 to 4.8		
EtIso High Limit	Off, 0.2 to 5.0	0.1	%
EtIso Low Limit	Off, 0.0 to 4.8		
FiIso High Limit	Off, 0.2 to 5.0		
FiIso Low Limit	Off, 0.0 to 4.8		
EtSev High Limit	Off, 0.2 to 8.0	0.1	%
EtSev Low Limit	Off, 0.0 to 7.8		
FiSevHigh Limit	Off, 0.2 to 8.0		
FiSev Low Limit	Off, 0.0 to 7.8		
EtDes High Limit	Off, 0.2 to 18.0	0.1	%
EtDes Low Limit	Off, 0.0 to 17.8		
FiDes High Limit	Off, 0.2 to 18.0		
FiDes Low Limit	Off, 0.0 to 17.8		

TABLE 13-28 Alarms

13.11.1.2 Effect of Interfering Gas on AG Measured Value

Gas Under Test	Quantitative Effect (Volume Fraction)[1]							
	CO_2	N_2O	HAL	SEV	ISO	ENF	DES	O_2
N_2O	0.1%	/	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%
HAL[2]	0.1%	0.1%	/	0.1%	0.1%	0.1%	0.1%	1.0%
SEV[2]	0.1%	0.1%	0.1%	/	0.1%	0.1%	0.1%	1.0%
ISO[2]	0.1%	0.1%	0.1%	0.1%	/	0.1%	0.1%	1.0%
ENF[2]	0.1%	0.1%	0.1%	0.1%	0.1%	/	0.1%	1.0%
DES[2]	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	/	1.0%

TABLE 13-29 Effect of Interfering Gas on AG Measured Value

1. *Maximum quantitive effect of each gas at concentrations within specified accuracy ranges for each gas. The total effect of all interferences shall not exceed 5%$_{REL}$ of gas concentration.*
2. *Multiple agent interference on CO2, N2O and O2 is typically the same as single agent interference.*

13.11.2 CO_2 Module

13.11.2.1 Sidestream CO_2 Module

Measurement Range:	CO_2: 0 to 20% (0 to 152 mmHg)
	O_2: 0 to 100%
Resolution:	CO_2: 0.1% (1 mmHg)
	O_2: 1%
Accuracy*:	CO_2: 0% (0 mmHg) to 5% (40 mmHg): ±0.2 vol.% (±2 mmHg) 5% (41 mmHg) to 10% (76 mmHg) (not including 5%): ± 5% of the reading 10% (77 mmHg) to 20% (152 mmHg) (not including 10%): ± 10% of the reading
	O_2: 0% to 25%: ±1 vol.% 25% to 80% (not including 25%): ±2 vol.% 80% to 100% (not including 80%): ±3 vol.%
Accuracy Drift:	Meet the requirement for measurement accuracy within 6 hours
Sampling Rate:	Sampling rate: Adult and Pediatric: 120 ml/min, 150 ml/min Neonate: 100 ml/min, 120 ml/min Accuracy: ±15 ml/min or ±15% of the setting value, whichever is greater.
Watertrap Emptying Interval[1]:	Neonate watertrap: ≥24h@100ml/min [2] ≥20h@120ml/min Adult/Pediatric watertrap: ≥20h@120ml/min ≥19h@150ml/min

TABLE 13-30 Sidestream CO_2 Module

Start-up Time:	< 90 s		
Rise Time (10%~90%):	**Gas**	**Measured by using adult/pediatric water trap and 2.5m sampling line**	**Measured by using neonatal water trap and 2.5m sampling line**
	CO_2	≤300ms@120ml/min ≤300 ms@150ml/min	≤250 ms@100ml/min ≤250 ms@120ml/min
	O_2	≤750ms@120ml/min ≤750 ms@150ml/min	≤800 ms@100ml/min ≤800 ms@120ml/min
System Total Response Time:	**Gas**	**Measured by using adult/pediatric water trap and 2.5m sampling line**	**Measured by using neonatal water trap and 2.5m sampling line**
	CO_2	≤5 s @120ml/min ≤5 s @150ml/min	<4.5 s @100ml/min <4.5 s @120ml/min
	O_2	≤5 s @120ml/min ≤5 s @150ml/min	<4.5 s @100ml/min <4.5 s @120ml/min
Rate Measurement:	Measurement range: 0 bpm to 150 bpm Resolution: 1 bpm Measurement accuracy: 0 bpm to 60 bpm: ± 1 bpm 61 bpm to 150 bpm: ± 2 bpm		

** Accuracy applies for the following conditions:*
1. Measurements begin after the CO_2 module warms up;
2. Ambient pressure is from 750 to 760 mmHg, and ambient temperature from 22 to 28℃;
3. The measured gas is a dry gas and the balance gas N_2O;
4. Gas sample flow rate is 100 ml/min, respiration rate is 50 bpm with a fluctuation between ± 3 bpm, and I:E is 1:2.
When the operating temperature (near the module detector) is 15-25℃ or 50-55℃, or the respiration rate is greater than 50 bpm, the measurement accuracy is: ± 4 mmHg (0 to 40 mmHg) or 12% of the reading (41 to 99 mmHg).

TABLE 13-30 Sidestream CO_2 Module

1. *Experiment condition: temperature of sampled gas is 37 °C, ambient temperature is 23 °C, relative humidity of sampled gas is 100%.*
2. *Cleaning time of watertrap ≥24h means that the liquid level will not exceed the MAX line within 24 hours.*

Gas	**Quantitive Effect***	
	CO_2	**O_2**
N_2O	0.1% (1 mmHg)	0.2%
HAL	0.1% (1 mmHg)	1%
SEV	0.1% (1 mmHg)	1%
ISO	0.1% (1 mmHg)	1%
ENF	0.1% (1 mmHg)	1%
DES	0.2% (2 mmHg)	1%

**: means an extra error should be added in case of gas interference when CO_2 measurements are performed between 0 to 40 mmHg.*

TABLE 13-31 Effect of Interfering Gas on Sidestream CO_2 Measured Value

Alarm Limit	Range	Step
$EtCO_2$ High	OFF, (low limit + 2) to 99 mmHg	1 mmHg
$EtCO_2$ Low	OFF, 0 to (high limit - 2) mmHg	
$FiCO_2$ High	OFF, 1 to 99 mmHg	
EtO_2 High	OFF, (low limit + 2%) to 100%	1%
EtO_2 Low	OFF, 10% to (high limit - 2%)	
FiO_2 High	(low limit + 2%) to 100%, OFF	
FiO_2 Low	18% to (high limit - 2%)	

TABLE 13-32 Alarm Limit of the Sidestream CO_2 Module

13.11.2.2 Mainstream CO_2 Module

CO_2 Range:	0% (0 mmHg) to 20% (150 mmHg)
CO_2 Resolution:	0.1% (1 mmHg)
CO_2 Accuracy:	0% (0 mmHg) to 5% (40 mmHg): ±0.2 vol.% (±2 mmHg) 5% (41 mmHg) to 9% (70 mmHg) (not including 5%): ± 5% of the real reading 9% (71 mmHg) to 13% (100 mmHg) (not including 9%): ± 8% of the real reading 13% (101 mmHg) to 20% (150 mmHg) (not including 13%): ± 10% of the real reading
Accuracy Drift:	Meet the requirement for measurement accuracy within 6 hours
Rise Time:	< 60 ms
System Total Response Time:	< 2 s
Rate Measurement:	Measurement range: 0 bpm to 150 bpm Resolution: 1 bpm Measurement accuracy: ± 1 bpm

TABLE 13-33 Mainstream CO_2 Module

Alarm Limit		Range	Step	Unit
$EtCO_2$	High Limit	OFF, (low limit + 2) to 99	1	mmHg
	Low Limit	OFF, 0 to (high limit - 2)		
$FiCO_2$	High Limit	OFF, 1 to 99		

TABLE 13-34 Alarm Limit of the Mainstream CO_2 Module

13.11.3 Monitor Mode

The system supports **Monitor** mode when the anesthesia system is configured with an external AG module.

When the anesthesia system is in **Monitor** mode, the external AG module continues to function, while the ventilation monitors and alarms of the anesthesia system will be off.

13.11.4 Oxygen Monitor Using Oxygen Cell

Oxygen Monitor	Type	Galvanic Fuel Cell
	Range	18% to 100%
	Accuracy	±(2.5% of volume fraction+2.5% of gas level)
	Accuracy Drift	Meets accuracy requirements within 6 hours
	System Total Response Time (21% to 100% O_2)	< 20 s

TABLE 13-35 Oxygen Monitor Using Oxygen Cell

13.11.4.1 Alarms

Alarm Limits		Range	Step	Unit
FiO_2	**High Limit**	Off, 20 to 100	1	%
	Low Limit	18 to 98		

TABLE 13-36 Alarms

13.11.4.2 Effect of Interfering Gas on Oxygen Cell Measured Value

Gas Under Test	Quantitative Effect (Volume Fraction)
	O_2
N_2O	1.0%
HAL	1.5% to 2.0%
SEV	1.0% to 1.5%
ISO	1.2% to 1.8%
ENF	1.2% to 1.8%
DES	2.0%

TABLE 13-37 Effect of Interfering Gas on Oxygen Cell Measured Value

13.11.5 Agent Usage Calculation and Agent Usage Speed

Agent Usage Calculation	
Calculation Range:	0 to 3000 ml
Accuracy:	± 2 ml, or ± 15% of the actual reading, whichever is greater.
Agent Usage Speed	
Anesthetic Agents:	Desflurane, Isoflurane, Sevoflurane and Halothane
Usage Speed Range:	Desflurane: 0 to 900 ml/h Sevoflurane: 0 to 450 ml/h Isoflurane and Halothane: 0 to 250 ml/h
Accuracy:	± 2 ml/h or ±15% of the actual reading, whichever is greater.

TABLE 13-38 Agent Usage Calculation and Agent Usage Speed

13.11.6 Anesthesia Prediction

Patient Information:	Height: 150 cm to 200 cm Weight: 40 kg to 140 kg Age: 18 years to 90 years	
Anesthetic Agents (AA):	Desflurane, Isoflurane, Sevoflurane and Halothane	
Prediction Deviation:	EtAA=0	≤ 0.05 vol.%
	EtAA≠0	-20% to 30% of the actual measured EtAA, or -5% to 7.5% of the vaporizer maximum setting, whichever is greater
	EtO_2	-10% to 15% of the actual measured EtO_2, or -5 vol.% to 7.5 vol.%, whichever is greater

TABLE 13-39 Anesthesia Prediction

13.11.7 Total Effect of the Anesthetic Drugs (eMAC)

Patient Information:	Height: 150 cm to 200 cm Weight: 40 kg to 140 kg Age: 18 years to 90 years
Supports the indication of the interaction effect of the following drugs. The total effect of the anesthetic drugs is displayed as equivalent MAC values.	
Anesthetic Agents:	Desflurane, Isoflurane, Sevoflurane
Intravenous Drugs:	Propofol, Remifentanil, Alfentanil, Sufentanil

TABLE 13-40 Total effect of the anesthetic drugs (eMAC)

13.11.8 BIS Module

Measured Parameters:	**Type**	**BISx**	**BISx4**	**Parameter Range**
	Bispectral index	BIS	BIS L, BIS R	0 to 100
	Accuracy: Unspecified			
	Resolution: 1			

TABLE 13-41 BIS Module

Calculated Parameters:	**Type**	**BISx**	**BISx4**	**Parameter Range**
	Signal quality index	SQI	SQI L, SQI R	0% to 100%
	Electromyography	EMG	EMG L, EMG R	0 dB to 100 dB
	Suppression ratio	SR	SR L, SR R	0% to 100%
	Spectral edge frequency	SEF	SEF L, SEF R	0.5 Hz to 30.0 Hz
	Total power	TP	TP L, TPR	40 dB to 100 dB
	Burst count	BC	BC L,BC R	0 to 30
	BIS variability index	/	sBIS L, sBIS R	0 to 10.0
	EMG variability index	/	sEMG L, sEMG R	0 to 10.0
	Asymmetry	/	ASYM	0% to 100%
EEG Signal Amplitude:	50 uV/Scale, 100 uV/Scale, 200 uV/Scale, 500 uV/Scale			
Sweep Speed:	6.25 mm/s, 12.5 mm/s, 25 mm/s or 50 mm/s			

TABLE 13-41 BIS Module

Alarm Item	**Setting Range**	**Step**
BIS High Limit	2 to 100	1
BIS Low Limit	0 to 98	

TABLE 13-42 Alarms

13.11.9 NMT Module

Stimulation Output:	Pulse width	100 µs, 200 µs, or 300 µs; monophasic rectangle pulse Accuracy: ± 10%
	Stimulation current peak	Output range: 0 to 60 mA Step: 5 mA Accuracy: ± 5% or ± 2 mA, whichever is greater
	Maximum skin resistance	3 kΩ @ 60 mA, 5 kΩ @ 40 mA
Block Recovery:	OFF, 1,2, 3, 4, 5%, 10%, 20%, 30%, 40%. 50%, 60%, 70%, 80%, 90%, 100%	
TOF (Train Of Four) Mode:	TOF-Ratio (response percentage)	5% to 160%
	TOF-Count (number of responses)	0 to 4
	TOF-T1% (response to the first stimulus as percentage of the reference value)	0% to 200%
ST (Single Twitch) Mode:	ST-Ratio (response percentage)	0% to 200%

TABLE 13-43 NMT Module

DBS (Double-Burst Stimulation) 3.2/ 3.3 Mode:	DBS-Ratio (response percentage)	5% to 160%
	DBS-Count (number of responses)	0 to 2
PTC (Post-Tetanic Count) Mode:	PTC-Count (number of responses)	0 to 20

TABLE 13-43 NMT Module

13.12 Ventilator Specifications

General Ventilator Specifications	
Drive Pressure:	280 to 600 kPa
Maximum Inspiratory Flow:	180 L/min
Low Flow Anesthesia:	The accuracy of Tidal Volume shall be within the specification at 0.2 L/min to 1 L/min total fresh gas flow.

TABLE 13-44 General Ventilator Specifications

Ventilator Setting Parameter	**Range**
Vt (under BTPS condition):	10 to 1500 ml (VCV, SIMV-VC), 5 to 1500 ml (PCV-VG, SIMV-VG), Step: 1 ml
RR:	2 to 100 bpm, Step: 1 bpm
Min RR:	2 to 60 bpm, Step: 1 bpm
I:E	4:1 to 1:10, Step: 0.5
Apnea I:E:	4:1 to 1:10, Step: 0.5
Tinsp:	0.2 to 10.0 s, Step: 0.1 s
Apnea Tinsp:	0.2 to 10.0 s, Step: 0.1 s
Pinsp:	3 to 80 cmH_2O, Step: 1 cmH_2O
∆Pinsp:	3 to 80 cmH_2O, Step: 1 cmH_2O
∆Psupp:	0, 3 to 60 cmH_2O Note: Under Pressure Support Ventilation Mode, ∆Psupp can be adjusted to 0, meaning CPAP mode. Step: 1 cmH_2O
∆Papnea:	3 to 60 cmH_2O, Step: 1 cmH_2O
Plimit:	10 to 100 cmH_2O, Step: 1 cmH_2O
PEEP:	OFF, 2 to 50 cmH_2O, Step: 1 cmH_2O
Tpause:	OFF, 5 to 60% of Tinsp, Step: 1%
Trig Window:	5 to 90%, Step: 1%
F-Trig (under BTPS condition):	0.2 to 15.0 L/min, Step: 0.1 L/min
P-Trig:	-20 to -1 cmH_2O, Step: 1 cmH_2O
Tslope:	0.0 to 2.0 s, Step: 0.1 s

TABLE 13-45 Ventilator Setting Parameter and Range

Phigh:	3 to 80 cmH_2O, Step: 1 cmH_2O
Plow:	OFF, 2 to 50 cmH_2O, Step: 1 cmH_2O
Thigh:	0.2 to 10.0 s, Step: 0.1 s
Tlow:	0.2 to 10.0 s, Step: 0.1 s
Exp%:	5 to 80%, Step: 1%
I:E (I:E=Thigh:Tlow):	50:1 to 1:50, Step: 0.5
MV%:	25 to 350%, Step: 1%

TABLE 13-45 Ventilator Setting Parameter and Range

Ventilator Monitored Parameters	Range
PEAK:	-20 to 120 cmH_2O
PLAT:	-20 to 120 cmH_2O
MEAN:	-20 to 120 cmH_2O
PEEP:	0 to 70 cmH_2O
Vt (under BTPS condition):	0 to 3000 ml
Vti (under BTPS condition):	
MV (under BTPS condition):	0 to 100 L/min
MVi (under BTPS condition):	
RR:	0 to 150 bpm
I:E:	50:1 to 1:50
Raw:	0 to 600 cmH_2O/(L/s)
Compl:	0 to 300 mL/cmH_2O
MVLeak (under BTPS condition):	0 to 10.0 L/min
ΔVt:	0 to 3000 ml
E:	0.003 to 10 hPa/mL(cmH_2O/ mL)
MPrs:	0.00 to 100.00 J/min
Pdrive:	0 to 120 cmH_2O

TABLE 13-46 Ventilator Monitored Parameters and Range

Control Parameters	Accuracy
Vt (VCV, SIMV-VC, under BTPS condition):	10 to 60 ml: ± 10 ml 60 to 210 ml (not including 60 ml): ± 15 ml 210 to 1500 ml (not including 210 ml): ± 7% of the setting value
Vt (PCV-VG, SIMV-VG, under BTPS condition):	5 to 10 ml: ± (the setting value - 1 ml) 10 to 60 ml (not including 10 ml): ± 10 ml 60 to 210 ml (not including 60 ml): ± 15 ml 210 to 1500 ml (not including 210 ml): ± 7% of the setting value

TABLE 13-47 Ventilator Control Accuracy

Pinsp:	± 2.5 cmH_2O or ± 7% of the setting value, whichever is greater
∆Pinsp:	
∆Psupp:	
∆Papnea:	
Plimit:	
PEEP:	Off: ± 3.0 cmH_2O 2 cmH_2O to 50 cmH_2O: ± 2.0 cmH_2O or ± 7% of the setting value, whichever is greater
Tslope:	0.1 s to 0.2 s: ± (the setting value - 0.01 s) 0.2 s to 2.0 s (not including 0.2 s): ± 0.2 s or ± 20% of the setting value, whichever is greater
RR:	± 1 bpm or ± 10% of the setting value, whichever is greater
Min RR:	
I:E:	2:1 to 1:4: ±10% of the setting value 4:1 to 2:1 and 1:4 to 1:10 (not including 2:1 and 1:4): ± 25% of the setting value
Apnea I:E:	
Apnea Tinsp:	± 0.2 s
Tinsp:	
Tpause:	5 to 8%: ± (the setting value - 0.1%) (absolute error) 8 to 60% (not including 8%): ± 8% (absolute error)
Trig Window:	5 to 10%: ± (the setting value - 0.1%) (absolute error) 10 to 90% (not including 10%): ± 10% (absolute error)
F-Trig (under BTPS condition):	0.2 to 1.0 L/min: ± (the setting value - 0.01 L/min) 1.0 to 15.0 L/min (not including 1.0 L/min): ± 1 L/min
P-Trig:	-2 cmH_2O to -1 cmH_2O: ± (the setting value + 0.1 cmH_2O) -20 cmH_2O to -2 cmH2O (not including -2 cmH_2O): ± 2 cmH_2O
Phigh:	± 2.5 cmH_2O or ± 7% of the setting value, whichever is greater
Plow:	Off: ± 3.0 cmH_2O 2 cmH_2O to 50 cmH_2O: ± 2.0 cmH_2O or ± 7% of the setting value, whichever is greater
Thigh:	± 0.2 s or ± 10% of the setting value, whichever is greater
Tlow:	
Exp%:	5 to 10%: ± (the setting value - 0.1%) (absolute error) 10 to 80% (not including 10%): ±10% (absolute error)

TABLE 13-47 Ventilator Control Accuracy

I:E (I:E=Thigh:Tlow):	2:1 to 1:4: ± 10% of the setting value 4:1 to 2:1 and 1:4 to 1:8 (not including 2:1 and 1:4): ± 25% of the setting value 50:1 to 4:1 and 1:8 to 1:50 (not including 4:1 and 1:8): ± 50% of the setting value
MV%:	± 10% or ± 10% of the setting value, whichever is greater

TABLE 13-47 Ventilator Control Accuracy

Monitored Parameters	Accuracy
Vt (under BTPS condition):	0 to 60 ml: ± 10 ml 60 to 210 ml (not including 60 ml): ± 15 ml 210 to 3000 ml (not including 210 ml): ± 7% of the actual reading
Vti (under BTPS condition):	
MV (under BTPS condition):	± 0.1 L/min or ± 8% of the actual reading, whichever is greater
MVi (under BTPS condition):	
PEAK:	± 2.0 cmH_2O or ± 4% of the actual reading, whichever is greater
PLAT:	
MEAN:	
PEEP:	
RR:	± 1 bpm or ± 5% of the actual value, whichever is greater
I:E:	2:1 to 1:4: ± 10% of the actual reading 50:1 to 2:1 (not including 2:1) and 1:4 to 1:50 (not including 1:4): ± 25% of the actual reading
Raw:	0 to 20 $cmH_2O/(L/s)$: ± 10 $cmH_2O/(L/s)$ 20 to 600 $cmH_2O/(L/s)$ (not including 20 $cmH_2O/(L/s)$): ± 50% of the actual reading
Compl:	± (10 mL/cmH_2O+20% of the actual reading)
MV Leak (under BTPS condition):	± 0.1 L/min or ± 8% of the actual reading, whichever is greater
ΔVt:	0 to 60 ml: ± 20 ml 60 to 210 ml (not including 60 ml): ± 30ml 210 to 3000 ml (not including 210 ml): ± 14% of the actual reading
E:	Unspecified
MPrs:	±(1 J/min + 15% of the actual reading)
Pdrive:	±(2 cmH_2O + 4% of the actual reading)

TABLE 13-48 Ventilator Monitoring Accuracy

Lung Recruitment
Lung Recruitment Tool includes Multi-Step Recruitment and One-Step Recruitment.

TABLE 13-49 Lung Recruitment Tool

Parameters	**Pressure Hold:**	Range: 20 to 60 cmH_2O
	Hold Time:	Range: 10 to 40 s
	PEEP on Exit*:	Range: OFF, 2 to 50 cmH_2O
	Cycle Interval:	Range: OFF, 1 to 180 min

** When the ventilation mode is APRV before entering the recruitment, the button name **PEEP on Exit** will indicate **Plow on Exit**.*

TABLE 13-49 Lung Recruitment Tool

High-Frequency Jet Ventilation (HFJV)		
Setting Parameter	**P HF:**	Range: 10 kPa to 200 kPa Step: 10 kPa Accuracy: ± 10%
	P NF:	Range: 10 kPa to 350 kPa Step: 10 kPa Accuracy: ± 10%
	F (high frequency):	Range: 50 bpm to 1500 bpm Step: 1 bpm Accuracy: ± 3%
	F (normal frequency):	Range: 1 bpm to 100 bpm Step: 1 bpm Accuracy: ± 3%
	I:E (high frequency):	Range: 3:1 to 1:5 Step: 0.5 Accuracy: ± 3%
	I:E (normal frequency):	Range: 3:1 to 1:5 Step: 0.1 Accuracy: ± 3%
	FiO_2 Jet:	Range: 21% to 100% Step: 1% Accuracy: ± 3%
Monitoring Parameter	**PEAK:**	Range: 0 cmH_2O to 120 cmH_2O Accuracy: ± 2 cmH_2O or ± 4% of the actual reading, whichever is greater
	MEAN:	Range: 0 cmH_2O to 120 cmH_2O Accuracy: ± 2 cmH_2O or ± 4% of the actual reading, whichever is greater
	PEEP:	Range: 0 cmH_2O to 70 cmH_2O Accuracy: ± 2 cmH_2O or ± 4% of the actual reading, whichever is greater

TABLE 13-50 High-Frequency Jet Ventilation (HFJV)

13.13 Displays and Controls Specifications

13.13.1 Electronic Controls

Main Display:	18.5 inch, 1920 * 1080 resolution with touch screen
AC Power Indicator:	Green. Lit when the AC power supply is connected.
Battery Status Indicator:	Green. Lit when a battery is installed and the AC power supply is connected; flashing when powered by batteries; extinguished when no battery is installed.
Working Light:	Settings: Off, Low, High

TABLE 13-51 Electronic Controls

13.13.2 Pneumatic Controls

Line Pressure Gauges:	Gauges: O_2, N_2O, Air, Range: 0 to 140 psi (0 to 1000 kPa) Accuracy: ± (4% of full scale reading + 8% of actual reading) Units of measure: kPa, psi
Cylinder Pressure Gauges:	Gauges: O_2, N_2O, Air O_2: 0 to 3500 psi (0 to 25 MPa) N_2O: 0 to 1400 psi (0 to 10 MPa) Air: 0 to 3500 psi (0 to 25 MPa) Accuracy: ± (4% of full scale reading + 8% of actual reading) Units of measure: kPa, psi
Electronic Flowmeter:	Direct Flow Control Mode: O_2 flow range: 0.00 L/min, 0.20 to 15.0 L/min Air flow range: 0.00 to 15.0 L/min N_2O flow range: 0.00 to 12.0 L/min O_2 flow accuracy: ± 50 mL/min or ± 5% of setting value, whichever is greater Balance gas (Air/N_2O) flow accuracy: ± 50 mL/min or ± 5% of setting value, whichever is greater O_2 concentration range in the O_2/N_2O mixed gas: ≥ 25% Total Flow Control Mode: Total flow range: 0.00 L/min, 0.20 to 20.0 L/min Total flow accuracy: ± 100 mL/min or ± 5% of setting value, whichever is greater O_2 concentration range: 21% to 100% (The balance gas is Air) 26% to 100% (The balance gas is N_2O) O_2 concentration accuracy: Volume fraction of ±5% (Flow <1L/min) ± 5% of the setting value (Flow ≥1L/min)

TABLE 13-52 Pneumatic Controls

Backup Flowmeter, Control Needle Valve and Knob:	Flow display on screen: O_2 flow range: (1.0±0.5) L/min to 15 L/min Flowmeter display accuracy: ± 10% of the indicated value (under the condition of 20°C and 101.3kPa, for flow between 10% and 100% of full scale) Glass tube flow display: Glass tube flowmeter display range: 0 to15 L/min Flowmeter display accuracy: ± 10% of the indicated value (under the condition of 20°C and 101.3kPa, for flow between 10% and 100% of full scale)
Auxiliary O_2 Flowmeter:	Flow adjustable range: 0.0 L/min to 15.0 L/min Flow control accuracy: ± 0.5 L/min or ± 10% of the indicated value, whichever is greater
Auxiliary O_2 and Air Flowmeters:	Total flow adjustable range: 0.0 L/min to 15.0 L/min Total flow control accuracy: ± 100 mL/min or ± 10% of the setting value, whichever is greater O_2 concentration adjustable range: 21% to 100% O_2 concentration control accuracy: Volume fraction of ± 5% Glass tube flowmeter display range: 0 L/min to 15 L/min Glass tube flowmeter display accuracy: ± 10% of the indicated value (under the condition of 20°C and 101.3kPa, for flow between 10% and 100% of full scale)
High Flow Nasal Cannula Oxygen (HFNC)	O_2 concentration setting range: 21% to 100% O_2 concentration control accuracy: Volume fraction of ± 5% Flow control range: 2 L/min to 100 L/min Flow control accuracy: ± (2 L/min + 10% of the setting value) Safety pressure: With pressure release protection, pressure at the outlet ≤ 6.0 kPa.
High Pressure Oxygen Outlet:	Pressure range: 280 to 600 kPa Maximum flow: ≥ 90 L/min
O_2 Flush:	Flow range: 25 to 75 L/min
Airway Pressure Gauge:	Range: -20 to 100 cmH_2O Accuracy: ± (2% of full scale reading + 4% of actual reading)

TABLE 13-52 Pneumatic Controls

13.14 Alarms

Alarm Indicators:	Audible: speaker Visual: alarm light and on-screen alarm messages (Audible and visual alarms comply with the requirements of IEC 60601-1-8.)
Alarm Categories:	Physiological alarms: three levels (high, medium, low) Technical alarms: three levels (high, medium, low)
Sound Levels:	10 alarm sound levels, adjustable (levels 1 to 10)

TABLE 13-53 Alarms

Vte:	High Limit	5 mL to 1600 mL
	Low Limit	OFF, 0 mL to 1595 mL
MV:	High Limit	0.2 L/min to 100 L/min
	Low Limit	0.0 to 15.0 L/min: 0.0 L/min to (high limit - 0.2) L/min 15.0 to 100.0 L/min: 15 L/min to (high limit - 1) L/min
RR:	High Limit	4 bpm to 100 bpm, OFF
	Low Limit	OFF, 2 bpm to 98 bpm
Paw:	High Limit	2 cmH_2O to 100 cmH_2O
	Low Limit	0 cmH_2O to 98 cmH_2O
Apnea alarm delay time is adjustable, Range: 5s to 60s, Accuracy: ±3s CO2 apnea delay time is adjustable, Range: 10s to 40s, Accuracy: ±3s		
It has Negative Pressure alarm function. **Negative Pressure in Airway** alarm is triggered when the airway pressure is lower than the atmospheric pressure by 10cmH2O.		

TABLE 13-54 Alarm Limits

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A.0 Accessories

WARNING: Please use the accessories specified in this chapter only. Using other accessories may lead to inaccurate measurements or equipment faults.

WARNING: Disposable accessories must be used only once. Repeated use may lead to deterioration in performance or cross-infection.

WARNING: Please do not use the accessory if its package or itself is damaged.

WARNING: 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.

WARNING: Parts which are intended to contact patients must comply with the biocompatibility requirement of ISO 10993-1 to prevent any adverse reactions arising from such contact.

CATEGORIES OF FEATURES	PART NUMBER	DESCRIPTION
Gas supply hose	082-001209-00	O2 supply hose, British standard, NIST, 5m, 34I-OXY-BS/NS-5
	082-001210-00	Air supply hose, British standard, NIST, 5m, 34I-AIR-BS/NS-5
	082-001211-00	N2O supply hose, British standard, NIST, 5m, 34I-N2O-BS/NS-5
	082-001212-00	O2 supply hose, Germany standard, NIST, 5m, 34I-OXY-GS/NS-5
	082-001213-00	Air supply hose, Germany standard, NIST, 5m, 34I-AIR-GS/NS-5
	082-001214-00	N2O supply hose, Germany standard, NIST, 5m, 34I-N2O-GS/NS-5
	082-001215-00	O2 supply hose, Australian standard, NIST, 5m, 34I-OXY-SIS/NS-5
	082-001216-00	Air supply hose, Australian standard, NIST, 5m, 34I-AIR-SIS/NS-5
	082-001217-00	N2O supply hose, Australian standard, NIST, 5m, 34I-N2O-SIS/NS-5
	082-001218-00	O2 supply hose, French standard, NIST, 5m, 34I-OXY-FS/NS-5
	082-001219-00	Air supply hose, French standard, NIST, 5m, 34I-AIR-FS/NS-5
	082-001220-00	N2O supply hose, French standard, NIST, 5m, 34I-N2O-FS/NS-5
	082-001227-00	O2 supply hose, US standard, BS, DISS, 5m, 34U-OXY-BS/DS-5

	082-001228-00	Air supply hose, US standard, BS, DISS, 5m, 34U-AIR-BS/DS-5
	082-001229-00	N2O supply hose, US standard, BS, DISS, 5m, 34U-N2O-BS/DS-5
	082-001354-00	N2O supply hose, US standard, Chemetron, DISS, 5m, 34U-N2O-CH/DS-5
	082-001355-00	Air supply hose, US standard, Chemetron, DISS, 5m, 34U-AIR-CH/DS-5
	082-001356-00	O2 supply hose, US standard, Chemetron, DISS, 5m, 34U-OXY-CH/DS-5
	082-001373-00	N2O supply hose, US standard, Ohmeda, DISS, 5m, 34U-N2O-OH/DS-5
	082-001374-00	Air supply hose, US standard, Ohmeda, DISS, 5m, 34U-AIR-OH/DS-5
	082-001376-00	O2 supply hose, US standard, Ohmeda, DISS, 5m, 34U-OXY-OH/DS-5
	082-001375-00	O2 supply hose, US standard, P-B, DISS, 5m, 34U-OXY-PB/DS-5
	082-001377-00	N2O supply hose, US standard, P-B, DISS, 5m, 34U-N2O-PB/DS-5
	082-001378-00	Air supply hose, US standard, P-B, DISS, 5m, 34U-AIR-PB/DS-5
	082-003443-00	O2 supply hose, US standard, DISS, DISS, 5m, 34U-OXY-DS/DS-5
	082-003444-00	N2O supply hose, US standard, DISS, DISS, 5m, 34U-N2O-DS/DS-5
	082-003445-00	Air supply hose, US standard, DISS, DISS, 5m, 34U-AIR-DS/DS-5
AG module	115-030368-00	AG module (with O2), without accessory
	115-030369-00	AG module (without O2), without accessory
	115-030370-00	AG module (with O2 and BIS), without accessory
	115-030371-00	AG module (without O2, with BIS), without accessory
	115-030379-00	AG module kit (with O2), with accessory
	115-030380-00	AG module kit (without O2), with accessory
	115-030381-00	AG module kit (with O2 and BIS), with AG accessory, without BIS accessory,
	115-030382-00	AG module kit (without O2, with BIS), with AG accessory, without BIS accessory
	115-030383-00	AG module kit (with O2 and BIS), with AG accessory, with BIS accessory,
	115-030384-00	AG module kit (without O2, with BIS), with AG accessory, with BIS accessory
	115-030385-00	AG accessory kit

CO2 module	115-030410-00	Mainstream CO2 module kit, with accessory
	115-030414-00	Mainstream CO2 module, without accessory
	115-097655-00	Mainstream CO2 accessory kit
	120-015033-00	Sidestream CO2 module kit, wtih accessory, Adult/ pediatric
	120-015034-00	Sidestream CO2 module kit, wtih accessory, Neonate
	120-013811-00	Sidestream CO2 module, without accessory
	115-024752-00	Sidestream CO2 accessory kit, Adult/Pediatric
	115-024753-00	Sidestream CO2 accessory kit, Neonate
	125-000365-00	Adult. EtCO2/O2 Nasal Divided Cannula, 25 pcs
	125-000366-00	Pefiatric. EtCO2/O2 Nasal Divided Cannula, 25 pcs
	125-000367-00	Neonate. EtCO2/O2 Nasal Divided Cannula, 25 pcs
	115-084741-00	Sidestream CO2 accessory kit, Adult, incluing EtCO2/O2 Nasal Divided Cannula
	115-084742-00	Sidestream CO2 accessory kit, Pefiatric, incluing EtCO2/ O2 Nasal Divided Cannula
	115-084743-00	Sidestream CO2 accessory kit, Neonate, incluing EtCO2/ O2 Nasal Divided Cannula
	115-043024-00	DRYLINE II watertrap, Adu/Ped, 10pcs/box
	115-043025-00	DRYLINE II watertrap, Neo, 10pcs/box
	115-043017-00	Sampling line, Adu/Ped, 2.5 m, 25 pcs/box
	115-043018-00	Sampling line, Neo, 2.5 m, 25 pcs/box
	115-043020-00	DRYLINE airway adapter, Straight, 10 pcs/box
	115-043019-00	DRYLINE airway adapter, Neo, Straight, 10 pcs/box
	115-043021-00	DRYLINE airway adapter, Elbow, 10 pcs/box
NMT module	120-024503-00	NMT module, without accessory
	120-024504-00	NMT module kit, with accessory
	040-001462-00	NMT main cable
	040-001463-00	NMT transducer cable
	040-001464-00	NMT stimulation cable
	115-097656-00	NMT accessory kit
	040-002258-00	Bandage for NMT sensor, disposable 20pcs/pouch
	0010-10-12304	ECG Electrodes: Adu, 10 pcs/pack, Kendall
BIS module	120-024501-00	BIS module kit, with accessory, Adult
	120-024502-00	BIS module kit, with accessory, Pediatric
	115-030406-00	BISx4 module kit, with accessory, Adult
	115-030407-00	BIS module, without accessory
	115-097650-00	BIS accessory kit, Pediatric
	115-097651-00	BIS accessory kit, Adult
	115-097649-00	BISx4 accessory kit, Adult
	6800-30-50761	BIS measuring cable assembly, 4.5 m, 1 pcs
	115-005707-00	BISx4 measuring cable assembly, 4.5 m, 1 pcs

Flow sensor	115-041507-00	Inspiration flow sensor, autoclavable, 1 pcs
	115-041508-00	Expiration flow sensor, autoclavable, 1 pcs
	115-041519-00	Flow sensor kit, autoclavable, including Inspiration flow sensor and Expiration flow sensor
HFNC oxygen and humidifier	040-006057-00	Single tube for HFNC, disposable, ID 22 mm, length 1.8 m
	040-006058-00	Tubing kit for HFNC, disposable, with heated wire, ID 22 mm， length 1m, 1.5m
	040-002376-00	Nasal cannula for HFNC, small
	040-002377-00	Nasal cannula for HFNC, medium
	040-002378-00	Nasal cannula for HFNC, large
	040-007389-00	Nasal cannula for HFNC with filter, small
	040-007390-00	Nasal cannula for HFNC with filter, medium
	040-007391-00	Nasal cannula for HFNC with filter, large
	115-032096-00	Jike humidifier SH330/Brazil/230V
	115-018053-00	Jike humidifier SH330/UK
	115-018050-00	Jike humidifier SH330/India
	115-018049-00	Jike humidifier SH330/EU
	115-018054-00	Jike humidifier SH330/US/220V
	115-032097-00	Jike humidifier SH330/Brazil/110V
	115-018051-00	Jike humidifier SH330/US/110V
	115-082898-00	Bracket for liquid collection bottles and humidifier
AGSS	115-084735-00	AGSS kit, low flow, high vacuum
	115-084736-00	AGSS kit, high flow, low vacuum
	115-017376-00	AGSS assembly, low-flow, high vacuum
	115-017375-00	AGSS assembly, high-flow, low vacuum
	115-081008-00	AGSS waste gas transfer hose, from main unit to AGSS assembly
	115-009097-00	AGSS high flow receiving hose, from AGSS assembly to hospital's waste gas disposal system
	115-009073-00	AGSS low flow receiving hose, from AGSS assembly to hospital's waste gas disposal system
	115-002342-00	Passive AGSS accessory kit
	115-020745-00	AGSS accessory kit, British standard
	082-001372-00	AGSS receiving hose
	115-026796-00	AGSS Three-way connector, from ACGO to AGSS

Breathing tube and breathing bag	040-001850-00	Breathing tube, silicon, reusable, adult, 1.5m
	040-001851-00	Breathing tube, silicon, reusable, child/infant, 1.5m
	040-001854-00	Breathing tube, silicon, reusable, adult, 0.45m
	040-001876-00	Disposable breathing circuit package, Adult, (including 1.5 m breathing tube, L connector, backup breathing tube, straight connector, filter, 3 Liter latex-free manual bag)
	040-001878-00	Disposable breathing circuit package, Child, (including 1.5 m breathing tube, L connector, backup breathing tube, straight connector, filter, 1 Liter latex-free manual bag)
	040-001866-00	connector, L type (Elbow), reusable, 22M/15F,22F
	040-001868-00	connector, Y-piece, reusable, with sample port
	040-001827-00	Latex-free breathing bag, disposable, 0.5L
	040-001828-00	Latex-free breathing bag, disposable, 1L
	040-001829-00	Latex-free breathing bag, disposable, 2L
	040-001830-00	Latex-free breathing bag, disposable, 3L
	040-001856-00	Silicon breathing bag, reusable, 0.5L
	040-001857-00	Silicon breathing bag, reusable, 1L
	040-001858-00	Silicon breathing bag, reusable, 2L
	040-001859-00	Silicon breathing bag, reusable, 3L
	040-001817-00	Aircushion mask, disposable, size #0
	040-001818-00	Aircushion mask, disposable, size #1
	040-001819-00	Aircushion mask, disposable, size #2
	040-001820-00	Aircushion mask, disposable, size #3
	040-001821-00	Aircushion mask, disposable, size #4
	040-001822-00	Aircushion mask, disposable, size #5
	040-001835-00	Silicon face mask, reusable, size #0
	040-001836-00	Silicon face mask, reusable, size #1
	040-001837-00	Silicon face mask, reusable, size #2
	040-001841-00	Silicon face mask, reusable, size #3
	040-001842-00	Silicon face mask, reusable, size #4
	040-001843-00	Silicon face mask, reusable, size #5
	115-031780-00	Reusable breathing circuit accessory kit, Adult
	115-031781-00	Reusable breathing circuit accessory kit, Child
	115-030717-00	Disposable breathing circuit accessory kit with mask, Adult
	115-030718-00	Disposable breathing circuit accessory kit with mask, Child
	040-001831-00	Bacteria filter, disposable , 1 pcs
	040-001703-00	T-piece system circuit
	040-001704-00	Mapleson C circuit

Negative pressure suction device	082-001333-00	Pipeline vacuum hose assembly, US standard, DISS, 35U-VAC-DS/DS-5
	082-001334-00	Pipeline vacuum hose assembly, US standard, PB, 35U-VAC-PB/DS-5
	082-001335-00	Pipeline vacuum hose assembly, US standard, OH, 35U-VAC-OH/DS-5
	082-001336-00	Pipeline vacuum hose assembly, US standard, CH, 35U-VAC-CH/DS-5
	082-001340-00	Pipeline vacuum hose assembly, US standard, 35U-VAC-BS/DS-5
	082-001337-00	Pipeline vacuum hose assembly, Australia(SIS), 35I-VAC-SIS/NS-5
	082-001338-00	Pipeline vacuum hose assembly, French-standard, 35I-VAC-FS/NS-5
	082-001339-00	Pipeline vacuum hose assembly, German-standard, 35I-VAC-GS/NS-5
	082-001341-00	Pipeline vacuum hose assembly, British-standard, 35I-VAC-BS/NS-5
	115-033264-00	Suction tube connect the anesthesia machine and liquid collection bottles, 3m, with filters
	040-001532-00	Vacuum liquid collection bottle/flask, with overflow protection
	040-001533-00	Vacuum liquid collection bottle/flask, without overflow protection
	115-081374-00	Venturi suction kit, Air drive, NIST
	115-081375-00	Venturi suction kit, Air drive, DISS
	115-081378-00	Pipeline continuous vacuum suction kit, US, US/DISS
	115-081379-00	Pipeline continuous vacuum suction kit, US, DISS/PB
	115-081380-00	Pipeline continuous vacuum suction kit, US, DISS/ Ohmeda
	115-081381-00	Pipeline continuous vacuum suction kit, US, DISS/ Chemetron
	115-081382-00	Pipeline continuous vacuum suction kit, US, DISS/BS
	115-081383-00	Pipeline continuous vacuum suction kit, Australian, NIST/SIS
	115-081384-00	Pipeline continuous vacuum suction kit, French, NIST/FS
	115-081385-00	Pipeline continuous vacuum suction kit, Germany, NIST/ GS
	115-081386-00	Pipeline continuous vacuum suction kit, Britain, NIST/BS
	115-095612-00	Pipeline continuous vacuum suction kit

Vaporizer and adapter	115-005345-0	Mindray V60 vaporizer, Isoflurane, Key Filler, with adpator
	115-005346-00	Mindray V60 vaporizer, Sevoflurane, Key Filler, with adapter
	115-005348-00	Mindray V60 vaporizer, Isoflurane, Pour Fill
	115-005349-00	Mindray V60 vaporizer, Sevoflurane, Pour Fill
	115-005350-00	Mindray V60 vaporizer, Sevoflurane, Quik-Fil, without adapter
	115-014138-00	Mindray V60 vaporizer, Halothane, Key Filler, with adapter
	115-014139-00	Mindray V60 vaporizer, Halothane, Pour Fill
	115-082973-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, US power cord (220V), English
	115-075080-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, EU power cord, English
	115-075081-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, UK power cord
	115-082884-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, Indian power cord
	115-082885-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, Korea power cord
	115-082875-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, Aus power cord
	115-082882-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, South Africa power cord
	115-082883-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, Brazil power cord, Portuguese
	115-082890-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, EU power cord, Russian
	115-082436-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, EU power cord, Turkish
	115-082888-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, EU power cord, Cezch
	115-082887-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, US power cord (220V), Spanish
	115-083552-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, US power cord (110V), Spanish
	115-084247-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, US power cord (110V), English
	115-094286-00	Mindray V80 vaporizer, Desflurane, Saf-T-Fill, Indonesia
	115-082300-00	Fill converter for Sevoflurane
	115-097633-00	Fill converter for Sevoflurane
	040-000063-00	Key Filler adapter for filling the vaporizer, Halothane
	040-000065-00	Key Filler adapter for filling the vaporizer, Isoflurane
	040-000066-00	Key Filler adapter for filling the vaporizer, Sevoflurane
	040-000067-00	Quik-Fil drain funnel adapter for draining the vaporizer, Sevoflurane
	115-026747-00	Quik-Fil adapter for filling the vaporizer, Sevoflurane
Li-ion battery	115-097419-00	Li-ion battery package

O2 sensor	040-001275-00	Oxygen sensor, Medicel MOX-3, 1 pcs
	115-084737-00	Oxygen monitoring kit, including base for Oxygen sensor and Oxygen sensor MOX-3
Bracket	115-066025-00	GCX bracket kit for N19/N22,fixed height
	115-066027-00	GCX bracket kit for N19/N22,variable height
	115-066028-00	GCX bracket for N12/15/17/ePM15,fixed height
	115-066029-00	GCX bracket for N12/15/17/ePM15,variable height
	115-070011-00	GCX bracket for ePM10/12/uMEC,fixed height
	115-070768-00	GCX bracket for ePM10/12/uMEC,variable height
	115-074073-00	Top shelf mounting kit for N12, ePM12/10
	115-070794-00	Top shelf mounting kit for N15/17, ePM15
	115-048035-00	Flexible bag arm assembly
	115-011304-00	Cable tie accessory kit
	115-021015-00	Accessory hook kit
	115-069585-00	GCX bracket kit for TE7
	115-024461-00	Support arm kit for holding breathing tubes
	115-024056-00	Cable arranging clamp material package
	115-024614-00	M series V Hub arm kit, for cable management
	115-084739-00	Top shelf mounting bracket
	115-084740-00	Fodable worktable
	115-097648-00	Infusion pump bracket for anesthesia system
Others	0348-00-0185	Cylinder yoke seal, 6 pcs
	115-033063-00	Cylinder yoke spanner
	040-007065-00	Bellows, gray
	115-066324-00	Sodalime canister with handle, for Pre-pak breathing circuit (A9/A8)
	115-017042-00	Quick connector and tube for gas return,0.5m,1 pcs
	115-052161-00	Quick connector
	115-017631-00	Vaporizer parking position
	043-010620-00	Hook mounting on the handles, for standard breathing tube
	045-004527-00	Cleaning adapter kit
	045-001333-01	HEPA filter for blower
	082-004173-00	HEPA assembly for internal air supply
	082-004082-00	Pressure reducer for N2O cylinder, NIST
	082-004083-00	Pressure reducer for N2O cylinder, DISS
	082-004411-00	Pressure reducer for O2 cylinder, NIST
	082-004412-00	Pressure reducer for O2 cylinder, DISS

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B.0 Parameters and Factory Defaults

B.1 Spirometry Screen

ITEM	DEFAULT
Loop Type	**P-V Loop**
Save Loop	**Reference**
Show Reference	Off
Review Loops	**P-V Loop**

B.2 BIS Screen

ITEM	DEFAULT
Views	**BIS & EEG**
Trend Length	**6 min**
EEG Size	**100 µV**
Sweep Speed	**25 mm/sec**

B.3 NMT Screen

ITEM	DEFAULT
Settings: Mode	**TOF**
Settings: Intervals: TOF	**1 min**
Settings: Intervals: ST	**10 Sec**
Settings: Intervals: DBS	**1 min**

B.4 Limits

PARAMETERS	DEFAULT
Alarms: Limits: PEAK High	Adult: 40 cmH_2O Pediatric: 40 cmH_2O Infant: 40 cmH_2O
Alarms: Limits: PEAK Low	Adult: 4 cmH_2O Pediatric: 4 cmH_2O Infant: 4 cmH_2O
Alarms: Limits: MV High	Adult: 12 L/min Pediatric: 6 L/min Infant: 6 L/min
Alarms: Limits: MV Low	Adult: 1 L/min Pediatric: 1 L/min Infant: 0.2 L/min
Alarms: Limits: Vte High	1000ml
Alarms: Limits: Vte Low	Off
Alarms: Limits: RR High	Off
Alarms: Limits: RR Low	Off
Alarms: Limits: Apnea Delay Time	30 sec
Alarms: Limits: PEAK(HFJV) High	Adult: 40 cmH_2O Pediatric: 30 cmH_2O Infant: 25 cmH_2O
Alarms: Limits: PEAK(HFJV) Low	0 cmH_2O

PARAMETERS	DEFAULT
Alarms: Limits: PP(HFJV) High	15 cmH_2O
Alarms: Limits: $EtCO_2$ High	Adult or pediatric: 50 mmHg Infant: 45 mmHg
Alarms: Limits: $EtCO_2$ Low	Adult or pediatric: 25 mmHg Infant: 30 mmHg
Alarms: Limits: $FiCO_2$ High	4 mmHg
Alarms: Limits: Apnea Delay Time	30 sec
Alarms: Limits: CO_2 Apnea Delay Time	30 sec
Alarms: Limits: FiO_2 High	Off
Alarms: Limits: FiO_2 Low	18 %
Alarms: Limits: EtO_2 High	100 %
Alarms: Limits: EtO_2 Low	Off
Alarms: Limits: FiN2O High	82 %
Alarms: Limits: BIS High	70
Alarms: Limits: BIS Low	20
Alarms: Agents: EtHal High	3 %
Alarms: Agents: EtHal Low	0 %
Alarms: Agents: FiHal High	2 %
Alarms: Agents: FiHal Low	0 %
Alarms: Agents: EtEnf High	3 %
Alarms: Agents: EtEnf Low	0 %
Alarms: Agents: FiEnf High	2 %
Alarms: Agents: FiEnf Low	0 %
Alarms: Agents: EtIso High	3 %
Alarms: Agents: EtIso Low	0 %
Alarms: Agents: FiIso High	2 %
Alarms: Agents: FiIso Low	0 %
Alarms: Agents: EtSev High	6 %
Alarms: Agents: EtSev Low	0 %
Alarms: Agents: FiSev High	5 %
Alarms: Agents: FiSev Low	0 %
Alarms: Agents: EtDes High	8 %
Alarms: Agents: EtDes Low	0 %
Alarms: Agents: FiDes High	6 %
Alarms: Agents: FiDes Low	0 %
Alarms: Agents: MAC High	Off
Alarms: Agents: MAC Low	Off

B.5 Main Menu

PARAMETERS	DEFAULT
Setup: Ventilation: Vt/IBW	7 ml/Kg
Setup: Ventilation: Vt Source	**IBW**
Setup: Ventilation: Time Control	**I:E**
Setup: Ventilation: Pressure Display	**PLAT**
Setup: Ventilation: Plimit Line	On

PARAMETERS	DEFAULT
Setup: Ventilation: Breathing System Warmer	On
Setup: O2: O2 Sensor Monitoring	On
Setup: AG: O2 Scale	0-100 %
Setup: AG: N2O Scale	0-100 %
Setup: AG: Des Scale	0-9.0 %
Setup: AG: Sev Scale	0-4.0 %
Setup: AG: Iso Scale	0-2.5 %
Setup: AG: Hal Scale	0-2.5 %
Setup: AG: Enf Scale	0-2.5 %
Setup: AG: Flow Rate	High
Setup: CO2: BTPS Compen. (Only applicable to sidestream CO_2 module)	Off
Setup: CO2: O2 Compen. (Only applicable to sidestream CO_2 module)	100 %
Setup: CO2: N2O Compen. (Only applicable to sidestream CO_2 module)	0 %
Setup: CO2: Des Compen. (Only applicable to sidestream CO_2 module)	0 %
Setup: CO2: Flow Rate (Only applicable to sidestream CO_2 module)	High
Setup: CO2: Max Hold (Only applicable to mainstream CO_2 module)	10 sec
Setup: CO2: Balance Gas (Only applicable to mainstream CO_2 module)	AIR
Setup: CO2: O2 Compen. (Only applicable to mainstream CO_2 module)	100 %
Setup: CO2: AG Compen. (Only applicable to mainstream CO_2 module)	0 %
Setup: BIS: BIS Module	On
Setup: BIS: Impedance Check	On
Setup: BIS: EEG Filter	On
Setup: BIS: Smoothing Rate	30 sec
Setup: BIS: SQI	On
Setup: BIS: SR	On
Setup: BIS: EMG	On
Setup: BIS: SEF	On
Setup: BIS: TP	On
Setup: BIS: BC	On
Setup: BIS: sBIS	On
Setup: BIS: sEMG	On
Setup: BIS: ASYM	On
Setup: NMT: Stimulation Current	Supra (60mA)
Setup: NMT: Pulse Width	**200 µs**
Setup: NMT: Block Recovery	Off
Setup: NMT: DBS Mode	**DBS 3.3**
Setup: HFJV: Trend Length	30 min
Setup: HFJV: FiO2 Jet Limit	40%
Setup: HFJV: HFJV Test Interval	30 days
Setup: Waveform: Units&Limits	On
Setup: Waveform: Waveform Type	**Fill**
Setup: Waveform: Sweep Speed	**6.25mm/s**
Setup: Waveform: CO2 Location	**Top**
Setup: Waveform: Color&Scale: Paw: Scale	Auto
Setup: Waveform: Color&Scale: Volume: Scale	Auto
Setup: Waveform: Color&Scale: Flow: Scale	Auto
Setup: Waveform: Color&Scale: CO2: Scale	0-60 mmHg

PARAMETERS	DEFAULT
Setup: Volume/Screen: Volume: Alarm Volume	30% of maximum volume
Setup: Volume/Screen: Volume: System Alert Volume	30% of maximum volume
Setup: Volume/Screen: Volume: Key Click Volume	30% of maximum volume
Setup: Volume/Screen: Volume: NMT Beep Volume	30% of maximum volume
Setup: Volume/Screen: Brightness: Main Screen	50% of maximum brightness
Setup: Volume/Screen: Brightness: Status Screen	50% of maximum brightness
Setup: Volume/Screen: Screen Saver: Screen Saver	30 min
Setup: Volume/Screen: Screen Saver: Bar Graph Display	Volume
Setup: System: Setup: Ventilation: Insp Pressure	**Pinsp**
Setup: System: Setup: Ventilation: AMV Setting	**MV%**
Setup: System: Setup: Quick Key: Alarm Reset	Off
Setup: System: Setup: Quick Key: Capture Event/Screen	Off
Setup: System: Setup: Quick Key: Procedures	On
Setup: System: Setup: Quick Key: Flow Pause	Off
Setup: System: Setup: Quick Key: Bypass in Auto mode	Off
Setup: System: Setup: AG: Null for 30s from zeroing	Off
Setup: System: Setup: AG: Types of Agent	Hal, Enf, Iso, Sev, Des
Setup: System: Setup: CO2: Null for 30s from zeroing	Off
Setup: System: Setup: Language/Unit: Language	**English**
Setup: System: Setup: Language/Unit: Pressure Unit	**cmH2O**
Setup: System: Setup: Language/Unit: CO2 Unit	**mmHg**
Setup: System: Setup: Language/Unit: Gas Supply Pressure	kPa
Setup: System: Setup: Language/Unit: Agent Cost Unit	**$**
Setup: System: Setup: Language/Unit: Patient Height	**cm**
Setup: System: Setup: Language/Unit: Patient Weight	**Kg**
Setup: System: Setup: Language/Unit: HFJV Drive Pressure Unit	bar
Setup: System: Setup: Optimizer: Optimizer	On
Setup: System: Setup: Optimizer: Agent Usage	On
Setup: System: Setup:Optimizer: Cost/ml of Liquid Agent: Sev	$ 0.00
Setup: System: Setup:Optimizer: Cost/ml of Liquid Agent: Des	$ 0.00
Setup: System: Setup:Optimizer: Cost/ml of Liquid Agent: Iso	$ 0.00
Setup: System: Setup:Optimizer: Cost/ml of Liquid Agent: Hal	$ 0.00
Setup: System: Setup:Optimizer: Cost/ml of Liquid Agent: Enf	$ 0.00
Setup: System: Setup: History: Clear History	Off
Setup: System: Setup: Time/Date: 24 Hour Time	Off
Setup: System: Setup: Time/Date: Time Zone	UTC-05:00
Setup: System: Setup: Time/Date: Time	00(24h),12AM(12h)
Setup: System: Setup: Time/Date: Date Format	**YYYY-MM-DD**
Setup: System: Setup: Time/Date: Date	2009-1-1
Setup: System: Setup: Time/Date: DayLight Savings	Off
Setup: System: Setup: Time/Date: Begin: Which week of each month	First
Setup: System: Setup: Time/Date: Begin: Which day of each week	Sunday
Setup: System: Setup: Time/Date: Begin: Month	Apr
Setup: System: Setup: Time/Date: Begin: Time	2:00 AM
Setup: System: Setup: Time/Date: End: Which week of each month	Last
Setup: System: Setup: Time/Date: End: Which day of each week	Sunday

PARAMETERS	DEFAULT
Setup: System: Setup: Time/Date: End: Month	Oct
Setup: System: Setup: Time/Date: End: Time	3:00 AM
Setup：System：Setup：Flow Control：Quick Key 1：L/min	1
Setup：System：Setup：Flow Control：Quick Key 1：O2%	100
Setup：System：Setup：Flow Control：Quick Key 2：L/min	2
Setup：System：Setup：Flow Control：Quick Key 2：O2%	100
Setup：System：Setup：Flow Control：Quick Key 3：L/min	5
Setup：System：Setup：Flow Control：Quick Key 3：O2%	100
Setup：System：Setup：Flow Control：Quick Key 4：L/min	10
Setup：System：Setup：Flow Control：Quick Key 4：O2%	100
Setup：System：Setup：Flow Control：Total Flow	2.0 L/min
Setup: System: Setup: Internal Air Supply: Disable the "Internal Air Supply in Use" prompt	Off
Setup: System: Network: Network Type: Network Type	**LAN**
Setup: System: Network: Network Type: Shared Hotspot	Off
Setup: System: Network: Ethernet1: Obtain IP Address Automatically	Off
Setup: System: Network: Ethernet1: IP Address	192.168.23.250
Setup: System: Network: Ethernet1: Subnet Mask	255.255.255.0
Setup: System: Network: Ethernet1: Default Gateway	-
Setup: System: Network: Ethernet1: Obtain DNS Server Address Automatically	Off
Setup: System: Network: Ethernet1: Preferred DNS Server	-
Setup: System: Network: Ethernet1: Alternate DNS Server	-
Setup: System: Network: Ethernet1: Device Name	-
Setup: System: Network: Serial: Protocol	None
Setup: System: Network: Serial: Baud Rate	115200
Setup: System: Network: Serial: Data Bits	8
Setup: System: Network: Serial: Stop Bits	1
Setup: System: Network: Serial: Parity	None
Setup: System: Network: Serial: Data Interval	1 min
Setup: System: Network: Serial: HL7 Protocol Version	Most Recent (V1.0)
Setup: System: Network: Serial: Send Alarms	Off
Setup: System: Network: Serial: Send Alarm Ack	Off
Setup: System: Network:HL7: Data+Waveforms: Destination IP	192.168.23.200
Setup: System: Network:HL7: Data+Waveforms: Port	1550
Setup: System: Network:HL7: Data+Waveforms: Data Interval	Off
Setup: System: Network:HL7: Data+Waveforms: HL7 Protocol Version	Most Recent (V1.0)
Setup: System: Network:HL7: Data+Waveforms: Send Waveforms	Off
Setup: System: Network:HL7: Alarms: Destination IP	192.168.23.200
Setup: System: Network:HL7: Alarms: Port	1550
Setup: System: Network:HL7: Alarms: HL7 Protocol Version	Most Recent (V1.0)
Setup: System: Network:HL7: Alarms: Send Alarms	Off
Setup: System: Network:HL7: Alarms: Send Alarm Ack	Off
Setup: System: Network: MD2: Destination IP	192.168.23.99
Setup: System: Network: Device Discover: Multicast Address	225.0.0.8
Setup: System: Network: Device Discover: Multicast TTL	1
Setup: System: Network: 4G/5G: 4G/5G	Off
Setup: System: Network: 4G/5G: CMS Station	Off

PARAMETERS	DEFAULT
Setup: System: Network: SNTP: Interval	Off
Setup: System: Network: SNTP: Primary Server IP Address	132.163.4.103
Setup: System: Network: SNTP: Secondary Server IP Address	210.72.145.44
Setup: System: Network: ADT: ADT	Off
Setup: System: Network: ADT: Destination IP	192.168.23.99
Setup: System: Network: ADT: Port	3502

B.6 History

PARAMETERS	DEFAULT
List Trends: Show Interval	1 min
List Trends: Show Group	All
Graphic Trends: Zoom	5 min
Graphic Trends: Show Group	All
Event Log: Filter	High

B.7 Lung Recruitment

PARAMETERS	DEFAULT
Procedures: Multi-Step Recruitment: Procedures	Procedure 1
Procedures: One-Step Recruitment: Pressure Hold	Adult: 35 cmH_2O Pediatric: 20 cmH_2O
Procedures: One-Step Recruitment: Duration	15 sec
Procedures: One-Step Recruitment: Cycle Interval	Off

B.8 Fresh Gas Control

PARAMETERS	DEFAULT
Fresh Gas Control: Control Mode	Total Flow
Fresh Gas Control: Balance Gas	**Air**
Fresh Gas Control: Total Flow: Total Flow	2.0 L/min
Fresh Gas Control: Total Flow: O2%	100%
Fresh Gas Control: Direct Flow: O2	2.0 L/min
Fresh Gas Control: Direct Flow: Air	0.0 L/min
Fresh Gas Control: Direct Flow: N2O	0.0 L/min
Fresh Gas Control: Direct Flow: None	0.0 L/min

B.9 Patient Information

PARAMETERS	DEFAULT
Size	**Adult**
Gender	Unspecified
Height	—
IBW	—
Weight	—

PARAMETERS	DEFAULT
Age	—
Patient ID	—
Visit Number	—
First Name	—
Last Name	—
DOB	—
Bed	—
Room	—
Department	—
Facility	—

B.10 Ventilation Mode

ITEM	DEFAULT
Ventilation Mode Tab	VCV

PARAMETERS	VCV	SIMV-VC	PCV	PCV-VG	SIMV-PC	CPAP/PS	SIMV-VG	APRV	AMV	HFJV	MANUAL
Vt	Adult: 500 mL Pediatric: 120 mL Infant: 20 mL	Adult: 500 mL Pediatric: 120 mL Infant: 20 mL	—	Adult: 500 mL Pediatric: 120 mL Infant: 20 mL	—	—	Adult: 500 mL Pediatric: 120 mL Infant: 20 mL	—	—	—	—
RR	Adult: 12 bpm Pediatric: 15 bpm Infant: 20 bpm	Adult: 12 bpm Pediatric: 15 bpm Infant: 20 bpm	Adult: 12 bpm Pediatric: 15 bpm Infant: 20 bpm	Adult: 12 bpm Pediatric: 15 bpm Infant: 20 bpm	Adult: 12 bpm Pediatric: 15 bpm Infant: 20 bpm	—	Adult: 12 bpm Pediatric: 15 bpm Infant: 20 bpm	—	—	—	—
Min RR	—	—	—	—	—	Adult: 4 bpm Pediatric: 6 bpm Infant: 12 bpm	—	—	—	—	—
I:E	1:2	—	1:2	1:2	—	—	—	—	—	—	—
Tinsp	—	Adult: 2.0 s Pediatric: 1.0 s Infant: 1.0 s	—	—	Adult: 2.0 s Pediatric: 1.0 s Infant: 1.0 s	—	Adult: 2.0 s Pediatric: 1.0 s Infant: 1.0 s	—	—	—	—
Pinsp	—	—	Adult: 15 cmH_2O Pediatric: 10 cmH_2O Infant: 10 cmH_2O	—	Adult: 15 cmH_2O Pediatric: 10 cmH_2O Infant: 10 cmH_2O	—	—	—	—	—	—
ΔPinsp	—	—	Adult: 15 cmH_2O Pediatric: 10 cmH_2O Infant: 10 cmH_2O	—	Adult: 15 cmH_2O Pediatric: 10 cmH_2O Infant: 10 cmH_2O	—	—	—	—	—	—
Tpause	Off	Off	—	—	—	—	—	—	—	—	—

PARAMETERS	VCV	SIMV-VC	PCV	PCV-VG	SIMV-PC	CPAP/PS	SIMV-VG	APRV	AMV	HFJV	MANUAL
Plimit	Adult: 30 cmH_2O Pediatric: 30 cmH_2O Infant: 20 cmH_2O	Adult: 30 cmH_2O Pediatric: 30 cmH_2O Infant: 20 cmH_2O	—	Adult: 30 cmH_2O Pediatric: 30 cmH_2O Infant: 20 cmH_2O	—	—	Adult: 30 cmH_2O Pediatric: 30 cmH_2O Infant: 20 cmH_2O	—	—	—	—
PEEP	Off	Off	Off	Off	Off	Off	Off	—	Off	—	—
ΔPsupp	—	Adult: 15 cmH_2O Pediatric: 5 cmH_2O Infant: 5 cmH_2O	—	—	Adult: 15 cmH_2O Pediatric: 5 cmH_2O Infant: 5 cmH_2O	Adult: 15 cmH_2O Pediatric: 5 cmH_2O Infant: 5 cmH_2O	Adult: 15 cmH_2O Pediatric: 5 cmH_2O Infant: 5 cmH_2O	—	—	—	—
F-Trig	—	Adult: 3.0 L/min Pediatric: 2.0 L/min Infant: 2.0 L/min	—	—	Adult: 3.0 L/min Pediatric: 2.0 L/min Infant: 2.0 L/min	Adult: 3.0 L/min Pediatric: 2.0 L/min Infant: 2.0 L/min	Adult: 3.0 L/min Pediatric: 2.0 L/min Infant: 2.0 L/min	—	Adult: 3.0 L/min Pediatric: 2.0 L/min	—	—
Trig Window	—	25%	—	—	25%	—	25%	—	—	—	—
Tslope	—	0.2 s	0.2 s	0.2 s	0.2 s	0.2 s	0.2 s	0.2 s	0.2 s	—	—
Exp%	—	25%	—	—	25%	25%	25%	—	25%	—	—
ΔPapnea	—	—	—	—	—	Adult: 15 cmH_2O Pediatric: 10 cmH_2O Infant: 10 cmH_2O	—	—	—	—	—
Apnea I:E	—	—	—	—	—	1:2	—	—	—	—	—
Apnea Ti	—	—	—	—	—	Adult: 2.5 s Pediatric: 1.5 s Infant: 1.0 s	—	—	—	—	—
Phigh	—	—	—	—	—	—	—	15 cmH_2O	—	—	—
Plow	—	—	—	—	—	—	—	5 cmH_2O	—	—	—

PARAMETERS	VCV	SIMV-VC	PCV	PCV-VG	SIMV-PC	CPAP/PS	SIMV-VG	APRV	AMV	HFJV	MANUAL
Thigh	—	—	—	—	—	—	—	Adult: 2.5 s Pediatric: 1.3 s Infant: 1.0 s	—	—	—
Tlow	—	—	—	—	—	—	—	Adult: 5.0 s Pediatric: 2.7s Infant: 2.0 s	—	—	—
MV%	—	—	—	—	—	—	—	—	100 %	—	—
Alarms	—	—	—	—	—	—	—	—	—	—	On
CO2 Alarms	—	—	—	—	—	—	—	—	—	—	On
FiO2 Jet	—	—	—	—	—	—	—	—	—	80 %	—
HF	—	—	—	—	—	—	—	—	—	On	—
f (HFJV)	—	—	—	—	—	—	—	—	—	600 bpm	—
i:e (HFJV)	—	—	—	—	—	—	—	—	—	1:2	—
P HF	—	—	—	—	—	—	—	—	—	0.3 bar	—
NF	—	—	—	—	—	—	—	—	—	On	—
F (HFJV)	—	—	—	—	—	—	—	—	—	12 bpm	—
I:E (HFJV)	—	—	—	—	—	—	—	—	—	1:1	—
P NF	—	—	—	—	—	—	—	—	—	0.3 bar	—

B.11 Ventilation Linkage Parameters

The table below describes how ventilation mode changes impact parameter values. For example, when the ventilation mode changes, its parameter values may be shared by the other ventilation mode with the same parameters. When the ventilation mode changes, other parameters may have different values set.

CURRENT VENTILATION MODE & AFFECTED PARAMETERS		PREVIOUS VENTILATION MODE									
		VCV	**SIMV-VC**	**PCV**	**PCV-VG**	**SIMV-PC**	**CPAP/PS**	**SIMV-VG**	**APRV**	**AMV**	**HFJV**
VCV	**Vt**	—	*	Vti measurement or the closest approximation	*	#	#	*	#	#	#
	RR	—	*	*	*	*	#	*	#	#	#
	I:E	—	#	*	*	#	#	#	#	#	#
	Tpause	—	*	#	#	#	#	#	#	#	#
	PEEP	—	*	*	*	*	*	*	#	*	#
	Plimit	—	*	#	*	#	#	*	#	#	#
SIMV-VC	**Vt**	*	—	Vti measurement or the closest approximation	*	#	#	*	#	#	#
	RR	*	—	*	*	*	#	*	#	#	#
	Tinsp	#	—	#	#	*	#	*	#	#	#
	Tpause	*	—	#	#	#	#	#	#	#	#
	PEEP	*	—	*	*	*	*	*	#	*	#
	Plimit	*	—	#	*	#	#	*	#	#	#
	ΔPsupp	#	—	#	#	*	*	*	#	#	#
	F-Trig/P-Trig	#	—	#	#	*	*	*	#	*	#
	Exp%	#	—	#	#	*	*	*	#	*	#
	Trig Window	#	—	#	#	*	#	*	#	#	#
	Tslope	#	—	*	*	*	*	*	*	*	#

** In the event that the previous ventilation mode and the current one share some parameter values, the parameter setting remains unchanged.*

 # For the parameters that are not shared by the previous ventilation mode and the current one, the most recent settings of the parameters apply.

CURRENT VENTILATION MODE & AFFECTED PARAMETERS		PREVIOUS VENTILATION MODE									
		VCV	**SIMV-VC**	**PCV**	**PCV-VG**	**SIMV-PC**	**CPAP/PS**	**SIMV-VG**	**APRV**	**AMV**	**HFJV**
PCV	**Pinsp**	PLAT or 80% of PEAK or the closest approximation	#	—	PLAT or the closest approximation	*	#	#	#	#	#
	RR	*	*	—	*	*	#	*	#	#	#
	I:E	*	#	—	*	#	#	#	#	#	#
	Tslope	#	*	—	*	*	*	*	*	*	#
	PEEP	*	*	—	*	*	*	*	#	*	#
PCV-VG	**Vt**	*	*	Vti measurement or the closest approximation	—	#	#	*	#	#	#
	RR	*	*	*	—	*	#	*	#	#	#
	I:E	*	#	*	—	#	#	#	#	#	#
	Tslope	#	*	*	—	*	*	*	*	*	#
	PEEP	*	*	*	—	*	*	*	#	*	#
	Plimit	*	*	#	—	#	#	*	#	#	#
SIMV-PC	**Pinsp**	PLAT or 80% of PEAK or the closest approximation	#	*	PLAT or PEAK or the closest approximation	—	#	#	#	#	#
	RR	*	*	*	*	—	#	*	#	#	#
	Tinsp	#	*	#	#	—	#	*	#	#	#
	ΔPsupp	#	*	#	#	—	*	*	#	#	#
	F-Trig/P-Trig	#	*	#	#	—	*	*	#	*	#
	PEEP	*	*	*	*	—	*	*	#	*	#
	Exp%	#	*	#	#	—	*	*	#	*	#
	Trig Window	#	*	#	#	—	#	*	#	#	#
	Tslope	#	*	*	*	—	*	*	*	*	#

** In the event that the previous ventilation mode and the current one share some parameter values, the parameter setting remains unchanged.*

 # For the parameters that are not shared by the previous ventilation mode and the current one, the most recent settings of the parameters apply.

CURRENT VENTILATION MODE & AFFECTED PARAMETERS		PREVIOUS VENTILATION MODE									
		VCV	SIMV-VC	PCV	PCV-VG	SIMV-PC	CPAP/PS	SIMV-VG	APRV	AMV	HFJV
CPAP/PS	Min RR	#	#	#	#	#	—	#	#	#	#
	ΔPsupp	#	*	#	#	*	—	*	#	#	#
	F-Trig/P-Trig	#	*	#	#	*	—	*	#	*	#
	PEEP	*	*	*	*	*	—	*	#	*	#
	Exp%	#	*	#	#	*	—	*	#	*	#
	Apnea I:E or Apnea Ti	#	#	#	#	#	—	#	#	#	#
	ΔPapnea	#	#	#	#	#	—	#	#	#	#
	Tslope	#	*	*	*	*	—	*	*	*	#
SIMV-VG	RR	*	*	*	*	*	#	—	#	#	#
	Tinsp	#	*	#	#	*	#	—	#	#	#
	ΔPsupp	#	*	#	#	*	*	—	#	#	#
	F-Trig/P-Trig	#	*	#	#	*	*	—	#	*	#
	PEEP	*	*	*	*	*	*	—	#	*	#
	Exp%	#	*	#	#	*	*	—	#	*	#
	Trig Window	#	*	#	#	*	#	—	#	#	#
	Vt	*	*	Vt measurement or the closest approximation	*	#	#	—	#	#	#
	Plimit	*	*	#	*	#	#	—	#	#	#
	Tslope	#	*	*	*	*	*	—	*	*	#

** In the event that the previous ventilation mode and the current one share some parameter values, the parameter setting remains unchanged.*

 # For the parameters that are not shared by the previous ventilation mode and the current one, the most recent settings of the parameters apply.

CURRENT VENTILATION MODE & AFFECTED PARAMETERS		PREVIOUS VENTILATION MODE									
		VCV	SIMV-VC	PCV	PCV-VG	SIMV-PC	CPAP/PS	SIMV-VG	APRV	AMV	HFJV
APRV	Phigh	#	#	#	#	#	#	#	—	#	#
	Plow	#	#	#	#	#	#	#	—	#	#
	Thigh	#	#	#	#	#	#	#	—	#	#
	Tlow	#	#	#	#	#	#	#	—	#	#
	Tslope	#	*	*	*	*	*	*	—	*	#
AMV	MV%	#	#	#	#	#	#	#	#	—	#
	PEEP	*	*	*	*	*	*	*	#	—	#
	F-Trig/P-Trig	#	*	#	#	*	*	*	#	—	#
	Tslope	#	*	*	*	*	*	*	*	—	#
	Exp%	#	*	#	#	*	*	*	#	—	#
HFJV	FiO2 Jet	#	#	#	#	#	#	#	#	#	—
	HF	#	#	#	#	#	#	#	#	#	—
	f	#	#	#	#	#	#	#	#	#	—
	i:e	#	#	#	#	#	#	#	#	#	—
	P HF	#	#	#	#	#	#	#	#	#	—
	NF	#	#	#	#	#	#	#	#	#	—
	F	#	#	#	#	#	#	#	#	#	—
	I:E	#	#	#	#	#	#	#	#	#	—
	P NF	#	#	#	#	#	#	#	#	#	—

** In the event that the previous ventilation mode and the current one share some parameter values, the parameter setting remains unchanged.*

 # For the parameters that are not shared by the previous ventilation mode and the current one, the most recent settings of the parameters apply.

B.12 Constraints Among Ventilation Parameters

VENTILATION MODES	PARAMETERS	PARAMETER RELATION FORMULA
VCV	RR	$Tinsp = \frac{60}{RR} \times \frac{I:E}{1+I:E} \geq 0.2$ $Texp = \frac{60}{RR} - Tinsp \geq 0.4$ 2 ⩽ RR ⩽ 100
	Vt	$\frac{Vt * RR}{1000} \leq 60$ 10 ⩽ Vt ⩽ 1500 Only applicable to anesthesia system without blower: $10 \leq \frac{Vt}{Tinsp(1-TP)} \leq 3000$ Only applicable to anesthesia system configured with blower: $10 \leq \frac{Vt}{Tinsp(1-TP)} \leq 1666$
	Plimit	Plimit ⩾ PEEP+5
SIMV-VC	RR	$Texp = \frac{60}{RR} - Tinsp \geq 0.4$ 2 ⩽ RR ⩽ 100
	Vt	$\frac{Vt * RR}{1000} \leq 60$ 10 ⩽ Vt ⩽ 1500 Only applicable to anesthesia system without blower: $10 \leq \frac{Vt}{Tinsp(1-TP)} \leq 3000$ Only applicable to anesthesia system configured with blower: $10 \leq \frac{Vt}{Tinsp(1-TP)} \leq 1666$
	ΔPsupp (from VCV, PCV-VG)	ΔPsupp ⩽ Plimit-PEEP 3 ⩽ ΔPsupp ⩽ 60
	Plimit	Plimit ⩾ PEEP+5 Plimit ⩾ ΔPsupp+PEEP

VENTILATION MODES	PARAMETERS	PARAMETER RELATION FORMULA
PCV	RR	$Tinsp = \frac{60}{RR} \times \frac{I:E}{1+I:E} \geq 0.2$ $Texp = \frac{60}{RR} - Tinsp \geq 0.4$ 2 ⩽ RR ⩽ 100
	Pinsp	If Pinsp is configured: Pinsp ⩾ PEEP+3 3 ⩽ Pinsp ⩽ 80 If ΔPinsp is configured: ΔPinsp ⩽ 80 - PEEP 3 ⩽ ΔPinsp ⩽ 80
PCV-VG	RR	$Tinsp = \frac{60}{RR} \times \frac{I:E}{1+I:E} \geq 0.2$ $Texp = \frac{60}{RR} - Tinsp \geq 0.4$ $\frac{Vt * RR}{1000} \leq 60$ 2 ⩽ RR ⩽ 100
	Plimit	Plimit ⩾ PEEP+5
SIMV-PC	RR	$Texp = \frac{60}{RR} - Tinsp \geq 0.4$ 2 ⩽ RR ⩽ 100
	ΔPsupp	3 ⩽ ΔPsupp ⩽ 60
	Pinsp	If Pinsp is configured: Pinsp ⩾ PEEP+3 3 ⩽ Pinsp ⩽ 80 If ΔPinsp is configured: ΔPinsp ⩽ 80 - PEEP 3 ⩽ ΔPinsp ⩽ 80
SIMV-VG	RR	$Texp = \frac{60}{RR} - Tinsp \geq 0.4$ $\frac{Vt * RR}{1000} \leq 60$ 2 ⩽ RR ⩽ 100
	ΔPsupp (from VCV, PCV-VG)	ΔPsupp ⩽ Plimit-PEEP 3 ⩽ ΔPsupp ⩽ 60
	Plimit	Plimit ⩾ PEEP+5 Plimit ⩾ ΔPsupp+PEEP
CPAP/PS	ΔPsupp	3 ⩽ ΔPsupp ⩽ 60 ΔPsupp ⩽ 80-PEEP
	ΔPapnea	3 ⩽ ΔPapnea ⩽ 60 ΔPapnea ⩽ 80-PEEP

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C.0

Theory of Operation

C.1 Pneumatic Diagram

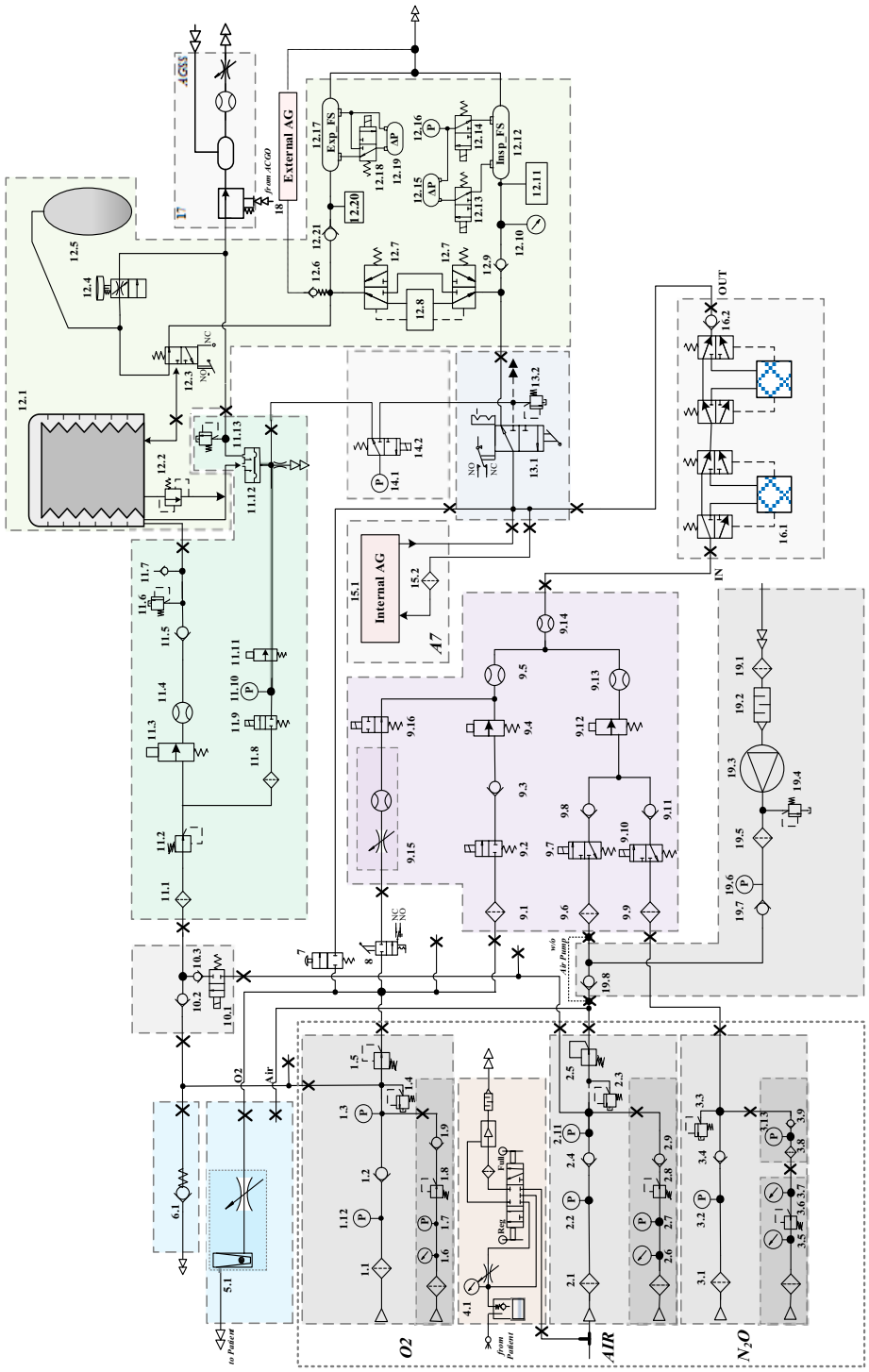

FIGURE C-1 Pneumatic Diagram

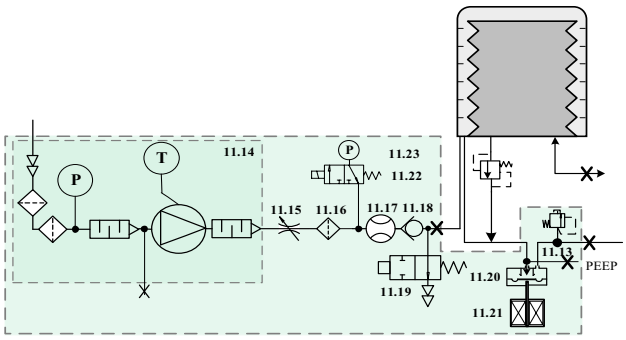

FIGURE C-2 Pneumatic Diagram of the Drive Gas (Only Applicable to Anesthesia System Configured with Blower)

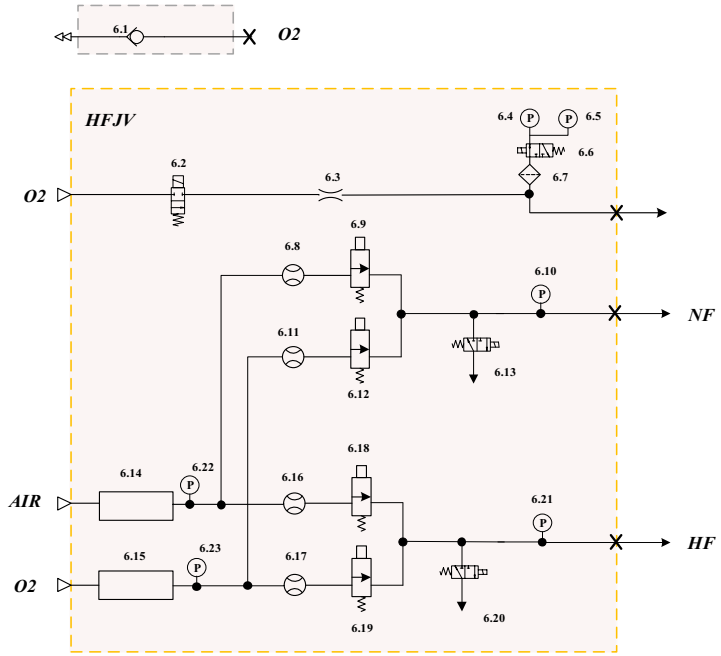

FIGURE C-3 Pneumatic Diagram of the HFJV Module

NO.	DESCRIPTION	NO.	DESCRIPTION	NO.	DESCRIPTION
1.1	Gas supply inlet filter	6.15	Drive pressure adjusting device	11.17	Flow sensor
1.2	Check valve	6.16	Flow sensor	11.18	Check valve
1.3	Electronic pressure sensor	6.17	Flow sensor	11.19	Normally opened valve
1.4	Pressure-relief valve	6.18	Proportional valve	11.2	Expiratory valve
1.5	Pressure regulator	6.19	Proportional valve	11.21	Voice coil motor

1.6	Cylinder pressure gauge	6.2	Normally opened valve	11.22	2/3 switch-over valve
1.7	Electronic pressure sensor	6.21	Pressure sensor	11.23	Pressure sensor
1.8	Gas cylinder pressure regulator	6.22	Pressure sensor	12.1	Bellows assembly
1.9	Check valve	6.23	Pressure sensor	12.2	Pop off valve
1.12	Electronic pressure sensor	7	O_2 flush	12.3	Manual/auto switch
2.1	Gas supply inlet filter	8	System switch	12.4	APL valve
2.2	Electronic pressure sensor	9.1	Filter	12.5	Manual bag
2.3	Pressure relief valve	9.2	Normally closed valve	12.6	Sample gas recirculation connector
2.4	Check valve	9.3	Check valve	12.7	Bypass assembly
2.5	Pressure regulator	9.4	Proportional valve	12.8	CO_2 absorbent canister
2.6	Cylinder pressure gauge	9.5	Flow sensor	12.9	Check valve
2.7	Electronic pressure sensor	9.6	Filter	12.1	Airway pressure gauge
2.8	Gas cylinder pressure regulator	9.7	2/3 switch-over valve	12.11	O_2 cell
2.9	Check valve	9.8	Check valve	12.12	Inspiratory flow sensor
2.11	Electronic pressure sensor	9.9	Filter	12.13	2/3 switch-over valve
3.1	Gas supply inlet filter	9.1	2/3 switch-over valve	12.14	2/3 switch-over valve
3.2	Electronic pressure sensor	9.11	Check valve	12.15	Differential pressure sensor
3.3	Pressure relief valve	9.12	Proportional valve	12.16	Airway pressure sensor
3.4	Check valve	9.13	Flow sensor	12.17	Expiratory flow sensor
3.5	Gas cylinder high pressure gauge	9.14	Flow sensor	12.18	2/3 switch-over valve
3.6	Gas cylinder pressure regulator	9.15	Backup flowmeter	12.19	Differential pressure sensor
3.7	Gas cylinder low pressure gauge	9.16	Normally opened valve	12.2	Watertrap
3.8	Gas supply inlet filter	10.1	Normally closed valve	12.21	Check valve
3.9	Check valve	10.2	Check valve	13.1	ACGO Assembly
3.13	Pressure sensor	10.3	Check valve	13.2	Pressure relief valve
4.1	Negative pressure suction device (Venturi)	11.1	Filter	14.1	Pressure sensor
5.1	Auxiliary O2 output	11.2	Pressure regulator	14.2	2/3 switch-over valve

6.1	High-pressure O_2 output	11.3	Proportional valve	15.1	Internal AG module
6.2	Normally closed valve	11.4	Flow sensor	15.2	Filter
6.3	Vapor lock	11.5	Check valve	16.1	Vaporizer
6.4	Pressure sensor	11.6	Pressure relief valve	16.2	Check valve
6.5	Pressure sensor	11.7	Check valve	17	AGSS
6.6	2/3 switch-over valve	11.8	Filter	18	External AG module
6.7	Filter	11.9	Normally closed valve	19.1	Filter
6.8	Flow sensor	11.1	Electronic pressure sensor	19.2	Muffler
6.9	Proportional valve	11.11	Proportional valve	19.3	Air pump
6.1	Pressure sensor	11.12	Expiratory valve	19.4	Pressure relief valve
6.11	Flow sensor	11.13	Pressure relief valve	19.5	Filter
6.12	Proportional valve	11.14	Blower box	19.6	Electronic pressure sensor
6.13	Normally opened valve	11.15	Large-diameter suction valve	19.7	Check valve
6.14	Drive pressure adjusting device	11.16	Filter	19.8	Check valve

TABLE C-1 Parts List

The pneumatic system of the anesthesia system is composed of six parts: the anesthetic gas delivery system, the anesthetic gas delivery equipment (vaporizer), the anesthetic System, the breathing system, the negative pressure suction system, and the Anesthetic Gas Scavenging System (AGSS).

The pneumatic circuit of the anesthetic gas delivery system is used to generate the mixed agent (fresh gas), with O_2, N_2O and Air as the input and the mixed agent (that is, fresh gas), the auxiliary O_2 supply gas, and the O_2 flush gas among others as the output.

The anesthetic gas delivery equipment (mechanical vaporizer) supplies concentration-controlled anesthetic gas vapor, for temperature compensation, flow compensation and pressure compensation purposes.

The pneumatic circuit of the anesthetic ventilator serves to drive the respiration process of patients.

The breathing system provides a closed loop for the anesthetic gas. The CO_2 in the patient's exhaled gas is absorbed in the inspiration phase, so that the exhaled gas can be recycled for inhalation to ensure the temperature, humidity and other conditions of the gas. The breathing system has two modes available: the manual ventilation and the automatic ventilation, controlled by the manual/auto ventilation switch. Meanwhile, the system also outputs corresponding electrical signals to update the Control Board on its own status.

The Anesthetic Gas Scavenging System (AGSS) is composed of the AGSS delivery system, the AGSS absorption system and the AGSS disposal system, with the waste gas discharged from the anesthesia system outlet as the input. Its output is channeled to the facility's disposal system (AGSS disposal system).

C.2 Electric System Structure

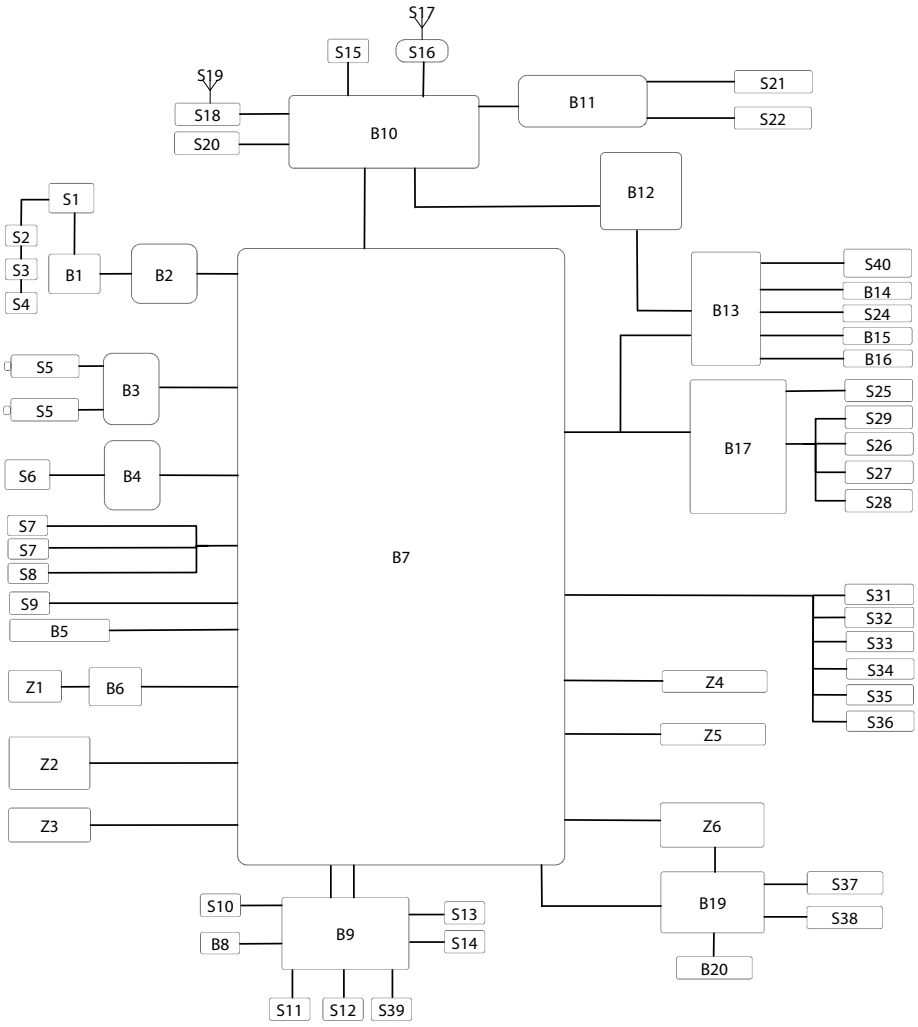

FIGURE C-4 Electric System Structure

NO.	DESCRIPTION	NO.	DESCRIPTION
S1	AC input socket	B1	AC- DC power board
S2	Main auxiliary output circuit breaker	B2	DC-DC power board
S3	Single-circuit auxiliary output circuit breaker	B3	Battery adapter
S4	Auxiliary outlet	B4	Sensor adapter board
S5	Battery	B5	Power indicator board

S6	Zeroing three-way valve	B6	Module rack backplane
S7	Pipeline pressure sensor	B7	Monitoring board
S8	Cylinder pressure sensor	B8	Negative pressure sensor board (only applicable to anesthesia system configured with blower)
S9	System switch	B9	Turbine board (only applicable to anesthesia system configured with blower)
S10	turbine (only applicable to anesthesia system configured with blower)	B10	Control board
S11	Inspiratory voice coil motor (only applicable to anesthesia system configured with blower)	B11	Key lighting board
S12	Expiratory voice coil motor (only applicable to anesthesia system configured with blower)	B12	External I/O interface board
S13	Electromagnet (only applicable to anesthesia system configured with blower)	B13	Small screen control board
S14	Flow sensor (only applicable to anesthesia system configured with blower)	B14	Flowmeter backlight board
S15	Display assembly	B15	Hall switch board
S16	4G/5G module	B16	Auxiliary flowmeter backlight board
S17	4G/5G antenna	B17	EFCS monitoring board
S18	Wi-Fi Module	Z1	Gas module
S19	Wi-Fi antenna	Z2	HFJV Module
S20	Speaker	Z3	Internal air supply assembly
S21	Flowmeter encoder	S31	O_2 sensor
S22	Master encoder	S32	Circuit switch
S24	Electromagnet	S33	CO2 absorbent canister switch
S25	Flow sensor	S34	ACGO switch
S26	Normally closed valve	S35	Warmer
S27	Normally open valve	B19	Auxiliary O_2/air adapter board
S28	Three-way valve	Z4	Pneumatic block assembly (only applicable to anesthesia system without blower)
S29	Proportional valve	Z5	Internal AG module
S36	Manual/auto switch	Z6	Auxiliary O2/air flowmeter assembly/ HFNC assembly
S37	Encoder	B20	Key control board
S38	Segment display	S40	Status display
S39	Turbine fan (only applicable to anesthesia system configured with blower)	/	/

TABLE C-2 Parts List

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D.0

Abbreviations, Symbols, and Units of Measure

D.1 Abbreviations

ABBREVIATIONS	DESCRIPTION
AA	Anesthetic agent
ACGO	Auxiliary common gas outlet
AG	Anesthetic gas
AGSS	Anesthetic gas scavenging system
Alpha	Power/total power of Alpha waveband
AMV	Adaptive minute ventilation
APL	Airway pressure limit
Apnea I:E	Ratio of inspiratory time to expiratory time of apnea
APRV	Airway pressure release ventilation
ASYM	Asymmetry
awRR	Airway respiration rate
BC	Burst count
Beta	Power/total power of Beta waveband
BIS	Bispectral index
BSR	Burst suppression rate
BTPS	Body temperature and pressure, saturated
CO_2	Carbon dioxide
Compl	Compliance
CPAP/PS	Continuous positive airway pressure/pressure support ventilation
Bypass	Cardiopulmonary bypass
DBS	Double burst stimulation
Delta	Power/total power of Delta waveband
Des	Desflurane
E	Elastance
EMG	Muscle activity and high frequency artifacts
eMAC	Total effect of the anesthetic drugs
Enf	Enflurane
Exp%	Expiration trigger level
FiO_2	Fraction of inspired oxygen
Flow	Flow
F-Trig	Flow trigger level
Hal	Halothane
HFJV	High frequency jet ventilation
HFNC	High-flow nasal cannula
IBW	Ideal body weight
I:E	Ratio of inspiratory time to expiratory time
Iso	Isoflurane
IntelliCycle	IntelliCycle
MAC	Minimum alveolar concentration
MEAN	Mean pressure
MF	Median frequency
Min RR	Minimum respiratory rate

ABBREVIATIONS	DESCRIPTION
MV	Minute volume
MV%	Percentage of minute ventilation
MVe	Expiratory minute ventilation
MVi	Inspiratory minute ventilation
MVleak	Minute leakage
N2O	Nitrous oxide
NMT	Neuromuscular transmission
O2	Oxygen
Pinsp	Pressure control level of inspiration
Plimit	Pressure limit level
Paw	Airway pressure
PCV	Pressure controlled ventilation
PCV-VG	Pressure controlled ventilation-volume guarantee
Pdrive	Drive pressure
PEAK	Peak pressure
PEEP	Positive end-expiratory pressure
PEEPi	Intrinsic PEEP
PEEPtot	Total positive end-expiratory pressure
Phigh	High pressure level
PLAT	Plateau pressure
Plow	Ligh pressure level
PPF	Peak power frequency
ΔPapnea	Apnea pressure
ΔPsupp	Pressure support level
PTC	Post tetanic counting
P-Trig	Pressure trigger level
Raw	Resistance
RR	Respiratory rate
SEF	Spectral edge frequency
Sev	Sevoflurane
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
SR	Suppression ratio
ST	Single twitch
T1	Response value to the first stimulation
T1%	T1 to reference value ratio
Theta	Power/total power of Theta waveband
Thigh	High pressure time
Tinsp	Time of inspiration
Tlow	Low pressure time
TOF	Train-of-four

ABBREVIATIONS	DESCRIPTION
TOL	Tolerance of Laryngoscopy
TOSS	Tolerance of Shake and Shout
TP	Total power
Tpause	Percentage of inspiratory pause time
Tslope	Rise time
Trig Window	Trigger window
VCV	Volume control ventilation
ΔVt	Difference between inspiratory tidal volume and expiratory tidal volume
Vt	Tidal volume
Vte	Expiratory tidal volume
Vti	Inspiratory tidal volume

D.2 Symbols

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
-	minus, negative	>	greater than
%	percent	≤	less than or equal to
/	per, divide, or	≥	greater than or equal to
≈	approximately	±	plus or minus
^	power, involution	×	multiply
+	plus, positive	©	copyright
=	equal to	™	trademark
<	less than	®	registered trademark

D.3 Units of Measure

UNITS OF MEASURE	DESCRIPTION	UNITS OF MEASURE	DESCRIPTION
A	Ampere, Amp	m	meter
Ah	Amp hour	mAh	milliampere hour
bpm	breath per minute	mbar	millibar
°C	degree Celsius	mg	milligram
cc	cubic centimeter	min	minute
cm	centimeter	ml, mL	milliliter
cmH_2O	centimeter of water	mm	millimeter
dB	decibel	mmHg	millimeter of mercury
°F	Fahrenheit	ms	millisecond
g	gram	mV	milliVolt
hr	hour	mW	milliWatt
Hz	Hertz	ppm	part per million
hPa	hectoPascal	s, sec	second

UNITS OF MEASURE	DESCRIPTION	UNITS OF MEASURE	DESCRIPTION
inch	inch	V	Volt
k	kilo	VA	Volt Amp
kg	kilogram	VAC	Volts alternating current
kPa	kiloPascal	Ω	Ohm
psi	pound-force per square inch	µA	microAmp
L, l	liter	µV	microVolt
lb	pound	W	Watt
nm	nanometer		

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E.0

Electromagnetic Compatibility

E.1 EMC

A7 anesthesia system complies with the EMC standard IEC 60601-1-2:2020.

WARNING: The use of unapproved accessories may diminish system performance.

WARNING: Use of components, accessories, probes, and cables other than those specified may result in increased emission or decreased immunity of system.

WARNING: A7 anesthesia system needs special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided below.

WARNING: Use of A7 anesthesia system adjacent to or stacked with other equipment should be avoided because it could result in improper operation. If such use is necessary, A7 anesthesia system and the other equipment should be observed to verify that they are operating normally.

WARNING: Use of accessories, transducers and cables other than those specified or provided by the manufacturer of A7 anesthesia system could result in increased electromagnetic emissions or decreased electromagnetic immunity of A7 anesthesia system and result in improper operation.

WARNING: Portable RF communications equipment (including peripherals such as antenna cables and external antennas) should be used no closer than 30 cm (12 inches) to any part of A7 anesthesia system , including cables specified by the manufacturer. Otherwise, degradation of the performance of A7 anesthesia system could result.

WARNING: Other devices may interfere with A7 anesthesia system even though they meet the requirements of CISPR.

WARNING: When the input signal is below the minimum amplitude provided in technical specifications, erroneous measurements could result.

WARNING: Use of portable or mobile communications devices can degrade the performance of the equipment.

WARNING: A7 anesthesia system is not intended for use in residential environments and can possibly not provide adequate protection to radio reception in such environments.

If A7 anesthesia system is operated within the electromagnetic environment listed in TABLE E-2, TABLE E-3, TABLE E-4 and TABLE E-5, A7 anesthesia system will remain safe and will provide the following basic performances: tidal volume monitoring accuracy, CO_2 monitoring accuracy, O_2 monitoring accuracy, airway pressure monitoring accuracy, anesthetic gas monitoring accuracy and PEEP monitoring accuracy.

GUIDANCE AND DECLARATION - ELECTROMAGNETIC EMISSIONS

A7 anesthesia system is intended for use in the electromagnetic environment specified below. The customer or the user of A7 anesthesia system should assure that it is used in such an environment.

EMISSIONS TEST	COMPLIANCE	ELECTROMAGNETIC ENVIRONMENT-GUIDANCE
RF emissions CISPR 11	Group 1	A7 anesthesia system uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class A	A7 anesthesia system is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

TABLE E-1

GUIDANCE AND MINDRAY DECLARATION—ELECTROMAGNETIC IMMUNITY

A7 anesthesia system is intended for use in the electromagnetic environment specified below. The customer or the user of A7 anesthesia system should assure that it is used in such an environment.

IMMUNITY TEST	IEC 60601 TEST LEVEL	COMPLIANCE LEVEL	ELECTROMAGNETIC ENVIROMENT – GUIDANCE
Electrostatic Discharge (ESD) IEC 61000-4-2	±8 kV contact; ±2 kV, ±4 kV, ±8 kV, ±15 kV air	±8 kV contact; ±2 kV, ±4 kV, ±8 kV, ±15 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast Transient / burst IEC 61000-4-4	±2 kV for power supply lines; ±1 kV for input/ output lines	±2 kV for power supply lines; ±1 kV for input/ output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±0,5 kV, ±1 kV line(s) to line(s); ±0,5 kV, ±1 kV, ±2 kV line(s) to earth	±0,5 kV, ±1 kV line(s) to line(s); ±0,5 kV, ±1 kV, ±2 kV line(s) to earth	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variation on power supply input voltage IEC 61000-4-11	0% U_T; 0.5 cycle At 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315° 0% U_T; 1 cycle 70% U_T for 25/30 cycle at 0° 0% U_T; 250/300 cycle	0% U_T; 0.5 cycle At 0°, 45°, 90°, 135°, 180°, 225°, 270° and 315° 0% U_T; 1 cycle 70% U_T for 25/30 cycle at 0° 0% U_T; 250/300 cycle	Mains power quality should be that of a typical commercial or hospital environment. If you require continued operation during power mains interruptions, it is recommended that our product be powered from an uninterruptible power supply or a battery.

TABLE E-2

Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	30 A/m	30 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.

NOTE: **U_T is the A.C. mains voltage prior to application of the test level.**

TABLE E-2

GUIDANCE AND MINDRAY DECLARATION—ELECTROMAGNETIC IMMUNITY

A7 anesthesia system is intended for use in the electromagnetic environment specified below. The customer or the user of A7 anesthesia system should assure that it is used in such an environment.

IMMUNITY TEST	IEC 60601 TEST LEVEL	COMPLIANCE LEVEL	ELECTROMAGNETIC ENVIROMENT – GUIDANCE
Conduced RF IEC 61000-4-6	3 Vrms 0,15 MHz to 80 MHz 6 Vrms in ISM bands[a] between 0,15 MHz and 80 MHz	3 Vrms 0,15 MHz to 80 MHz 6 Vrms in ISM bands[a] between 0,15 MHz and 80 MHz	Portable and mobile RF communications equipment should be used no closer to any part of A7 anesthesia system, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. Recommended separation distance: $d = 1.2\times\sqrt{P}$ $d = 2\times\sqrt{P}$
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2.7 GHz	3 V/m 80 MHz to 2.7 GHz	$d = 1.2\times\sqrt{P}$ 80 MHz to 800 MHz $d = 2.3\times\sqrt{P}$ 800 MHz to 2.7 GHz Where, P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey[b], should be less than the compliance level in each frequency range[c]. Interference may occur in the vicinity of equipment marked with the following symbol: 

TABLE E-3

NOTE: **At 80 MHz and 800 MHz, the higher frequency range applies.**

NOTE: **These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.**

[a] The ISM (industrial, scientific, and medical) bands between 150 kHz and 80 MHz are 6,765 MHz to 6,795 MHz; 13,553 MHz to 13,567 MHz; 26,957 MHz to 27,283 MHz; and 40,66 MHz to 40,70 MHz. The amateur radio bands between 0,15 MHz and 80 MHz are 1,8 MHz to 2,0 MHz, 3,5 MHz to 4,0 MHz, 5,3 MHz to 5,4 MHz, 7 MHz to 7,3 MHz, 10,1 MHz to 10,15 MHz, 14 MHz to 14,2 MHz, 18,07 MHz to 18,17 MHz, 21,0 MHz to 21,4 MHz, 24,89 MHz to 24,99 MHz, 28,0 MHz to 29,7 MHz and 50,0 MHz to 54,0 MHz.

[b] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the device is used exceeds the applicable RF compliance level above, the device should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the device.

[c] Over the frequency ranges 150 kHz to 80 MHz, field strengths should be less than 3V/m.

TABLE E-3

GUIDANCE AND MINDRAY DECLARATION—ELECTROMAGNETIC IMMUNITY

A7 anesthesia system is intended for use in the electromagnetic environment specified below. The customer or the user of A7 anesthesia system should assure that it is used in such an environment.

IMMUNITY TEST	IEC 60601 TEST LEVEL	COMPLIANCE LEVEL	ELECTROMAGNETIC ENVIROMENT – GUIDANCE
Proximity magnetic fields IEC 61000-4-39	65 A/m 134,2 kHz Pulse modulation 2,1 kHz	65 A/m 134,2 kHz Pulse modulation 2,1 kHz	/
	7,5 A/m 13,56 MHz Pulse modulation 50 kHz	7,5 A/m 13,56 MHz Pulse modulation 50 kHz	

TABLE E-4

RECOMMENDED SEPARATION DISTANCES BETWEEN PORTABLE AND MOBILE RF COMMUNICATIONS EQUIPMENT AND A7 ANESTHESIA SYSTEM

A7 anesthesia system is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of A7 anesthesia system can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the A7 anesthesia system as recommended below, according to the maximum output power of the communications equipment. Portable and mobile radio communications equipment (e.g. two-way radio, cellular/ cordless telephones and similar equipment) should be used no closer to any part of this system, including cables, than determined according to the following method:

TEST FREQUENCY (MHZ)	BAND (MHZ)	SERVICE	MODULATION	MAXIMUM POWER (W)	DISTANCE (M)	IMMUNITY TEST LEVEL (V/M)

TABLE E-5

385	380 - 390	TETRA 400	Pulse modulation 18 Hz	1.8	0.3	27
450	430 -470	GMRS 460 FRS 460	FM ±5 kHz deviation 1 kHz sine	2	0.3	28
710	704 - 787	LTE Band 13,17	Pulse modulation 217 Hz	0.2	0.3	9
745						
780						
810	800 - 960	GSM 800/ 900, tetra 800, iDEN 820, CDMA 850, LTE Band 5	Pulse modulation 18 Hz	2	0.3	28
870						
930						
1720	1700 - 1990	GSM 1800, CDMA 1900, GSM 1900, DECT, LTE Band 1, 3,4,25,UMTS	Pulse modulation 217 Hz	2	0.3	28
1845						
1970						
2450	2400 - 2570	Bluetooth, WLAN, 802.11 b/g/ n, RFID 2450, LTE Band 7	Pulse modulation 217 Hz	2	0.3	28
5240	5100 - 5800	WLAN, 802.11 a/n	Pulse modulation 217 Hz	0.2	0.3	9
5500						
5785						

TABLE E-5

RECOMMENDED SEPARATION DISTANCES BETWEEN PORTABLE AND MOBILE RF COMMUNICATION DEVICE AND A7 ANESTHESIA SYSTEM

A7 anesthesia system is intended for use in an electromagnetic environment in which radiated RF disturbance are controlled. The customer or the user of A7 anesthesia system can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communication equipment (transmitters) and system as recommended below, according to the maximum output power of the communication equipment.

TABLE E-6

Rated Maximum Output power of Transmitter (W)	**Separation Distance According to Frequency of Transmitter**			
	150 kHz to 80 MHz Out ISM bands $d=1.2\sqrt{P}$	150 kHz to 80 MHz in ISM bands $d=2\sqrt{P}$	80 MHz to 800 MHz $d=1.2\sqrt{P}$	800 MHz to 2.7 GHz $d=2.3\sqrt{P}$
0.01	0.12	0.20	0.12	0.23
0.1	0.38	0.64	0.38	0.73
1	1.2	2.0	1.2	2.3
10	3.8	6.4	3.8	7.3
100	12	20	12	23

For transmitters at a maximum output power not listed above, the recommended separation distanced in meters (m) can be determined using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE: At 80 MHz and 800 MHz, the higher frequency range applies.

NOTE: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

TABLE E-6

NO.	NAME	CABLE LENGTH(m)	SHIELD OR NOT	REMARKS
1	Anesthesia System Power input	5.0	Not shield	/
2	V80 Power input	3.0	Not shield	/
3	BIS cable	1.3	Shield	/
4	BIS cable	2.7	Shield	/
5	NM13101 cable	2.9	Shield	/
6	NM13401 cable	0.4	Shield	/
7	NM13701 cable	0.3	Shield	/
8	Mainstream CO_2 module cable	2.9	Shield	/

TABLE E-7

E.2 Radio Regulatory Compliance

ITEM	DESCRIPTION
Wi-Fi	IEEE 802.11 a/b/g/n/ac
Operating frequency	2412 MHz to 2472 MHz, 5180 MHz to 5320 Mz, 5500 MHz to 5700 MHz, 5745 MHz to 5825 MHz
Modulation mode	BPSK, QPSK, 16QAM, 64QAM, 256QAM
Output power (dBm)	<20 dBm (CE requirements, detection mode: RMS) <30 dBm (FCC requirements, detection mode: peak power)

TABLE E-8

ITEM	DESCRIPTION
4G	GSM/TD-SCDMA/WCDMA/cdma200/TED-LTE/LTE FDD
Operating frequency	GSM 900: 880 to 915 MHz 925 to 960 MHz GSM 1800: 1710 to 1785 MHz 1805 to 1880 MHz WCDMA Band I: 1920 to 1980 MHz 2110 to 2170 MHz WCDMA Band : 880 to 915 MHz 925 to 960 MHz LTE FDD Band 1: 1920 to 1980 MHz 2110 to 2170 MHz LTE FDD Band 3: 1710 to 1785 MHz 1805 to 1880 MHz LTE FDD Band 7: 2500 to 2570 MHz 2620 to to 2690 MHz LTE FDD Band 8: 880 to 915 MHz 925 to 960 MHz LTE FDD Band 20: 832 to 862 MHz 791 to 821 MHz LTE FDD Band 28A: 703 to 733 MHz 758 to 788 MHz LTE FDD Band 38: 2570 to 2620 MHz LTE FDD Band 40: 2300 to 2400 MHz
Modulation mode	GMSK/8PSK/0QPSK QPSK/16QAM
Output power (dBm)	33/30dBm±2dB ⩽ 24 dB +1dB 23dBm±2.7dB ⩽ 30 dB

TABLE E-9

ITEM	DESCRIPTION
Operating frequency	WCDMA/TD-LTE/LTE FDD/5G NR

TABLE E-10

Modulation mode	UMTS 900 MHz Band VIII: 880 MHz to 915 MHz; 925 MHz to 960 MHz UMTS 1800 MHz Band III: 1710 MHz to 1785 MHz; 1805 MHz to 1880 MHz UMTS 2100 MHz Band I: 1920 MHz to 1980 MHz; 2110 MHz to 2170 MHz E-UTRA LTE Band 1 (UL CA_1C): 1920 MHz to 1980 MHz; 2110 MHz to 2170 MHz E-UTRA LTE Band 3 (UL CA_3C): 1710 MHz to 1785 MHz; 1805 MHz to 1880 MHz E-UTRA LTE Band 7 (UL CA_7C): 2500 MHz to 2570 MHz; 2620 MHz to 2690 MHz E-UTRA LTE Band 8: 880 MHz to 915 MHz; 925 MHz to 960 MHz E-UTRA LTE Band 20: 832 MHz to 862 MHz; 791 MHz to 821 MHz E-UTRA LTE Band 28: 703 MHz to 748 MHz; 758 MHz to 803 MHz E-UTRA LTE Band 32 (DL CA-only): 1452 MHz to 1496 MHz E-UTRA LTE Band 34: 2010 MHz to 2025 MHz; 2010 MHz to 2025 MHz E-UTRA LTE Band 38: 2570 MHz to 2620 MHz; 2570 MHz to 2620 MHz E-UTRA LTE Band 40 (UL CA_40C): 2300 MHz to 2400 MHz; 2300 MHz to 2400 MHz E-UTRA LTE Band 42 (UL CA_42C): 3400 MHz to 3600 MHz; 3400 MHz to 3600 MHz E-UTRA LTE Band 43: 3600 MHz to 3800 MHz; 3600 MHz to 3800 MHz E-UTRA LTE Band 46 (DL CA-only): 5150 MHz to 5925 MHz 5G NR _n1 (SA): 1920 MHz to 1980 MHz; 2110 MHz to 2170 MHz 5G NR _n3 (SA): 1710 MHz to 1785 MHz; 1805 MHz to 1880 MHz 5G NR _n7 (SA): 2500 MHz to 2570 MHz; 2620 MHz to 2690 MHz 5G NR _n8 (SA): 880 MHz to 915 MHz; 925 MHz to 960 MHz 5G NR _n20 (SA): 832 MHz to 862 MHz; 791 MHz to 821 MHz 5G NR _n28 (SA): 703 MHz to 748 MHz; 758 MHz to 803 MHz 5G NR _n38 (SA): 2570 MHz to 2620 MHz; 2570 MHz to 2620 MHz 5G NR _n40 (SA): 2300 MHz to 2400 MHz; 2300 MHz to 2400 MHz 5G NR n41 (SA, NSA): 2496 MHz to 2690 MHz; 2496 MHz to 2690 MHz 5G NR_n77 (SA, NSA): 3300 MHz to 4200 MHz; 3300 MHz to 4200 MHz 5G NR n78 (SA, NSA): 3300 MHz to 3800 MHz; 3300 MHz to 3800 MHz
Output power (dBm)	BPSK QPSK/16QAM BPSK/QPSK/16QPSK/64QAM/256QAM
Operating frequency	24dBm+1.7/-3.7dB 23dBm±2.7dB 26dBm±2.7dB 26.0dBm+3/-4dB 23.0dBm+2/-2.5dB

TABLE E-10

NOTE: Keep a distance of at least 20cm away from the monitor when Wi-Fi function is in use.

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F.0

Software Instructions

This product uses the following off-the-shelf software. During product development, Mindray will evaluate security patches according to the development process to determine whether updates are necessary.

VENDOR NAME	COMPONENT NAME	COMPONENT VERSION	DESCRIPTION/ USE
Linux Kernel Organization, Inc	Linux embedded operating system	5.4.70	Operating System
Digia Plc	QT framework	5.2.1	GUI/Application

P/N: 046-027758-00(2.0)