Dräger medical
A Dräger and Siemens Company

Operating Instructions

Apollo

WARNING!
For a full understanding of the performance characteristics of this medical device, the user should carefully read this manual before use of the device.

Inhalation Anesthesia Machine Software 4.n

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Introduction

Contents

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Working with these Operating Instructions

Header Line

The header line on each page contains the title of the chapter. This helps you find your way quickly from subject to subject.

Page Body

The page body in these Operating Instructions combines text and illustrations. The information is presented as sequential steps of action, giving the user hands-on experience in learning how to use the Apollo inhalation anesthesia machine.

Left-Hand Column - the Text

The text in the left-hand column provides explanations and step-by-step instructions on the practical use of the machine.

Bullet points indicate separate actions. Numbers are used both to refer to relevant details in the illustrations and to specify the sequence of actions where several actions are described.

Right-Hand Column - the Illustrations

The illustrations provide visual reference for the text and for locating the various parts of the equipment. Elements mentioned in the text are highlighted. Renderings of screen displays guide the user and provide a way to reconfirm actions performed.

Typing Conventions

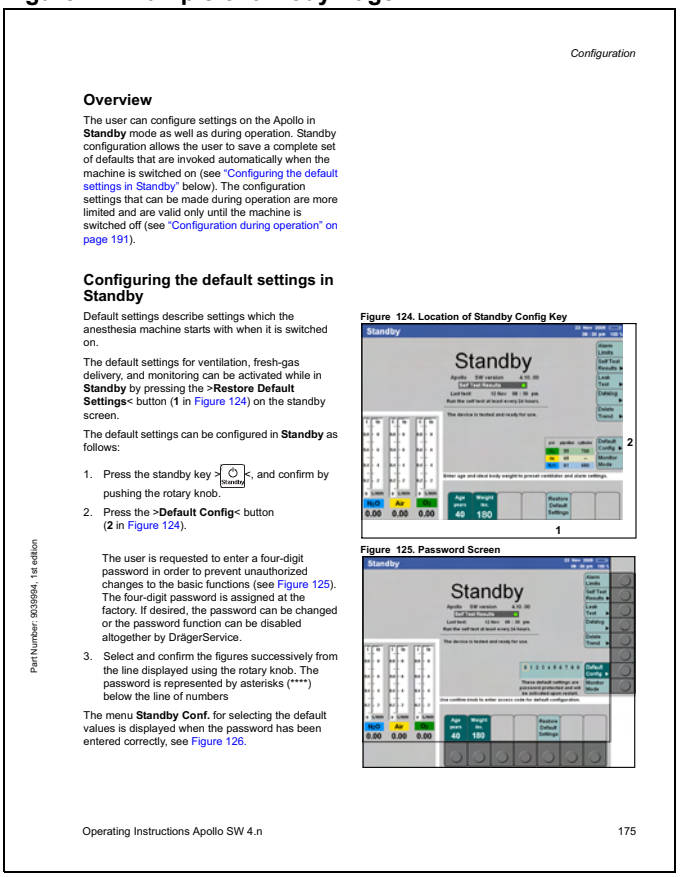
User controls are designated as >**Control Name**<, e.g.:

>**PEEP**<

Screen messages and screen options are printed in bold, e.g.:

Default Alarm Limits

Figure 1. Example of a Body Page



Configuration

Overview

The user can configure settings on the Apollo in **Standby** mode as well as during operation. Standby configuration allows the user to save a complete set of defaults that are invoked automatically when the machine is switched on (see "Configuring the default settings in Standby" below). The configuration settings that can be made during operation are more limited and are valid only until the machine is switched off (see "Configuration during operation" on page 191).

Configuring the default settings in Standby

Default settings describe settings which the anesthesia machine starts with when it is switched on.

The default settings for ventilation, fresh-gas delivery, and monitoring can be activated while in **Standby** by pressing the >**Restore Default Settings**< button (**1** in Figure 124) on the standby screen.

The default settings can be configured in **Standby** as follows:

1. Press the standby key >⏻<, and confirm by pushing the rotary knob.
2. Press the >**Default Config**< button (**2** in Figure 124).

   The user is requested to enter a four-digit password in order to prevent unauthorized changes to the basic functions (see Figure 125). The four-digit password is assigned at the factory. If desired, the password can be changed or the password function can be disabled altogether by DrägerService.
3. Select and confirm the figures successively from the line displayed using the rotary knob. The password is represented by asterisks (****) below the line of numbers

The menu **Standby Conf.** for selecting the default values is displayed when the password has been entered correctly, see Figure 126.

Figure 124. Location of Standby Config Key

Figure 125. Password Screen

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Definitions

WARNING!

A WARNING statement provides important information about a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION!

A CAUTION statement provides important information about a potentially hazardous situation which, if not avoided, may result in minor or moderate injury to the user or patient or in damage to the equipment or other property.

Note: A NOTE provides additional information intended to avoid inconvenience during operation.

Symbols and Abbreviations

Please refer to “Symbols” on page 17 and “Abbreviations” on page 19 for explanations.

Notice

This document is provided for customer information only, and will not be updated or exchanged without customer request.

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For Your Safety and that of Your Patients

Strictly follow these Operating Instructions

WARNING!

Strictly follow these Operating Instructions.

Any use of the medical device requires full understanding and strict observation of all portions of these instructions. The medical device is only to be used for the purpose specified under "Indications for Use" on page 13 and "Intended Use" on page 13, and in conjunction with appropriate patient monitoring (see page 14). Strictly observe all WARNING and CAUTION statements throughout these Operating Instructions and all statements on medical device labels. Non-compliance with these WARNING and CAUTION statements constitutes a use of the medical device which is not in accordance with its Intended Use.

Maintenance

WARNING!

The device must be inspected and serviced regularly by properly trained service personnel. Repair of the device may also only be carried out by properly trained service personnel.
We recommend that a service contract be obtained with DrägerService and that all repairs also be carried out by them. We recommend that only authentic Dräger repair parts be used for maintenance. Otherwise, the correct functioning of the device may be compromised.

Accessories

WARNING!

Only the accessories indicated on the list of accessories (8603528) have been tested and approved for use with the medical device. Accordingly it is strongly recommended that only these accessories be used in conjunction with the specific medical device. Otherwise the correct functioning of the medical device may be compromised.

Not for use in areas of explosion hazard

WARNING!

This medical device is neither approved nor certified for use in areas where combustible or explosive gas mixtures (e.g. O_2 or agent-enriched environments) are likely to occur.

Safe connection with other electrical equipment

WARNING!

Risk of electric shock.

Electrical connections to equipment not listed in these Operating Instructions should only be made following consultations with the respective manufacturers of the equipment involved.

WARNING!

Risk of electric shock.

A test for leakage current must be performed by qualified biomedical engineering personnel before use if the Apollo is interfaced with other equipment.

WARNING!

Risk of explosion, fire.

If an oxygen leak is suspected within or near the anesthesia machine, do not initiate operation.

Disconnect all oxygen supplies and contact a trained service technician.

WARNING!

Risk of use error.

Various potentially dangerous situations may occur which demand the attention of properly trained personnel.

The anesthesia machine may only be used under the supervision of qualified medical personnel so that assistance can be provided immediately in the event of any malfunctions.

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WARNING!

Risk of fire.

In order to reduce a fire hazard, explosive anesthetics, such as ether or cyclopropane, must not be used.

WARNING!

Risk of device failure and/or danger to patient.

Magnetic fields may negatively influence the proper function of the anesthesia machine, thus endangering the patient.

Apollo must not be used with magnetic resonance imaging (MRT, NMR, NMI)!

WARNING!

Risk of fire.

To prevent a fire hazard, drugs or other substances based on flammable solvents, such as alcohol, must not be introduced into the patient system. In addition oxygen must be vented away from the surgical site when using electrosurgical equipment.

Adequate ventilation must be ensured if highly inflammable substances are used for disinfection.

Note on EMC/ESD risk for the device function

General information on electromagnetic compatibility (EMC) pursuant to the international EMC standard IEC 60601-1-2: 2001

Electromedical devices are subject to special precautionary measures concerning electromagnetic compatibility (EMC) and must be installed and put into operation in accordance with the EMC information included, see page 267.

WARNING!

Portable and mobile radio communication equipment such as cellular radio telephones can interfere with electromedical devices (see “EMC declaration” on page 267).

WARNING!

Pins of connectors identified with the ESD warning symbol shall not be touched and not be connected unless ESD precautionary procedures are used. Such precautionary procedures may include anti-static clothing and shoes, the touch of a ground stud before and during connecting the pins, or the use of electrically isolating and anti-static gloves. All staff involved in the above shall receive instruction in these procedures.

WARNING!

Risk of electric shock.

Connecting devices to the auxiliary outlets of the anesthesia machine can cause an increase in leakage current beyond permissible values if the protective conductor of a device fails.

Check the leakage current when connecting devices to the auxiliary outlets. If connecting a device (or devices) increases the leakage current to a value which exceeds the permissible value, do not use the auxiliary outlets of the anesthesia machine: use a separate wall socket.

The system must meet the requirements for medical equipment in accordance with IEC/EN 60601-1-1 and IEC/EN 60601-1-2.

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Safe networking of computers

When networking with electrical devices, the operator is responsible for ensuring that the resulting system meets the requirements set forth by the following standards:

– EN 60601-1 (IEC 60601-1)
  Medical electrical equipment
  Part 1: General requirements for safety
– EN 60601-1-1 (IEC 60601-1-1)
  Medical electrical equipment
  Part 1-1: General requirements for safety
  Collateral standard: Safety requirements for medical electrical systems
– EN 60601-1-2 (IEC 60601-1-2)
  Medical electrical equipment
  Part 1-2: General requirements for safety
  Collateral standard: Electromagnetic compatibility; Requirements and tests
– EN 60601-1-4 (IEC 60601-1-4)
  Medical electrical equipment
  Part 1-4: General requirements for safety
  Collateral standard: Programmable electrical medical devices

Follow Assembly Instructions and Instructions for Use.

Patient safety

The design of the medical device, the accompanying literature, and the labeling on the medical device take into consideration that the purchase and use of the medical device are restricted to trained professionals, and that certain inherent characteristics of the medical device are known to the trained operator. Instructions, warnings, and caution statements are limited, therefore, largely to the specifics of the Dräger design.

This publication excludes references to various hazards which are obvious to a medical professional and operator of this medical device, to the consequences of medical device misuse, and to potentially adverse effects in patients with abnormal conditions. Medical device modification or misuse can be dangerous.

Patient monitoring

The operators of the medical device must recognize their responsibility for choosing appropriate safety monitoring that supplies adequate information on medical device performance and patient condition.

Patient safety may be achieved through a wide variety of different means, ranging from electronic surveillance of medical device performance and patient condition to simple, direct observation of clinical signs.

The responsibility for the selection of the best level of patient monitoring lies solely with the medical device operator.

General Warnings and Cautions

The following WARNINGS and CAUTIONS apply to general operation of the Apollo. WARNINGS and CAUTIONS specific to subsystems or particular features appear with those topics in later chapters of these Operating Instructions or in the device-specific Instructions for Use.

Accessories in sterile packaging

Do not use accessories in sterile packaging if the packaging has been opened, damaged or if there are other signs that the accessories are not sterile. Reprocessing and resterilization of single-use accessories is not permitted.

WARNING!

Each institution and user has a duty to independently assess, based on its, his or her unique circumstances, what components to include in an anesthesia system. However, Dräger, in the interest of the patient safety, strongly recommends the use of an oxygen analyzer, pressure monitor, volume monitor, and end-tidal CO_2 monitor in the breathing circuit at all times.

CAUTION!

Risk of patient injury.

An incorrect diagnosis or misinterpretation of measured values, or other parameters, may endanger the patient.

Do not base therapy decisions on individual measured values or monitoring parameters only.

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WARNING!

Risk of patient injury.

If ventilation of the patient is no longer assured due to an obvious fault in the equipment, the patient must immediately be ventilated with a separate emergency ventilator.

Always keep a manual ventilator at hand.

WARNING!

Risk of burns.

Conductive breathing hoses or face masks may cause burns during HF surgery.

Do not use these types of hoses and masks in combination with HF surgery.

CAUTION!

Risk of mechanical failure.

The shock and vibrations caused by transportation may lead to a mechanical failure. The application of a wall or ceiling mounting is designated for buildings.

Do not use the anesthesia machine for mobile facilities such as ambulances, helicopters, or ships.

CAUTION!

Risk of physical injury.

To avoid physical injury, e.g. pinching, pay special attention to edges, moving parts, and corners when working with

– drawers,
– the ventilator module,
– doors,
– the writing tray,
– swivel arms for mounted devices,
– gas cylinders,
– vaporizer units,
– CLIC absorbers and CLIC adapters,

as well as other accessories.

CAUTION!

Risk of device failure.

Compressed gas supply (pipeline supply or cylinder): To avoid damaging the device(s) attached to a gas supply, use only medical gases. Pay particular attention to national and international standards regulating the use of medical gases.

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Indications for Use

The Apollo is indicated as a continuous flow anesthesia system. The Apollo may be used for manually assisted or automatic ventilation, delivery of gases and anesthetic vapor, and monitoring of oxygen and CO_2 concentration, breathing pressure, respiratory volume, and anesthetic agent concentration and identification.

For USA: Rx only.
Caution: Federal Law restricts this device to sale by or on the order of a physician.

Intended Use

WARNING!

Risk of device failure and/or danger to patient.

If the intended use of this anesthesia machine is not adhered to, it may fail and/or the patient may be endangered.

Use the anesthesia machine only as specified in the intended use of these Operating Instructions.

The Apollo is an inhalation anesthesia machine for use in operating, induction, and recovery rooms. It can be used with rebreathing systems, semi-closed to virtually closed systems with low flow and minimal flow techniques, and non-rebreathing systems (with the Auxiliary Common Gas Outlet).

It may be used with O_2, N_2O, and Air supplied by a medical gas pipeline system or by externally mounted gas cylinders. Anesthetic agent can be delivered via vaporizers mounted on the machine.

The Apollo is equipped with a compact breathing system, providing fresh-gas decoupling, PEEP, and pressure limitation. It has an electrically driven and electronically controlled ventilator.

Ventilation modes

- Volume-controlled ventilation in **Volume Mode**. With activation of:
  - **Sync.** (Synchronization)
  - **Press. Support** (Pressure Support) (optional)
- Pressure-controlled ventilation in **Pressure Mode**. With activation of:
  - **Sync.** (Synchronization)
  - **Press. Support** (Pressure Support) (optional)
- Manual Ventilation **Man.**
- Spontaneous Breathing **Spont.**
- Pressure-Assisted Spontaneous Breathing in **Pressure Support CPAP** (optional)
- **Volume AF** (Volume Mode AutoFlow) (optional). With activation of:
  - **Sync.** (Synchronization)
  - **Press. Support** (Pressure Support) (optional).

The following measured values are displayed

- Peak pressure **PEAK**,
  Mean pressure **P_{MEAN}**,
  Plateau pressure **PLAT**,
  Positive end-expiratory pressure **PEEP**
- Expiratory minute volume **MV**,
  Difference between insp. and exp. minute volume **MV_{LEAK}**,
- Patient compliance **C_{PAT}**,
  Tidal volume **V_T**,
  Breathing rate **Freq.**
- Inspiratory and expiratory concentration of O_2, N_2O, anesthetic gas, and CO_2
- Difference between insp. and exp. O_2 concentration **$\Delta O2$**

Optional:

- Functional oxygen saturation **SpO_2**,
  Pulse rate **Pulse**

The following parameters are displayed as curves

- Airway pressure **P_{AW}**
- Inspiratory and expiratory flow
- Inspiratory and expiratory concentration of O_2, CO_2, and anesthetic gas

Optional:

- Plethysmogram
- **PAW-V** loops and **V-Flow** loops

The following are displayed as bar graphs

- Inspiratory, expiratory, and leakage tidal volume
- Volumeter
- Pressure
- Low-flow wizard for indicating fresh-gas utilization (optional)

Trends showing the measured values over time and a logbook are also available.

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Monitoring

By means of adjustable alarm limits which can automatically be adapted to the momentary ventilation situation.

With monitoring for

– Airway pressure **PAW**
– Expiratory minute volume **MV**
– Apnea
– Inspiratory and expiratory anesthetic gas concentration
– Detection of anesthetic gas mixtures (simultaneous detection of up to two anesthetic agents)
– Inspiratory O_2 and N_2O concentrations
– Inspiratory and expiratory CO_2 concentrations
– Special alarm response in Bypass Mode
– Automatic agent alarm activation for multiples of **MAC** (xMAC)

Optional:

– Oxygen saturation
– Pulse rate **Pulse**

MEDIBUS Protocol

MEDIBUS is a software protocol for use in transferring data between the Apollo and an external medical or non-medical device (e.g. hemodynamic monitors, data management systems, or a Windows-based computer) via the RS-232 interface (see MEDIBUS Instructions for Use of the Apollo, part number 9037426, 6th edition or higher).

WARNING!

Risk of patient injury.

Data transferred via MEDIBUS interfaces is for information only and is not intended as a basis for diagnosis or therapy decisions.

WARNING!

Risk of electric shock.

Connecting devices to the auxiliary outlets of the anesthesia machine can cause an increase in leakage current beyond permissible values if the protective conductor of a device fails.

Check the leakage current when connecting devices to the auxiliary outlets. If connecting a device (or devices) increases the leakage current to a value which exceeds the permissible value, do not use the auxiliary outlets of the anesthesia machine: use a separate wall socket.

The system must meet the requirements for medical equipment in accordance with IEC/EN 60601-1-1 and IEC/EN 60601-1-2.

The system must meet the requirements about medical electrical equipment in accordance to IEC/EN 60601-1-1 and IEC/EN 60601-1-2.

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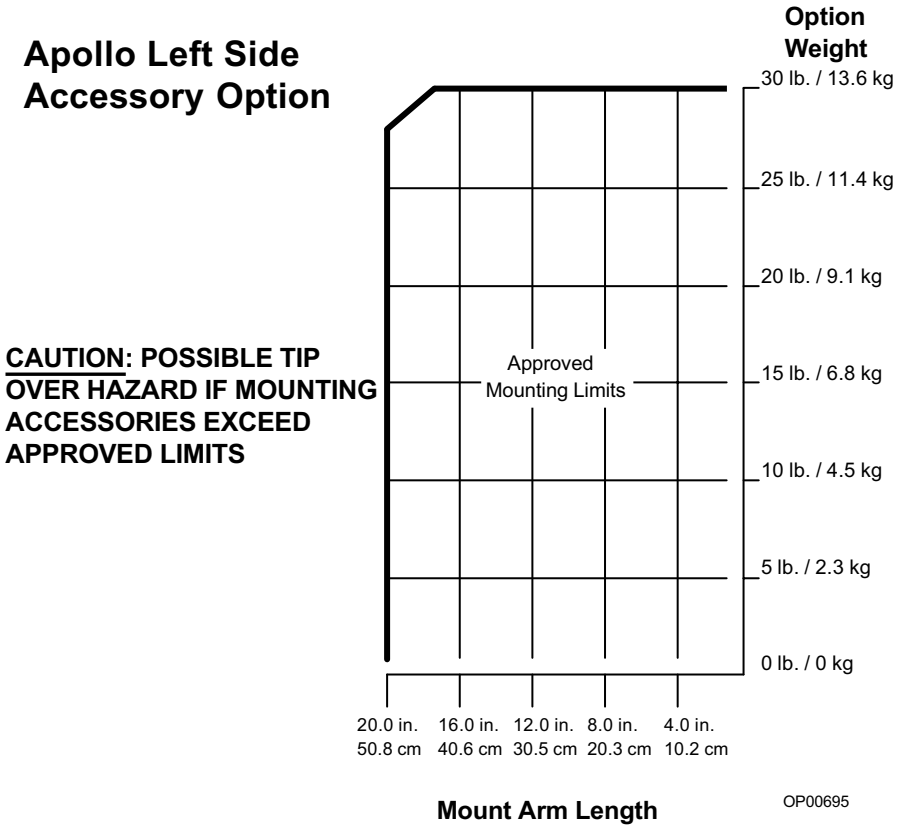
Accessory weight limits

The following figures specify the maximum safe weight limits for accessories mounted to the Apollo.

In addition to the arm-mounted accessory weight limits, the following mounted accessory weights may not be exceeded:

– 30 lbs. maximum on either side of machine for accessories mounted close to the machine side.
– 100 lbs. maximum for accessories mounted to the top shelf.

Figure 2. Accessory Weight Limits - Apollo Left Side



CAUTION: Maximum weight per arm 30 lb./ 13.6 kg.

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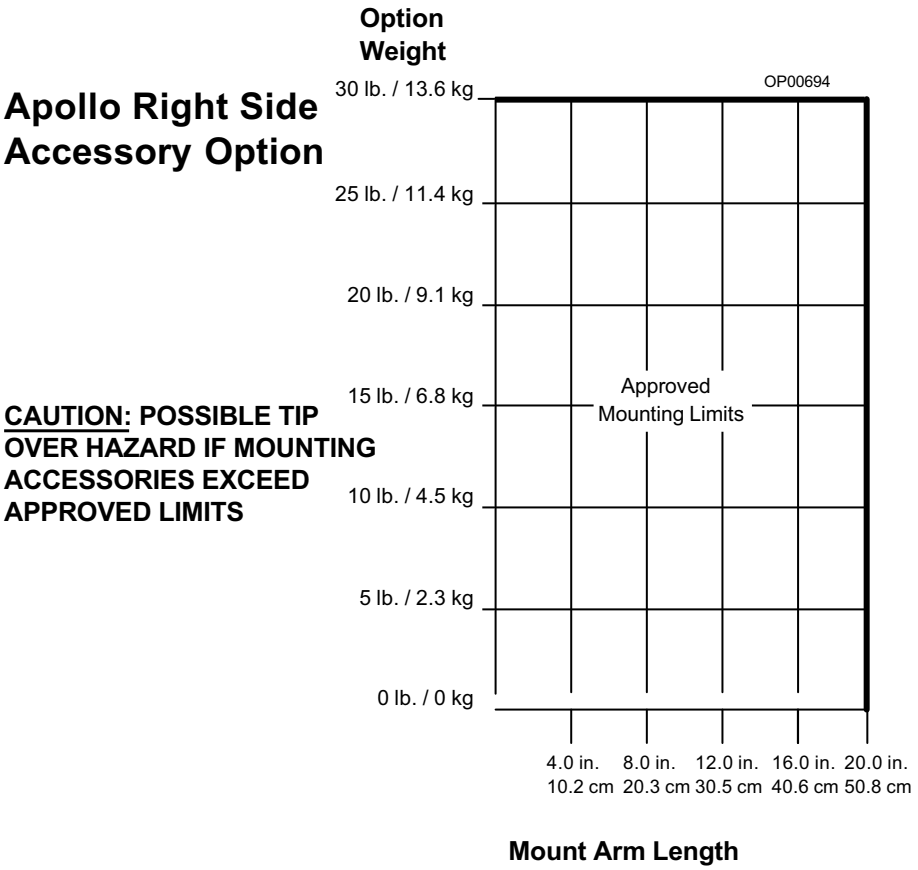
Figure 3. Accessory Weight Limits - Apollo Right Side



CAUTION: Maximum weight per arm 30 lb./ 13.6 kg.

CAUTION!

Risk of device failure.

If the anesthesia machine is operated when tilted, components may be damaged or may function improperly.

Do not operate the anesthesia machine if it is tilted more than 5°.

CAUTION!

Risk of inadvertent movement.

If not properly secured, the device may move inadvertently during operation.

Apply the brakes on the device to ensure it cannot be moved accidentally during operation.

CAUTION!

Risk of injury.

If mounting accessories exceed the approved limits, the anesthesia machine may tip over.

Maximum weight per arm = 30 lbs.

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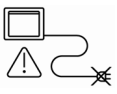
Symbols

The following symbols appear on the Apollo and are defined below.

Symbol	Explanation
	Suppress alarm tone for 2 minutes; change priority of technical alarms and acknowledge them
	Display standard screen
	Display the three basic screens in succession
	Standby/operation switch
	Access more user options/screens
	Pulse rate
	Action in progress
	Upper and lower alarm limits
	Upper alarm limit only
	Lower alarm limit only
	Upper and lower alarm limits disabled
	Upper alarm limit disabled
	Lower alarm limit disabled
– –	Alarm limit or measuring function disabled
* * * *	4-digit password entered
	Protection class type BF (body floating)
	Connection for potential equalization

Symbol	Explanation
	Consult accompanying documents.
	Exit menu, return to preceding menu
	Non-rebreathing system at common gas outlet
	Remaining battery capacity (uninterruptible power supply UPS)
	Manual ventilation
	Automatic ventilation
	Connector for pipeline gas supply
	Backup gas cylinder
	UL test mark
	Plug system for vapor units
	Connection for halogen lamp
	Surface hot; do not touch.
	ESD warning label
	Leakage current label Warning: Do not connect the mains of external display(s) to AC outlets. Use external power outlets.
	Interference
	Battery supply
	Alarm tone suppressed for 2 minutes

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Symbol	Explanation
	Alarm monitoring inactive
	Alarm monitoring temporarily inactive
	Apnea alarm disabled
	Caution!
	Rotary knob
	System power switch
	Physical injury
	Mains voltage

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Abbreviations

List of abbreviations used in the software and on the device

Abbreviation	Explanation
Agent/agent	Anesthetic gas
Air/AIR	Compressed air for medical use
APL	Adjustable Pressure Limitation
Aux CGO	Auxiliary Common Gas Outlet
BW	Body weight
CAL	Calibration
CO_2	Carbon dioxide
COM1 COM2	Interfaces used as MEDIBUS interfaces
CPAP	Continuous Positive Airway Pressure
C_{PAT}	Patient compliance
C_{SYS}	System compliance
ΔO_2	Difference between inspiratory and expiratory O_2
ΔPPS	Difference in pressure to PEEP in Pressure Support mode
ΔVT	Difference between inspiratory and expiratory tidal volume
Des.	Desflurane
$etCO_2$	End-expiratory CO_2 concentration
Enf.	Enflurane
exp.	Expiratory
FG	Fresh gas
$FiCO_2$	Fractional inspiratory CO_2 concentration
FiO_2	Fractional inspiratory O_2 concentration
Freq./freq.	Frequency
$Freq_{MIN}$	Mandatory minimum frequency in Pressure Support mode
Hal.	Halothane
HF	High frequency
I:E	Ratio of inspiration time to expiration time

Abbreviation	Explanation
insp.	Inspiratory
inDes	Inspiratory desflurane concentration
inEnf	Inspiratory enflurane concentration
inHal	Inspiratory halothane concentration
inIso	Inspiratory isoflurane concentration
inSev	Inspiratory sevoflurane concentration
INOP	Inoperable
Iso.	Isoflurane
$Leak_{SYS}$	System leakage
MAC	Minimum Alveolar Concentration
Man.Spont., MAN/SPONT	Manual/Spontaneous breathing
MV	Expiratory minute volume
MV_{LEAK}	Difference between inspiratory and expiratory minute volume
N_2O	Nitrous oxide
O_2	Oxygen
O_2+	O_2 flush
PAW	Airway pressure
PAW-V loop	Pressure-Volume Loop
PEAK	Peak pressure
PEEP	Positive end-expiratory pressure
P_{INSP}	Inspiratory pressure in Pressure Mode
PLAT	Plateau pressure
pleth	Plethysmogram
P_{MAX}	Pressure limitation in Volume Mode
P_{MEAN}	Mean pressure
Pressure/ Press. Mode	Pressure Mode Pressure-controlled ventilation
Press. Support/ Press. Supp.	Pressure Support mode Pressure-assisted ventilation
Sev.	Sevoflurane
SpO_2	Functional O_2 saturation

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Abbreviation	Explanation
Standby Conf.	Standby configuration for default values and settings
Sync./sync.	Synchronization
TIP : TINSP	Ratio of inspiratory pause time to inspiration time
TINSP	Inspiration time
Trigger	Trigger level
TSLOPE	Rise time
Vent. mode	Ventilation mode
V-Flow loop	Volume flow loop
Volume/ Vol. Mode	Volume Mode Volume-controlled ventilation
Volume AF	Volume Mode AutoFlow
VT	Tidal volume
V_{TINSP}	Measured inspiratory tidal volume

List of general abbreviations

Abbreviation	Explanation
AC	Alternating current
AGS	Anesthetic gas receiving system
ATPS	Measuring conditions at ambient temperature, current atmospheric pressure and with saturated gas
BTPS	Measuring conditions at body temperature, current atmospheric pressure and with saturated gas
cmH_2O	Centimeter of water
CS	Pipeline gas supply / Piped medical gas supply for O_2, N_2O, Air, and vacuum
EMC	Electromagnetic compatibility
ESD	Electrostatic discharge
HF surgery	High-frequency surgery
HME	Heat and moisture exchanger
hPa	Hectopascal
in	Inches
IV	Intravenous
kg	Kilogram
kPa	Kilopascal
lbs.	Pounds
MAN/AUTO	Manual/mechanical ventilation
mbar	Millibar
mmHg	Millimeter of Mercury
mL	Milliliter
NiBP	Non-invasive blood pressure
NTPD	Normal temperature pressure dry (68 °F [20 °C], 1013 hPa [760 mmHg], dry)
P_{EIRP}	“Equivalent isotropic radiated power” of the adjacent RF transmitter
ppm	Parts per million
PS	Pressure Support
psi	Pounds per square inch
RF	Radio frequency
SORC	Sensitive oxygen ratio controller
T_{EXP}	Expiratory time
UPS	Uninterruptible power supply
VAC	Vacuum (e.g. for secretion aspiration)
Vol.%	Percentage gas rate in relation to total gas volume
V	Volt
xMAC	Multiple of MAC

Units

Note: Throughout these Operating Instructions:
Ventilation pressures: cmH_2O = mbar = hPa
Supply pressures: bar = kPa x 100

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System Components

Contents

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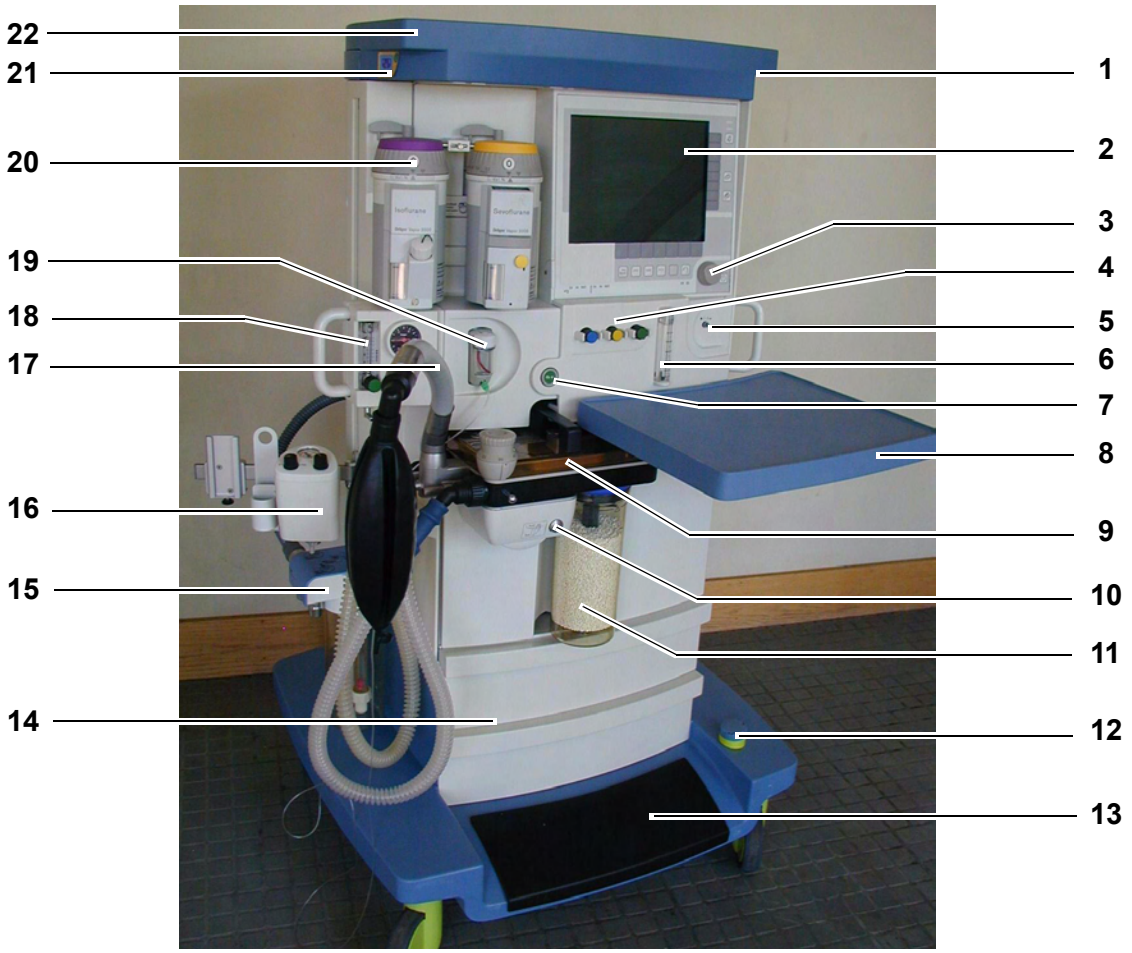
Overview

This chapter identifies the major physical components of the Apollo anesthesia machine and provides a brief description of specific parts.

Machine Front view



1	Lighting control (dimmer) location	12	Central brake
2	Screen with user interface	13	Footrest
3	Rotary knob	14	Drawers (2) (for storage)
4	Fresh-gas flow controls: O_2, Air, N_2O	15	Anesthetic gas receiving system AGS (optional)
5	Mains power switch	16	Endotracheal aspiration system (optional)
6	Total flow meter	17	Flexible breathing bag arm
7	O_2 flush button **O_2+**	18	Auxiliary oxygen flow meter
8	Writing table	19	Water trap with sample line connection
9	Breathing system	20	Vaporizer units with interlock system (optional)
10	Release button for ventilator module	21	Auxiliary AC outlet (for Desflurane vaporizer)
11	Absorber (optional: disposable CLIC absorber)	22	Top shelf (for external monitors)

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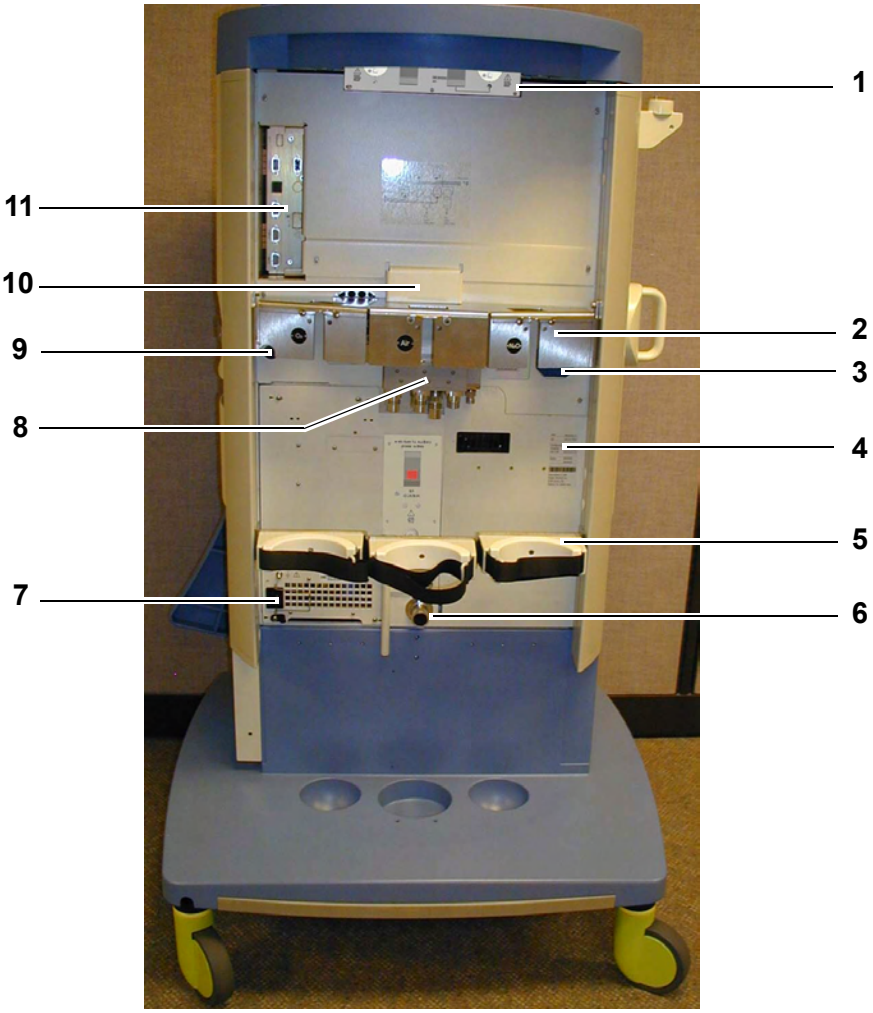
Machine Rear view



1 Auxiliary outlet panel
2 Cylinder tank yoke bar
3 Filter for fan
4 Type plate
5 Cylinder support bar
6 Scavenging nozzle
7 AC power connector
8 Gas supply block
9 Connector for optional halogen lamp (remove cap before use). Use the lamp specified in the list of accessories only.
10 Connectors (3) for backup gas cylinder pressure sensors (covered; access from behind gas supply block)
11 Interface panel

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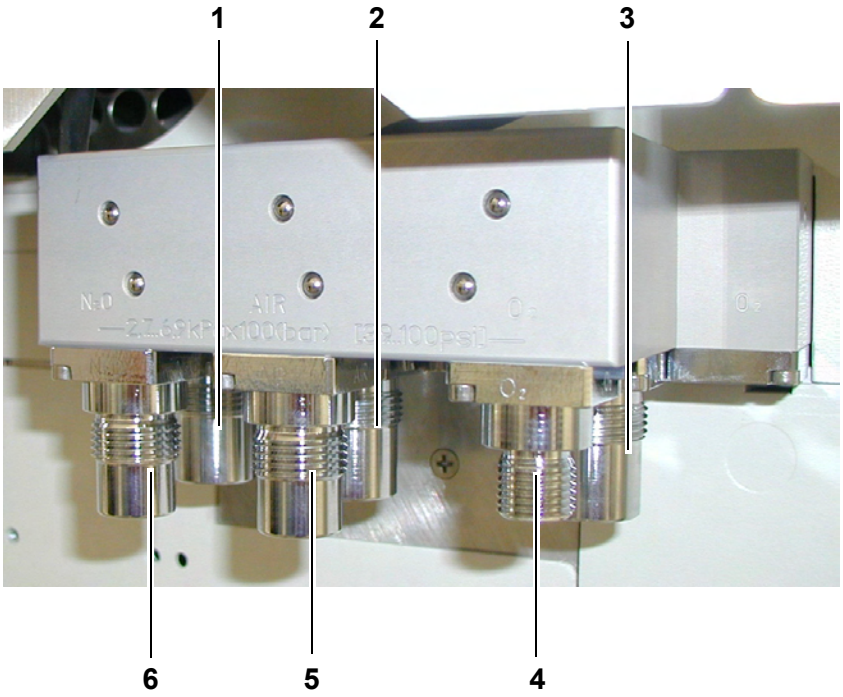
Gas supply block



1 Connection for **N_2O** cylinder
2 Connection for **Air** cylinder
3 Connection for **O_2** cylinder
4 Connection for pipeline **O_2**
5 Connection for pipeline **Air**
6 Connection for pipeline **N_2O**

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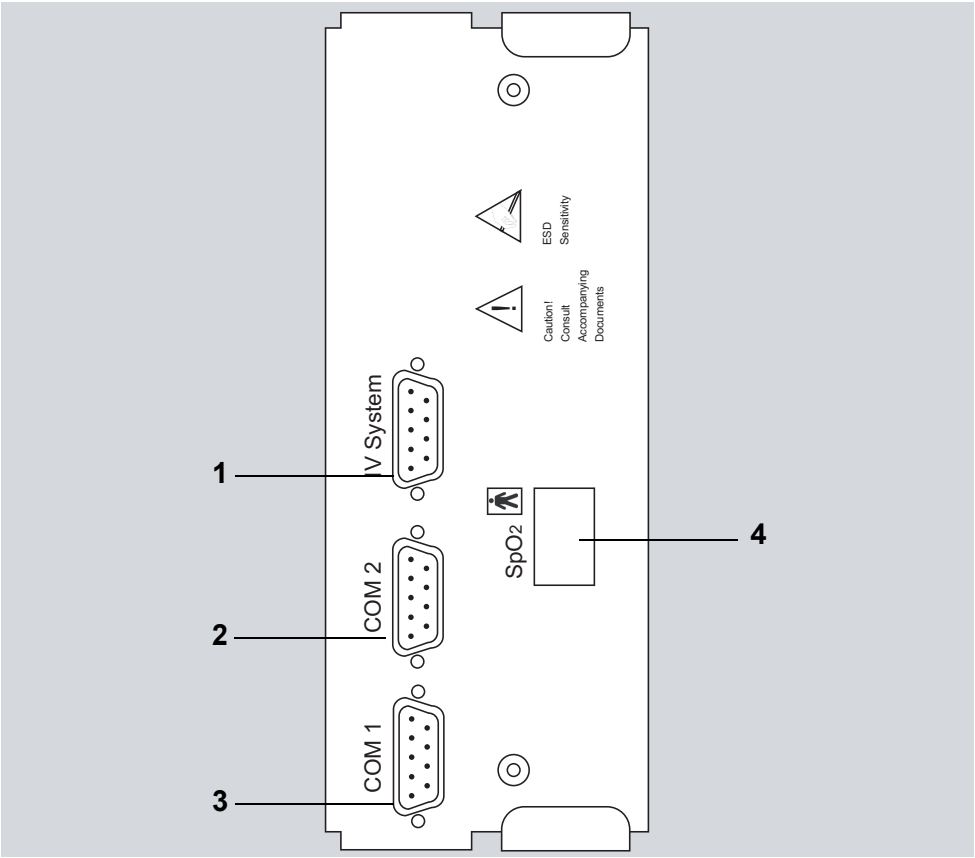
Interface panel



1	**IV System**	Connection for Dräger IV System*
2	**COM2**	MEDIBUS interface
3	**COM1**	MEDIBUS interface
4	**SpO2**	Socket for SpO2 sensor (optional)

*not for sale in the U.S.

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Vaporizers (Optional)

Note: Before operating the vaporizer, pay special attention to the Instructions for Use of the vaporizer being used. Note especially the vaporizer flow limits.

The Dräger Vapor anesthetic agent vaporizers are used to enrich the fresh gas with a precisely metered quantity of vapor from the liquid anesthetic agent being used, i.e. Isoflurane, Halothane, Enflurane, Sevoflurane, or Desflurane.

When using a Desflurane vaporizer, it must be connected to mains power. The auxiliary power outlet (IEC/EN 60320-2-2/F) near the vaporizer exclusion system is provided for that purpose.

The vaporizers being used must comply with standard ISO 8835-4. If the internal gas measurement system fails, an independent measurement system complying with ISO 21647 must be used.

CAUTION!

Risk of patient injury.

If the vaporizer is not correctly mounted, the fresh-gas flow will not be supplied with anesthetic agent and the patient will not receive the correct anesthesia.

Always double-check the position of the vaporizer, make sure it is correctly mounted and do not mount the vaporizer park holder close to the operable vaporizer.

Vaporizer exclusion systems

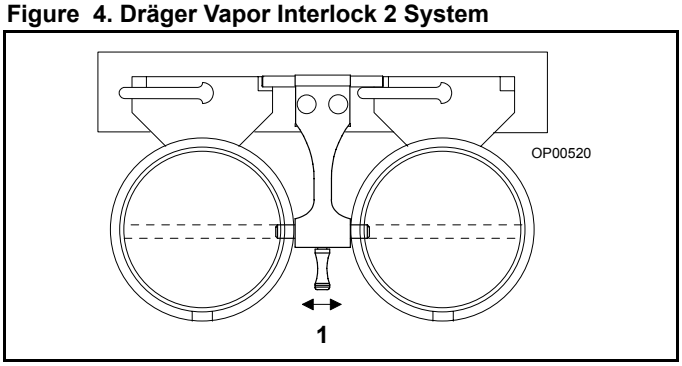
The exclusion systems available for the Apollo are described below.

Dräger Vapor Interlock 2 System (Optional)

The Dräger Interlock 2 system is used to ensure that only one of two vaporizers can be used at a time. It has a selector lever used to select which vaporizer is enabled.

Moving the selector lever away from the desired vaporizer allows that vaporizer to be used and the other to be locked out of use.

Figure 4. Dräger Vapor Interlock 2 System



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Note that the selector lever (**1** in Figure 4) is shown in the center position. This ensures that both vaporizers are in the locked position. Also, this is the recommended position for the selector lever when moving the Apollo.

Selectatec (Optional)

The interlock system for the Selectatec is built into the vaporizers. When a vaporizer is selected for use, the interlocking index pins will protrude from the sides of the vaporizer thereby not allowing the adjacent vaporizer to be opened. For more specific information on the Selectatec, refer to the Selectatec Vaporizer's instruction manual.

Dräger Auto Exclusion 2-Vaporizer Mount (Optional)

This system has an automatic interlock system that ensures only one vaporizer can be used at a time. When one of the two vaporizers is selected for use (opened), the interlock mechanism within that vaporizer's mounting system is activated automatically, preventing the other vaporizer from being used.

Note: Only vaporizers labeled as "AUTO EXCLUSION" vaporizers are compatible with the Dräger Auto Exclusion 2-Vaporizer Mount. See Table 1 for the Auto Exclusion Vaporizer technical data.

When using a Desflurane vaporizer, it must be plugged into the auxiliary power outlet located on the side of the machine above the vaporizer mount.

Table 1. Dräger Auto Exclusion Vaporizer Technical Data

Normal Operating Range	≤ 10 L/min	Dräger Vapor 2000 Instruction for Use Manual's delivered concentration accuracy values apply.
Extended Operating Range	>10 ≤ 15 L/min	Dräger auto exclusion vaporizer concentration output accuracy may be reduced.

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Dräger Auto Exclusion 3-Vaporizer Mount (Optional)

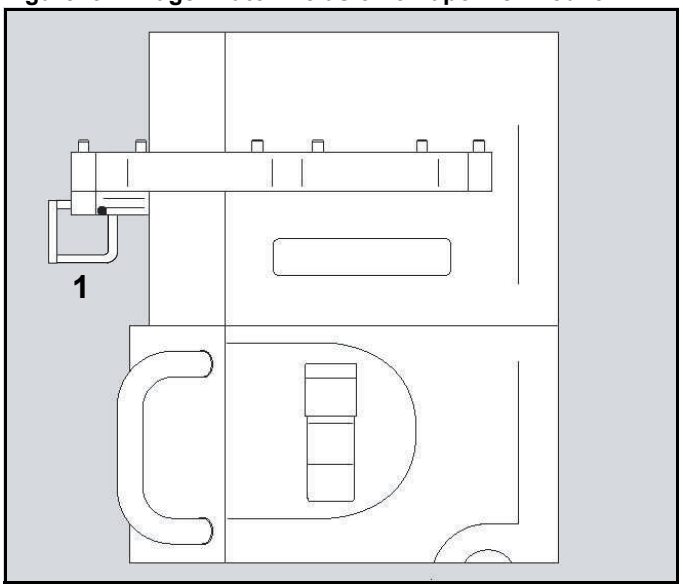
This system has an automatic interlock system that ensures only one vaporizer can be used at a time. When any one of the three vaporizers is selected for use (opened), the interlock mechanism within that vaporizer's mounting system is activated automatically, preventing the other two vaporizers from being used.

Note: Only vaporizers labeled as "AUTO EXCLUSION" vaporizers are compatible with the Dräger Auto Exclusion 3-Vaporizer Mount. See Table 1 for the Auto Exclusion Vaporizer technical data.

When using a Desflurane vaporizer, it must be plugged into the auxiliary power outlet located on the side of the machine above the vaporizer mount.

Note: The Desflurane vaporizer should be installed in the far left position (**1** in Figure 5) with the Dräger Auto Exclusion 3-Vaporizer Mount in order to have optimum viewing area of the display screen.

Figure 5. Dräger Auto Exclusion 3-Vaporizer Mount



APL valve

The APL valve has two functions. It limits the maximum pressure during manual ventilation and exhausts excess gas into the scavenger system during manual and spontaneous ventilation.

The APL valve is connected to the patient airway through the ventilator. It functions only when the ventilator is in Manual/Spontaneous mode.

The adjustment knob (**1** in Figure 6) is used to select between spontaneous and manual modes of ventilation. It's labeled to indicated approximate pressure settings.

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For spontaneous ventilation:

Pressure is released for spontaneous ventilation when the adjustment knob is rotated fully counterclockwise, when the index mark on the knob lines up with the index mark on the bottom of the APL valve (**2** in Figure 6). Spontaneous ventilation eliminates both resistance to patient exhalation and the need to readjust back pressure.

For manual ventilation:

In manual mode, the APL valve adjustment knob can be rotated to change the approximate pressure at which gas will flow through the valve and into the scavenging system. Clockwise rotation of the adjustment knob increases the pressure, and counterclockwise rotation of the adjustment knob decreases the pressure. Pulling up on the APL valve knob will temporarily relieve pressure.

Note: The APL valve is automatically excluded from the breathing circuit whenever an automatic ventilation mode is selected. It is suggested that even in automatic ventilation, the APL valve is adjusted to a pressure that is safe for the patient.

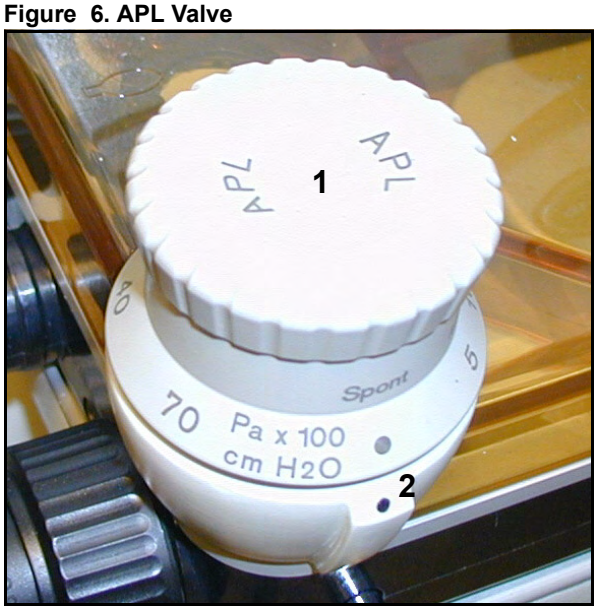
WARNING!

Risk of patient injury.

If the APL valve becomes blocked due to e.g. lines or cables being caught under the knob, the patient may be endangered.

Route all cables away from the APL valve; do not hang lines, hoses or cables, e.g. the sample line, on or near the APL valve.

Figure 6. APL Valve

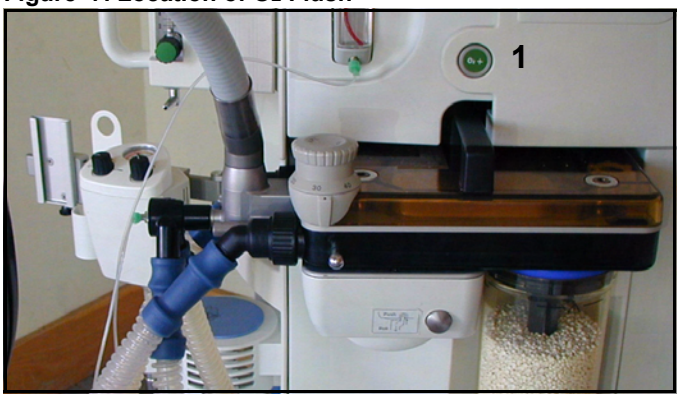


O_2 flush

A manually operated O_2 flush valve is located on the front of the machine (**1** in Figure 7). When actuated, the valve delivers an unmetered flow of at least 35 L/min to the breathing system and breathing bag while bypassing the ventilator. The Apollo does not have to be switched on to use the O_2 flush.

1. To operate the O_2 flush, press the **O_2+** button. Oxygen flows into the breathing system without anesthetic gas as long as the button is pressed in.

Figure 7. Location of O_2 Flush



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Auxiliary oxygen flow meter

The auxiliary oxygen flow meter delivers a metered flow of pure oxygen, used, for example in the delivery of oxygen through a nasal cannula. Auxiliary oxygen can be used in any ventilation mode, in **Standby**, or even if the machine is switched off.

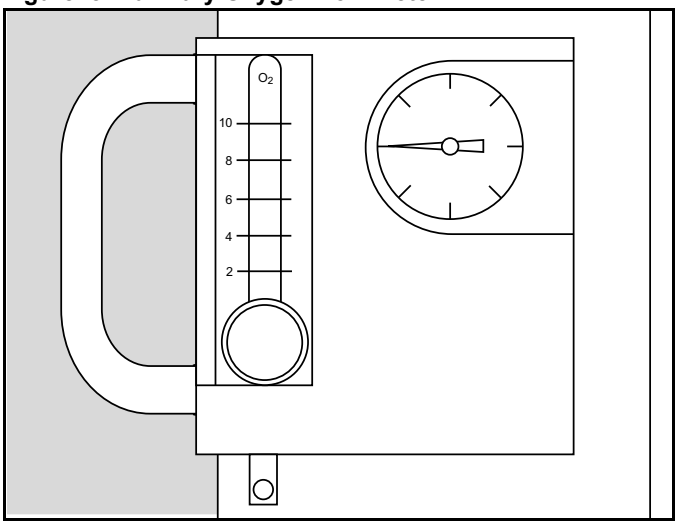
CAUTION!

Risk of inadequate pressure monitoring.

The optional auxiliary outlets are not pressure monitored.

Pressure monitoring must be ensured by the connected device.

Figure 8. Auxiliary Oxygen flow meter



Writing table

The Apollo is equipped with a writing table (**1** in Figure 9) which can be moved left or right or folded down completely for convenient positioning.

To fold down the writing table, support the table with one hand, then pull up on the release knob (**2** in Figure 9) and fold down. To bring the table up again, swing it upward until it clicks into place.

Figure 9. Writing Table

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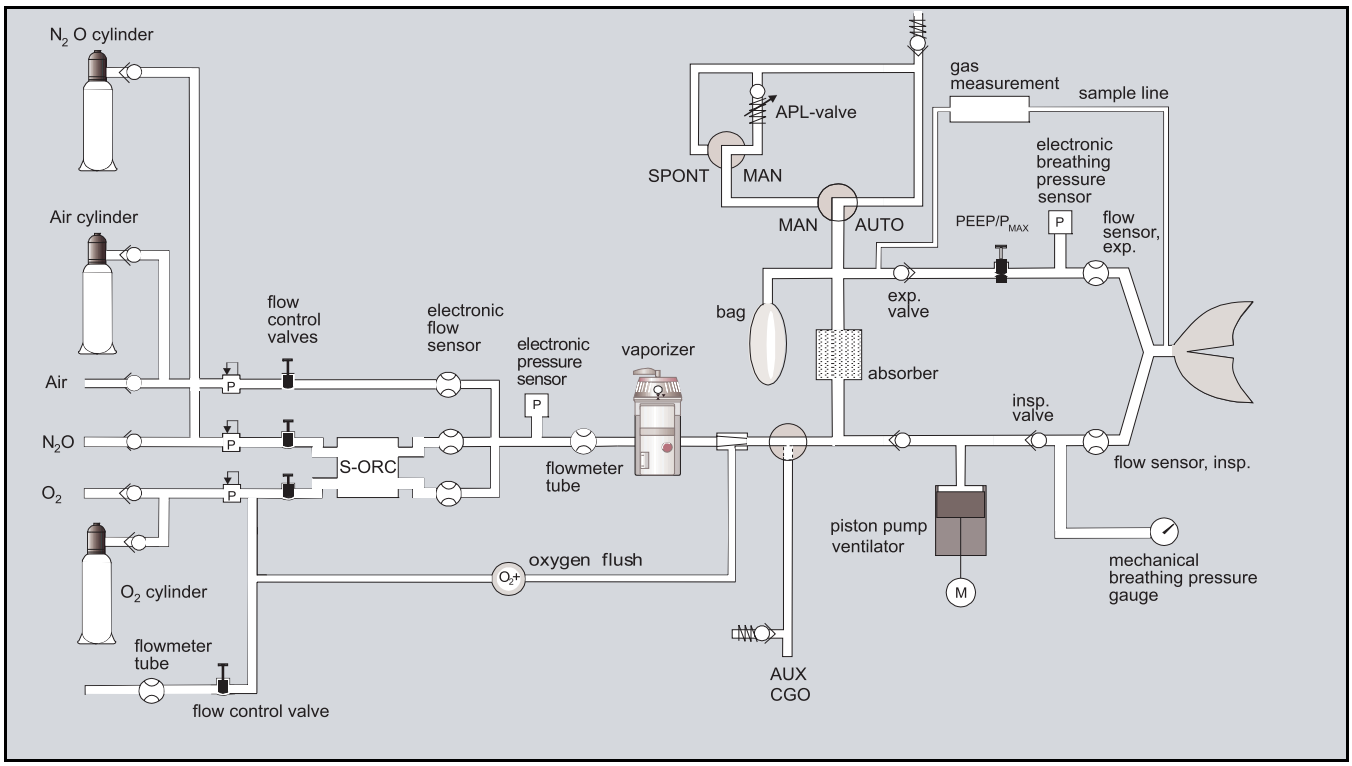
Gas flow diagram



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User Interface

Contents

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Overview

This chapter provides a description of the Apollo user interface, which enables you to view and change monitoring, ventilation, and status information using keys and the rotary knob.

Main screen display

The screen display is organized into four functional areas:

– Gas measurement
– Monitoring
– Fresh-gas delivery
– Ventilation

Figure 10 illustrates the general functional areas and identifies the following smaller screen elements:

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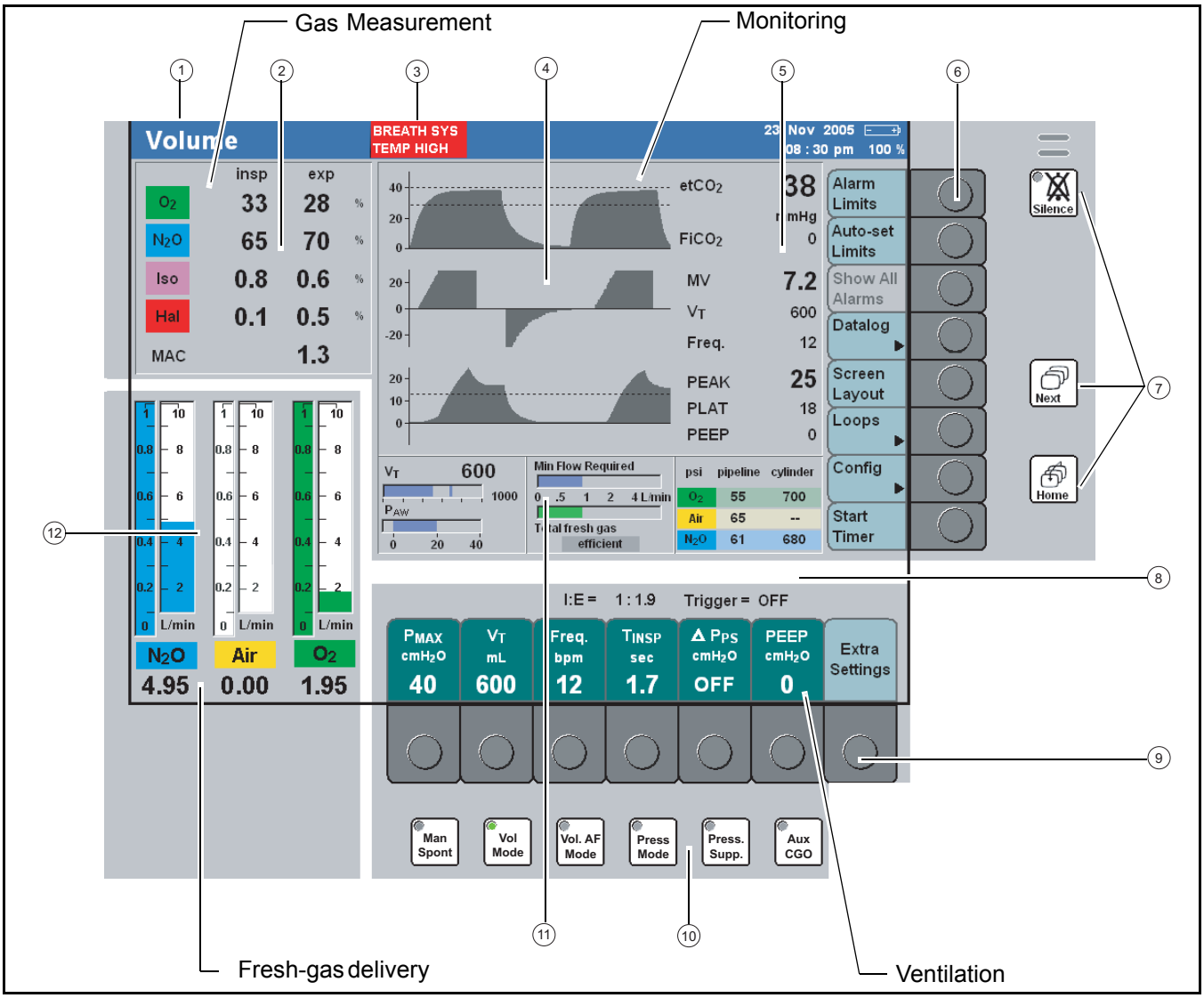
Figure 10. Standard Monitor Screen Layout



1. Status field; displays information about the current operating mode
2. Numeric field for gas and agent measurement values
3. Alarm message field; displays alarm messages
4. User-configurable graphics field for curves and bar graphs
5. Numeric field for monitored parameter values
6. Monitoring/configuration buttons
7. Standard function keys; for selecting monitoring screens and silencing alarms
8. Prompt field; displays messages for the user
9. Ventilation parameter buttons
10. Ventilation mode keys
11. User-configurable monitoring area
12. Fresh-gas bar graphs (virtual flow tubes)

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User controls

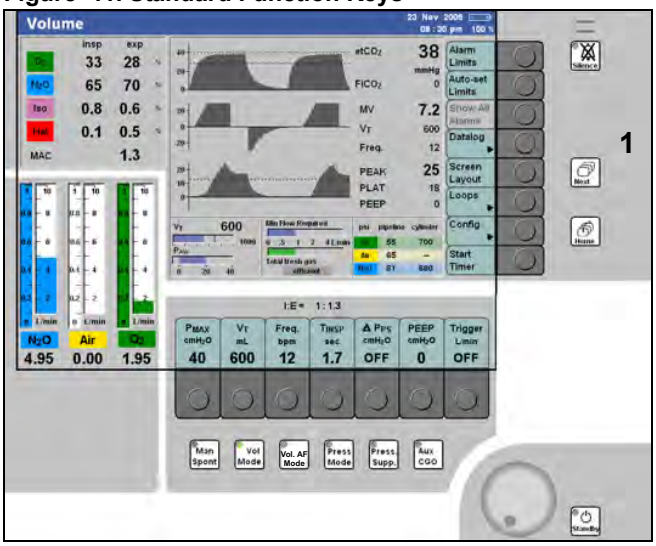
Changes to system settings and screen displays are made using the rotary knob, “keys” (keys with permanently defined functions), and “buttons” (keys with variable functions). All controls are described in the following paragraphs.

Standard function keys

Three keys for standard functions are located on the right side of the display screen (**1** in Figure 11):

Silence	**Press this key to suppress audible alarms for 2 minutes; or to change the priority of technical alarms and acknowledge them.**
Next	**Press this key to display in succession the three available monitoring screens: standard, data, and trend.**
Home	**Press this key to display the standard monitoring screen.**

Figure 11. Standard Function Keys



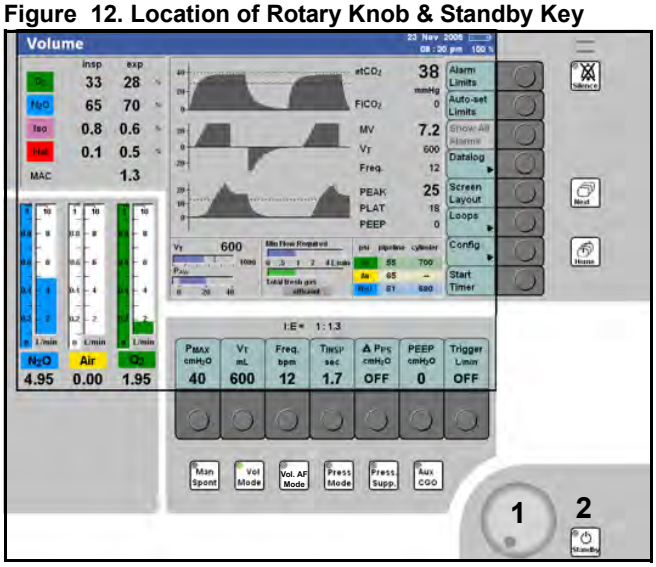
Rotary knob

The rotary knob is located on the bottom right side (**1** in Figure 12). It is the main control used to select and confirm all monitoring and system settings:

– **turn** the rotary knob to change or select a value or parameter (clockwise rotation increases a value; counterclockwise rotation decreases a value).

– **press** the rotary knob to set a value or confirm a selection. If the selection is not confirmed, the value or parameter will not change.

Figure 12. Location of Rotary Knob & Standby Key



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Standby key

The standby key (**2** in Figure 12) is used to switch between operating modes and **Standby**.

1. to set the machine to **Standby** mode, press the standby key >Standby<. Then press the rotary knob to confirm.

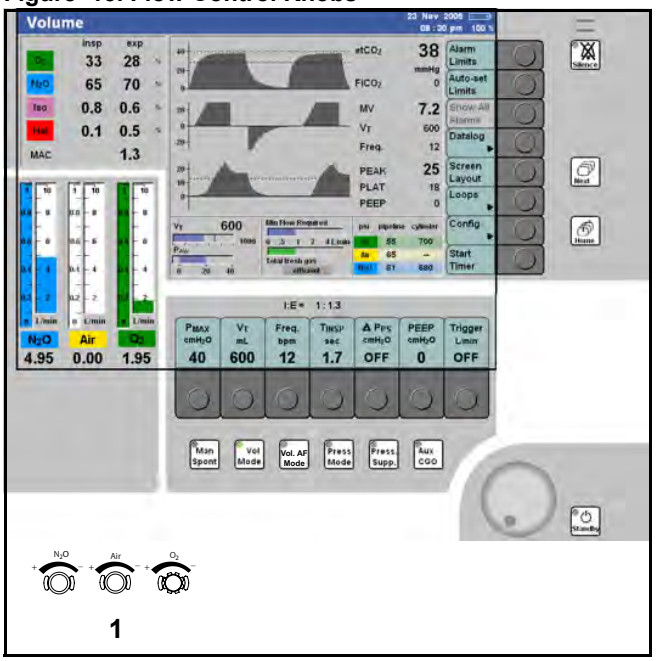
The standby key is also used to enter monitoring mode while in **Standby** (see “Monitoring mode” on page 153 for more information).

Flow control knobs

Three control knobs for the adjustment of N_2O, Air, and O_2 flow are located below their respective virtual flow meters in the bottom left of the display (**1** in Figure 13). They are labeled and color-coded. The oxygen flow control is also touch-coded with a fluted knob.

– to increase flow, turn the appropriate flow control knob counterclockwise
– to decrease flow, turn the appropriate flow control knob clockwise

Figure 13. Flow Control Knobs



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Ventilation control keys

Ventilation functions are controlled using two sets of keys located at the bottom of the screen.

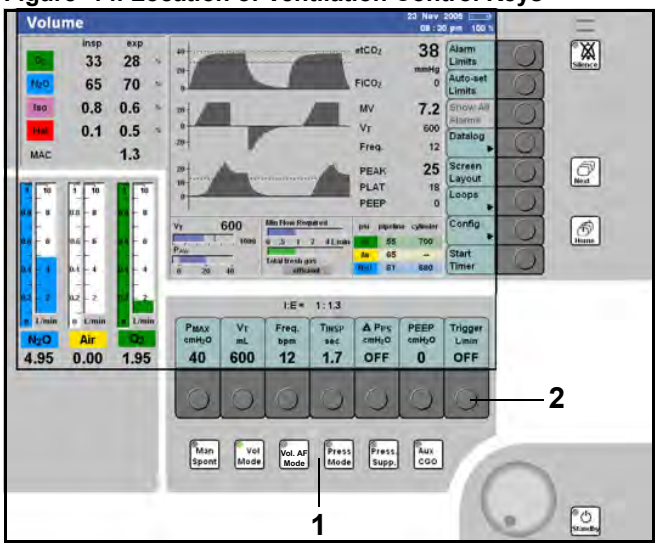
The ventilation keys (**1** in Figure 14) are used primarily to select the ventilation mode: >**Man Spont**<, >**Vol Mode**<, >**Vol. AF Mode**<, >**Press Mode**<, and >**Press. Supp.**< (optional). The key >**Aux CGO**< is used to select the optional auxiliary common gas outlet.

Selecting Ventilation Mode or Aux CGO (optional)

1. Press the appropriate ventilation key. The key's LED and the status field will flash.
2. Press the rotary knob to confirm the selection.

The ventilation buttons (**2** in Figure 14), located above the keys, are used to set ventilation parameters. These keys have variable functions, depending on the operating status or ventilation mode.

Figure 14. Location of Ventilation Control Keys



Setting/Selecting Ventilation Parameters

Example: setting PEEP

1. Press the button >**PEEP**<.
2. Turn the rotary knob until the desired value is displayed.
3. Press the rotary knob to confirm the new value. If the new value is not confirmed within 15 seconds, it automatically reverts to the original value.

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Monitoring/Configuration control keys

The majority of monitoring and configuration functions are performed using the vertical column of buttons along the right side of the screen (**1** in Figure 15). These keys have variable functions and their labels change according to which monitoring screen is selected (standard, data, or trend). An arrow (▶) on the button label indicates that pressing that key will bring up a second set of buttons with further user options.

Setting/Selecting Monitoring Functions

Example: change lower alarm limit for $etCO_2$:

1. Press the button >**Alarm Limits**< (**2** in Figure 15). The alarm limits menu is displayed on the screen.
2. Turn the rotary knob to select the low alarm limit value for $etCO_2$ (see Figure 16).
3. Press the rotary knob to confirm the selection.
4. Turn the rotary knob until the desired alarm value is displayed.
5. Press the rotary knob to confirm the new alarm limit value.
6. Exit the alarm limits menu by either:
   - confirming the close symbol >⟶< with the rotary knob, or
   - pressing the >Home< key.

Figure 15. Location of Monitoring/Configuration Keys

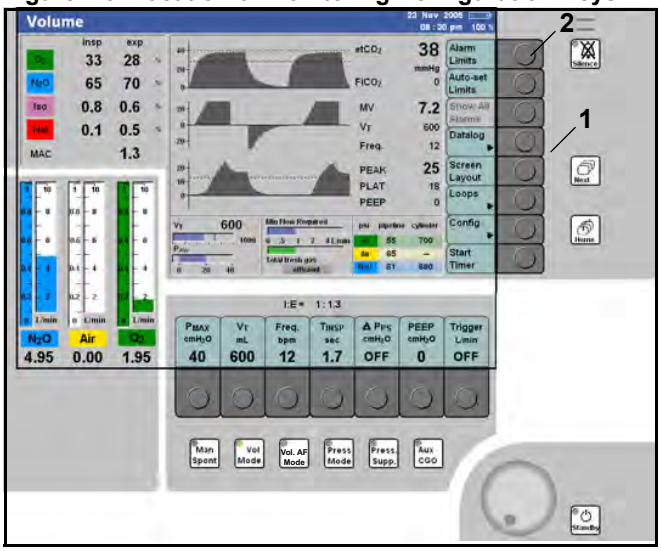
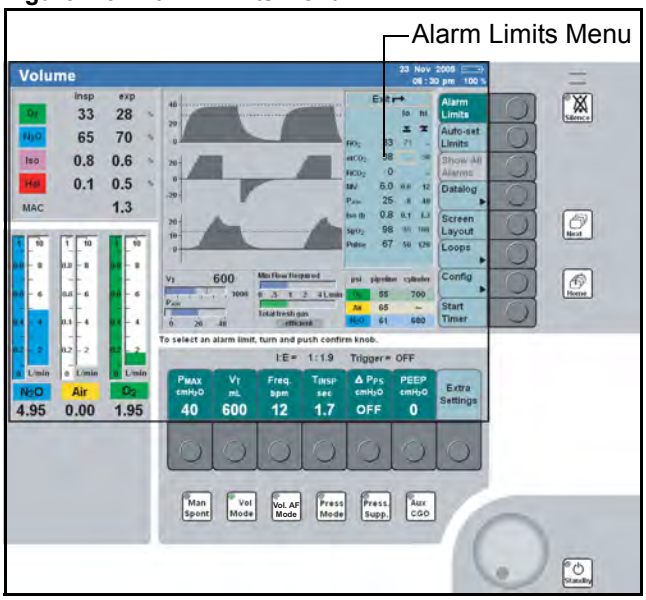


Figure 16. Alarm Limits Menu



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System LED indicators

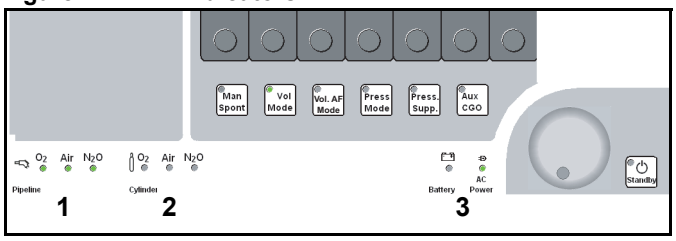
A number of LED indicators are located at the bottom of the front panel. They can light up green or red, or can remain extinguished, to indicate gas supply and machine power status.

The pipeline supply LEDs (**1** in Figure 17) can be either green, which indicates that the pipeline supply is connected and pressure is adequate, or off (extinguished). If the pipeline pressure transducer is inoperable, the corresponding LED will flash green.

If the backup gas cylinder is connected and pressure is adequate, the corresponding LED (**2** in Figure 17) will be green. If the backup gas cylinder is connected, but the pressure is inadequate and the pipeline supply is not available, the LED will flash red. If the backup cylinder is not connected, the LED will be dark (extinguished).

The Battery and AC Power LEDs (**3** in Figure 17) have two states: green or off (extinguished). The LED that is green indicates the active power source.

Figure 17. LED Indicators



Screen colors

Colors are used on the screen to indicate the status of buttons and to highlight operating sequences.

Color	Meaning
Light green	– can be operated, leads to another menu or operating function – not yet active, presettings
Yellow	– selected, can be changed or set, not yet confirmed
Dark green	– active parameter, can be operated – current selection (configuration menu)
Gray type	– cannot be operated

Ventilation Buttons

The ventilation buttons appear dark green when operable and turn yellow when selected. Once the value is changed and confirmed, the button turns back to dark green.

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Some values change automatically when another parameter button is selected, and those values will be displayed in yellow in addition to the selected parameter.

Values shown in gray indicate that:

– there is a discrepancy between set and actual values, or
– specified accuracy is not being maintained.

Monitoring/Configuration Buttons

The monitoring buttons along the right side of the screen appear light green when operable. When selected, their color changes to dark green. They also change to dark green when another submenu or function is displayed.

Colors of Parameter Settings/Values in Menus

When the user selects a menu the parameters and values will appear on a dark green background. Currently selected submenus are framed in an orange border. Parameters in gray type are inactive and cannot be selected.

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System Setup

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Overview

This chapter of the Operating Instructions provides information on how to set up and install all system components needed to prepare the Apollo for use. The setup procedure shall be followed by the performance of the periodic manufacturer's procedure.

WARNING!

Risk of patient injury.

Correct preparation of the anesthesia machine is required to minimize the general risks associated with the anesthesia machine.

Use only clean and disinfected parts and always strictly follow the cleaning and assembly instructions contained in these Operating Instructions to prevent infection of patient or user.

Preparation before first use

The Apollo has to be prepared before first use according to the cleaning and disinfection guidelines in the chapter "Disinfecting/Cleaning/Sterilizing" on page 212.

Charging the battery for emergency operation

Apollo has a built-in uninterruptible power supply UPS which maintains the power supply for at least 30 minutes (up to 90 minutes, depending on the ventilation parameters) in the event of a mains power failure, provided that the battery is fully charged.

Switching to battery power (UPS) takes place automatically and is indicated on the screen by the message: **POWER FAIL**.

The battery recharges automatically when the anesthesia machine is plugged into the mains, but only up to a maximum ambient temperature of 95° F/ 35° C.

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The battery must be charged for 10 hours before using the anesthesia machine for the first time:

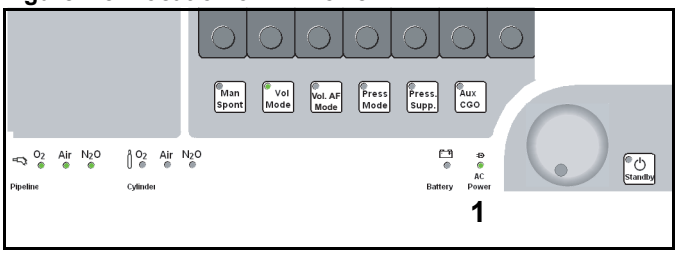
1. Plug the mains power plug of the Apollo anesthesia machine into the mains outlet.

The mains voltage must correspond to that specified on the rating plate on the back of the machine.

The green LED labeled >⏻ AC Power< lights up (**1** in Figure 18).

2. Leave the Apollo connected to the mains for 10 hours. The anesthesia machine does not have to be switched on.

Figure 18. Location of AC Power LED



CAUTION!

Risk of device failure.

In the event of a power failure, any devices connected to auxiliary power outlets will not be powered by the UPS.

Pay special attention to all power indicators of connected devices.

WARNING!

Risk of battery failure.

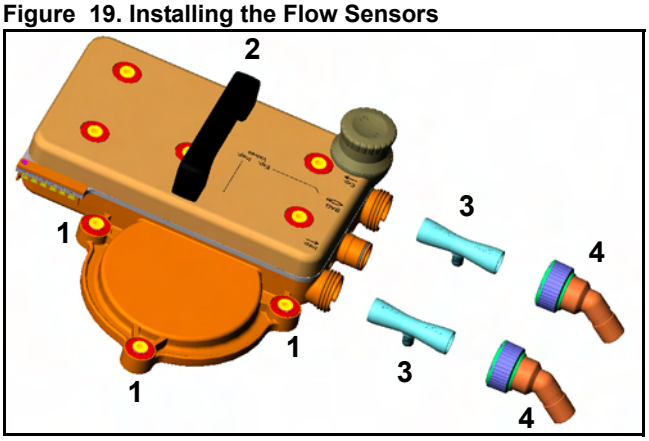
Allowing the battery to run low can damage it.

It must be charged at least every four weeks.

Installing the breathing system and flow sensors

1. Press the release button on the ventilator unit and pull it out.
2. Loosen the three sealing screws on the ventilator (**1** in Figure 19) a quarter turn counterclockwise with the wrench supplied.
3. Pull the breathing system up and out by the handle (**2** in Figure 19).
4. Unscrew the inspiratory and expiratory ports (**4** in Figure 19) by turning them counterclockwise.
5. Insert the flow sensors (**3** in Figure 19) into the two port connections on the breathing system,

Figure 19. Installing the Flow Sensors



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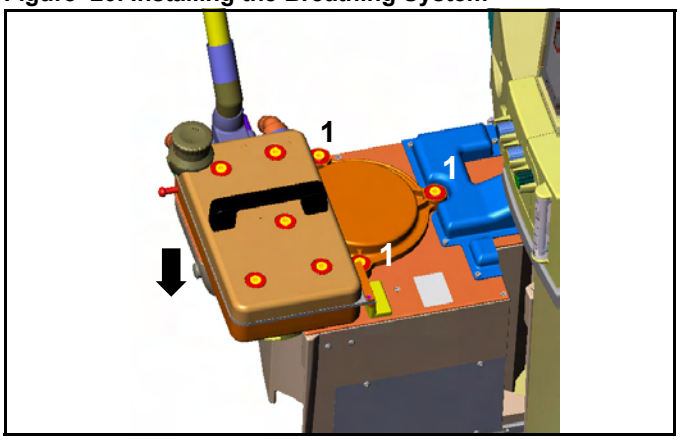
with the electric connection on each sensor facing down in the slot.

Note: Flow sensors must be recalibrated after replacement by performing the power-on self test (see chapter "Pre-use Checkout").

6. Orient the inspiratory and expiratory ports (**4** in Figure 19) so that the key on each port lines up with the slot. Install the ports and tighten by turning clockwise. Carefully seat the breathing system onto the ventilator module, and tighten the three sealing screws (**1** in Figure 20) on the ventilator cover.

Figure 20. Installing the Breathing System



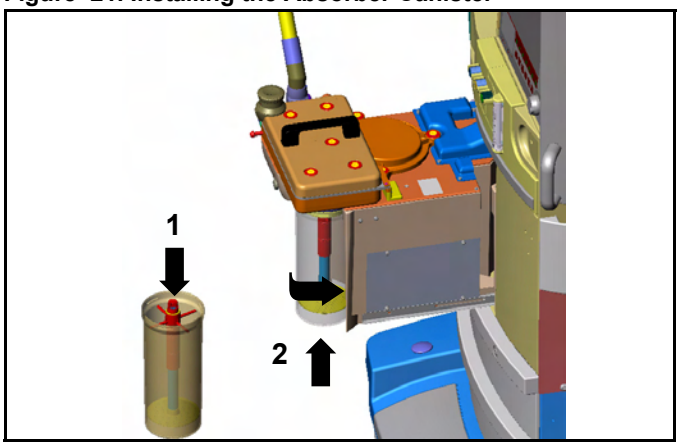
Filling and installing the absorber

A reusable absorber or the disposable CLIC absorber can be used.

Reusable absorber

1. Push the insert fully into the absorber canister (**1** in Figure 21).
2. Fill the absorber canister with fresh soda lime up to the **MAX** mark.

Figure 21. Installing the Absorber Canister



WARNING!

Risk of injury.

Absorbent is caustic and is a strong eye, skin, and respiratory tract irritant.

Use care when handling the absorbent to avoid spills.

CAUTION!

Risk of device failure.

It is recommended that Drägersorb 800 + or Drägersorb FREE are used.

Do not use powdered soda lime, as a higher dust load may impair functionality of the Apollo anesthesia machine.

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3. Fit the canister into position below the breathing system, and turn counterclockwise as far as possible (**2** in Figure 21).
4. Slowly push in the ventilator module until it engages.
5. Reset the soda lime change log to current date by pressing the >**soda lime changed**< button, see page 77.

If the breathing system is not to be used within the next 24 hours:

– Only fill with soda lime immediately before use.

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Disposable CLIC absorber (optional)

The appropriate adapter must be installed by trained personnel, e.g. DrägerService.

WARNING!

The disposable absorber must be clicked into place before switching on the Apollo. This ensures that the absorber is included in the leak and compliance test for the anesthesia machine.

To click the absorber into place:

1. Press the button (**1** in Figure 22); the mounting swings open.
2. Before fitting, shake the disposable absorber, e.g. by turning it upside down several times in order to loosen the soda lime.
3. Remove the seal from the new disposable absorber.
4. Slide the new disposable absorber onto the mounting (**2** in Figure 22).
5. Push the absorber into the anesthesia machine until it engages.
6. Reset the soda lime change log to current date by pressing the >**soda lime changed**< button, see page 77.

WARNING!

Risk of patient injury.

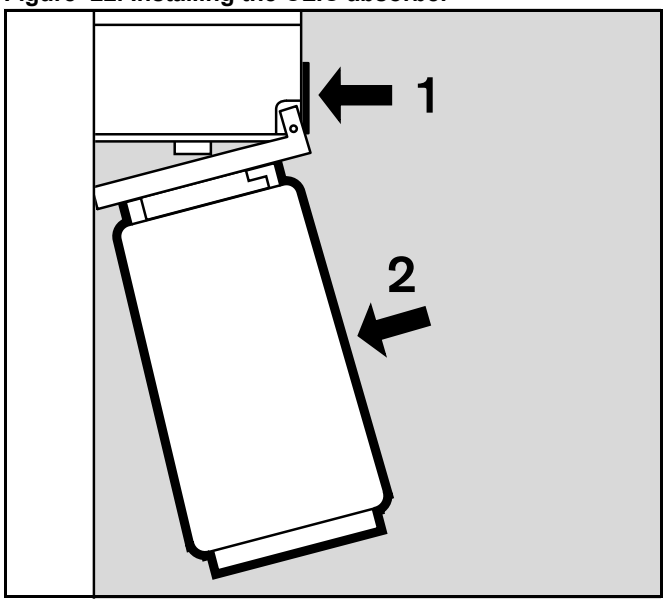
The soda lime loses humidity. Generally, if the humidity falls below a minimum set point, the following undesirable reactions can occur, independent of the type of lime and the inhalation anesthetic being used:

- **reduced CO2 absorption;**
- **increased heat build-up in the absorber and thus, an increased breathing gas temperature;**
- **formation of CO;**
- **absorption and/or decomposition of the inhalation anesthetic.**

These reactions could pose a danger to the patient.

If using dry gases, only briefly flush the anesthesia system and only if necessary.

Figure 22. Installing the CLIC absorber



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Connecting the gas supply

WARNING!

Risk of explosion, fire.

Oil and grease may combine explosively with oxygen or nitrous oxide. For this reason, oil and grease must never come in contact with pipelines, cylinders, cylinder valves, gauges, fittings, etc., which conduct oxygen or nitrous oxide within the machine.

CAUTION!

Risk of gas supply failure.

If all gas supplies (pipeline or cylinder) are not connected correctly, the reserve system will not be available in the event of a gas supply failure.

Make sure that all supplies are connected according to the engraving on the gas supply block and the illustrations at the back of the machine. After connecting the supplies, ensure proper functionality.

CAUTION!

Risk of device failure.

Compressed gas supply (pipeline or cylinder): To avoid damaging the device(s) attached to a gas supply, use only medical gases. Pay particular attention to national and international standards regulating the use of medical gases.

Part Number: 9039994, 2nd edition

Connecting pipeline supply of N_2O, Air, and O_2

WARNING!

Risk of patient injury.

Pipeline delivery hoses used between wall outlets and anesthesia machines have caused accidents when, during assembly, an oxygen fitting was placed on one end of the hose and a nitrous oxide fitting on the other end.

Carefully check hoses each time you connect a machine to a wall outlet to ensure that both ends of the hose are indexed for the same gas.

CAUTION!

Risk of device failure.

In order for the inhalation anesthesia machine to operate as specified, the supply pressures at the machine inlet must be within a range of 2.7 and 6.9 kPa x 100.

Make sure this is the case before initiating operation.

1. Connect the gas fitting on each pipeline supply hose to the corresponding fitting on the gas supply block on the rear of the machine (see Figure 23).
2. Connect the other end of the pressure hoses to the terminal unit.
3. Make sure that all supplies are connected correctly and functioning properly.
4. Ensure that the pipeline pressures are between 50 psi and 55 psi (see “Operating data” on page 254 for ranges) by checking that the three pipeline supply LEDs on the front machine panel (**1** in Figure 24) are illuminated green.

   If the pipeline supply pressure LEDs remain dark, it means that the pressure is below 39 psi or that the hoses are not connected properly.

Figure 23. Pipeline supply connections

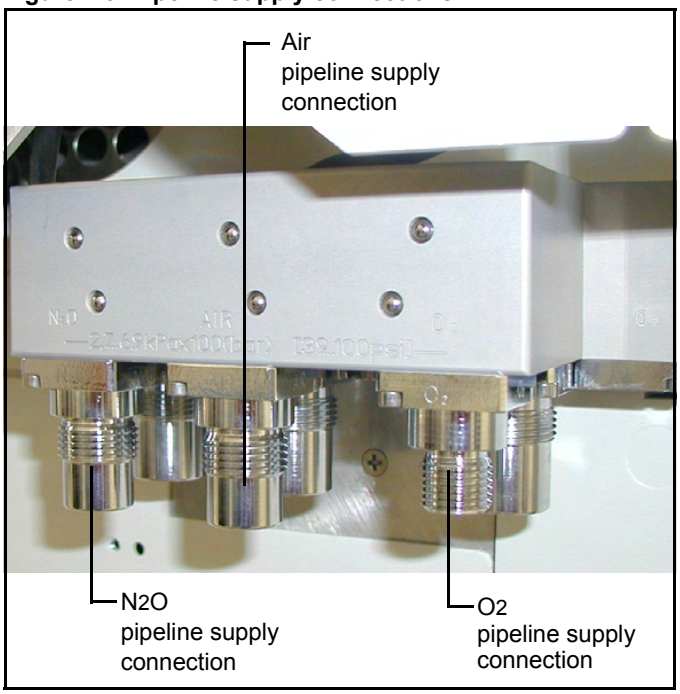
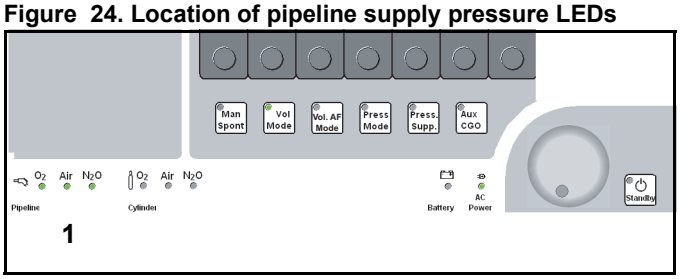


Figure 24. Location of pipeline supply pressure LEDs



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Connecting the backup gas cylinders for O_2, N_2O, and Air

CAUTION!

Risk of gas supply failure.

Should the pipeline gas supply fail, the backup gas cylinders on the anesthesia machine will provide a reserve gas supply.

To prevent a complete gas failure, the backup gas cylinders should remain on the device, valves closed, in reserve even if the anesthesia machine is connected to pipeline gas supply.

The Apollo is equipped with ANSI standard pin-indexed hanger yokes for E-size cylinders to connect backup gas cylinders to the anesthesia machine. The yoke for O_2 is standard, the yokes for N_2O and Air are optional. All cylinder yokes are located on the back of the machine as shown in Figure 25.

WARNING!

Risk of gas supply failure.

When attaching a cylinder, ensure that only one washer is installed between the cylinder and the yoke gas inlet. The use of multiple washers will inhibit the pin-index safety system. Be sure to verify the presence of the index pins each time a cylinder is installed. Never attempt to override the pin-index safety system.

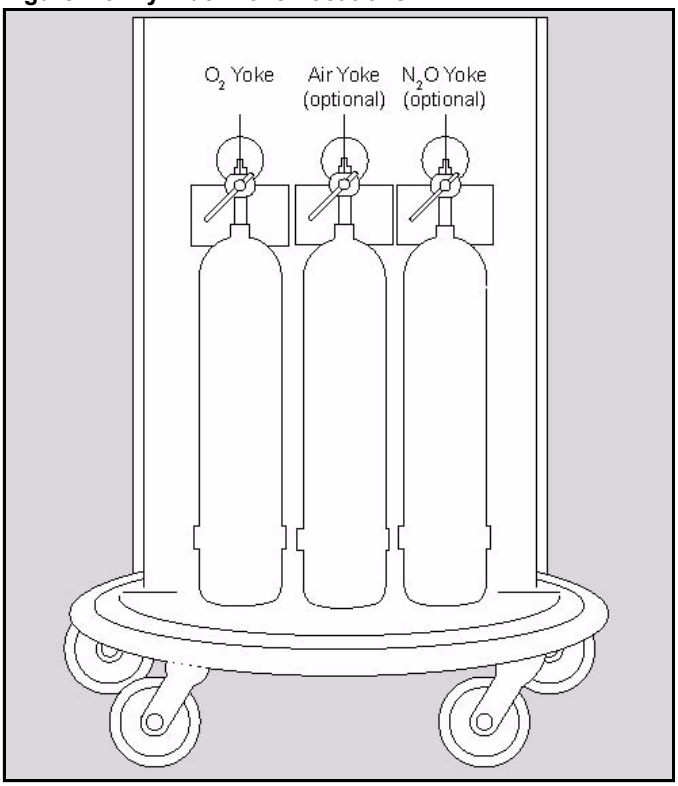
WARNING!

Risk of supply failure.

If pressure reducers not having the required sensors and measurement features are used instead of Dräger pressure reducers, backup gas cylinders and their fill levels will not be subject to alarm and monitoring functionalities during the power-on self test and operation.

Without this monitoring, in the event of a loss of the pipeline gas supply, the backup functionality of the backup gas cylinders may not be available. If monitoring for the remaining capacity of the backup gas cylinders is not available, the user must take other equivalent measures.

Figure 25. Cylinder Yoke Locations



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The numbers in boldface in Step 1 below refer to Figure 26.

1. Connect a gas cylinder **(1)** to its yoke as specified below:
   - Remove the old washer **(2)** and install a new washer on the seat of the yoke gas inlet connection.
   - Verify that the two index pins **(3)** below the gas inlet **(4)** are present.
   - Insert the head **(5)** of the gas cylinder into the yoke from below. Ensure that the gas outlet and indexing holes on the cylinder head align with the gas inlet and index pins of the yoke assembly **(6)**. Engage the indexing holes with the index pins.
   - Turn the yoke handle **(7)** clockwise against the cylinder head, so that the point of the yoke handle bolt is aligned with the indent on the back of the cylinder head. Verify that the washer is in place, the index pins are engaged, and the cylinder hangs vertically.
   - Tighten the yoke firmly.

Note: When required, the cylinder valve **(8)** is opened using the cylinder wrench **(9)** that is provided.

2. Connect the hose from each cylinder to the corresponding ports of the gas supply block on the back of the machine (see Figure 27).
3. Open the cylinder valves.
4. To ensure that the cylinder pressures are adequate, check that the gauges above the cylinder yokes indicate pressures recommended in Table 2 on the next page. Also, if the cylinder pressures are adequate, the cylinder pressure LEDs on the front machine panel (**1** in Figure 28) are illuminated green.

If the cylinder pressure LEDs remain dark, it means that the cylinder pressure is inadequate or that the cylinders are not connected properly.

5. Close the cylinder valves.

Figure 26. Pin-Index Cylinder Mounting

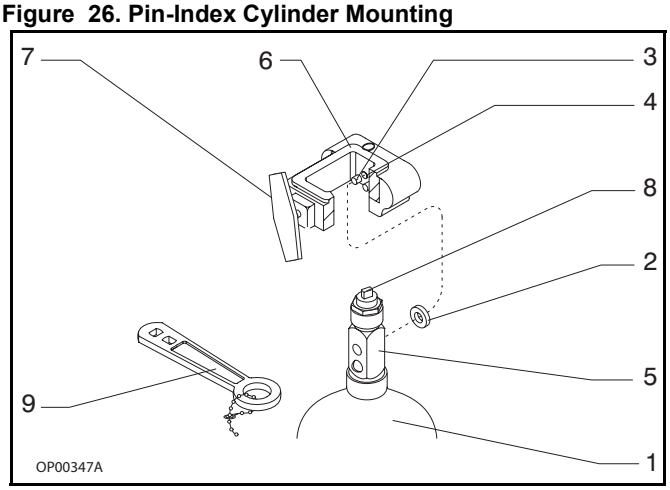


Figure 27. Cylinder Connections

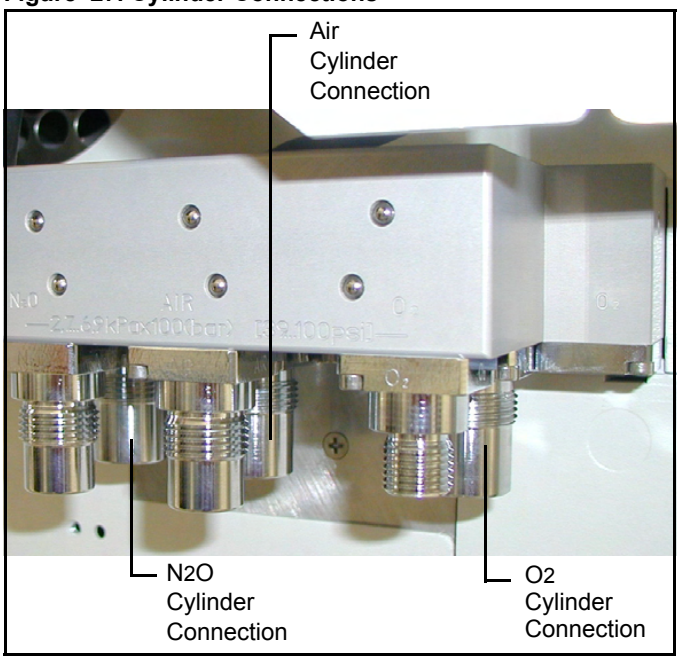
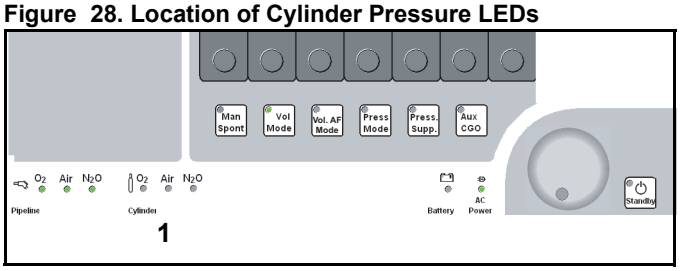


Figure 28. Location of Cylinder Pressure LEDs



WARNING!

Risk of gas supply failure.

If the valves remain open when connected to the pipeline gas supply, gas may be withdrawn from the backup gas cylinders.

Close backup gas cylinder valves whenever pipeline gas supply is sufficient.

Cylinders attached to the hanger yokes must contain gas at the recommended pressures shown in Table 2. (Indicated pressures are for E-size cylinders at 70°F/21°C.) Cylinders measuring less than the minimum recommended pressure (PSI - MIN) should be replaced with new, full cylinders.

Table 2. Recommended Cylinder Gas Pressures

GAS	PSI/bar - FULL (typical full load)	PSI/bar - MIN
Air	1900/131	1000/69
N_2O	745/51	600/42
O_2	1900/131	1000/69

Caution when handling O_2 cylinders

WARNING!

Risk of explosion.

Oil and grease may combine explosively with oxygen.

For this reason, oil and grease must never come in contact with pipelines, cylinders, cylinder valves, gauges, fittings, etc., which conduct oxygen.

Note: Follow the Instructions for Use included with the pressure regulator.

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Connecting the scavenger system

The Apollo can be equipped with one of two kinds of scavenger systems to provide the best match with the hospital's waste-gas disposal system. These scavenger systems must comply with ISO 8835-3.

Connecting the anesthetic gas receiving system AGS (Optional)

The anesthetic gas receiving system AGS is used with vacuum waste-gas disposal systems.

CAUTION!

Risk of increased ambient gas concentration.

Ambient air may become contaminated with anesthetic agent if the scavenger hoses are functionally inhibited.

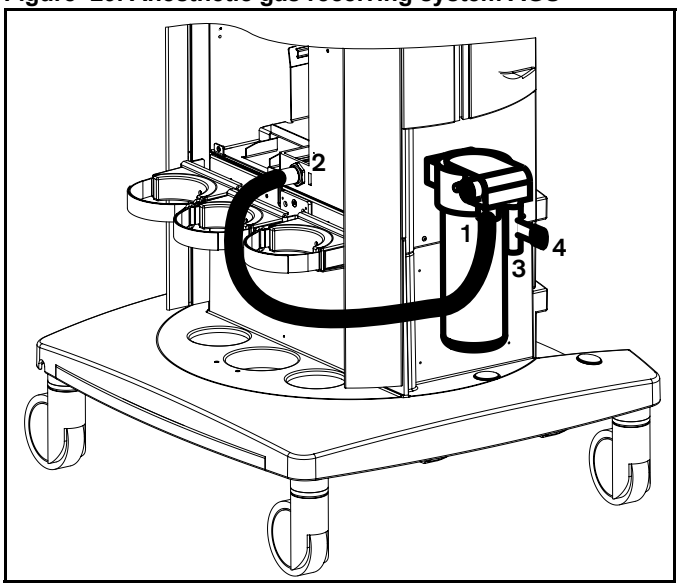
The scavenger hoses must not be pinched, kinked, or blocked in any manner.

1. Install the receiving system on the machine by sliding its bracket onto the two shoulder screws on the side of the machine.
2. Connect one end of the transfer hose to the fitting on the receiving system (**1** in Figure 29).
3. Connect the other end of the transfer hose to the scavenger connection on the back of the anesthesia machine (**2** in Figure 29).
4. Connect the waste-gas vacuum hose to the output connection on the receiving system (**3** in Figure 29).
5. Connect the other end of the vacuum hose to the hospital waste-gas disposal system.

Note: Activate hospital vacuum system before using the receiving system.

Note: During use, the float indicator in the flow indicator should stay between the upper and lower marks. If necessary, regulate flow using the flow adjustment valve (**4** in Figure 29).

Figure 29. Anesthetic gas receiving system AGS



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WARNING!

Risk of patient injury.

If the AGS manifold is blocked, negative pressure may result in the breathing system and the patient's lungs.

Always make sure the manifold is not blocked.

Note the Instructions for Use of the anesthetic gas receiving system AGS.

Connecting the passive scavenger system (Optional)

The passive scavenger system is used only with non-recirculating exhaust systems. It is not meant to be used with vacuum disposal systems.

CAUTION!

Risk of increased ambient gas concentration.

Ambient air may become contaminated with anesthetic agent if the scavenger hoses are functionally inhibited.

The scavenger hoses must not be pinched, kinked, or blocked in any manner.

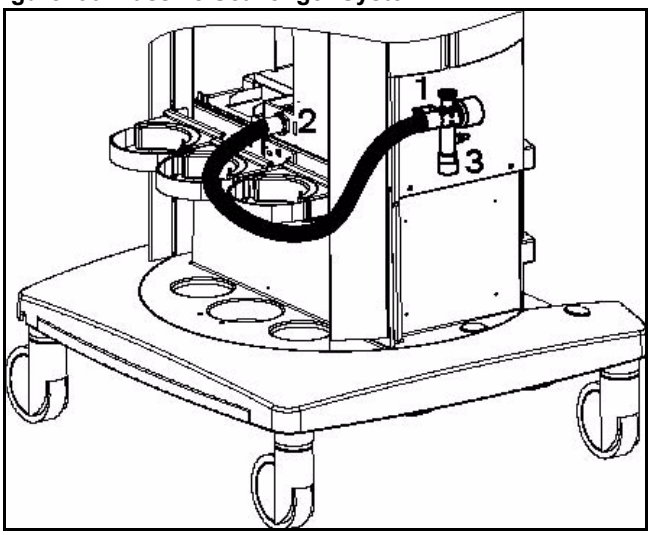
1. Install the passive scavenger on the machine by sliding its bracket onto the two shoulder screws on the side of the machine.

Note: Remove the socket from the scavenger hose before connecting.

2. Connect one end of the transfer hose to the side fitting on the scavenger (**1** in Figure 30).
3. Connect the other end of the transfer hose to the scavenger connection on the back of the anesthesia machine (**2** in Figure 30).
4. Connect the waste-gas hose to the bottom connection on the scavenger (**3** in Figure 30).
5. Connect the other end of the hose to the hospital waste-gas disposal system.

For detailed information on the passive scavenger system, refer to separate Instructions for Use.

Figure 30. Passive Scavenger System



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Connecting the endotracheal aspiration system (Optional)

The optional endotracheal aspiration system for the Apollo consists of a suction regulator and a bracket that attaches to the side of the anesthesia machine. The bracket is used to hold the regulator and a suction bottle assembly of the customer's choice.

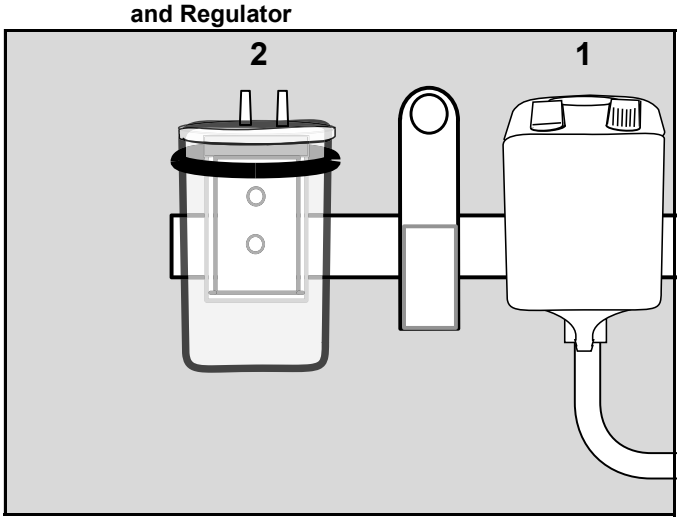
1. Attach the endotracheal aspiration system bracket to the side rail on the left side of the anesthesia machine.
2. Mount the suction regulator (**1** in Figure 31) onto the bracket.
3. Prepare the suction bottle assembly according the Instructions for Use provided with the bottle.
4. Install the bottle assembly in the slide mount (**2** in Figure 31) on the bracket.
5. Make all necessary connections between the suction bottle, suction regulator, and piped vacuum system as specified in the Instructions for Use provided with the endotracheal aspiration system.

WARNING!

Risk of patient injury.

Do not apply unregulated suction to the patient circuit when using this device.

Figure 31. Endotracheal aspiration system Bracket and Regulator



Installing vaporizers

Install vaporizers as directed in the appropriate Instructions for Use supplied with the vaporizers available for use with the Apollo.

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Installing the flexible arm for the manual breathing bag

WARNING!

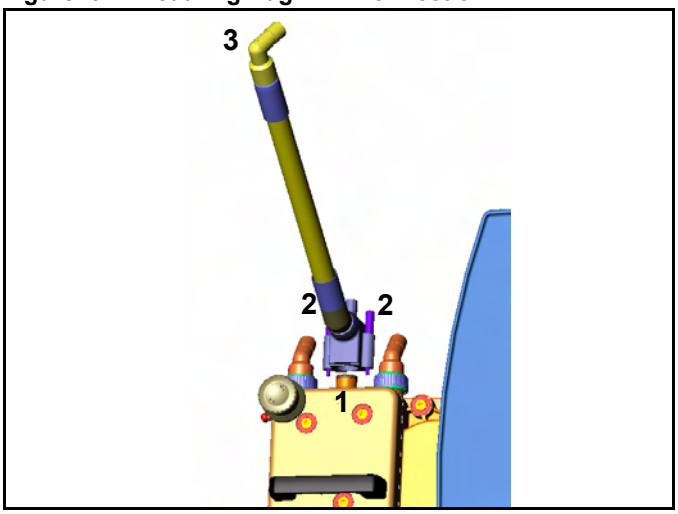
Risk of patient injury.

If incompatible materials are used in the patient circuit, metabolic products may build up.

Breathing bags used on the Apollo must comply with current ANSI standards.

1. Slide the bag arm assembly onto the breathing bag port on the side of the breathing system (**1** in Figure 32).
2. Tighten the two thumb screws (**2** in Figure 32) to secure.
3. Attach the 90° fitting to the end of the bag arm (**3** in Figure 32), and attach the breathing bag to the other end of the fitting.

Figure 32. Breathing Bag Arm Connection



Installing the patient system

WARNING!

Risk of burns.

Conductive breathing hoses or face masks may cause burns during HF surgery.

Do not use these types of hoses and masks in combination with HF surgery.

CAUTION!

Risk of inadequate gas concentrations.

If the patient system components are not tightly connected, ambient air will be added to the gas mixture.

Make sure that all patient system components are tightly connected.

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Note: Apollo (without accessories) has no components containing latex. For latex-free use: Use latex-free breathing bag and breathing hoses

Note: Only use original sample line - other lines may change the technical data for the device.

Note: For sample lines available for use with the Apollo, see the Accessories List, P/N 8603528.

Advisory when using accessories for ventilating adults, children, and neonates

When applying the lower tidal volume limits of a particular patient group, use a smaller breathing bag and a smaller breathing hose set.

When ventilating, in particular neonates and children, it is important to set the patient age properly.

Depending on the patients' age setting, the MAC and xMAC algorithms, the trigger sensitivity, and the sensitivity of the flow measurement adapt automatically.

Table 1. Advisory when using accessories

Tidal volume	Manual breathing bag	Hose set
<50 mL	0.5 L	neonatal (or pediatric)
50 mL to 200 mL	1 L	pediatric
201 mL to700 mL	2 L	adult
>700 mL	3 L	adult

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Connecting the patient circuit

Note: If you use a microbial filter on the Y-piece, do not use microbial filters in the inspiratory and expiratory ports of the breathing system.

WARNING!

Risk of patient injury.

To protect the patient from particles and dust, a filter must be used between the inspiratory limb of the breathing circuit and the patient, i.e. Y-piece filter or filter on inspiratory limb.

1. Connect 22 mm (0.87 in) breathing hoses to the inspiratory and expiratory ports or to the optional microbial filters or filters on the breathing system (**1** in Figure 33).
2. Connect the other end of the breathing hoses to the Y-piece (**2** in Figure 33), or to the optional filter on the Y-piece.
3. Make sure the breathing bag is attached.
4. Fit the new or empty water trap into its holder on the front of the machine (**3** in Figure 33) until it clicks into place.
5. Connect one end of the sample line to the Luer Lock on the water trap (**4** in Figure 33).
6. Connect the other end of the sample line to the Luer Lock on the Y-piece (**2** in Figure 33). Ensure that all Luer fittings are securely connected.
7. Make sure that the sample line is guided correctly by using the sample line clip. This clip should be attached to the expiratory port of the breathing system.

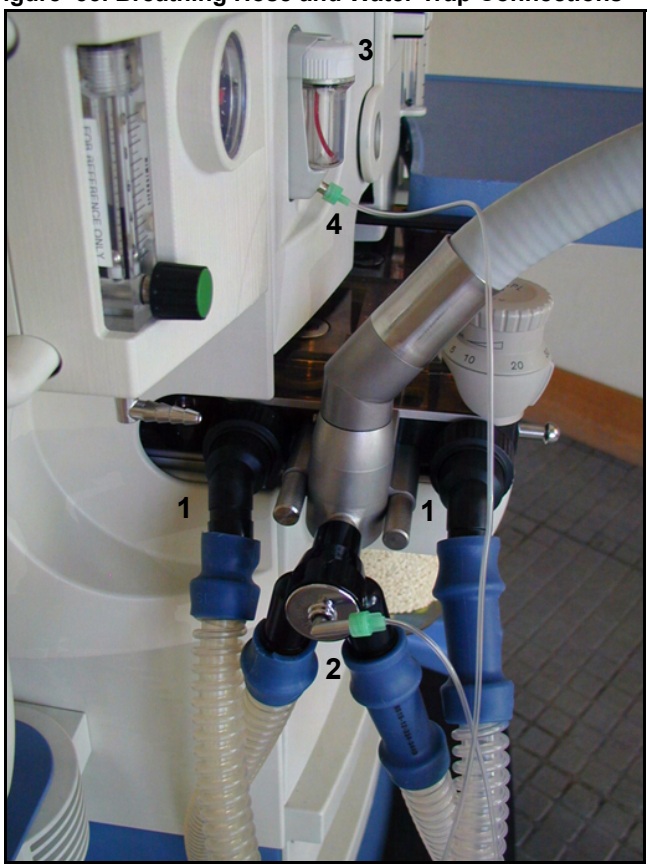
CAUTION!

Risk of gas measurement failure and device failure.

Disinfectants can damage the sample gas line and the diaphragm of the water trap.

Sample gas lines are single-use articles and must not be disinfected.

Figure 33. Breathing Hose and Water Trap Connections



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WARNING!

Risk of gas measurement failure.

If the water trap is used longer than intended, the diaphragm may become brittle and allow water and bacteria to enter the measurement system. Such contamination affects the gas measurement which may fail as a result.

The water trap must be replaced at least every four weeks.

WARNING!

Risk of gas measurement failure and device failure.

If alcohol or cleaning agents/disinfectants come in contact with the inside of the water trap, they can damage the diaphragm and the measurement system may fail as a result.

Do not use these substances and do not wash, flush, or sterilize the water trap.

WARNING!

Risk of patient injury.

If the APL valve becomes blocked due to e.g. lines or cables being caught under the knob, the patient may be endangered.

Route all cables away from the APL valve; do not hang lines, hoses or cables, e.g. the sample line, on or near the APL valve.

CAUTION!

Risk of contamination of the device.

Do not put the device into operation without a water trap.

CAUTION!

Risk of inaccurate data.

Silicone can enter the measuring cuvette and distort the gas measurement and it may fail as a result.

Do not spray the O-rings of the water trap holder with silicone spray.

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CAUTION!

Risk of inaccurate data.

Aerosols can damage the diaphragm and the measurement system may fail as a result.

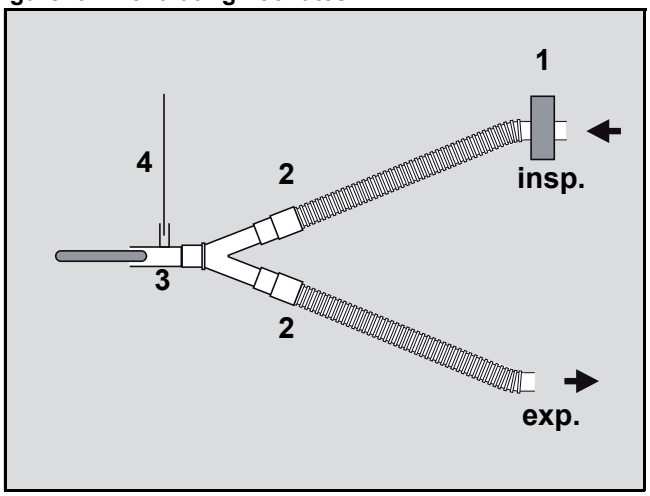
Do not use aerosols in the breathing system. The water trap must not be used in combination with a medical nebulizer.

Ventilating neonates

1. For tidal volumes V_T of less than 50 mL: use pediatric hoses.
2. Use a microbial filter with a low resistance and a low compliance. At this location in the breathing circuit (**1** in Figure 34), the resistance of a microbial filter remains constant due to less humidity in the inspiratory gas mixture. In the expiratory hose, no filter should be used to avoid the possibility of building up an intrinsic PEEP in the patient's circuit.
3. Slip the breathing hoses with the large sleeves onto the inspiratory and expiratory sockets and connect the small sleeves (**2** in Figure 34) to the Y-piece.
4. Use a tube adapter (**3** in Figure 34) with connection for the sample line (**4** in Figure 34). Tube adapters with a side port for connecting a sample line support the CO_2 measurement and help flush the dead space in the Y-piece and tube adapter.
5. Connect a 0.5 L breathing bag with socket to the large connection sleeves. Slip the breathing hose over the angled connector.
6. Connect the sample line to the side port of the tube adapter.

To determine the system compliance and leakage, firmly connect the Y-piece to the cone. When doing so, use the patient circuit which will be used for the next case.

Figure 34. Ventilating neonates



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WARNING!

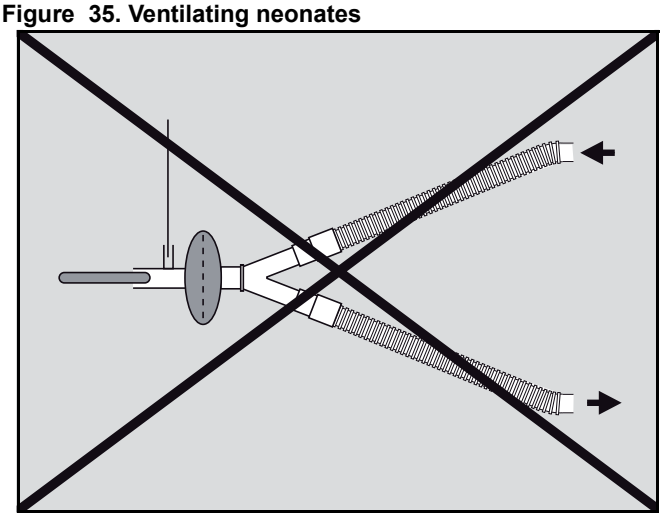
Risk of patient injury.

If filters are blocked, sample gas taken from the patient's lungs could quickly lead to a negative lung pressure.

When ventilating children and neonates, do not use HME filters or other filters at the Y-piece in connection with a tube adapter having a connection for a sample line in the patient circuit.

For measurement purposes, a permanent side stream flow of 200 mL/min runs through the sample line to the gas measurement system. In case of a blocked HME filter or filter in this position at the Y-piece, the measurement system would produce negative pressure situations in the patient's lungs.

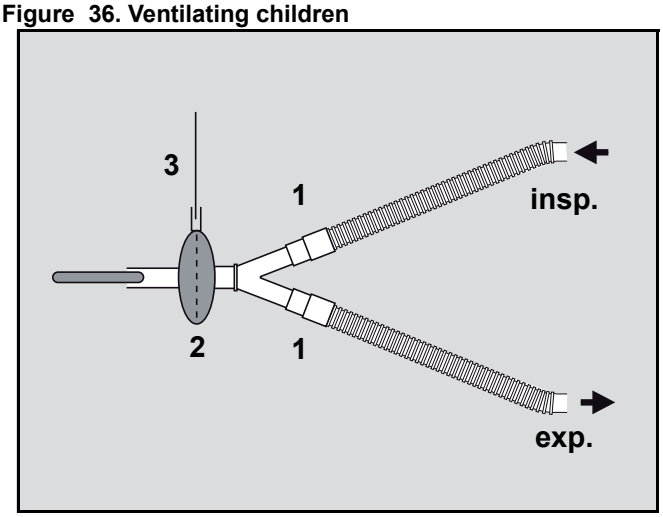
Figure 35. Ventilating neonates



Ventilating children

1. For tidal volumes V_T between 50 mL and 200 mL: use pediatric hoses.
2. Slip the breathing hoses with the large sleeves onto the inspiratory and expiratory sockets and connect the small sleeves to the Y-piece (**1** in Figure 36).
3. Use an HME filter (**2** in Figure 36) or filter with connection for the sample line.
4. Connect the breathing bag with socket to the large connection sleeves. Slip the breathing hose over the angled connector.
5. Connect the sample line (**3** in Figure 36) to the HME filter or filter and water trap.

Figure 36. Ventilating children



Part Number: 9039994, 2nd edition

WARNING!

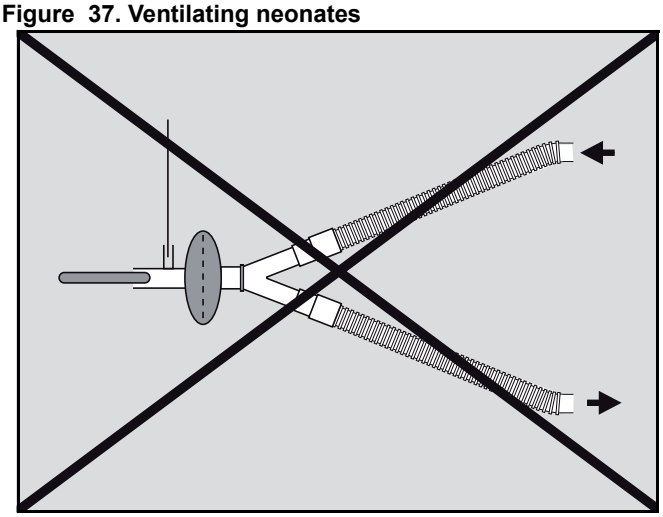
Risk of patient injury.

If filters are blocked, sample gas taken from the patient's lungs could quickly lead to a negative lung pressure.

When ventilating children and neonates, do not use HME filters or other filters at the Y-piece in connection with a tube adapter having a connection for a sample line in the patient circuit.

For measurement purposes, a permanent side stream flow of 200 mL/min runs through the sample line to the gas measurement system. In case of a blocked HME filter or filter in this position at the Y-piece, the measurement system would produce negative pressure situations in the patient's lungs.

Figure 37. Ventilating neonates



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Connecting AC power

Connecting auxiliary devices

The Apollo has two auxiliary outlets on the back of the machine (**1** in Figure 38). Each outlet is rated 4 amps and is protected by circuit breakers.

1. Connect the external device to an outlet on the back of the machine

CAUTION!

Risk of device failure.

In the event of a power failure, any devices connected to auxiliary outlets will not be powered by the UPS.

Pay special attention to all power indicators of connected devices.

CAUTION!

Risk of device failure.

If HF surgical devices are connected to the auxiliary outlets, the leakage current may influence the electronics of the anesthesia machine causing it to fail.

Do not connect HF surgical equipment to the anesthesia machine's auxiliary outlets.

There is also a dedicated (2 amp) outlet for a Desflurane vaporizer on the side of the machine, above the vaporizer mount (**1** in Figure 39). This outlet is protected by safety fuses.

1. Install the Desflurane vaporizer in its mount and connect it to the outlet on the side of the machine.

WARNING!

Risk of device failure.

If additional power extension sockets are connected to the auxiliary outlets, device internal electronics may be overloaded.

Do not connect additional power adapter sockets to the auxiliary outlets.

Figure 38. Location of Auxiliary Outlets on Back of Machine

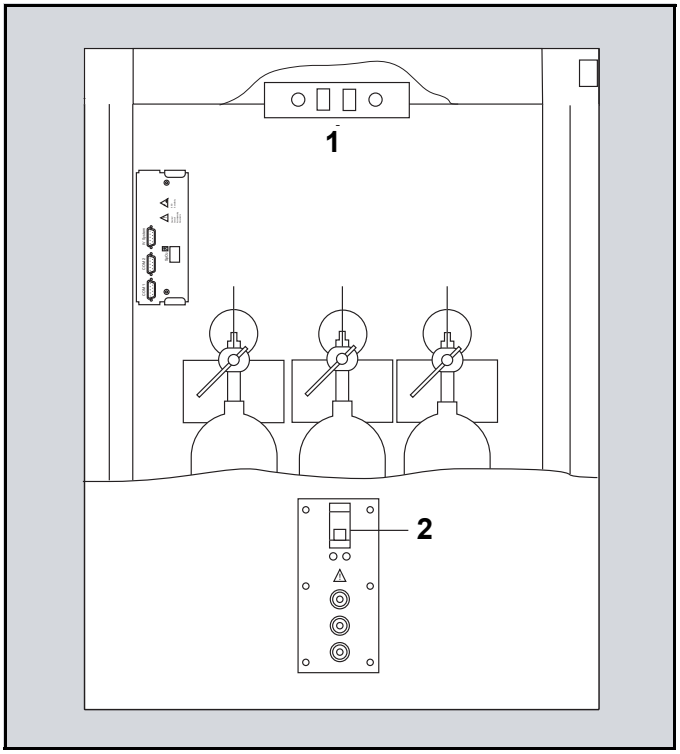
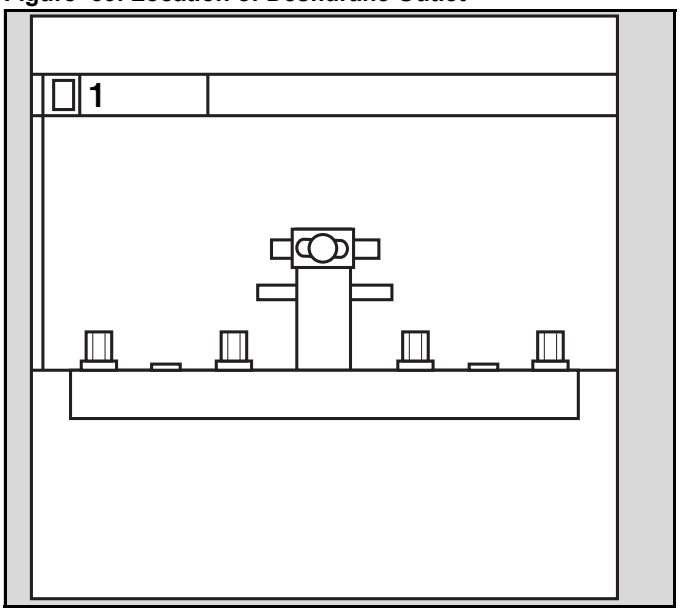


Figure 39. Location of Desflurane Outlet



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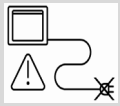
WARNING!

Risk of electric shock.



Connecting devices to the auxiliary outlets of the anesthesia machine can cause an increase in leakage current beyond permissible values if the protective conductor of a device fails.

Check the leakage current when connecting devices to the auxiliary outlets. If connecting a device (or devices) increases the leakage current to a value which exceeds the permissible value, do not use the auxiliary outlets of the anesthesia machine: use a separate wall socket.

The system must meet the requirements for medical equipment in accordance with IEC/EN 60601-1-1 and IEC/EN 60601-1-2.

Fuses for auxiliary outlets

If a circuit breaker is tripped (position 0):

1. Remedy the fault.
2. Press the switch on the circuit breaker into position 1.

The circuit breaker is active again.

In cases of a blown safety fuse:

1. Remedy the fault.
2. Have the safety fuse replaced by an electrician.

Connecting the Apollo to ground

For e.g. intracardiac or intracranial surgery.

1. Connect one end of the grounding cable to one of the connecting pins located at the back of the anesthesia machine.
2. Connect the other end of the grounding cable to the specified grounding point, e.g. on the operating table or ceiling lamp.
3. Connect potential equalization point to the auxiliary systems.

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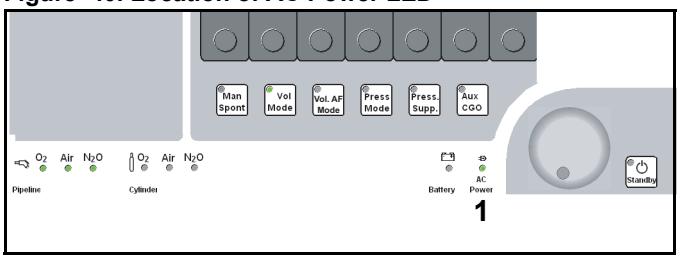
Connecting the Apollo to mains power

The mains voltage must correspond to that specified on the rating plate on the back of the machine.

1. Plug the mains power plug of the Apollo anesthesia machine into the mains outlet. The green LED labeled >⏻ AC Power< lights up (**1** in Figure 40).

Note: The main circuit breaker for the machine is located on the back of the machine below the pipeline supply connections and behind the cylinder mounts (**2** in Figure 38).

Figure 40. Location of AC Power LED



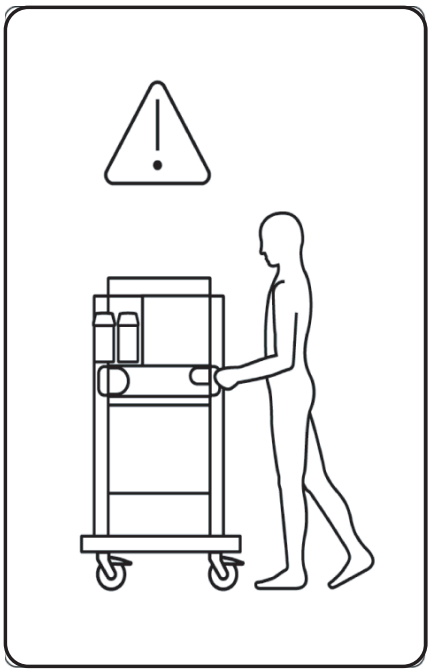
Information about transport within the clinic

Transport is defined as:

– Moving the device, other than for pure calibration purposes.
– Removing the ceiling/wall-mounted variant from the corresponding holder.

When transporting the anesthesia device:

– Only move the device using the handles provided for this purpose.
– The anesthesia device should only be moved by persons who are physically able.
– Dräger recommends that the anesthesia device should be moved by two persons. This also helps to improve maneuverability.
– Take special care not to bump or knock the device when moving it over uneven surfaces, around corners or at thresholds (e.g. in doors or elevators).
– Do not attempt to drag the device over hoses, cables, or other obstructions on the floor.



WARNING!

Risk of injury.

If handled incorrectly, the anesthesia machine may become top-heavy and tip over causing injury to patients and/or operators.

Observe the following points to prevent this hazard.

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To increase toppling stability:

– Remove all monitors and devices from the upper storage area.
– Dismantle any additional mounted devices on swivel arms or on the upper side of the device (e.g. patient monitoring, data management systems, syringe pumps, etc.)
– Clear the writing table and fold it down completely.
– Position the breathing bag arm close to the device.
– Push in the ventilator module and drawers.

CAUTION!

Risk of physical injury.

To avoid physical injury, e.g. pinching, pay special attention to edges, moving parts and corners when working with
– drawers,
– the ventilator module,
– doors,
– the writing tray,
– swivel arms for mounted devices,
– gas cylinders,
– vaporizer units,
– CLIC absorbers and CLIC adapters,
as well as other accessories.

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Pre-use Checkout

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Overview

The pre-use checkout procedure must be performed to ensure that the Apollo is ready for use. This is a recommended procedure. Follow the institution's policies for specific procedures.

If the Apollo fails any checkout routine, do not use the machine until corrective action is taken. If indicated, contact an authorized representative of DrägerService for inspection of the unit.

WARNING!

Risk of device failure and/or patient injury.

Do not insert any additional components into or modify the Apollo after the checkout procedure has been started.

The anesthesia machine will not meet the specified technical data.

WARNING!

Risk of patient injury.

Inappropriate hose length affects compliance and can result in incorrect tidal volume delivery to the patient.

Patient hoses must be adjusted to the appropriate lengths prior to performing the leak and compliance tests.

Checking the Workstation according to the Check List

The pre-use checkout procedure consists of a manual procedure performed by the user, followed by an automated self test. The manual procedure is summarized in the check list that is displayed after the machine is powered on.

Prerequisites

The device has been prepared (see "Cleaning and Maintenance" on page 201) and assembled ready for operation.

The pipeline supply and the power supply must be connected.

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WARNING!

Risk of explosion, fire.

If an oxygen leak is suspected within or near the inhalation anesthesia machine, do not initiate operation.

Disconnect all oxygen supplies and contact a trained service technician.

CAUTION!

Risk of inadvertent movement.

If not properly secured, the device may move inadvertently during operation.

Apply the brakes on the device to ensure it cannot be moved accidentally.

WARNING!

Risk of electric shock.

Connect the electrical power cable to a hospital-grade live AC receptacle that accepts and properly grounds the power cable. Do not use “cheater plugs”. The term “cheater plug” implies any and all electrical plugs or other devices that can inhibit or prohibit the proper grounding of the anesthesia machine.

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Power on

1. Power on the machine by pressing the main power switch on the front of the machine (**1** in Figure 41). An acoustic tone sounds.

   All LEDs and the loudspeakers are tested.

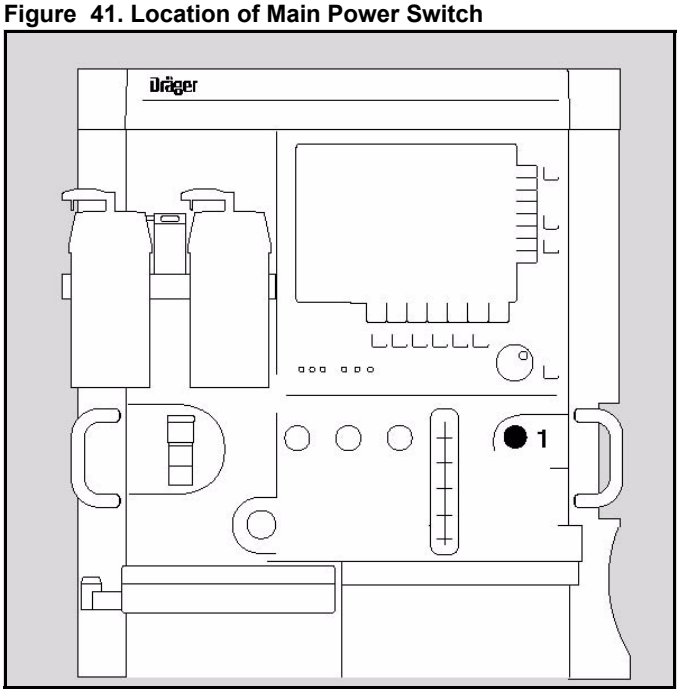
Note: If all LEDs do not light up upon initialization, contact DrägerService.

The initial screen appears after about 20 seconds. Apollo now loads its software and tests its internal memory.

Check list

After about 35 seconds, a check list for manual tests to be performed by the user is displayed (see Figure 42).

Figure 41. Location of Main Power Switch



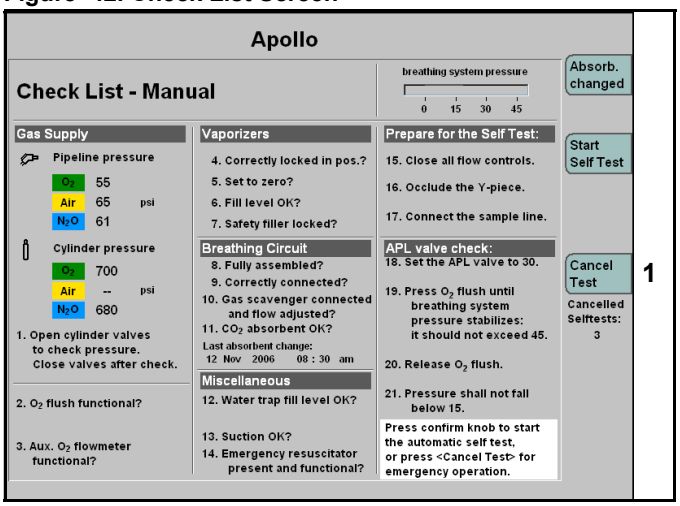
1. Check the components as instructed in the check list on the screen and as described in this procedure.

If the self test has to be interrupted, e.g. for a quick start in an emergency:

2. Press the button >**Cancel Test**< (**1** in Figure 42), and proceed as specified in “Emergency start” on page 87.

The self test can be canceled up to ten consecutive times.

Figure 42. Check List Screen



WARNING!

Risk of device failure and/or patient injury.

Canceling the self test may lead to malfunctions; greater attention is required during operation.

Always perform a complete self test, unless acting in an emergency situation. If canceled for an emergency, carry out a complete self test as soon as practicable.

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Check the pipeline gas supply:

1. Verify that the pipeline supply LEDs on the front panel light up green (**1** in Figure 43). The LEDs light up green when all pipeline supplies are available and the pressures are between 39 psi and 100 psi.

If the LEDs remain dark, it means that the pipeline supply pressure is less than 39 psi or that the hoses are not connected.

Note: If accessories are connected to the optional O_2 or Air outlets on the gas supply block, make sure they work correctly.

Check the cylinder gas supply

CAUTION!

Risk of gas supply failure.

If the valves are open when connected to the pipeline gas supply, gas may be withdrawn from the backup gas cylinders.

Close cylinder valves whenever the pipeline gas supply is sufficient.

1. Using the provided cylinder wrench, slowly open the cylinder valves.
2. Verify that the cylinder pressure LEDs light up green (**2** in Figure 43).

The LEDs light up green when the cylinder pressure for O_2 and Air is over 290 psi and the pressure for N_2O is over 145 psi.

The cylinder pressures are shown in the Check List screen (see Figure 42).

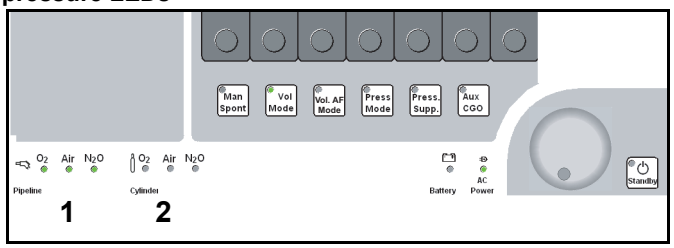
3. Close the cylinder valves.

Note: A flashing cylinder pressure LED indicates that the cylinder pressure transducer on the back of the machine is disconnected.

The gas supplies available can be selected in the menu **Standby Conf.**, see page 179. Only these gas supplies will then be checked during the self test and an alarm issued in the event of a fault during normal operation. The external oxygen supply and the O_2 cylinder cannot both be configured as not present at the same time.

Open the backup gas cylinders which have been configured as present for the self test and then close them.

Figure 43. Location of pipeline supply and cylinder pressure LEDs



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Test the O_2 flush:

O_2 must be connected for the following self test.

1. Occlude the Y-piece firmly onto the cone.
2. Press the >**O_2+**< button on the front of the machine (**1** in Figure 44).
3. Verify that the breathing bag inflates with an audible flow.

Test the auxiliary O_2 flow meter:

1. Adjust the flow knob (**2** in Figure 44) and make sure the float moves freely over the full range of the flow meter.

Test the function of the fresh-gas flow control knobs:

1. Adjust the flow control knob for each available gas (**3** in Figure 44) and verify that the float moves freely over the full range of the total flow meter (**4** in Figure 44).

Breathing bag:

1. Verify that the breathing bag is properly installed and ready for operation (**5** in Figure 44).

Verify that the vaporizers are installed and ready for use:

WARNING!

Risk of patient injury.

Before operating the vaporizer, pay special attention to the Instructions for Use of the vaporizer being used. Note especially the vaporizer flow limits. For example, for the Vapor 2000, flow is 0.25 to 15 L/min, or 0.25 to 10 L/min at concentrations higher than 5%.

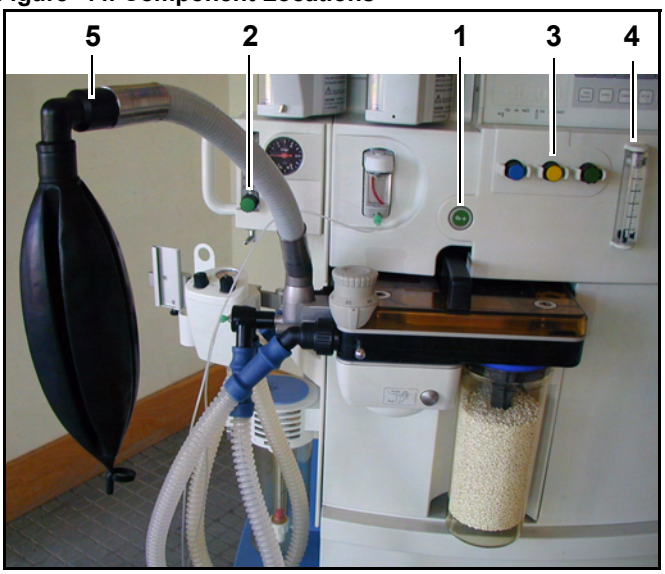
If incorrect vaporizer settings are used, the patient may be injured.

The vaporizers being used must comply with standard ISO 8835-4. If the internal gas measurement system fails, an independent measurement system complying with ISO 21647 must be used.

Note: The self test does not check for internal vaporizer leakage; after filling or changing vaporizers, perform the Standby leak test on each vaporizer (see page 98).

Vapor 2000 is shown and described below.

Figure 44. Component Locations



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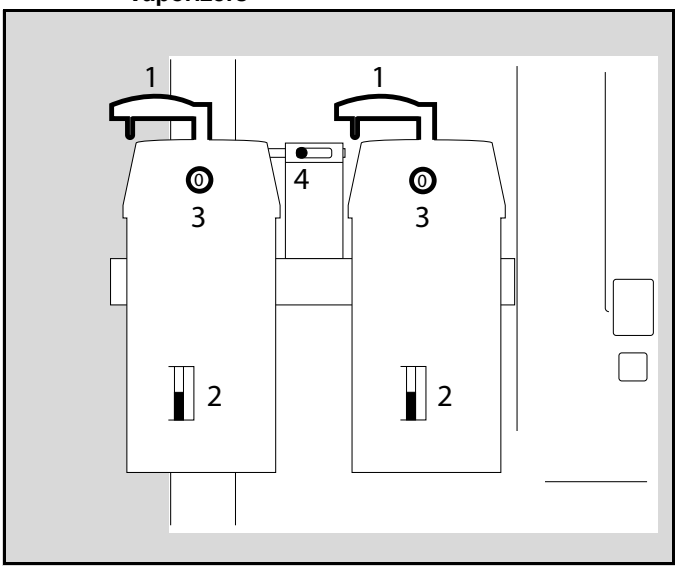
For the Dräger Interlock 2 System:

1. Vaporizers are mounted straight and seated securely on the mounts.
2. Locking levers point to the left = locked position (**1** in Figure 45).
3. Check the sight glass (**2** in Figure 45) and ensure an adequate filling level.
4. Handwheel set to >**0**< and button is engaged (**3** in Figure 45).
5. Check the interlock mechanism.
   Move the selector lever (**4** in Figure 45) to the left to lock the left vaporizer. Turn the handwheel on the right vaporizer to a position other than >**0**<, and make sure that the left vaporizer remains locked in its >**0**< position.
6. Repeat test for other vaporizer.
7. Turn both handwheels to >**0**< positions.

Figure 45. Dräger Interlock 2 System with Vapor 2000 Vaporizers



For the Dräger Auto Exclusion System:

1. Vaporizers are mounted straight and seated securely on the mounts.
2. Locking levers point to the left = locked position.
3. Check that the sight glass and ensure an adequate filling level.
4. Handwheel set to >**0**< and the button is engaged.
5. Check the interlock mechanism.
   Turn the handwheel on one vaporizer to a position other than >**0**<, and make sure that the other vaporizer remains locked in its >**0**< position.
6. Repeat test for other vaporizer.
7. Turn both handwheels to >**0**< positions.

Note: For three-vaporizer mounts, perform this test for all three vaporizers.

Note: The self test does not check for internal vaporizer leakage; after filling or changing vaporizers, perform the Standby leak test on each vaporizer (see page 98).

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Check the breathing system:

1. Make sure patient hoses are securely connected, with optional filters inserted.
2. Make sure fresh absorbent is in the canister, without violet discoloration.

Note: If the absorbent is changed during this procedure, the date and time can be logged by pressing the >**Absorb. changed**< key on the Check List screen (**1** in Figure 46). The label of the key then changes to >**Undo Change**<, and can be pushed again to undo the absorbent change information. The absorbent change information will be logged in the system when the automatic test is started.

Note: Drain any water that may have collected in the ventilator diaphragm.

For diaphragm location and disassembly instructions see page 165.

WARNING!

Risk of device failure.

The correct operation of the anesthesia machine will be impaired if condensation enters the breathing system and/or the ventilator diaphragm.

If condensation is a frequent problem, install water traps in the breathing hoses.

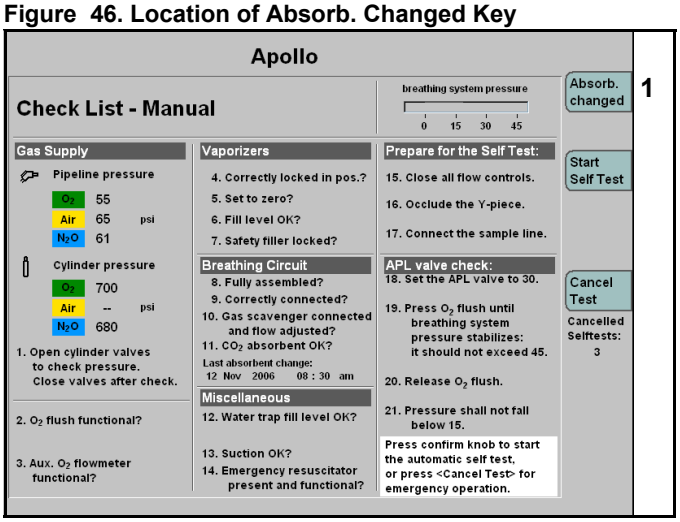
WARNING!

Risk of strangulation.

If not positioned with care, hoses, cables, and similar machine components may endanger the patient.

Take special care when connecting the patient.

Figure 46. Location of Absorb. Changed Key



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WARNING!

Risk of patient injury.

The soda lime loses humidity. Generally, if the humidity falls below a minimum set point, the following undesirable reactions can occur, independent of the type of lime and the inhalation anesthetic being used:

- **reduced CO_2 absorption,**
- **increased heat build-up in the absorber and thus an increased breathing gas temperature,**
- **formation of CO,**
- **absorption and/or decomposition of the inhalation anesthetic.**

These reactions could pose a danger to the patient.

If using dry gases, only flush the anesthesia system briefly, and only if necessary.

WARNING!

Risk of patient injury.

If the flow controls are left open, the ensuing flow of gas may dry out the soda lime, endangering the patient.

The flow control valves should be closed when the machine is in the standby mode or when it is switched off.

Note the Instructions for Use of the Drägersorb 800 + or Drägersorb Free soda lime.

Verify that the scavenging system is ready for use:

1. Check that the scavenger hose between the AGS and the scavenger connection on back of the machine is securely connected.
2. Check that the hose between the output connector on the scavenger and the hospital waste-gas disposal system is securely connected.
3. On the AGS, make sure that the float is in between the two marks in the sight glass on the AGS.

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Emptying the water trap

If the water trap needs to be drained or replaced, see "Emptying the water trap" on page 227 and "Replacing the water trap" on page 228.

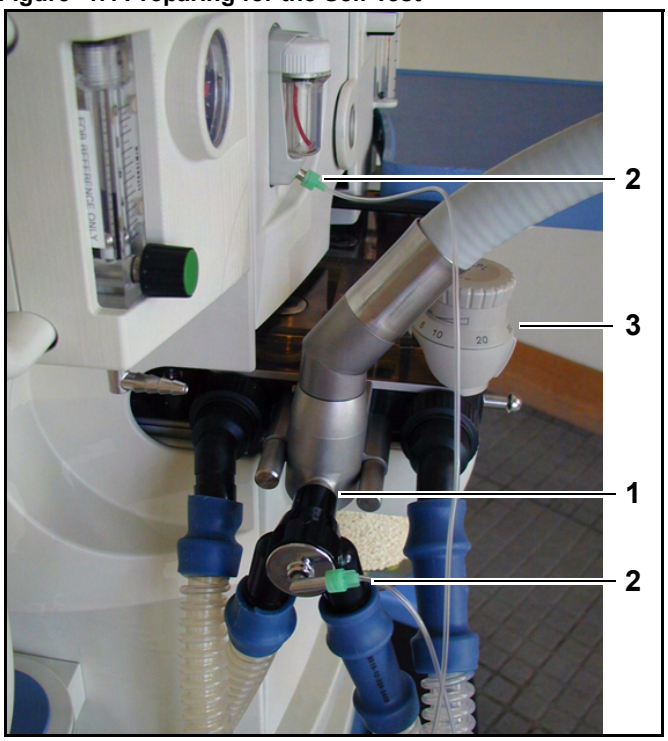
Prepare the Apollo for the self test as follows:

1. Ensure that all flow controls are closed.
2. Occlude the Y-piece by inserting it onto the plug on the bag arm assembly (**1** in Figure 47).
3. Ensure that the sample line is connected between the water trap and the Y-piece (**2** in Figure 47).

Check the function of the APL valve:

1. Set the APL valve to 30 (**3** in Figure 47).
2. Press the O_2 flush button until system pressure stabilizes; it should not exceed 45.
3. Release the O_2 flush button.
4. Verify that pressure does not fall below 15.

Figure 47. Preparing for the Self Test



Notes on the use of bacterial/viral filters, endotracheal tubes, Y-pieces, breathing hoses, soda lime and other accessories for breathing systems

WARNING!

Risk of patient injury.

When using additional components in the breathing system or configurations which deviate from the standard hose system, the inspiratory and expiratory breathing resistances can be increased to values which exceed the standard requirements.

If configurations of this kind are used, the user must pay special attention to the measured values.

With spontaneous breathing, higher breathing resistances mean that the patient must do more breathing work.

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During volume-controlled ventilation, an increase in breathing resistance has a slight effect on the applied volume during inspiration. However, the peak pressure **PEAK** is increased with the plateau pressure **PLAT** remaining constant. The time constant (RC) is increased in the expiration phase as a result. If the expiration times are too short, the lung might not be emptied completely, resulting in a dynamic overfilling of the lungs (air trapping).

During pressure-controlled ventilation, an increase in the airway resistance can reduce the inspiratory or expiratory volume.

Before the self test is performed, the accessories which are to be used for the application must be connected. The expansion hoses must be drawn out to the intended user length. This is the only way of ensuring that the compliance is determined correctly and a correct tidal volume is applied during volume-controlled ventilation.

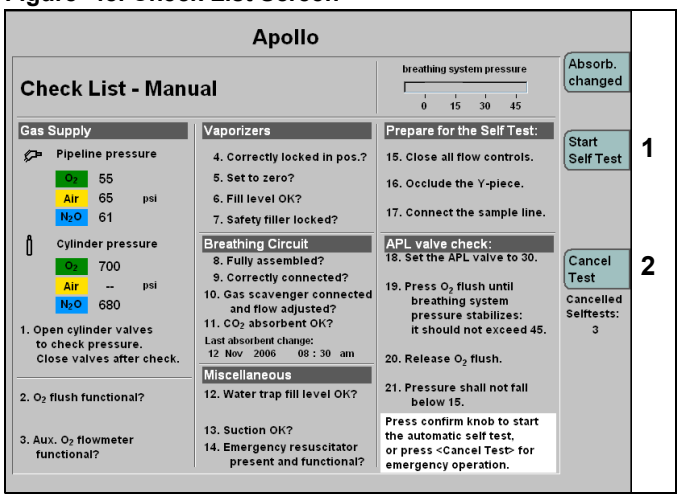
If coaxial hoses are used, leaks between the inner and outer hose are not detected during the self test/ leak test.

Self test

If all checks in the **Check List** are completed successfully:

1. Press the rotary knob or the >**Start Self Test**< key on the check list screen (**1** in Figure 48) to begin the Apollo automated self test.

Figure 48. Check List Screen



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The automatic self test lasts approximately 3 minutes. The bar graph at the top of the Self Test screen shows the progress of the test (see Figure 49).

After the self test has been started, a double tone (speaker test ”passed”) and a single tone (speaker test in the power supply unit “passed”) sound one after the other with the set alarm tone volume.

Note: If no tone is sounded, contact DrägerService.

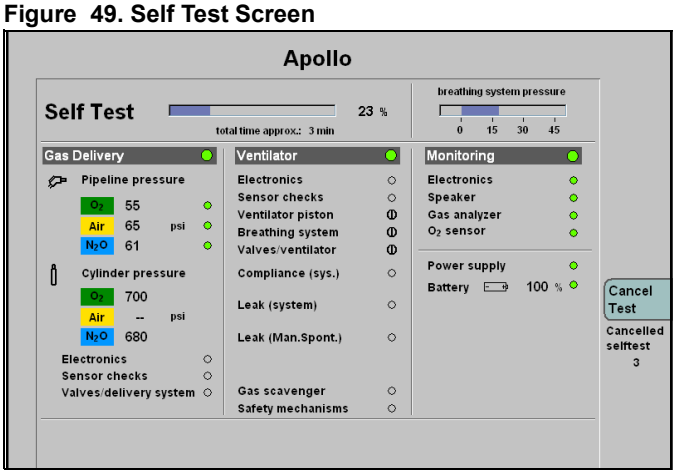
The tests that are performed are listed on the screen. A clock symbol >🕘< is displayed in the small circle next to the component that is currently being tested. As each component test is finished, the clock symbol is replaced by a color code that indicates the result of the test.

Errors discovered during the self test are marked with yellow or red behind the respective test result. An advisory window with information on how to remedy the problem is displayed on the screen.

Test results are color-coded:

Green	Test completed successfully.
Yellow	A non-critical fault was detected. The anesthesia machine can be used with restrictions. Functions highlighted in yellow can be confirmed with the >**Accept**< button which is then displayed (Figure 50), e.g. speaker failure. The anesthesia machine starts operation without this function.
Red	Operation of the anesthesia machine is impossible or not permitted. The error must be remedied and the test must be repeated. The self-test can no longer be canceled at this point.

Figure 49. Self Test Screen



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Interruption of the test is symbolized by an exclamation mark.

WARNING!

Risk of device failure or patient injury.

Functions coded yellow do not meet with the specified technical data.

The error should be remedied as soon as possible.

WARNING!

Risk of device failure or patient injury.

Functions coded red must be remedied before starting, e.g. if there is no O_2 supply.

The device cannot be operated in this state.

WARNING!

Risk of inadequate monitoring.

If the flow sensor, oxygen sensor, or gas sensor is not operational, adequate substitute monitoring must be ensured before starting the anesthesia machine!

Special attention is required if operation is initiated.

When the self test is completed, the system switches to **Standby**. The results of the self test are indicated on the screen by a color-coded circle (**1** in Figure 51).

Green FUNCTIONAL
Every component of the system is in satisfactory operational order.

Yellow CONDITIONALLY FUNCTIONAL
A non-critical fault was detected. Apollo may be used, but call DrägerService or your local authorized service organization.

Empty The self test was canceled.

In addition, a message containing instructions for further procedures, if any, appears in the middle of the screen (**2** in Figure 51).

Figure 50. Non-Critical Error During Self Test

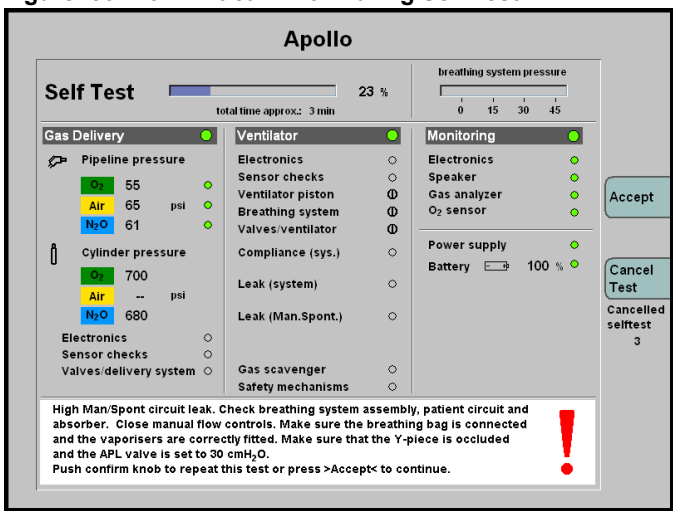
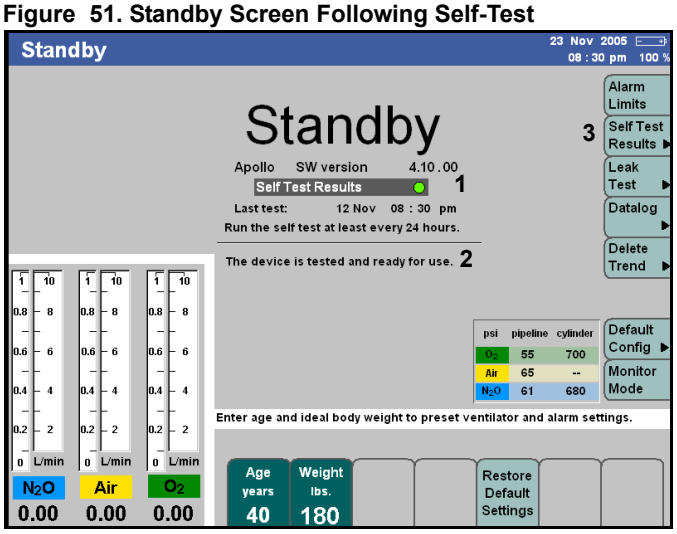


Figure 51. Standby Screen Following Self-Test



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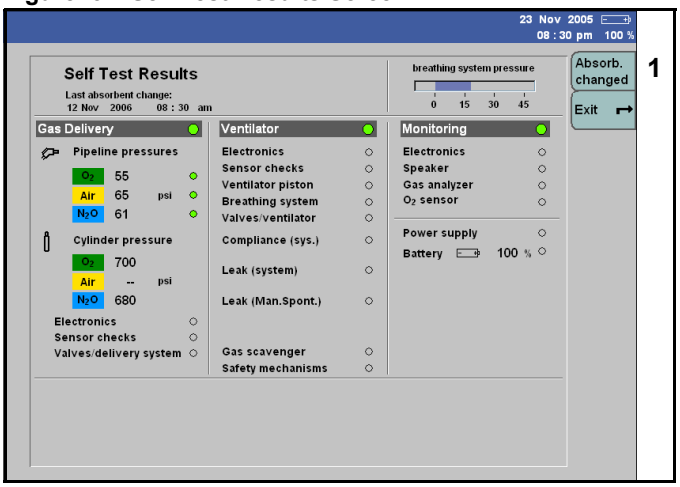
More specific results can be displayed by pressing the >**Self Test Results**< button on the standby screen (**3** in Figure 51). The Self Test Results screen is displayed (Figure 52).

Figure 52. Self Test Results Screen



The Self Test Results screen contains the >**Absorb. changed**< key (**1** in Figure 52). If the absorbent is changed between cases, this key can be pressed to log the date and time. The label of the key then changes to >**Undo Change**<, and can be pushed again to undo the absorbent change information. The absorbent change information will be logged in the system when the Self Test Results screen is exited.

Cancelling the self test:

To cancel the self test before completion, for example, for a quick start in an emergency:

1. Press the >**Cancel Test**< key (**2** in Figure 48), and proceed as specified in "Emergency start" on page 87. The self test can be canceled up to ten consecutive times.

WARNING!

Risk of device failure and/or patient injury.

Canceling the self test may lead to malfunctions. Special attention is required during operation.

Always perform a complete self test, unless acting in an emergency situation. If canceled for an emergency situation, perform a complete self test as soon as practicable.

System compliance test

The Apollo determines the current compliance of the patient system with any filters, hoses, and a Y-piece.

The system compliance test result is indicated on the Self Test result screen by the red/yellow/green indicator and by posting the compliance value.

For data of the system compliance see "Specifications" on page 253 and the Instructions for Use of the devices specified in the accessories list.

The compliance value is used during volume-controlled ventilation to correct for the reduction of tidal volume due to system compliance. For more information, see "Compliance compensation" on page 109.

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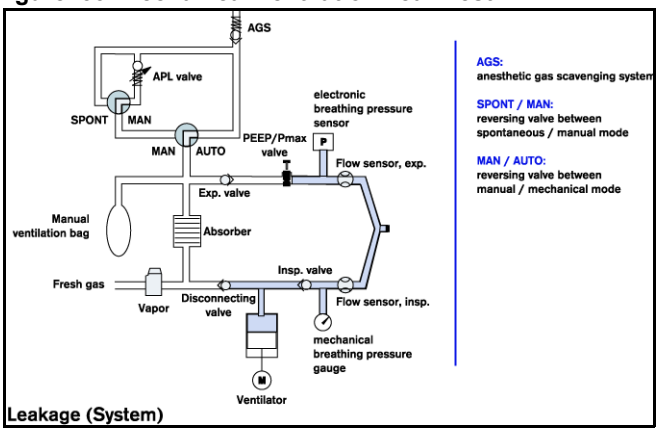
Leak tests

The Apollo tests for leaks in the mechanical subsystem and in the Man/Spont system.

Leak system

- Figure 53 shows the components tested in the mechanical ventilation branch.
- This branch is tested with positive pressure.
- Leaks are indicated on the Self Test Results screen by the yellow/green test result indicator and by posting the leak value in mL/min (**Leak (system)** test result in Figure 52).

Figure 53. Mechanical Ventilation Leak Test



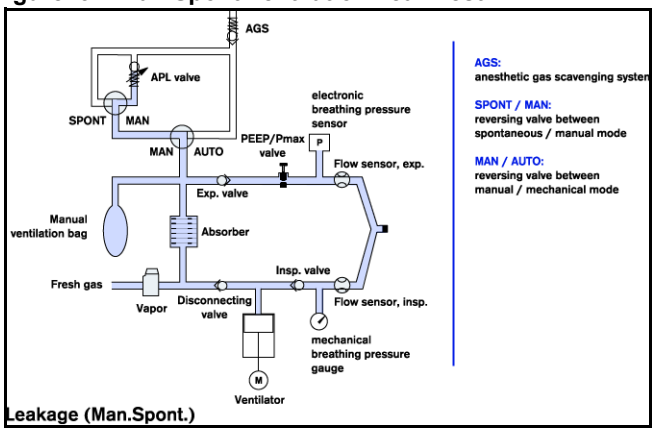
Leak Man/Spont

- Figure 54 shows the components tested in the Man/Spont leak test.
- This test is performed with sub-atmospheric pressure.
- Leaks are indicated on the Self Test Results screen by the red/yellow/green test result indicator and by posting the leak value if it is over 150 mL/min (**Leak (Man/Spont)** result in Figure 52).

The Apollo determines the current leakage of the breathing system and breathing hoses. The system tolerates leaks of up to 150 mL/min.

Note: For leaks of more than 150 mL/min: Check the components of the breathing system and the breathing hoses. Repair any leaks and repeat the leak test.

Figure 54. Man/Spont Ventilation Leak Test



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Locating and eliminating leaks

The self test incorporates a leak test. If this test is not passed, the leaks must be remedied before continuing the test by pressing the rotary knob. A leak test can also be carried out later in **Standby** with the >**Leak Test**< key.

Possible causes of leaks include:

– Absorber not firmly screwed to the breathing system.
– APL valve is not firmly fixed to the breathing system cover (damage) or not set to 30 hPa (cmH_2O).
– Manual breathing bag, breathing hoses, Y-piece, or microbial filter are not connected correctly or damaged.
– Flexible arm for manual breathing bag not fitted correctly on the breathing system, sealing ring soiled or damaged.
– Water trap not connected.
– Sample line for gas measurement not connected or leaky (there may be a kinked bend in the connections).
– Connections for the sample line for gas measurement cracked or defective.
– O-ring of the inspiratory and expiratory ports missing, soiled, or damaged.
– Flow sensors not fitted correctly or damaged, rear O-ring missing.
– Breathing system cover not mounted correctly, not all five sealing screws closed.
– Visible damage on valves or seals of the breathing system metal valve plate.
– Breathing system not mounted correctly, not all three sealing screws closed.
– Ventilator diaphragm defective or not fitted correctly (Dräger legend must be visible from above).
– 15 mm (0.59 in) cone for connecting the Y-piece scratched or damaged.
– Vaporizer fill or drain connections leaky or opened, vaporizer not mounted correctly, O-ring missing or handwheel not set to >**0**<.

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Additional suggestions to isolate components of the breathing system for leaks:

Carry out the described measures:

Patient Sample Line Isolation:

1. Remove the sample line for gas measurement and seal the Luer Lock connection on the Y-piece.
2. Perform leak test.

Exclude the breathing hoses from the leak test

1. Remove the patient circuit from the breathing system.
2. Install a knwn tight 22 mm (0.87 in) hose between the inspiration and expiration ports. The breathing bag must be on the bag arm.
3. Perform leak test.

Isolation of Vaporizers:

1. Remove the vaporizers from the anesthesia machine.
2. Perform leak test.

Note: The self test does not check for internal vaporizer leakage; after filling or changing vaporizers, perform the Standby leak test on each vaporizer (see page 98).

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Emergency start

WARNING!

Risk of incorrect delivery.

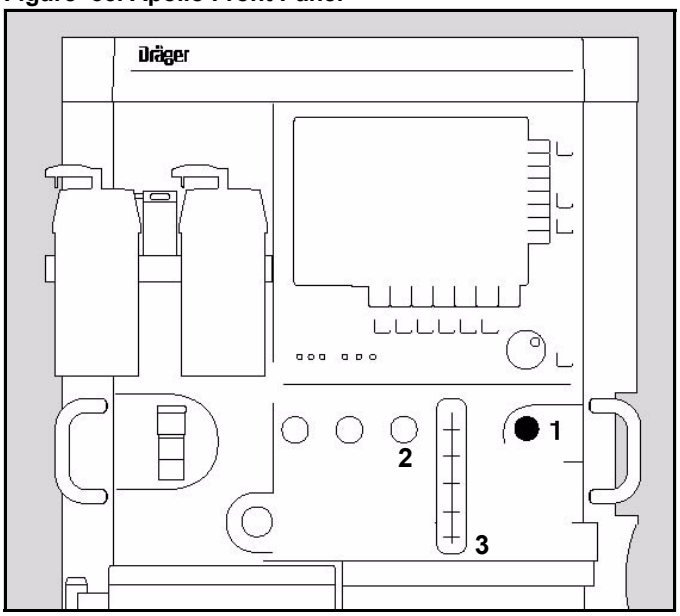
The leak and compliance tests are not performed if the self test is cancelled, and no leak and compliance information is available. The accuracy levels specified in the chapter "Specifications" of this operating instructions cannot be guaranteed.

The emergency start procedure shortens the self test when the Apollo must be operational immediately.

Note: To prevent abuse of this feature, the emergency start procedure can be performed up to ten times in succession. After ten cancellations, the system will not allow another cancellation and a complete self test must be performed.

1. Power on the anesthesia machine by pressing the main power switch on the front of the machine (**1** in Figure 55).
2. Check that all vaporizers are closed.
3. Set an appropriate fresh-gas flow using the oxygen flow control knob (**2** in Figure 55). Verify adequate flow by checking the total flow meter (**3** in Figure 55).
4. Start manual ventilation.
5. Continue manual ventilation while the software is internally loaded and the electronics are tested. After about 35 seconds, the Check List screen appears.

Figure 55. Apollo Front Panel



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6. Press the >**Cancel Test**< key on the Check List screen (**1** in Figure 56).
   The machine runs through a minimal self test that lasts about 10 seconds. Manual ventilation is interrupted during this time, but spontaneous breathing can continue.

Apollo is ready for operation about 1 minute after initiating. The O_2 sensor is completely calibrated after about 2 minutes.

WARNING!

Risk of device failure and/or patient injury.

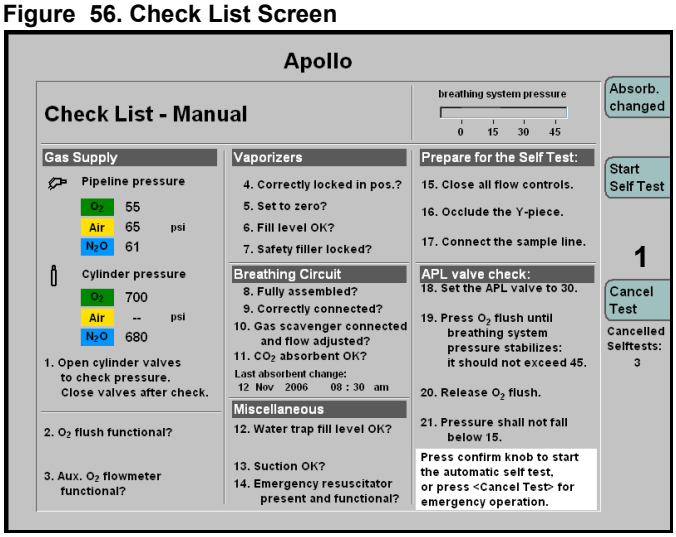
Canceling the self test may lead to malfunctions; greater attention is required during operation.

Always perform a complete self test, unless acting in an emergency situation. If canceled for an emergency situation, carry out a complete self test as soon as practicable.

After the minimal self test, the anesthesia machine switches to **Standby**.

Note: The >**Cancel Test**< key is also available in the self test screen.

Figure 56. Check List Screen



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Operation Summary

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Overview

This chapter of the Operating Instructions summarizes basic operation of the Apollo, including starting operation, changing patients, and ending operation. Specific information on setting ventilation and monitoring parameters is provided in later chapters of the Operating Instructions.

Typical operation

Operation of the Apollo begins with the standby screen which is displayed after the initial self tests. This screen allows the user to restore default settings and enter the patient parameters needed to begin a case.

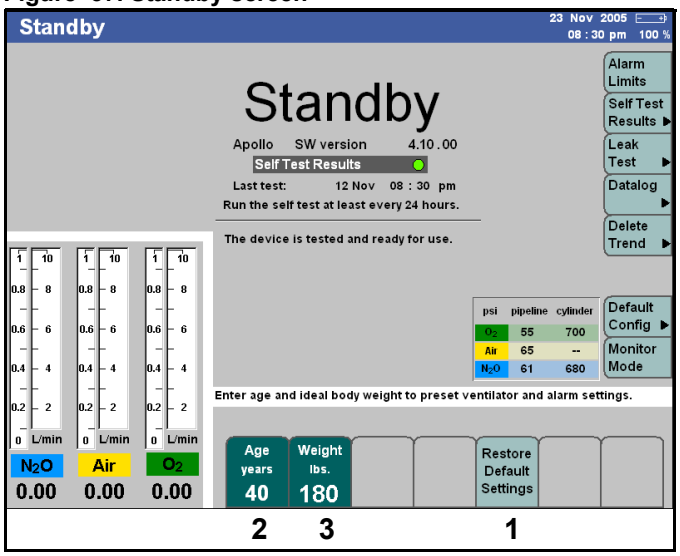
Loading default settings

The default settings for fresh-gas delivery, ventilation, and alarms are loaded in the standby screen and can be modified in the standard configuration if necessary.

These default settings are valid whenever the Apollo is switched on. They can be changed and set as required for the specific hospital concerned, see “Configuring the default settings in Standby” on page 179 for complete instructions.

1. Press the >**Restore Default Settings**< key on the standby screen (**1** in Figure 57).
2. Press the rotary knob to confirm the restore.

Figure 57. Standby screen



Entering the patient’s age

The set age influences the calculation of the MAC value, the volumeter scale, the vertical axis of the loops and ventilation monitoring graphs as well as the alarm limits for (optional) SpO_2 monitoring, and the automatic volume adjustment of the Breathing Sound Emulator (BSE) module during operation.

In addition, the trigger sensitivities and software algorithms for suppressing artifacts are also modified, thus influencing the quality of ventilation in modes supporting spontaneous breathing.

1. Press the >**Age**< key on the standby screen (**2** in Figure 57).

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2. Turn the rotary knob until the correct patient age is displayed, and press the rotary knob to confirm.

The patient age parameter is available in the standby screen as well as in all ventilation modes. Changing the patient's age during operation immediately impacts the parameters described above.

Entering the patient's ideal body weight (Optional)

The patient's ideal body weight describes that portion of the body relevant to setting the ventilation parameters (the patient's body weight minus the assumed excess fat).

The set ideal body weight influences the ventilator default settings for tidal volume **VT** and frequency **freq**, as well as the alarm limits for expiratory minute volume **MV** during operation.

1. Press the >**Weight**< button on the standby screen (**3** in Figure 57).
2. Turn the rotary knob until the correct weight is displayed, and press the knob to confirm.

The patient weight parameter is available in the standby screen as well as inall ventilation modes. Changing the patient's weight during **Volume**, **Volume AF**, **Pressure,** and **Press. Support** has no influence on current ventilation settings.

Adjustment ranges and default values upon delivery

Parameter	Adjustment range	Defalut value upon delivery
Age	<1 - 120 years	40
Weight	1 lb to 240 lbs. (1 kg to 120 kg)	--

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Setting the fresh-gas flow

1. Set the fresh-gas flow to desired levels using the flow control knobs on the front panel of the machine (**1** in Figure 58).

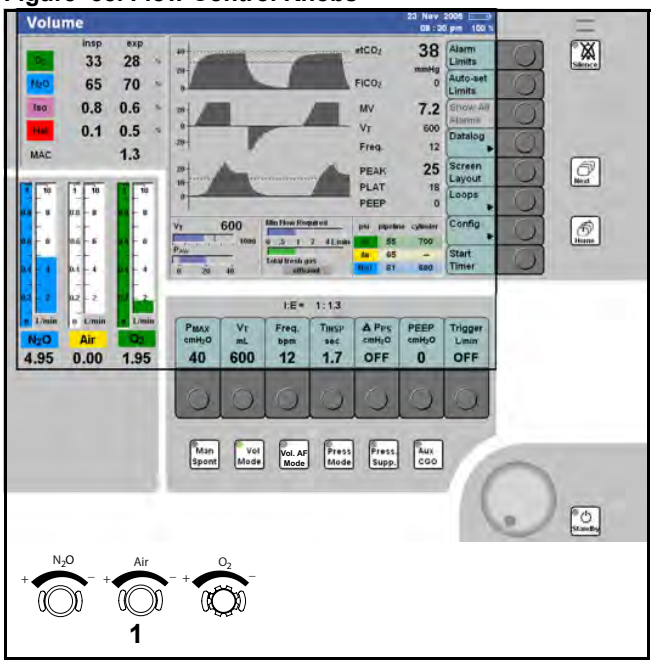
CAUTION!

Risk of patient injury.

The use of minimum flow or low flow settings may lead to the accumulation of metabolic products in the breathing system.

To avoid this risk, use appropriate soda lime, or set higher fresh-gas flows, and always use the gas measurement module provided by the anesthesia machine.

Figure 58. Flow Control Knobs



SORC (Sensitive Oxygen Ratio Controller)

The Apollo is equipped with an O_2 minimum delivery system to avoid hypoxic gas mixtures when N_2O is selected as the carrier gas.

At flow rates of 200 mL/min and above, the N_2O concentration can be freely set between 0 and 79%.

During an O_2 shortage, the SORC limits the N_2O concentration in the fresh gas, so that the O_2 concentration does not fall below 21%. When the N_2O flow control is open and the O_2 flow control is closed (or O_2 flow is less than 200 mL/min), the SORC prevents N_2O flow. During N_2O failure, O_2 can still be administered.

The SORC is not active when Air is selected as the carrier gas and 100% Air can be metered throughout the entire flow range.

Fresh-gas Failure Detection

During operation, the Apollo checks that the piston cylinder unit has a sufficient level of fresh gas.

If a sufficient level of fresh gas is not possible, the system first displays the message "**FGAS LOW OR LEAK**".

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In addition the alarm "**PINSP. NOT ACHIEVED**" or "**VT NOT ACHIEVED**" is displayed if the system is unable to maintain the defined ventilation.

To ensure continued ventilation, the anesthesia machine will use ambient air to supplement the gas volume if it is too low. This may change the gas composition. Carefully check the gas composition.

WARNING!

Risk of patient awareness.

If a complete gas supply failure occurs, the anesthesia machine will continue to function with ambient air. However, anesthetic agents will no longer be delivered and the inspiratory gas composition will be diluted.

Carefully monitor the gas mixture and, if necessary, use IV anesthetics.

DrägerService can change the behavior of the device so that it does not use ambient air for supplementing the gas volume. The device will then ventilate with limited VT or PINSP. if possible.

1. Increase the fresh-gas flow.
2. Seal any possible leaks.

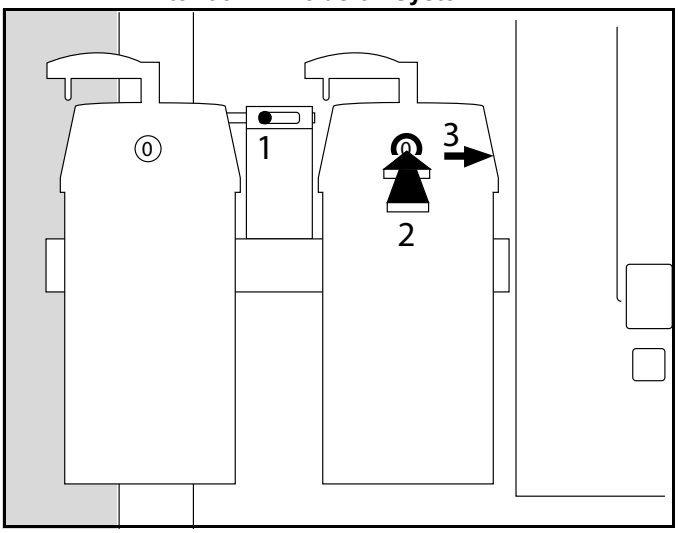
Setting vaporizer concentration

Note: Refer to the appropriate Instructions for Use for the vaporizer being used. Vapor 2000 is shown and described below.

For the Dräger Interlock 2 exclusion system:

1. Lock the unused vaporizer by moving the selector lever completely towards it. For example, to lock the left vaporizer, move the lever to the left (**1** in Figure 59.).
2. With the handwheel set to >**T**< position on the unlocked vaporizer, press the button and engage the handwheel at >**0**< (**2** in Figure 59.) Wait 5 seconds for the pressure to balance.
3. Press the button and turn the handwheel counterclockwise to set the required anesthetic gas concentration (**3** in Figure 59.).

Figure 59. Setting Vaporizer Concentration - Dräger Interlock 2 Exclusion System



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For the Dräger Auto Exclusion system:

1. Close any open vaporizers.
2. With the handwheel set to >**T**< position, press the button and engage the handwheel at >**0**<. Wait 5 seconds for the pressure to balance.
3. Press the button and turn the handwheel counterclockwise to set the required anesthetic gas concentration.

Setting ventilation mode

Set the ventilation mode as described in the chapter "Ventilation" of this Operating Instructions.

Changing patients

Follow the steps below for successive patient cases.

Switch to standby mode

1. Press the standby key >Standby<, and confirm with the rotary knob.

The functions of the anesthesia machine are switched off. All the current settings from the previous case are retained, including fresh-gas delivery and ventilation parameters, alarm limits, and patient age and weight.

To activate the default settings instead of using the current settings:

1. Press the >**Restore Default Settings**< key on the standby screen, and press the rotary knob.

The default settings for gas delivery, ventilation, and alarm limits are restored.

Enter the new patient's age and ideal body weight (optional) as instructed on page 92, and proceed.

WARNING!

Risk of patient injury.

Restored default settings may contain settings inappropriate for a new patient.

After default settings have been restored, make sure the ventilation monitoring settings are appropriate to the patient connected.

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Changing soda lime

A reusable absorber or the disposable CLIC absorber can be used with the Apollo. The soda lime must be exchanged, if:

– the soda lime in the absorber has turned violet. The color indicator can regenerate slowly and the soda lime may revert to white, but its absorption capacity is nevertheless spent. You should therefore dispose of used absorbers immediately.
– the fractional inspiratory CO_2 concentration $FiCO_2$ exceeds 5 mmHg.

Reusable absorber

1. Press the standby key >Standby<, and confirm with the rotary knob.
2. Swing the writing tray out of the way.
3. Press the release button on the ventilator unit, and pull out the unit.
4. Turn the absorber canister counterclockwise and pull it down and off.
5. Empty the used soda lime and refer to the Instructions for Use of the soda lime for waste removal and refilling.
6. Fill the absorber canister to upper mark with fresh soda lime.
7. Fit the canister into position below the breathing system, and turn it clockwise as far as possible.
8. Push the breathing system inwards until it clicks into place.
9. Reset the absorbent change log to current date by pressing the >**soda lime changed**< button.

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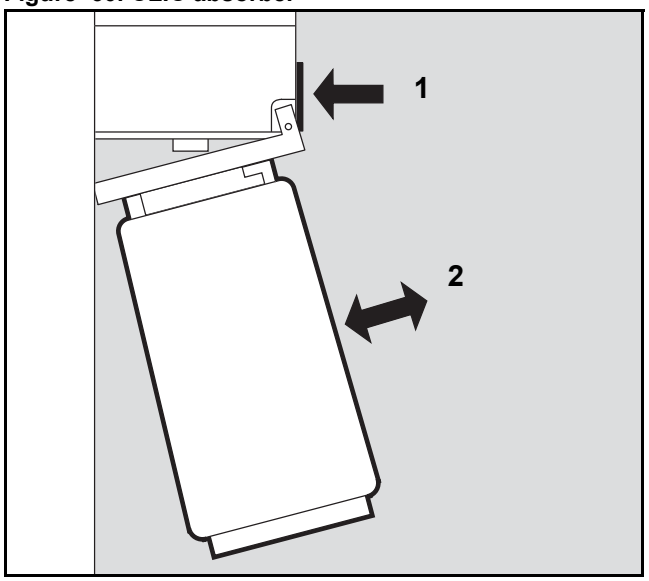
Disposable CLIC absorber (Optional)

The disposable absorber can be replaced during operation. The valve in the mounting ensures that the breathing system remains tightly sealed when the absorber is removed.

Note: Since a leak test cannot be performed during operation, no leak and compliance information on the changed absorber is available. Greater attention is required during operation.

Replace the disposable absorber to ensure continuous CO_2 absorption in the breathing system.

Figure 60. CLIC absorber



Remove the spent absorber

1. Press the button (**1** in Figure 60): the absorber swings open sealing the breathing system so that the ventilation can continue.
2. Slide the disposable absorber off the mount (**2** in Figure 60).
3. Dispose of the spent absorber.

Refer to the Instructions for Use of the CLIC absorber for information on disposal.

Install the new absorber

1. Before fitting, shake the disposable absorber, e.g. by turning it upside down several times in order to loosen the soda lime.
2. Remove seal from new disposable absorber.
3. Slide the new disposable absorber onto the mount (**2** in Figure 60)
4. Push the absorber into the machine until it engages.
5. Reset the absorbent change log to current date by pressing the >**soda lime changed**< button (only available in Standby mode).

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Leak test

WARNING!

Risk of patient injury.

The system will be pressurized during the leak test.

To prevent patient injury, do not perform the leak test with a patient connected to the anesthesia machine.

WARNING!

Risk of misleading data.

Changing the breathing hoses, vaporizers, or soda lime can modify the calculated leak and compliance values of the anesthesia machine and influence the therapy settings.

Perform a leak test after the breathing hoses, vaporizers, or soda lime have been replaced.

With the system in Standby mode:

1. Set the handwheel of the vaporizer being tested to a concentration of at least 0.2 Vol.%.
2. Press the >**Leak Test**< button on the standby screen (**1** in Figure 61).

   The following prompt is displayed:

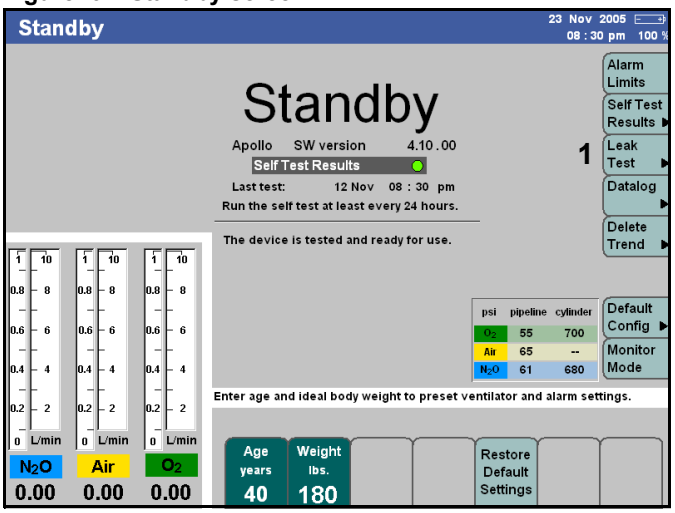
   Before starting leak test, close the Y-piece, connect the sample line and make sure that all flow controls are closed. If vaporizer leaks need to be tested, open respective vaporizer to at least 0.2 Vol.%. Press rotary knob to start the leak test.
3. Perform the actions as instructed.

Apollo performs the leak test for **Volume Mode**/ **Pressure Mode** in about 90 seconds, then system compliance is determined for volume correction and the overall system is checked for leaks in the breathing system.

Note: The breathing bag and its hose are also tested for leaks at the same time.

Leakage is tested in the automatic (mechanical) ventilation line (**leak (system)**) and in the overall system (leak **(Man/Spont)**).

Figure 61. Standby screen



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The clock symbol disappears when the test is complete and Apollo displays the following test results:

– Breathing system **Breathing System**
– System compliance **Compliance (sys.)**
– Leak system **Leak (system)**
– Leak Man/Spont **Leak (Man/Spont)**
if applicable (values >150 mL/min), see “Leak Man/Spont” on page 84.

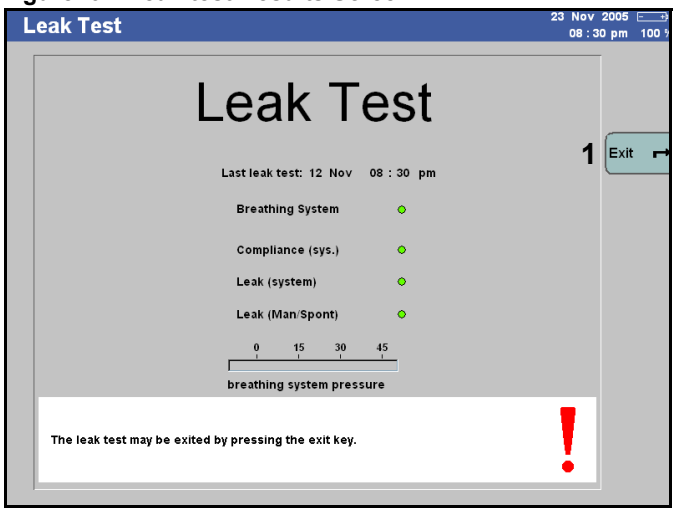
The results of the leak test are displayed on the data screen at all times.

To return to the standby screen:

1. Press the >**Exit**< key (**1** in Figure 62).
2. Turn the handwheel of the vaporizer being tested to the >**0**< position.

Repeat leak test for each additional installed vaporizer, if present.

Figure 62. Leak test Results Screen



Activating the CO_2 bypass function (Optional)

1. Press the release button (**1** in Figure 63).

The disposable absorber swings open on its mounting. The breathing system is sealed at the same time and ventilation continues.

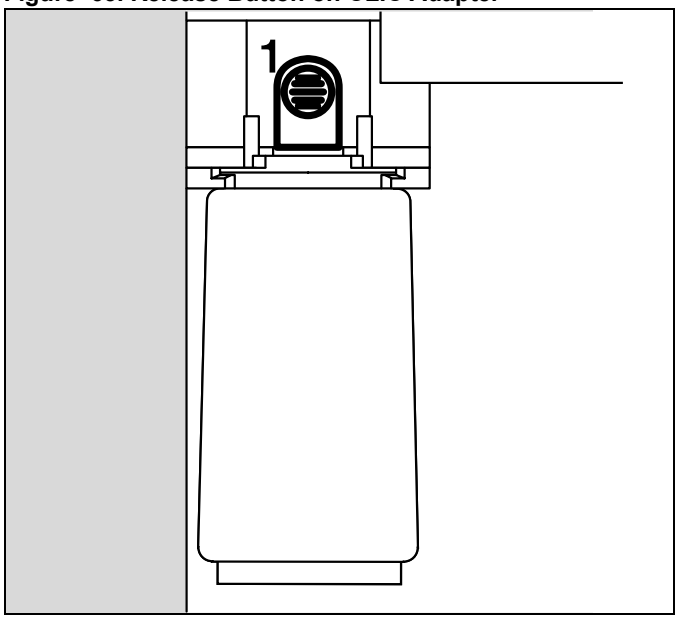
WARNING!

Risk of increased inspiratory carbon dioxide concentrations.

CO_2 is not absorbed in the breathing system when the absorber is swung out.

Always make sure the absorber is clicked into place after installing or replacing.

Figure 63. Release Button on CLIC Adapter



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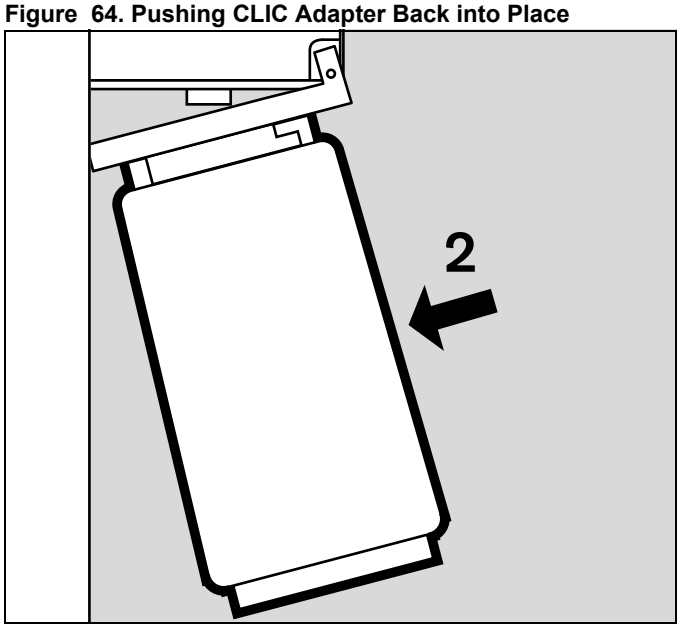
To deactivate the CO_2 bypass function, swing the disposable absorber (**2** in Figure 64) back into the system until it engages.

Figure 64. Pushing CLIC Adapter Back into Place



End of operation

To set the Apollo to Standby mode:

1. Press the standby key >Standby<, and press the rotary knob.

The workstation is now in **Standby**. The fresh-gas flow should be turned off.

To turn the Apollo off completely (from Standby):

1. Press the main power switch on the front of the machine.

   An acoustic tone sounds, and the shut down screen shown in Figure 65 is displayed during a 10-second shut down delay.

Note: During the shut down delay, the Apollo can be restarted immediately by pressing the main power switch.

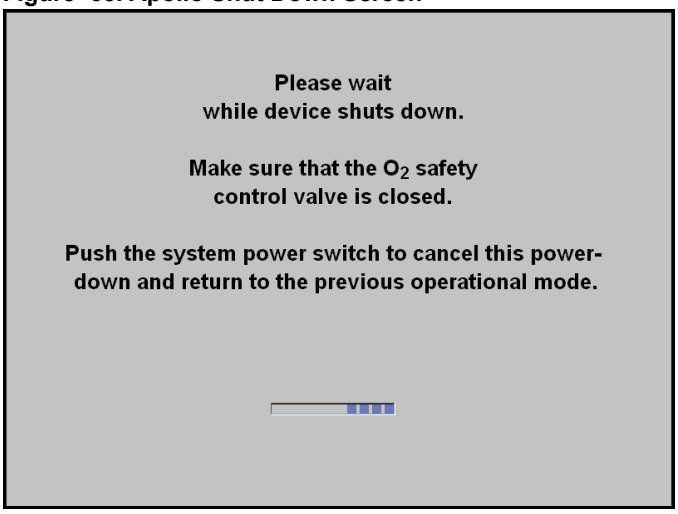
2. Make sure the flow control valves are closed.
3. Disconnect the pipeline supply hoses from the wall supply outlets.

WARNING!

Risk of fire.

In order to avoid the accumulation of potentially hazardous oxygen concentrations in the anesthesia machine or the operating room, all sources of oxygen must be closed and the anesthesia machine disconnected from them when the anesthesia machine is not in use.

Figure 65. Apollo Shut Down Screen



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CAUTION!

Risk of gas supply failure.

If the valves remain open when connected to the pipeline gas supply, gas may be withdrawn from the backup gas cylinders.

Close cylinder valves whenever the pipeline gas supply is sufficient.

4. Close the cylinder valves.
5. Disconnect the scavenging hose.

WARNING!

Risk of gas supply contamination.

If the supply hoses remain connected to the wall outlets, minor internal leaks may lead to contamination of the supply gases.

Always disconnect the supply hoses when the device is not in use.

Note: Leave the Apollo plugged into mains power in order to charge the uninterruptible power supply UPS.

WARNING!

Risk of device failure and/or patient injury.

The self test checks sensitive internal device processes the functionality of which, if not regularly tested, may fail or not be available.

It is strongly recommend that the Apollo be switched off once a day in order to carry out the power-on self test.

CAUTION!

Risk of device failure.

Larger quantities of condensation may impair operation of the anesthesia machine and/or lead to failure of the equipment.

Remove any water which may have accumulated in the ventilator diaphragm.

See “Removing the ventilator diaphragm” on page 206.

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When Apollo is not in use

WARNING!

Risk of battery failure.

Allowing the battery to run low can damage it.

It must be charged at least every four weeks.

Observe the following if the Apollo is not used for an extended period of time:

1. Unplug the gas pipeline hoses from the wall pipeline supply.
2. Close the cylinder valves on the backup gas cylinders.
3. Leave the anesthesia machine connected to the mains at all times. The green LED labeled >⏻ AC Power< lights up.

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Ventilation

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Overview

The Apollo supports the following ventilation modes:

- Manual/Spontaneous ventilation **Man/Spont**
- Volume-controlled ventilation **Volume Mode**.
  With activation of:
  - **Sync.** (Synchronization)
  - **Press. Support** (Pressure Support) (optional)
- Pressure-controlled ventilation **Pressure Mode**.
  With activation of:
  - **Sync.** (Synchronization)
  - **Press. Support** (Pressure Support) (optional)
- Pressure-assisted spontaneous breathing **Pressure Support CPAP** (optional)
- **Volume AF** (Volume Mode AutoFlow) (optional).
  With activation of:
  - **Sync.** (Synchronization)
  - **Press. Support** (Pressure Support) (optional).

In addition, the optional auxiliary common gas outlet (**Aux CGO**) is available for use of non-rebreathing systems.

CAUTION!

Risk of inadequate alarm monitoring.

Some Alarm limits may be automatically modified when the ventilation is changed or the settings are modified.

Check or adapt alarm limits each time the ventilation mode is changed or when the settings are modified while a patient is being ventilated.

This chapter of the Operating Instructions contains descriptions of these modes, along with complete instructions for setting the corresponding ventilation parameters.

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Manual/Spontaneous ventilation

To use the Manual/Spontaneous ventilation mode, the user must first set the APL valve to the appropriate mode and then select the mode using the button >**Man/Spon**t< on the front display panel.

WARNING!

Risk of patient injury.

If the APL valve becomes blocked due to for example, lines or cables being caught under the knob, the patient may be endangered.

Route all cables away from the APL valve. Do not hang lines, hoses or cables, for example, the sample line, on or near the APL valve.

Setting the APL valve

For manual ventilation

1. Turn the APL valve adjustment knob to the desired pressure. Clockwise rotation increases the pressure, and counterclockwise rotation decreases the pressure.

The patient can be ventilated by hand using the manual breathing bag. The pressure is limited to the value set on the APL valve.

To temporarily relieve pressure:

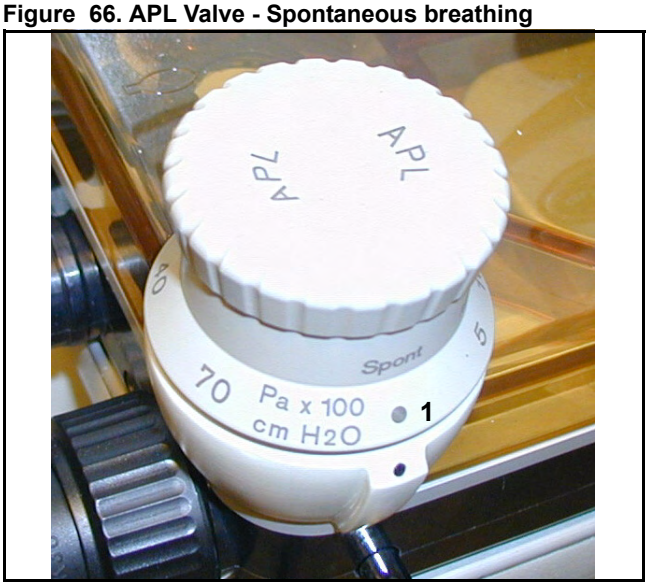
– Pull up on the APL valve knob.

For spontaneous breathing

1. Rotate the APL valve adjustment knob fully counterclockwise, until the index mark on the knob lines up with the index mark on the bottom of the valve (**1** in Figure 66).

The valve is now open for spontaneous patient breathing.

Figure 66. APL Valve - Spontaneous breathing



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Starting Manual/Spontaneous Ventilation

Presetting the Manual/Spontaneous mode

Prior to activating Man/Spont mode, the user can preset the Man/Spont parameters.

1. Press the >**Man Spont**< key located at the bottom of the display panel (**1** in Figure 67). The LED on the key and the status field at the top of the screen (**2** in Figure 67) flash on and off.

   The row of buttons for the ventilation parameters valid for ManSpont mode are displayed light green (**4** in Figure 67). This means that they are not yet active.

2. Press the button for the parameter to be changed; its color changes to yellow to indicate that it's selected.

3. Turn the rotary knob to adjust the parameter to the desired value, and press the rotary knob to confirm (**3** in Figure 67).

   Continue to set the values for the other parameters.

   The parameters that can be set for ManSpont mode are shown in Table 3, along with their adjustment ranges and factory default values.

   The patient's ideal body weight is the actual weight minus estimated excess fat.

Starting the Manual/Spontaneous mode

4. When all the **Man/Spont** parameters have been preset, press the rotary knob to start **Man/Spont** ventilation (**3** in Figure 67).

   The parameter buttons turn dark green and display the preset parameter values. The "**Man/Spont**" indication in the status field stops flashing and is displayed continuously. Manual/Spontaneous ventilation begins.

5. Set an appropriate fresh-gas flow. Verify adequate flow by checking the total flow meter.

   If a Man/Spont parameter has to be changed during ventilation:

   – Press the button for the parameter to be changed, turn the rotary knob to the desired value, and press the rotary knob to confirm.

Figure 67. Man/Spont Screen

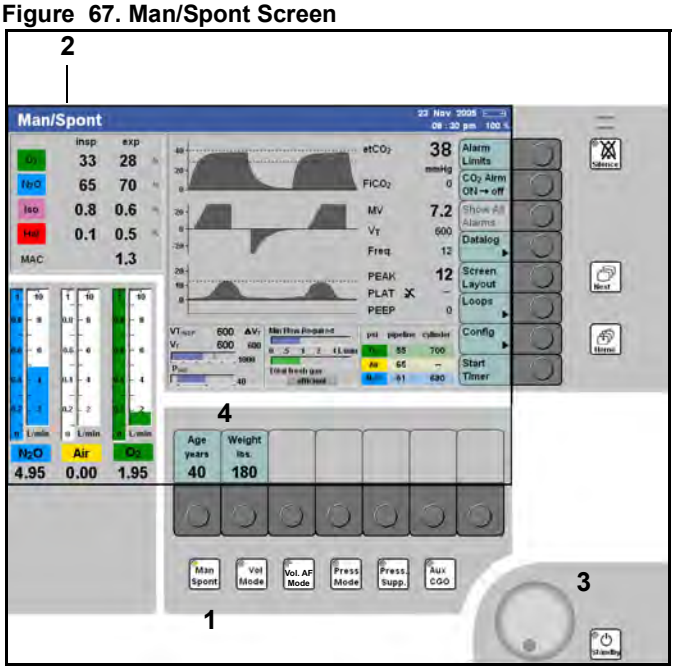

Table 3 . Adjustment ranges and default values upon delivery for Man/Spont mode

Ventilation parameters	Adjustment ranges	Default value[1] upon delivery
Age >**Age**< [years]	<1 to 120	40
Ideal body weight >**Weight**<[2] [kg/lbs.]	1 to 120 kg, 1 to 240 lbs.	--

1. Site defaults can be set instead.
2. Optional

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Note: Man/Spont mode can also be started without presetting values:

– Press the >**Man Spont**< key located at the bottom of the display panel, and press the rotary knob. Default parameter values are used.

or

– If in **Standby** or Monitoring mode, set fresh-gas flow. This activates Manual/ Spontaneous ventilation automatically. Default parameter values are used.

Certain alarms are disabled automatically in Manual/ Spontaneous mode to avoid artifacts. See the chapter "Alarms" in this Operating Instructions for a list of alarms active in Manual/Spontaneous mode.

Note: There is 15-second timeout period for making ventilation mode changes, with a 5-second audible tone sequence after the first 10 seconds. If the new setting is not confirmed within the timeout period, the current ventilation setting remains in effect.

O_2 flush

For flushing and rapidly filling the breathing system and breathing bag with O_2 while bypassing the vaporizer.

Press the >**O_2+**< button (**1** in Figure 68). O_2 flows into the breathing system without anesthetic gas as long as the button is pressed.

Figure 68. Location of the O_2 flush button

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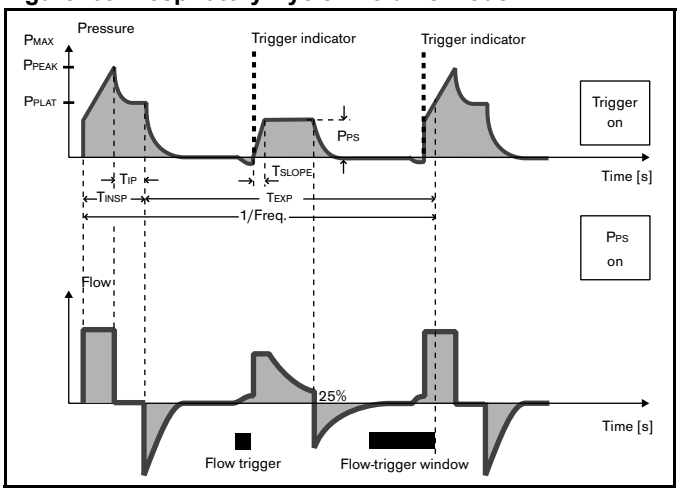
Volume-Controlled Ventilation

The Apollo has a volume-controlled ventilation mode with fixed mandatory tidal volume (VT) and frequency (Freq.). Synchronization can be activated, as well as variable Pressure Support for spontaneous breathing efforts (optional).

The respiratory cycle (see Figure 69) is defined through the frequency (Freq.), the inspiratory time (TINSP), the inspiratory pause time (TIP:TINSP) and the tidal volume (VT). Synchronization and Pressure Support are controlled by the sensitivity of the flow trigger and the level of ΔPPS. The maximum time interval for controlled ventilation is set via the frequency. In order to maintain a constant frequency, a time interval triggered prematurely is compensated in the next cycle.

Figure 69. Respiratory Cycle - Volume Mode

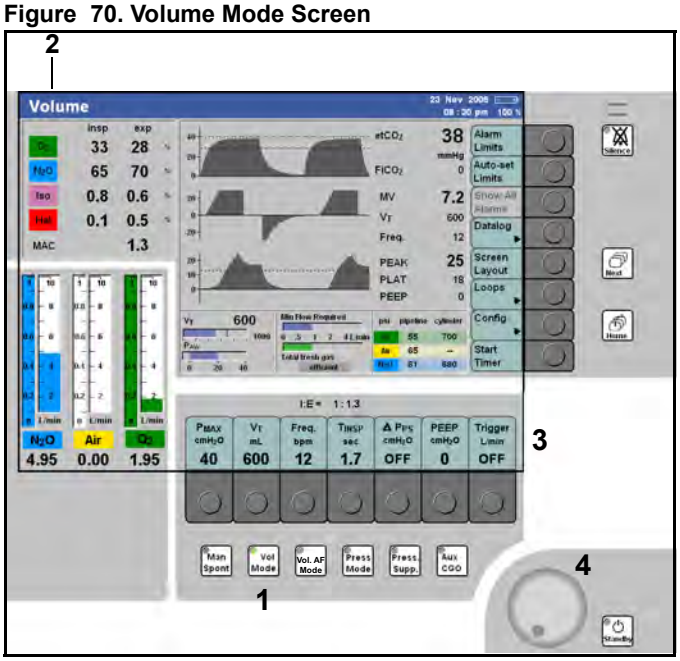


Compliance compensation

Ventilator compliance compensation is continuously applied during volume-controlled ventilation so that the tidal volume delivered to the patient corresponds to the VT setting. Ventilator compliance is determined during the leak test performed in **Standby** mode. To have compliance compensation work accurately, it is important that the patient hoses used during the leak test match the type of hoses used during the procedure.

Note: When the ventilator settings for **Volume Mode** cause the ventilator to operate at its limits of performance, it is not possible for the Apollo to apply compliance compensation. If the ventilator's performance limit is reached, it is not possible to increment the VT setting using the **>VT<** button.

Figure 70. Volume Mode Screen



Starting volume-controlled ventilation

Presetting the volume-controlled ventilation mode

Prior to activating **Volume Mode**, the user can preset the Volume Mode parameters.

1. Press the **>Vol Mode<** key located at the bottom of the display panel (**1** in Figure 70). The LED on the key and the status field at the top of the screen (**2** in Figure 70) flash on and off.

   The row of buttons for the ventilation parameters valid for **Volume Mode** are displayed with a light green background (**3** in Figure 70). This means that they are not yet active.

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2. Press the button for the parameter to be changed; its color changes to yellow to indicate that it is selected.
3. Turn the rotary knob to adjust the parameter to the desired value, and press the rotary knob to confirm (**4** in Figure 70).

   Continue to set the values for the other parameters.

   The parameters that can be set for **Volume Mode** are shown in Table 4, along with their adjustment ranges and factory default values.

Starting the volume-controlled ventilation mode

4. When all the parameters have been preset, press the rotary knob to start volume ventilation (**4** in Figure 70).

   The parameter buttons turn dark green and display the preset parameter values. The "**Volume**" indication in the status field stops flashing and is displayed continuously. Volume ventilation begins.

   If a volume parameter has to be changed during ventilation:

   – Press the button for the parameter to be changed, turn the rotary knob to the desired value, and press the rotary knob to confirm.

Note: **Volume Mode** can also be started without presetting values:

– Press the **>Vol Mode<** key located at the bottom of the display panel, and press the rotary knob. Default parameter values are used.

Note: There is 15-second timeout period for making ventilation mode changes, with a 5-second audible tone sequence after the first 10 seconds. If the new setting is not confirmed within the timeout period, the current ventilation setting remains in effect.

Table 4. Adjustment ranges and default values upon delivery for Volume Mode

Ventilation parameters	Adjustment range	Default value [1] upon delivery
Pressure limitation **>PMAX<** [cmH2O]	10 to 70 min. **PEEP** +10	40
Tidal volume **>VT<** [mL]	20 to 1400[2]	600
Frequency **>Freq<**[3,4] [bpm]	3 to 100	12
Inspiratory time **>TINSP<**[4] [sec.]	0.2 to 6.7	1.7
Insp. pause time : insp. time **>TIP : TINSP<** [%]	0 to 60	10
>PEEP< [cmH2O]	0 to 20 max. **PMAX** –10	0
Trigger sensitivity **>Trigger<** [L/min]	**OFF**, 0.3 to 15	3.0 (**Press. Supp.**) OFF (**Vol./Press. Mode**)
Pressure Support **>ΔPPS<**[5] [cmH2O]	**OFF**, 3 to 50 max. **PMAX–PEEP**	5 (**Press. Supp.**) **OFF** (**Vol./Press. Mode**)
Rise time **>TSLOPE<** [sec.]	0.0 to 2.0	0.0
Age **>Age<** [years]	<1 to 120	40
Ideal body weight **>Weight<**[5] [kg/lbs.]	1 kg to 120 kg, 1 lbs. to 240 lbs.	--

1. Site defaults can be set instead.
2. Optionally 5 mL to 1400 mL.
3. Depending on the configuration, the inspiratory time (TINSP) can be automatically changed together with adjustment of the frequency so that the resultant ratio of inspiration to expiration (I:E) remains constant. Only applies if trigger = OFF. See the chapter "Configuration".
4. The resultant ratio of inspiration to expiration (I : E) is also displayed in parallel.
5. Optional.

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Synchronized volume-controlled ventilation

Synchronization is activated by entering a value for the trigger sensitivity using the >**Extra Settings**< parameter button:

1. Press the >**Extra Settings**< button on the Volume Mode screen (**1** in Figure 71). New buttons appear, including the trigger sensitivity >**Trigger**< (**2** in Figure 71).
2. Press the button >**Trigger**<. The key turns yellow and shows the last trigger value that was set.

The "**sync**" indication in the status field flashes on and off (**3** in Figure 71).

3. Turn the rotary knob to adjust the trigger to the desired value, and press the rotary knob to confirm (**4** in Figure 71).

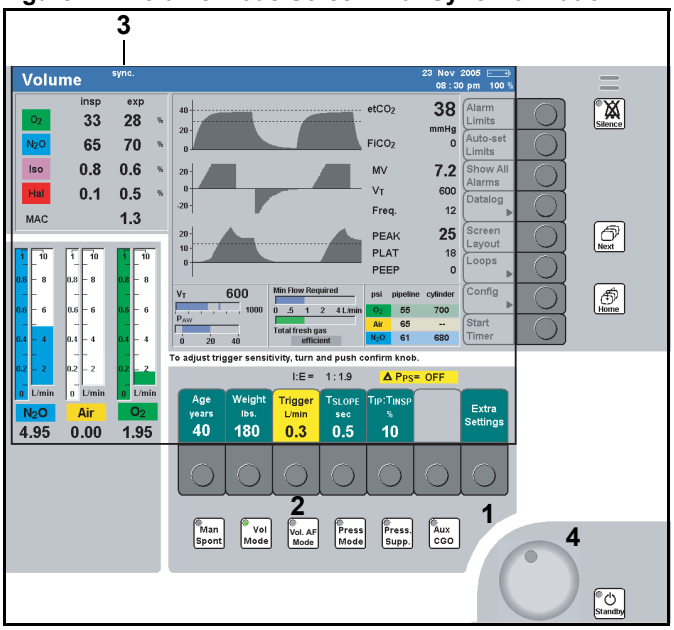
When the trigger value is confirmed, the "**sync**" indication in the status field stops flashing and is displayed continuously.

A mandatory breath triggered by the patient is represented by a continuous vertical black line in the pressure curve and in the flow curve (trigger indicator). The active window for the stroke triggered by the patient corresponds to the last 25% of the applicable expiratory time.

Note: A triggered V_T will be corrected by the volume which the patient spontaneously inhaled prior to beginning volume-controlled ventilation. Independent of that, at least 50 % of the set respiratory volume will always be applied to ensure adequate volume ventilation.

4. Press the button >**Extra Settings**< (**1** in Figure 71) again, the actual trigger sensitivity is shown above the ventilation parameter buttons.

Figure 71. Volume Mode Screen with Synchronization



Synchronized volume-controlled ventilation with Pressure Support (Optional)

Pressure Support is activated during volume-controlled ventilation by entering a value for the level of support. This can be defined via the button >ΔPPS<.

1. Press the button >ΔPPS< on the Volume Mode screen (**1** in Figure 72). The key turns yellow, and the last value set for Pressure Support appears, together with the last value set for the trigger sensitivity above it (**2** in Figure 72).

The "**PressSupp**" indication in the status field flashes on and off (**3** in Figure 72).

2. Turn the rotary knob to adjust the Pressure Support to the desired value, and press the rotary knob to confirm (**4** in Figure 72).

When the value is confirmed, the "**PressSupp**" indication in the status field stops flashing and is displayed continuously.

If the patient was being ventilated without synchronization when Pressure Support is activated, synchronization will now be activated automatically with the last trigger setting used.

The "**sync**" indication will appear in the status field (**3** in Figure 72).

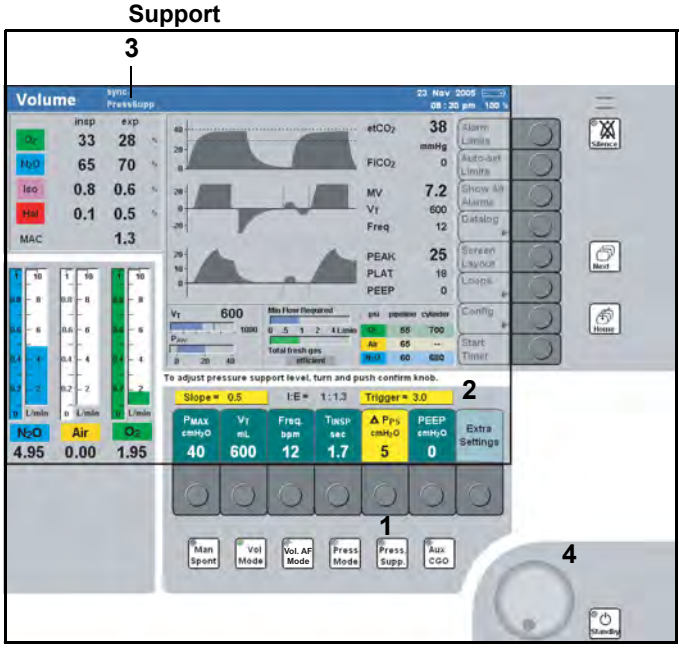
Synchronization is maintained with the set value when Pressure Support is deactivated and set to "**OFF**".

In case of a continuous and strong patient activity, it is possible that the mandatory breathing effort of the patient coincides with the pressure supported ventilation, resulting in an increased tidal volume VT.

Pressure Support is automatically deactivated when the trigger is deactivated and set to "**OFF**".

The actual trigger sensitivity is shown above the keys for the ventilation parameters (**2** in Figure 72).

Figure 72. Volume Mode Screen with optional Pressure Support



Part Number: 9039994, 2nd edition

Volume Mode AutoFlow - Volume AF (Optional)

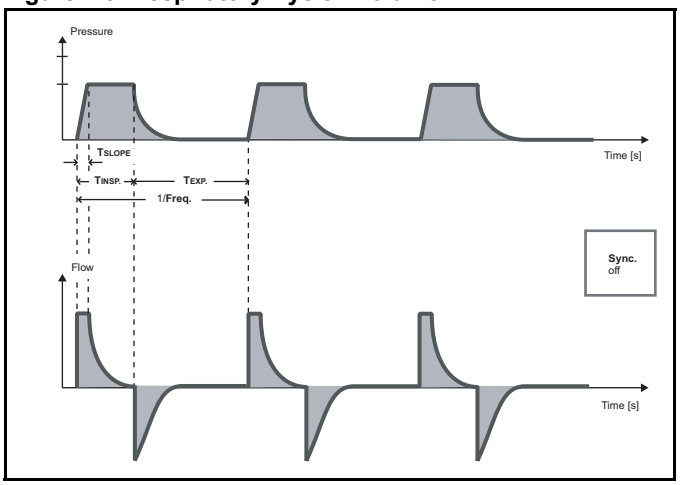
The Apollo has the optional ventilation mode **Volume AF**, a pressure-controlled ventilation mode with a guaranteed tidal volume V_T and frequency Freq. as well as optional synchronization activation and variable Pressure Support for spontaneous breathing efforts (optional).

Volume AF combines the advantages of pressure controlled and volume-controlled ventilation mode. The set tidal volume V_T is delivered in a pressure-controlled ventilation mode. The inspiratory pressure automatically adapts to the set tidal volume, limited by a maximum pressure P_{MAX} (see Figure 73). When starting the ventilation with **Volume AF**, the first mandatory breath is volume-controlled in order to identify the necessary pressure level, if not known from a previous mode.

Apollo automatically adapts the inspiratory pressure to the changing lung condition from breathing cycle to breathing cycle in steps of max. ±3 cmH_2O.

The delivery of tidal volume for one breathing cycle is limited to 130 % of the set tidal volume. If the volume limitation is active, the ventilation pressure for the following breath will be reduced to 75 % of the target pressure, but limited to a maximum of 15 mbar above **PEEP**.

Figure 73. Respiratory Cycle - Volume AF



Part Number: 9039994, 2nd edition

Starting Volume Mode AutoFlow

Presetting the Volume AutoFlow ventilation mode

Prior to activating **Volume AF**, the user can preset the **Volume AF** parameters.

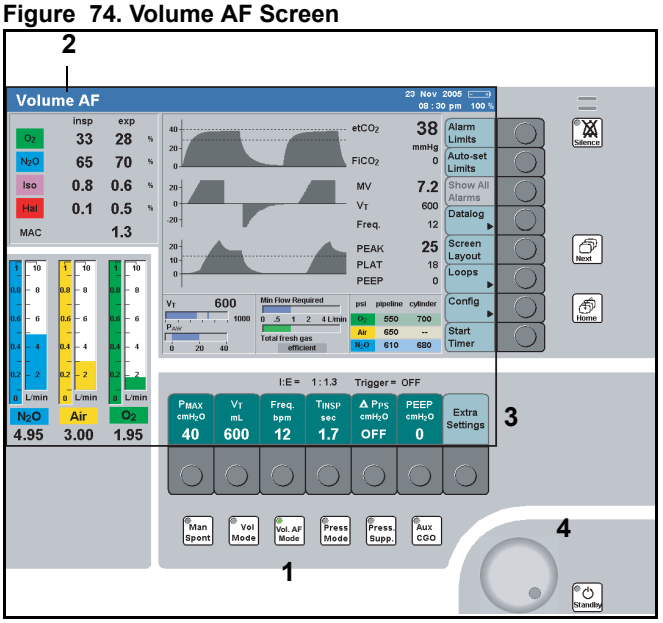
1. Press the >**Vol. AF Mode**< key located at the bottom of the display panel (**1** in Figure 74). The LED on the key and the status field at the top of the screen (**2** in Figure 74) flash on and off.

The row of buttons for the ventilation parameters valid for **Volume AF** are displayed with a light green background (**3** in Figure 74). This means that they are not yet active.

2. Press the button for the parameter to be changed; its color changes to yellow to indicate that it is selected.
3. Turn the rotary knob to adjust the parameter to the desired value, and press the rotary knob to confirm (**4** in Figure 74).

Continue to set the values for the other parameters.

Figure 74. Volume AF Screen



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Starting the Volume AutoFlow ventilation mode

1. When all the parameters have been preset, press the rotary knob to start Volume AF ventilation (**4** in Figure 74).

The parameter buttons turn dark green and display the preset parameter values. The "**Vol. AF**" indication in the status field stops flashing and is displayed continuously. Volume AutoFlow ventilation begins.

If a volume parameter has to be changed during ventilation:

1. Press the button for the parameter to be changed, turn the rotary knob to the desired value, and press the rotary knob to confirm.

Note: **Volume AF** can also be started without presetting values:

– Press the **>Vol. AF Mode<** key located at the bottom of the display panel, and press the rotary knob. Default parameter values are used.

Table 5. Adjustment ranges and default values upon delivery for Volume AF mode

Ventilation parameters	**Adjustment range**	**Default value upon delivery** [1]
Pressure limitation >**PMAX**< [cmH2O]	10 to 70 min. **PEEP** +10	40
Tidal volume >**VT**< [mL]	20 to 1400[2]	600
Frequency >**Freq**<[3,4] [bpm]	3 to 100	12
Inspiratory time >**TINSP**<[4] [sec.]	0.2 to 6.7	1.7
>**PEEP**< [cmH2O]	0 to 20	0
Trigger sensitivity >**Trigger**< [L/min]	**OFF**, 0.3 to 15	3.0 (**PressSupp.**) **OFF** (**Volume AF**)
Pressure Support >Δ**PPS**<[5] [cmH2O]	**OFF**, 0 to 50 max. **PMAX**–**PEEP**	5 (**PressSupp.**) **OFF** (**Volume AF**)
Rise time >**TSLOPE**< [sec.]	0.0 to 2.0	0.0
Age >**Age**< [years]	<1 to 120	40
Ideal body weight >**Weight**<[5] [kg/lbs.]	1 kg to 120 kg 1 lbs. to 240 lbs.	--

1. Site defaults can be set instead.
2. Optionally 5 mL to 1400 mL.
3. Depending on the configuration, the inspiratory time (TINSP) can be automatically changed together with adjustment of the frequency so that the resultant ratio of inspiration to expiration (I:E) remains constant. Only applies if trigger = OFF. See the chapter "Configuration".
4. The resultant ratio of inspiration to expiration (I : E) is also displayed in parallel.
5. Optional.

Part Number: 9039994, 2nd edition

Synchronized volume-guaranteed ventilation

Synchronization is activated by entering a value for the trigger sensitivity using the >**Extra Settings**< parameter button.

1. Press the button >**Extra Settings**< (**1** in Figure 75). The trigger sensitivity button >**Trigger**< (**2** in Figure 75) is displayed.
2. Press the button >**Trigger**<. The last value set appears as default value when the key is activated.
3. Turn the rotary knob to adjust the trigger sensitivity to the desired value, and press the rotary knob to confirm (**3** in Figure 75).

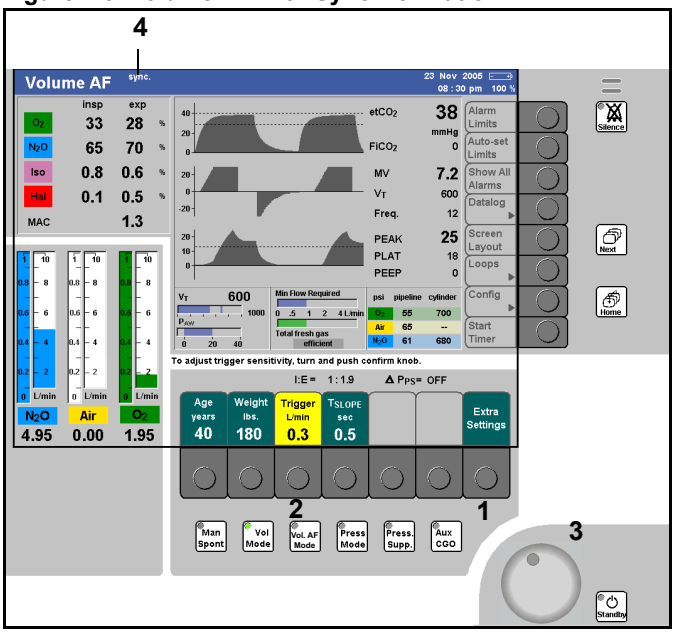
When the value is confirmed, the "**sync.**" indication in the status field (**4** in Figure 75) stops flashing and is displayed continuously.

A mandatory breath triggered by the patient is represented by a continuous vertical black line in the pressure curve and in the flow curve (trigger indicator). The active window for the stroke triggered by the patient corresponds to the last 25 % of the applicable expiratory time.

In **Volume AF**, the patient can additionally end the inspiratory phase during the last 50 % of the applicable inspiratory time when synchronization is activated. An inspiratory phase ended by the patient is represented by a continuous vertical black line in the pressure curve and in the flow curve (trigger indicator).

4. Press the button >**Extra Settings**< again. The actual trigger sensitivity is shown above the keys for the ventilation parameters.

Figure 75. Volume AF with Synchronization



Part Number: 9039994, 2nd edition

Synchronized volume-guaranteed ventilation with Pressure Support (Optional)

Pressure Support is activated during **Volume AF** by entering a value for the level of Pressure Support. This can be defined via the button >ΔPPS<.

1. Press the button >ΔPPS< on the Volume AF screen (**1** in Figure 76). The key turns yellow, and the last value set for Pressure Support appears, together with the last value set for the trigger sensitivity above it (**2** in Figure 76).

The "**PressSupp**" indication in the status field flashes on and off (**3** in Figure 76).

2. Turn the rotary knob to adjust the Pressure Support to the desired value, and press the rotary knob to confirm (**4** in Figure 76).

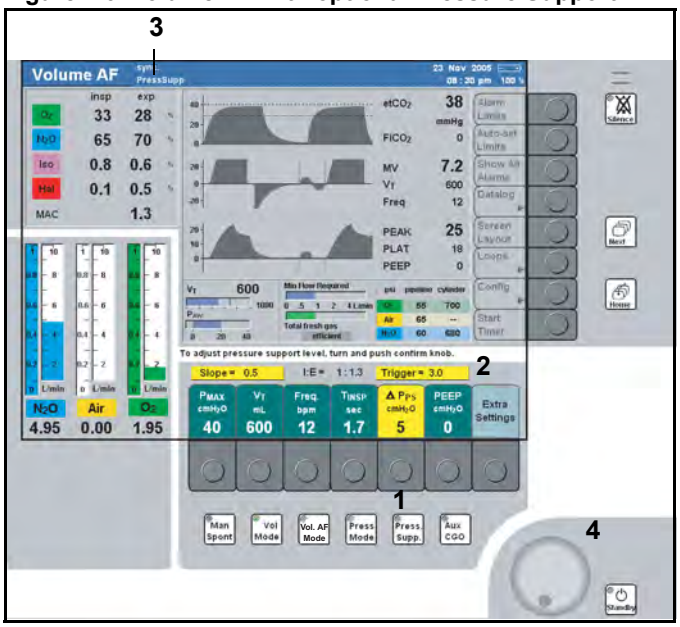
When the value is confirmed, the "**PressSupp**" indication in the status field stops flashing and is displayed continuously.

If the patient was ventilated without synchronization when Pressure Support was activated, synchronization will be activated automatically with the last trigger setting used. Synchronization is maintained with the set value when Pressure Support is deactivated and set to "**OFF**".

In case of a continuous and strong patient activity, it is possible that the mandatory breathing effort of the patient coincides with the pressure supported ventilation, resulting in an increased tidal volume VT.

The actual trigger sensitivity is shown above the keys for the ventilation parameters. (**2** in Figure 76). The parameters that can be set for **Pressure Mode** are shown in Table 6, along with their adjustment ranges and default values upon delivery.

Figure 76. Volume AF with optional Pressure Support



Part Number: 9039994, 2nd edition

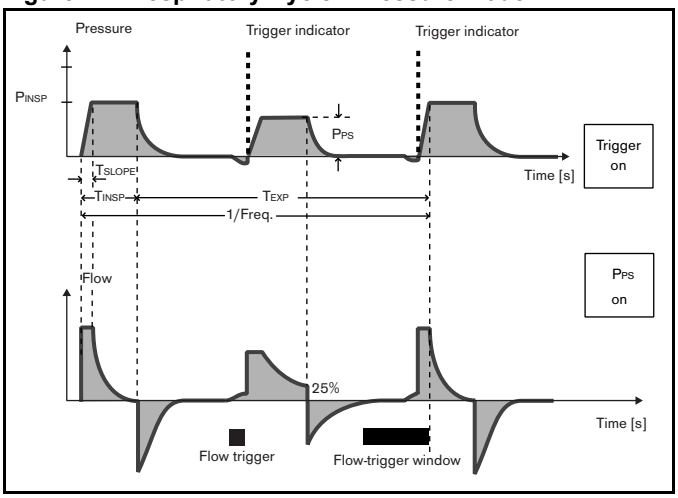
Pressure-Controlled Ventilation

The Apollo has a pressure-controlled ventilation mode with fixed pressure limitation PINSP and frequency Freq. as well as with optional synchronization and variable Pressure Support for spontaneous breathing efforts (optional).

A continuous pressure is applied to the patient during the inspiratory time TINSP (refer to Figure 77). The rate at which the pressure curve rises is preset via the rise time TSLOPE. Synchronization and Pressure Support are controlled by the sensitivity of the flow trigger and the level of ΔPPS. The maximum time interval for controlled ventilation is set via the frequency. To maintain a constant frequency, a time interval triggered prematurely is compensated in the next cycle.

Changes in lung compliance and ventilation parameters influence the tidal volume.

Figure 77. Respiratory Cycle - Pressure Mode



Starting Pressure-Controlled Ventilation

Presetting the pressure-controlled ventilation mode

Prior to activating **Pressure Mode**, the user can preset the Pressure Mode parameters.

1. Press the >**Press Mode**< key located at the bottom of the display panel (**1** in Figure 78). The LED on the key and the status field at the top of the screen (**2** in Figure 78) flash on and off.

   The row of buttons for the ventilation parameters valid for **Pressure Mode** are displayed on a light green background (**3** in Figure 78). This means that they are not yet active.

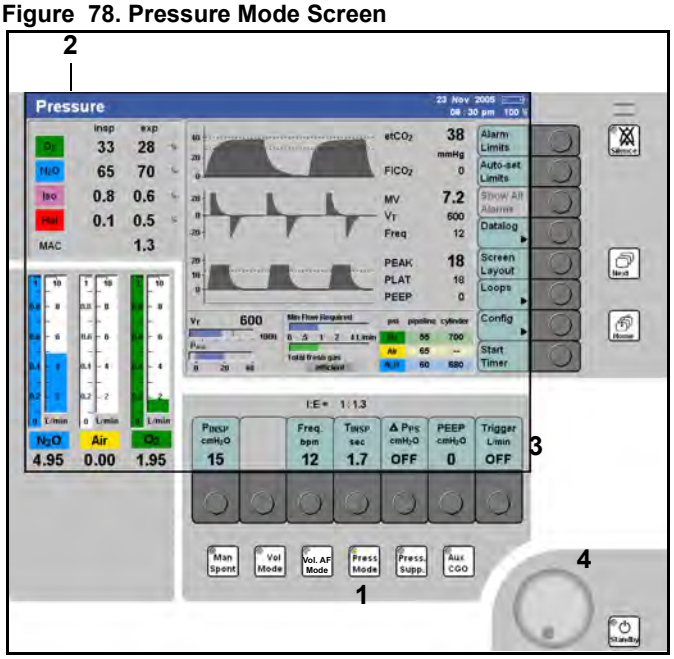
2. Press the button for the parameter to be changed; its color changes to yellow to indicate that it is selected.

3. Turn the rotary knob to adjust the parameter to the desired value, and press the rotary knob to confirm (**4** in Figure 78).

   Continue to set the values for the other parameters.

   The parameters that can be set for **Pressure Mode** are shown in Table 6, along with their adjustment ranges and default values upon delivery.

Figure 78. Pressure Mode Screen



Part Number: 9039994, 2nd edition

Starting the pressure-controlled ventilation mode

1. When all the parameters have been preset, press the rotary knob to start pressure ventilation (**4** in Figure 78).

   The parameter buttons turn dark green and display the preset parameter values. The "**Pressure**" indication in the status field stops flashing and is displayed continuously. Pressure ventilation begins.

   If a pressure parameter has to be changed during ventilation:

   – Press the button for the parameter to be changed, turn the rotary knob to the desired value, and press the rotary knob to confirm.

Note: **Pressure Mode** can also be started without presetting values:

– Press the **>Press Mode<** key located at the bottom of the display panel, and press the rotary knob. Default parameter values are used.

Note: There is 15-second timeout period for making ventilation mode changes, with a 5-second audible tone sequence after the first 10 seconds. If the new setting is not confirmed within the timeout period, the current ventilation setting remains in effect.

Table 6. Adjustment ranges and default values upon delivery for Pressure Mode

Ventilation parameters	Adjustment range	Default value[1] upon delivery
Pressure limitation **>PINSP<** [cmH2O]	5 to 70 min. **PEEP** +5	15
Frequency **>Freq<**[2,3] [bpm]	3 to 100	12
Inspiratory time **>TINSP<**[3] [sec.]	0.2 to 6.7	1.7
>PEEP<[4] [cmH2O]	0 to 20 max. **PINSP** –5	0
Trigger sensitivity **>Trigger<** [L/min]	**OFF**, 0.3 to 15	3.0 (**Press. Supp.**) **OFF** (**Vol./Press. Mode**)
Pressure Support **>ΔPPS<**[5] [cmH2O]	**OFF**, 3 to 50 max. **PMAX–PEEP**	5 (**Press. Supp.**) **OFF** (**Vol./Press. Mode**)
Rise time **>TSLOPE<** [sec.]	0.0 to 2.0	0.0
Age **>Age<** [years]	<1 to 120	40
Ideal body weight **>Weight<**[5] [kg/lbs.]	1 kg to 120 kg, 1 lbs. to 240 lbs.	--

1. Site defaults can be configured instead.
2. Depending on the configuration, the inspiratory time (TINSP) can be automatically changed together with adjustment of the frequency so that the resultant ratio of inspiration to expiration (I : E) remains constant. Only applies if trigger = OFF. See the chapter "Configuration".
3. The resultant ratio of inspiration to expiration (I : E) is also displayed in parallel.
4. Depending on the configuration, the pressure limit (PINSP) can be changed automatically together with adjustment of the PEEP value. See the chapter "Configuration".
5. Optional.

Part Number: 9039994, 2nd edition

Synchronized pressure-controlled ventilation

Synchronization is activated by entering a value for the trigger sensitivity. This can be defined via the button >**Extra Settings**<.

1. Press the >**Extra Settings**< button on the Pressure Mode screen (**1** in Figure 79). New buttons appear, including the trigger sensitivity >**Trigger**< (**2** in Figure 79).
2. Press the button >**Trigger**<. The key turns yellow and shows the last trigger value that was set.

The “**sync**” indication in the status field flashes on and off (**3** in Figure 79).

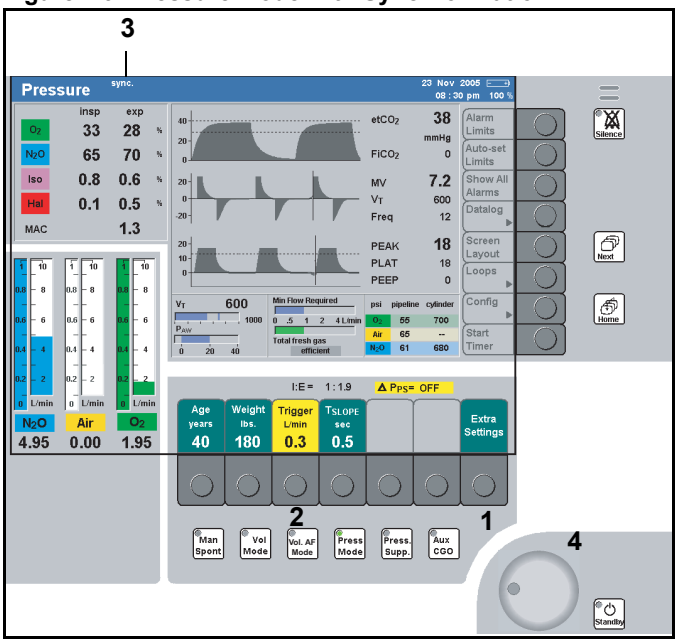
3. Turn the rotary knob to adjust the trigger to the desired value, and press the rotary knob to confirm (**4** in Figure 79).

   When the trigger value is confirmed, the “**sync**” indication in the status field stops flashing and is displayed continuously.

A ventilation stroke triggered by the patient is represented by a continuous vertical black line in the pressure curve and in the flow curve (trigger indicator). The active window for the stroke triggered by the patient corresponds to the last 25% of the applicable expiratory time.

4. Press the button >**Extra Settings**< again, the actual trigger sensitivity is shown above the ventilation parameter buttons.

Figure 79. Pressure Mode with Synchronization



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Synchronized pressure-controlled ventilation with Pressure Support (Optional)

Pressure Support is activated during pressure-controlled ventilation by entering a value for the level of support. This can be defined via the button >ΔPPS<.

1. Press the >ΔPPS< button on the Pressure Mode screen (**1** in Figure 80). The key turns yellow, and last value that was set for Pressure Support is displayed, together with the last value set for the trigger sensitivity above it (**2** in Figure 80).

The “**PressSupp**” indication in the status field flashes on and off (**3** in Figure 80).

2. Turn the rotary knob to adjust the Pressure Support to the desired value, and press the rotary knob to confirm (**4** in Figure 80).

When the value is confirmed, the ”**PressSupp**” indication in the status field stops flashing and is displayed continuously.

If the patient was ventilated without synchronization when Pressure Support is activated, synchronization will now be activated automatically with the last trigger setting used.

Synchronization is maintained with the set value when Pressure Support is deactivated and set to “**OFF**”.

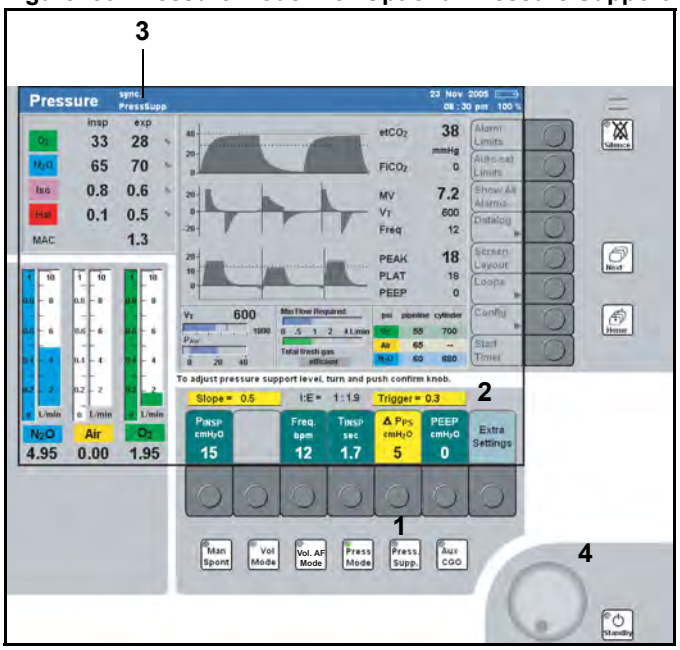
Pressure Support is automatically deactivated when the trigger is deactivated and set to “**OFF**”.

In case of a continuous and strong patient activity, it is possible that the mandatory breathing effort of the patient coincides with the pressure supported ventilation, resulting in an increased tidal volume VT.

The trigger sensitivity is shown above the ventilation parameter buttons (**2** in Figure 80).

The parameters that can be set for **Pressure Mode** are shown in Table 6, along with their adjustment ranges and default values upon delivery.

Figure 80. Pressure Mode with Optional Pressure Support



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Pressure Support Ventilation (Optional)

The Apollo has a pressure-assisted ventilation mode for patients with spontaneous breathing. Synchronization and Pressure Support for the spontaneous breathing efforts are controlled by the sensitivity of the flow trigger and by the level of ΔP_{PS}. The rate at which the pressure curve rises is preset by the rise time T_{SLOPE}. Refer to Figure 81.

The maximum inspiratory time for a spontaneous breathing stroke varies according to age:
1.5 seconds for patients aged 4 years and younger, and 4 seconds for patients over 4 years.

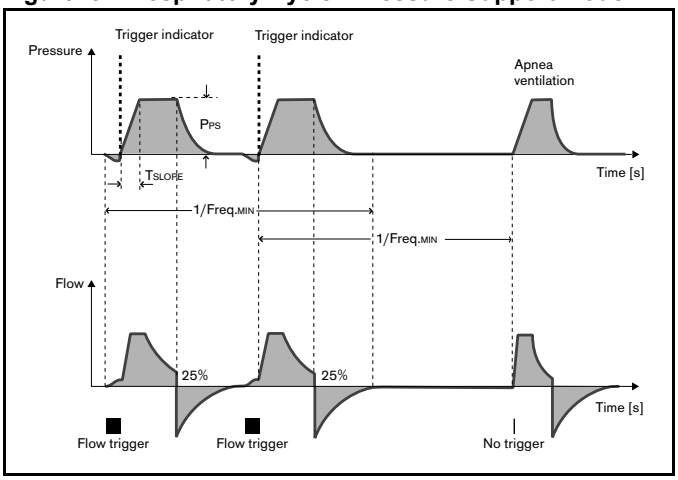
Inspiration is ended as soon as the current inspiration flow drops below 25 % of the inspiratory peak flow. Any leakage is compensated simultaneously with the actual airway pressure.

Apnea ventilation can additionally be set with the minimum frequency $Freq_{MIN}$. The ventilator is automatically triggered by $Freq_{MIN}$ if there is no spontaneous breathing activity by the patient.

This is not a mandatory ventilation stroke by the ventilator; the patient can end the stroke triggered by the ventilator at any time by breathing spontaneously. This stroke is not identified by a trigger indicator.

Apnea ventilation can also be deactivated again by setting the $Freq_{MIN}$ to “**OFF**”.

Figure 81. Respiratory Cycle - Pressure Support Mode



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Starting Pressure Support Ventilation

Presetting the Pressure Support ventilation mode

Prior to activating Pressure Support mode, the user can preset the Pressure Support mode parameters.

1. Press the >**Press. Supp.**< key located at the bottom of the display panel (**1** in Figure 82). The LED on the key and the status field at the top of the screen (**2** in Figure 82) flash on and off.

The row of buttons for the ventilation parameters valid for Pressure Support mode are displayed on a light green background (**3** in Figure 82). This means that they are not yet active.

2. Press the button for the parameter to be changed; its color changes to yellow to indicate that it is selected.
3. Turn the rotary knob to adjust the parameter to the desired value, and press the rotary knob to confirm (**4** in Figure 82).

Continue to set the values for the other parameters.

The parameters that can be set for **Pressure Support** mode are shown in Table 7, along with their adjustment ranges and factory default values.

Note: The rise time should be set such that the plateau pressure is reached within 1/3 of the patient inspiration time.

Starting the Pressure Support ventilation mode

1. When all the parameters have been preset, press the rotary knob to start Pressure Support Ventilation (**4** in Figure 82).

The parameter buttons turn dark green and display the preset parameter values. The "**Press. Support**" indication in the status field stops flashing and is displayed continuously. Pressure Support Ventilation begins.

If a Pressure Support parameter has to be changed during ventilation:

1. Press the button for the parameter to be changed, turn the rotary knob to the desired value, and press the rotary knob to confirm.

Figure 82. Pressure Support Mode Screen

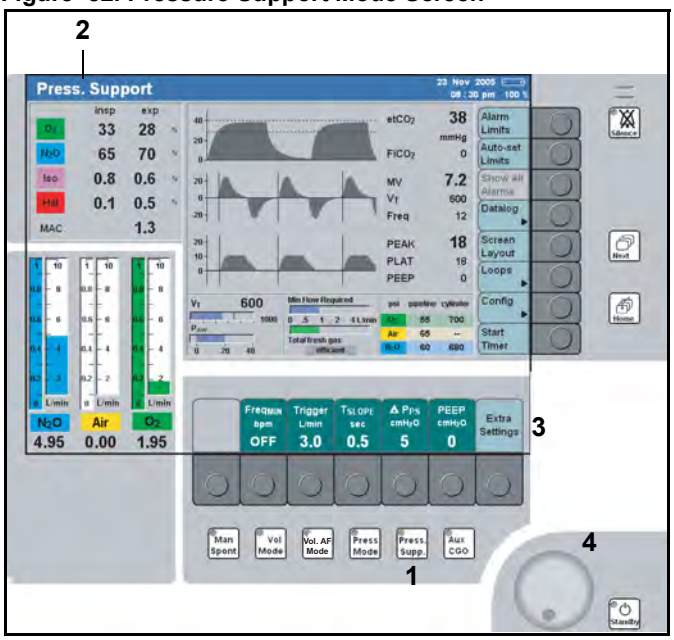

Table 7 . Adjustment ranges and default values upon delivery for Pressure Support mode

Ventilation parameters	Adjustment range	Default value[1] upon delivery
Minimum frequency[2] >**FreqMIN**< [bpm]	**OFF**, 3 to 20	3
>**PEEP**< [cmH2O]	0 to 20	0
Trigger sensitivity >**Trigger**< [L/min]	0.3 to 15	3.0
Pressure Support >Δ**PPS**< [mbar]	3 to 50	5
Rise time >**TSLOPE**< [sec.]	0.0 to 2.0	0.0
Age >**Age**< [years]	<1 to 120	40
Ideal body weight >**Weight**<[3] [kg/lbs.]	1 kg to 120 kg, 1 lbs. to 240 lbs.	--

1. Site defaults can be set instead.
2. The inspiratory time is limited by adjustment of Freq.MIN to yield a maximum ratio of 1:1 for (I : E), thus ensuring an adequate expiratory time.
3. Optional

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Note: Pressure Support mode can also be started without presetting values:

– Press the >**Press. Supp**< key located at the bottom of the display panel, and press the rotary knob. Default parameter values are used.

Note: There is 15 second timeout period for making ventilation mode changes, with a 5-second audible tone sequence after the first 10 seconds. If the new setting is not confirmed within the timeout period, the current ventilation setting remains in effect.

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Continuous Positive Airway Pressure CPAP - in Pressure Support Mode (Optional)

The pressure support option on the Apollo is enhanced with Continuous Positive Airway Pressure (CPAP).

CPAP allows the patient to breath spontaneously on an increased pressure level and therefore helps to increase the functional residual capacity. It is indicated for use only in patients who are breathing spontaneously.

Continuous Positive Airway Pressure is activated in Pressure Support when the value for the Pressure Support ΔP_{PS} is set <= 2 cmH_2O.

The apnea ventilation is not active during Pressure Support CPAP. When CPAP is activated, the minimum frequency $Freq_{MIN}$ is set to OFF and the rise time is set to 0.0.

The parameters that can be set for **CPAP** mode are shown in Table 8, along with their adjustment ranges and factory default values.

Table 8. Adjustment ranges and default values upon delivery for CPAP

Ventilation parameters	Adjustment range	Default value[1] upon delivery
Minimum frequency >**$Freq_{MIN}$**< [bpm]	**OFF**, 3 to 20 **OFF** (**CPAP**)	3
>**PEEP**< [cmH_2O]	0 to 20	0
Trigger sensitivity >**Trigger**< [L/min]	0.3 to 15	3.0
Pressure Support >Δ**P_{PS}**<[2] [cmH_2O]	>2 to 50 0 to 2 (**CPAP**)	5
Rise time >**T_{SLOPE}**< [sec.]	0.0 to 2.0 0.0 (**CPAP**)	0.0
Age >**Age**< [years]	<1 to 120	40
Ideal body weight >**Weight**<[3] [kg/lbs.]	1 kg to 120 kg, 1 lbs. to 240 lbs.	--

1. Site defaults can be configured instead.
2. Depending on the configuration, the inspiratory time (T_{INSP}) can be automatically changed together with adjustment of the frequency so that the resultant ratio of inspiration to expiration (I : E) remains constant. Only applies if trigger = OFF. See the chapter "Configuration".
3. Optional.

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Changing between ventilation modes

When changing to a different ventilation mode, the presettings are adopted or appropriately derived from the parameters of the preceding mode.

Parameters which are identical in both ventilation modes are adopted directly (e.g. Freq., TINSP, ΔPPS, Trigger).

When changing from volume-controlled to pressure-controlled ventilation modes:

The measured parameter PLAT is adopted as the new value for PINSP. If a valid plateau pressure value is not available, the last value used in the case will be used as the preset value (the preset value of PINSP will be at least PEEP + 5). The **PAW LOW** alarm limit will be pre-set to PINSP-2 if the alarm limit was higher than PINSP-2 during volume-controlled ventilation.

When changing from pressure-controlled to volume-controlled ventilation modes:

The new tidal volume VT is adopted from the measured minute volume MV and the set frequency Freq. Only the minute volume applied by the ventilator is taken into account. Pressure supported breathing strokes by the patient are disregarded.

When changing from automatic ventilation modes to Pressure Support mode (optional):

The set PEEP, ΔPPS, and Trigger are adopted.

If ΔPPS and/or Trigger were set to "**OFF**", the last values used are adopted in Pressure Support mode. In all other cases the configured default settings are used.

The **PAW LOW** alarm limit will be pre-set to PEEP+ΔPPS-2 if the alarm limit was higher than PEEP+ΔPPS-2 during automatic ventilation mode.

When changing from Pressure Support mode (optional) to automatic ventilation modes:

The set PEEP, ΔPPS, and Trigger values are adopted. The last values that were set are used for the other parameters and the configured default settings in all other cases.

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Automatic parameter changes

With the proper configuration setting in the Standby Configuration screen, certain ventilation parameters change automatically when a related parameter is changed. See the chapter "Configuration" for complete information.

TINSP changes

TSLOPE may be reduced simultaneously if TINSP is reduced.

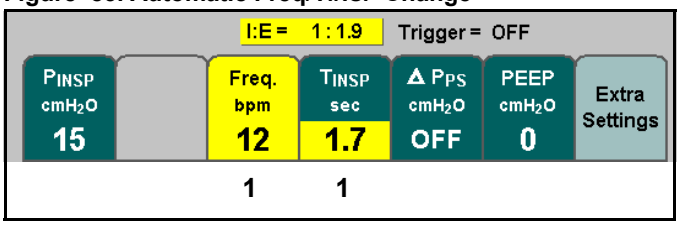
Frequency changes

Depending on the configuration, the inspiratory time TINSP can be automatically changed together with adjustment of the frequency Freq. in volume-controlled or pressure-controlled ventilation modes without synchronization, so that the resultant ratio of inspiration to expiration I:E remains constant.

To make a combined Freq./TINSP parameter change:

1. Press the >**Freq**< button on the Volume or Pressure Mode screen. The key lights up yellow, along with the value for TINSP, to indicate that both values will change (**1** in Figure 83).
2. Turn the rotary knob to adjust the frequency value. The TINSP value is adjusted at the same time.
3. When the desired frequency value is displayed, press the rotary knob to set the value. Both the >**Freq.**< and the >**TINSP**< keys turn green and the I:E ratio remains constant.

Figure 83. Automatic Freq/TINSP Change



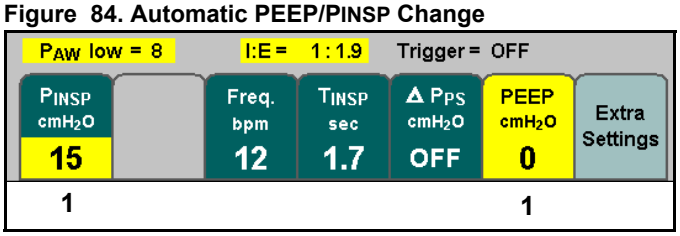
PEEP changes

Depending on the configuration, the inspiratory pressure PINSP can be automatically changed when the PEEP value is changed in the pressure-controlled ventilation mode.

To make a combined PEEP/PINSP parameter change:

1. Press the >**PEEP**< button on the Pressure Mode screen. The key lights up yellow, along with the value for PINSP, to indicate that both values will change (**1** in Figure 84).
2. Turn the rotary knob to adjust the PEEP value. The PINSP value is adjusted at the same time.

Figure 84. Automatic PEEP/PINSP Change



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3. When the desired PEEP value is displayed, press the rotary knob to set the value. Both the >**PEEP**< and the >**PINSP**< keys turn green.

   If so configured, the lower alarm limit for the airway pressure PAW will be automatically changed when the PEEP value is changed.

Auxiliary common gas outlet (Aux CGO) ventilation (Optional)

WARNING!

Risk of patient injury.

Using a non-rebreathing system may injure the patient if the following is not observed:

- **Only use devices with a breathing bag and/ or pressure relief valve.**
- **Check the fresh-gas flow and the condition of the breathing bag.**
- **Do not use the non-rebreathing system if the flow is insufficient.**

Example: Bain system

1. Prepare the system according to the corresponding Instructions for Use.

To monitor O_2, CO_2, and anesthetic gases:

2. Connect the sample line to the Luer lock connection on the mask manifold and to the water trap connection on the front of the Apollo (**1** in Figure 85).

For mask manifolds without a sample line connector:

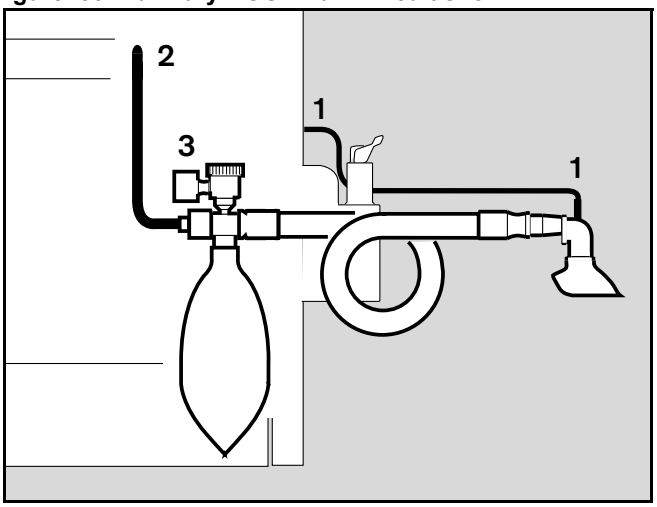
– Place a T-piece with filter between the mask pipe and fresh-gas connection port.

or:

– where applicable, use a Luer lock filter connection.

3. Connect the fresh-gas hose of the Bain system to the auxiliary common gas outlet (**2** in Figure 85).
4. Connect the gas scavenging system hose of the non-rebreathing system (**3** in Figure 85) to the Y-piece of the Apollo breathing system.
5. Follow the Instructions for Use provided with the non-rebreathing system.

Figure 85. Auxiliary CGO - Bain Circuit shown



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Diverting fresh gas to the auxiliary CGO

Presetting the auxiliary CGO monitoring

Prior to activating auxiliary CGO monitoring, the user can preset the auxiliary CGO parameters.

1. Press the >**Aux CGO**< key located at the bottom of the display panel (**1** in Figure 86).

The LED on the key and the status field at the top of the screen (**2** in Figure 86) flash on and off.

The buttons for the parameters valid for auxiliary CGO monitoring are displayed on a light green background (**4** in Figure 86). This means that they are not yet active.

2. Press the button for the parameter to be changed; its color changes to yellow to indicate that it is selected.
3. Turn the rotary knob to adjust the parameter to the desired value, and press the rotary knob to confirm (**3** in Figure 86).

Continue to set the values for the other parameter.

The parameters that can be set for auxiliary CGO monitoring are shown in Table 9, along with their adjustment ranges and factory default values.

Note: The patient's ideal body weight is the actual weight minus estimated excess fat.

Starting the auxiliary CGO monitoring

1. When all the auxiliary CGO monitoring parameters have been preset, press the rotary knob to start auxiliary CGO monitoring (**3** in Figure 86).

The parameter buttons turn green and display the preset parameter values. The "**Aux CGO**" indication in the status field stops flashing and is displayed continuously. Auxiliary CGO monitoring begins.

2. Set an appropriate fresh-gas flow. The fresh-gas supply must be equal to at least twice the minute volume in order to exclude rebreathing.

If an auxiliary CGO monitoring parameter has to be changed during ventilation:

1. Press the button for the parameter to be changed, turn the rotary knob to the desired value, and press the rotary knob to confirm.

Figure 86. Auxiliary CGO Ventilation Screen

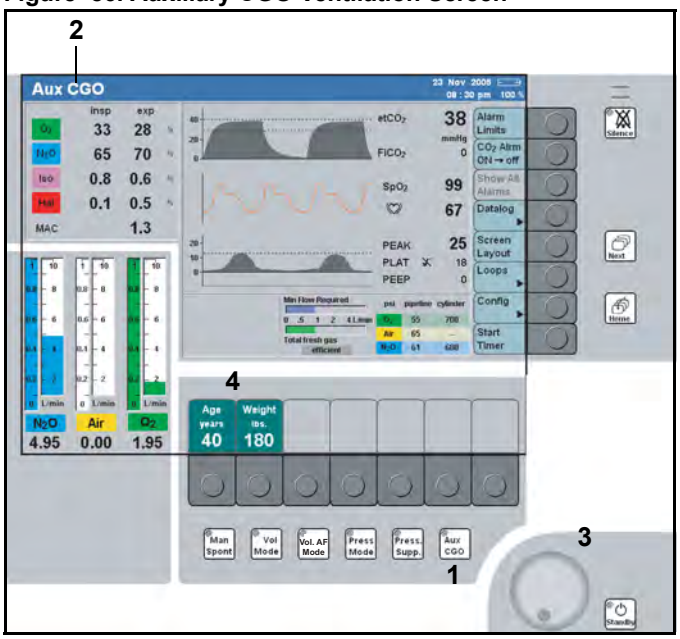

Table 9 . Adjustment ranges and factory default values for auxiliary CGO monitoring parameters

Ventilation parameter (auxiliary CGO monitoring)	Adjustment range	Factory default value[1]
Age >**Age**< [years]	<1 to 120	40
Ideal body weight >**Weight**<[2] [kg/lbs.]	1 kg to 120 kg, 1 lbs. to 240 lbs.	--

1. Site defaults can be set instead.
2. Optional

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Note: Auxiliary CGO monitoring can also be started without presetting values:

– Press the >**Aux CGO**< key located at the bottom of the display panel, and press the rotary knob. Default parameter values are used.

Note: There is 15 second timeout period for making ventilation mode changes, with a 5-second audible tone sequence after the first 10 seconds. If the new setting is not confirmed within the timeout period, the current ventilation setting remains in effect.

Airway pressure PAW and the mandatory frequency Freq., PPEAK, and PMEAN are measured at the auxiliary common gas outlet.

Pressure measurement may be impaired by activating the O_2 flush.

The minute volume MV and tidal volume VT are not measured.

Certain alarms are disabled automatically in order to avoid artifacts. See the chapter "Alarms" for complete information.

Excess fresh gas can be discharged into the anesthetic gas scavenging line via the breathing system of the Apollo. For this purpose, the non-rebreathing system must be connected to the Y-piece of the breathing hoses connected to the breathing system.

WARNING!

Risk of patient injury.

If the bag does not inflate, the patient will not receive adequate ventilation. Switch to the Apollo internal breathing system and ventilate the patient using an automatic ventilation mode.

CAUTION!

Risk of increased ambient gas concentration.

Ambient air may become contaminated with anesthetic agent when using non-rebreathing systems.

Ensure sufficient ambient air circulation.

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Ending the auxiliary CGO ventilation

1. Press any ventilation mode key, other than >**Aux CGO**<. The LED of the selected ventilation mode key and the status field flash on and off.
2. Press the rotary knob. The ventilation is switched to the Apollo internal rebreathing system.

Note: When changing back to the Apollo rebreathing system, reconnect the sample line to the Y-piece.

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Monitoring

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Overview

The Apollo has three basic screens for the display of monitoring information: standard, data, and trend. The gas measurement and gas delivery windows remain displayed in all three screens, but the information presented in the graphical/numerical window will change, depending on the selected screen and user configuration.

This chapter of the Operating Instructions defines all monitoring parameters and provides instructions for selecting and configuring monitoring screens and parameters.

WARNING!

Risk of patient injury.

If the display loses patient data, it is possible that active monitoring is not being performed.

Close patient observation or alternate monitoring de-vices should be used until monitor function is restored.

Standard screen

The standard screen is automatically displayed whenever a ventilation mode is selected.

This screen can always be selected during operation:

1. By pressing the >Home< key to display the standard screen directly (**1** in Figure 87).

or

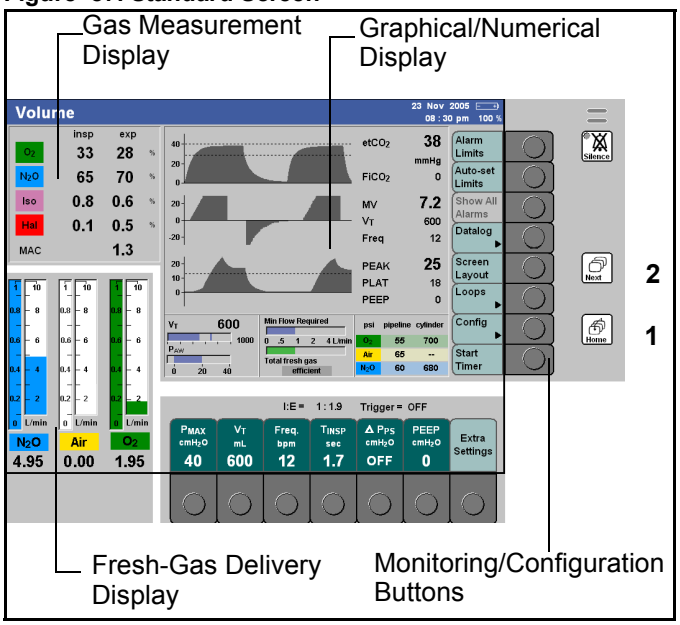
1. By pressing the >Next< key repeatedly until the standard screen is displayed (**2** in Figure 87).

The most important parameters are grouped together:

The left side of the standard screen displays the **Gas Measurement Display** and the **Fresh-Gas Delivery Display** which remain displayed on the screen at all times during operation (refer to Figure 87).

The center of the standard screen displays the **Graphical/Numerical Display**, which shows the majority of the Apollo parameter information and can be customized by the user for screen layout and/or content. The top section contains real-time curves and corresponding numeric values for monitored parameters, and the bottom section contains

Figure 87. Standard Screen



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modules that are configured by the user and provide various types of ventilation and system information.

The right side of the standard screen displays the **Monitoring/Configuration Buttons**, which allow the user to customize the display and provide access to additional functions.

For a list of monitored parameters, see “Displayed parameters” on page 137.

Screen layout

Selecting a default layout

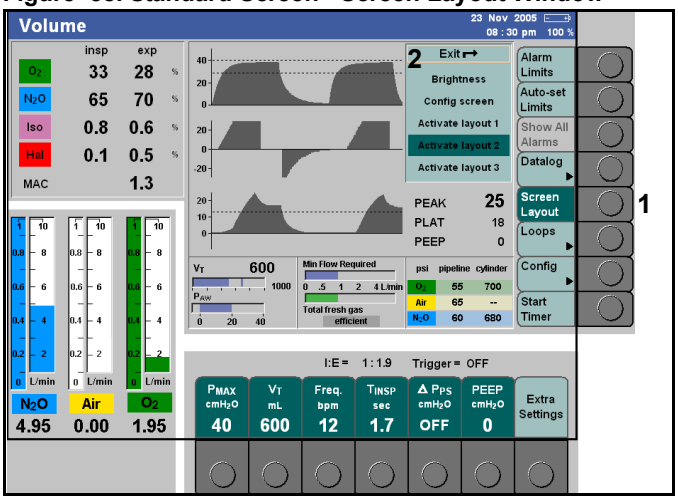
The user can select a default screen layout for the standard screen. The selection determines the three curves that are displayed, as well as the three modules that are shown below the curves.

Three default layouts are available. They can only be configured in the standby Configuration screen. See the chapter “Configuration” of the Operating Instructions for complete information.

1. Press the >**Screen Layout**< key on the standard screen (**1** in Figure 88). The screen layout window appears (**2** in Figure 88), with the currently selected layout highlighted.
2. Turn the rotary knob to select a different layout, and press the rotary knob to confirm.

The screen layout window is removed and the standard screen is displayed with the selected layout.

Figure 88. Standard Screen - Screen Layout Window



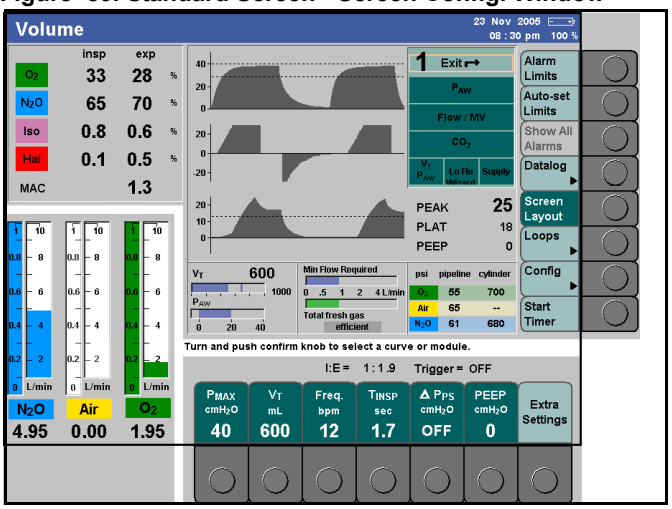
Modifying current layout

The user can also modify the layout of the currently selected screen:

1. Press the >**Screen Layout**< key on the standard screen (**1** in Figure 88). The screen layout window appears (**2** in Figure 88).
2. Turn the rotary knob to select the >**Config screen**< option, and press the rotary knob to confirm. The screen configuration window appears (**1** in Figure 89).

The top three options in the configuration window are used to select the curves to be displayed, and the bottom three options determine the modules to be displayed below the curves.

Figure 89. Standard Screen - Screen Config. Window



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3. Turn the rotary knob to select an option, and press the rotary knob to confirm. The option becomes highlighted in yellow.
4. Turn the rotary knob until the desired curve or module is displayed, and press the rotary knob to confirm.

Continue to select other curves/modules.

5. Exit the **Screen Config** window by either:

   – Confirming the exit symbol >⟶< with the rotary knob

   or

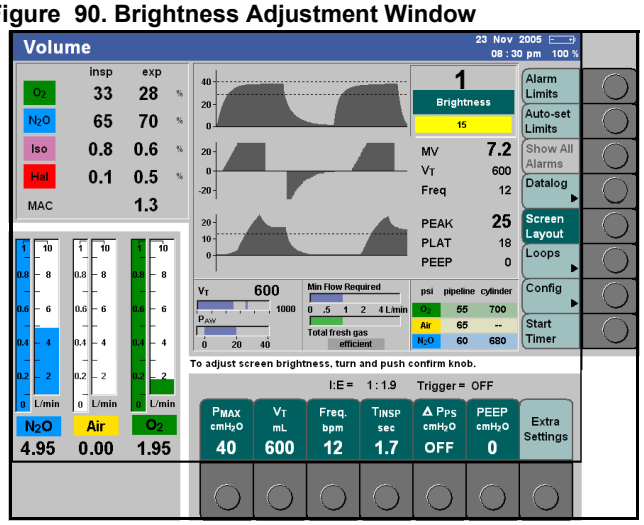
   – Pressing the >Home< key.

Adjusting display brightness

To adjust the brightness level of the display:

1. Press the >**Screen Layout**< key on the standard screen (**1** in Figure 88). The screen layout window appears (**2** in Figure 88).
2. Turn the rotary knob to select the >**Brightness**< option, and press the knob to confirm. The brightness adjustment window appears with the current brightness level highlighted in yellow (**1** in Figure 90).
3. Turn the rotary knob to adjust the brightness level (from 1 to 16), and press the rotary knob to confirm.

Figure 90. Brightness Adjustment Window



Displayed parameters

The following parameters are displayed on the Apollo:

Note: The specific parameters that are displayed will vary, depending on the selected screen and user configuration.

CO_2 concentration

– Curve display
– Numerical display:
  – $etCO_2$ (end-tidal CO_2 concentration)
  – $FiCO_2$ (fractional inspiratory CO_2 concentration)
– Trend curve for CO_2

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Note: The CO_2 curve can be displayed in gray, dark gray, red, yellow, blue, or green. This setting can be configured by an authorized DrägerService representative.

O_2 concentration

- Curve display
- Numerical display:
  - FiO_2 (fractional inspiratory O_2 concentration)
  - exO_2 (expiratory O_2 concentration)
  - ΔO_2 (difference between inspiratory and expiratory O_2 concentration)
- Trend curve for O_2

Anesthetic gas

- Curve display
- Numerical display:
  - inAgent (inspiratory gas concentration)
  - exAgent (expiratory gas concentration)
- MAC (minimum alveolar concentration)
- Trend curve for anesthetic gases and MAC

Airway pressure

- Curve display (P_{AW})
- Numerical display:
  - PEAK (peak pressure)
  - PLAT (plateau pressure)
  - PEEP (positive end-expiratory pressure)
  - MEAN (mean pressure) (only on data screen)
- Bar graph

Respiratory flow and volume

- Curve display for flow (insp/exp)
- Numerical display:
  - MV (expiratory minute volume)
  - V_T (tidal volume)
  - VT_{INSP} (measured inspiratory tidal volume)
  - ΔV_T (difference between inspiratory and expiratory tidal volume)
  - Freq. (respiratory rate)
  - MV_{LEAK} (difference between the inspiratory and expiratory minute volume) (only on data screen)
  - C_{PAT}* (patient lung compliance) (only on data screen)
- Trend curve for MV and C_{PAT}
- V_T bar graph

*$C_{PAT} = \frac{V_T}{(PLAT - PEEP)}$ with mandatory breaths.

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SpO_2 concentration (Optional)

– Curve display (plethysmogram)
– Numerical display:
  – SpO_2 (functional O_2 saturation level of blood)
  – ♥ (pulse rate)
– Trend curve for SpO_2 and pulse

Loops (Optional)

Shows two pairs of measured values that are plotted against each other. Each pair appears as a loop: the Pressure/Volume loop and the Flow/Volume loop. See “Loops (Optional)” on page 147 for more detailed information.

Virtual flow tubes

This is an indication (in bar graph and numeric form) of the individual flows actually delivered by the fresh-gas control valves.

Gas supply module

Shows pipeline supply and cylinder gas supply pressures in tabular form.

psi	pipeline	cylinder
O_2	55	700
Air	65	--
N_2O	60	680

Ventilation source module

Shows the indicators for the ventilation sources (with the active source highlighted) and displays the P_{AW} real-time signal.


Manual ventilation (Man/Spont)


Non-rebreathing system at the auxiliary common gas outlet (Aux CGO)


Automatic ventilation

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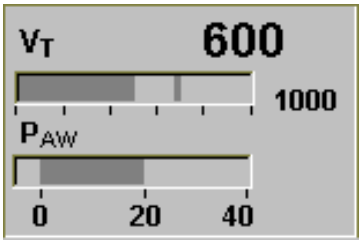
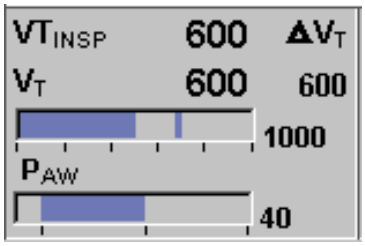
VT/PAW module

Shows the tidal volume VT and airway pressure PAW as bar graphs, as well as a numerical value for tidal volume. See "Volumeter Module" on page 141 for more information on the tidal volume graph.



ΔVT module

Shows the tidal volume VT and airway pressure PAW as bar graphs, as well as a numerical value for inspiratory tidal volume VTINSP, expiratory tidal volume VT, and the difference between inspiratory and expiratory tidal volume ΔVT. See "Volumeter Module" on page 141 for more information on the tidal volume graph.



The low flow wizard

WARNING!

Risk of patient injury.

If used incorrectly, the reaction time of fresh-gas concentration changes could increase, increasing also the risk of undesirable soda lime compounds.

This tool should not be used when higher flows are required such as during induction, emergence, or other times when rapid changes to the concentration of gases in the circuit are desired, or when the chemical pharmacology of the agent being used indicates otherwise.

The low flow wizard shows bar graphs for the minimum required flow (leak and uptake) and for the total fresh-gas flow. Both graphs have the same scale.

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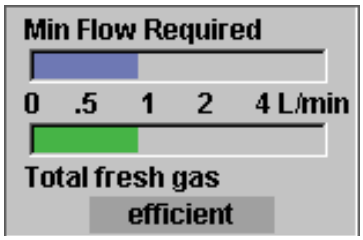

The total fresh-gas flow bar graph has three ranges:

Indication	Bar graph color	Meaning
too much	yellow	fresh-gas delivery is more than 1 L/min above the gas consumption (leak + uptake)
efficient	green	fresh-gas delivery efficient
too little	red	fresh-gas delivery less than minimum flow required (leak + uptake)

Gas consumption depends on patient uptake, leakage, and the CO_2 volume converted in the absorber.

If fresh-gas data is unavailable, the bar graph will be inactive and the text will appear grayed out.

Volumeter Module

The volumeter module shows the tidal volume V_T and minute volume as bar graphs. The scales can be configured by the user (see the chapter "Configuration" for more information).

The Tidal Volume (Upper) Graph

The tidal volume graph increases during the inspiratory flow and decreases during the expiratory flow. A blue vertical line remains on the graph to indicate the inspiratory volume, while the bar recedes from the line to indicate the expiratory phase.

The expiratory tidal volume is shown in numerics above the graph. Leakage is indicated by the bar remaining in the graph at the end of the expiratory phase.

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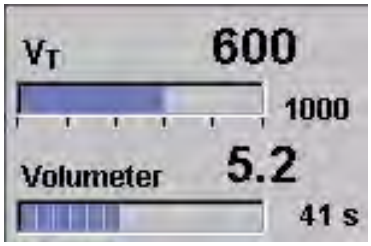
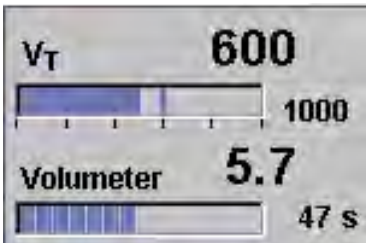
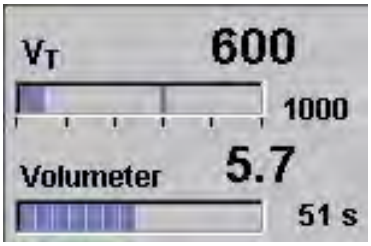
Inspiratory phase



Expiratory phase



End of expiratory phase



The Minute Volume (Lower) Graph

The minute volume, or volumeter, provides a graphical and numerical indication of the expiratory minute volume. Each unit in the graph represents one breath. The total volume is shown above the graph and the expired time is shown beside the graph in seconds. The measured values are displayed for four minutes and the deleted.

To start the volumeter

1. Press the rotary knob.

The measurement begins and stops automatically after 60 seconds. The volumeter is stopped if the rotary knob is pressed again within 60 seconds; the values are deleted and the rotary knob must be pressed again to restart.

Gas measurement

The concentration of O_2, CO_2, and of the anesthetic agents N_2O, halothane, enflurane, isoflurane, desflurane, and sevoflurane is measured.

Apollo automatically identifies the anesthetic agent used and adjusts the measurement and monitoring of the anesthetic gas concentration to suit the gas identified.

When no anesthetic agent is applied, the message "**No agent**" appears below the O_2/N_2O measurement.

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WARNING!

Risk of gas measurement failure.

The presence of aerosols in the breathing circuit should be avoided, as the displayed agent concentrations and/or the water trap membrane may be affected.

The presence of organic cleaning agents or gases containing haloalkanes (e.g. CFC) will impair the accuracy of the integrated gas analyzer.

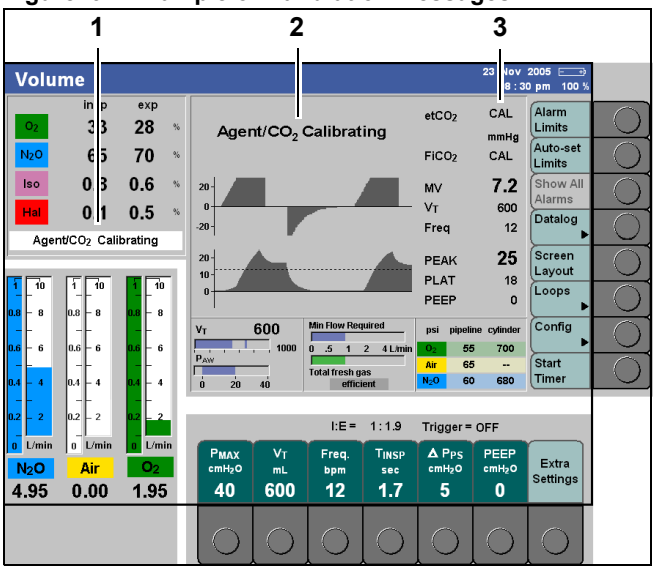
Calibration

The gas measuring module is calibrated automatically every time the anesthesia machine is started and then at two-hour intervals, as long as it is switched on.

O_2 calibration is performed parallel to the gas measuring module every eight hours.

During calibration, messages informing the user about the calibration appear on the screen (**1** and **2** in Figure 91), and the measurement values are replaced with the word **CAL** (**3** in Figure 91).

Figure 91. Example of Calibration Messages



CO_2 and O_2

The CO_2 and O_2 concentrations are side-stream measured, thus delaying an indication of the real-time values by approximately four seconds. The displayed CO_2 and O_2 curves are not synchronized with the pressure and flow curves.

If apnea occurs, the display for $etCO_2$ is replaced by the message **apnea CO_2**. The apnea time [min:sec] is displayed instead of the measured value.

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Anesthetic agents

The anesthetic agents are side-stream measured in the same way as CO_2 and O_2.

Mixture detection

Apollo automatically detects the anesthetic gas used and switches the measurement and monitoring of anesthetic gas concentration to the gas detected.

If there is a mixture of two volatile anesthetic agents, the concentration of the secondary anesthetic agent is displayed if the xMAC value is 0.1 MAC or greater. The gas with the higher expiratory xMAC value is displayed above the secondary anesthetic agent.

A secondary anesthetic agent becomes the main anesthetic agent if its xMAC value exceeds the MAC value of the main anesthetic agent by 0.2 MAC.

A mixture of more than two volatile anesthetic agents cannot be reliably detected.

Note: A mixture of more than two agents may lead to a temporary time-out of the measured O_2 value.

WARNING!

Risk of patient injury.

If the anesthetic agent displayed does not match the label of the anesthetic vaporizer being applied (open), make sure the vaporizer is filled correctly.

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MAC definition

1 MAC is the anesthetic gas concentration in the blood at 760 mmHg (1013 hPa), at which 50% of patients no longer respond to a skin incision with movement.

The integrated MAC algorithm is based on the MAC values as indicated on the list. These values are merely guideline values. It is the information on the slip accompanying the anesthetic agents which is binding.

	1 MAC corresponds to: (in 100 % O_2)
Halothane	0.77 Vol.%
Enflurane	1.7 Vol.%
Isoflurane	1.15 Vol.%
Desflurane	6.65 Vol.%
Sevoflurane	2.1 Vol.%
N_2O	105 Vol.%

The MAC values are dependent on the age of the patient. The values indicated in the table relate to an age of 40 years.

Age-dependent MAC values

The MAC values used in Apollo are corrected for age. Therefore make sure that the age of the patient is entered correctly. Calculation follows the equation from W.W. Mapleson (British Journal of Anaesthesia 1996, P. 179-185). The equation applies to patients older than 1 year of age.

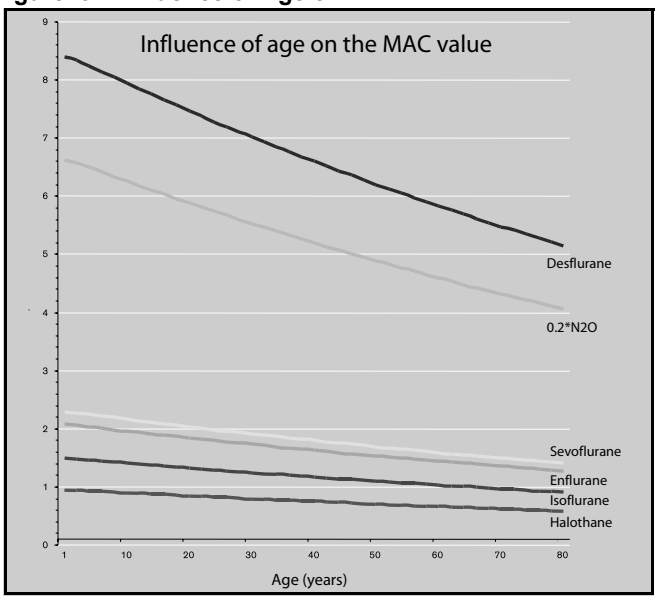
$MAC_{age\text{-}corrected} = MAC\ 40 \times 10^{(-0.00269 \times (age - 40))}$

The formula shows the reciprocal relationship existing between MAC and age.

Apollo automatically adjusts the MAC calculation according to the ambient pressure.

Note: The age “1” is used when the age is set to “<1”. Special attention is required for patients younger than one year.

Figure 92. Influence of Age on MAC



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xMAC display (MAC multiple)

The MAC value is a simple navigation aid for anesthetic gas metering.

Apollo indicates the MAC multiple (xMAC), which is determined from the present expiratory measurements and the age-dependent MAC values. In the gas of gas mixtures, the respective multiples for nitrous oxide and the anesthetic agents are added in accordance with the following equation:

$$xMAC = \frac{\text{exp. conc. agent}_1}{\text{MAC}_{\text{age-corrected agent}_1}} + \frac{\text{exp. conc. agent}_2}{\text{MAC}_{\text{age-corrected agent}_2}} + \frac{\text{exp. conc. } N_2O}{\text{MAC}_{\text{age-corrected } N_2O}}$$

Example:

Exp. Sev. = 1.5 Vol.%
Exp. N_2O = 60 Vol.%
Age = 10 years

$\text{MAC}_{\text{age-corrected}}$ of Sev.: MAC = 2.2 Vol.%
$\text{MAC}_{\text{age-corrected}}$ of N_2O: MAC = 125 Vol.%

xMAC = 0.7 + 0.5 = 1.2

The influence of other medication (opiates or intravenous hypnotics) is not taken into account when calculating MAC values.

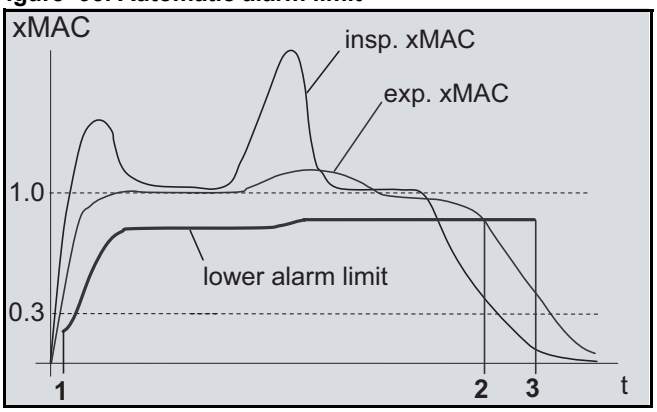
Automatic agent alarm activation

The lower alarm limit of an anesthetic agent is intended to help the user prevent patient awareness during a case. Examples of problems which, if ignored or unnoticed, could lead to patient awareness include leaks in the breathing circuit, an incorrect fitted vaporizer, or an insufficient anesthetic gas supply to a vaporizer.

The alarm limits for the anesthetic agents have to be activated manually and are often not used for that reason. Apollo provides an alarm management system for the xMAC level, which is automatically activated when the expiratory xMAC reaches about 0.3.

After activation (**1** in Figure 93), the automatic alarm limit adapts to the level of anesthesia supplied. It adapts only to increasing xMAC values. Apollo generates an advisory message '**MAC low**' as soon as the expiratory xMAC value falls below the alarm limit (**2** in Figure 93).

Figure 93. Automatic alarm limit



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Without confirmation the priority will automatically change to a caution after 30 sec. When the alarm message is present the alarm limit menu will automatically open and the confirmation field for the alarm '**MAC low OK?**' is preselected. The user can now confirm the alarm message by pressing the rotary knob.

The automatic agent alarm activation can be configured in the default configuration in **Standby**.

Loops (Optional)

Display loops on the screen

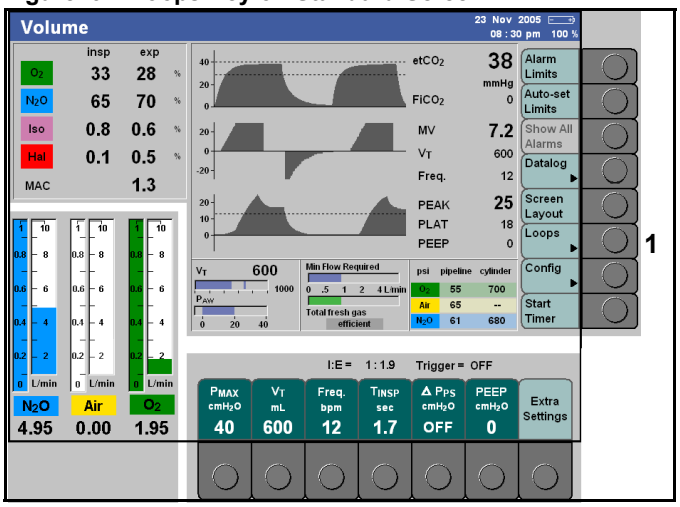
1. Press the >**Loops**< button on the standard screen (**1** in Figure 94).

The label of the button changes to >**Exit Loops**< and the P/V Loop and the Flow/Vol loop are displayed instead of the two lower curves (refer to Figure 95). Each loop remains on display for three breathing cycles; the color intensity of the loop decreases with each cycle.

The scale of the Pressure and Flow axes depends on the scale selected for the real-time curves. The scale of the volume axis depends on the scale in the VT/ PAW module.

See the chapter "Configuration" for more information on scale configuration.

Figure 94. Loops Key on Standard Screen



To display the current loop in a different color to use it as a reference:

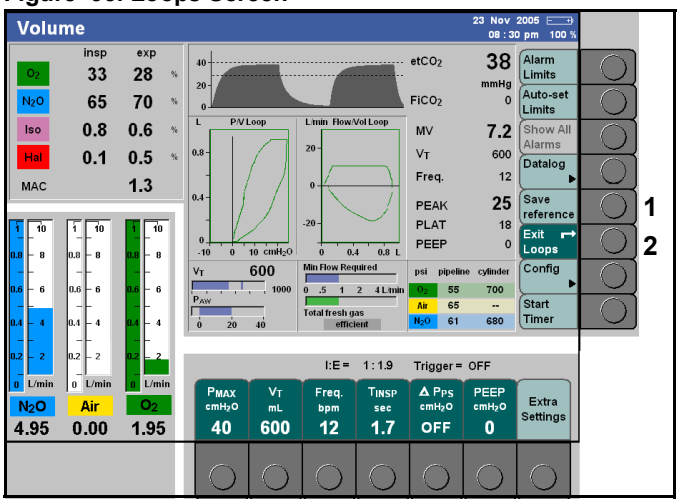
1. Press the >**Save reference**< button while in the loops screen (**1** in Figure 95). The label of the button changes to >**Delete reference**<.

The reference loop can be deleted by pressing the button >**Delete reference**< again or by changing to Standby mode.

To remove loops from the screen:

1. Press the >**Exit Loops**< button while in the loops screen (**2** in Figure 95). The loops are removed and the two lower curves are displayed again.

Figure 95. Loops Screen



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Datalog

The Datalog is a chronological record of measured values and events that occur during the case. The Apollo automatically records events such as performed or canceled tests, changes of agent, and changes of ventilation mode (followed by the date). At the end of each case, the case duration, the use of each fresh gas, patient uptake, and total use of anesthetic agent are recorded.

The datalog can also be configured by the user to record each WARNING or CAUTION or to record patient parameter data at specified intervals of 1, 2, 5, or 10 minutes. Each WARNING and CAUTION entry is followed by the measured values recorded at the time of the alarm's occurence. See the chapter "Configuration" of this Operating Instructions for more information.

The Datalog can be accessed during operation as well as in **Standby**. It consists of two pages: >**page 1**< lists standard patient parameters, and >**page 2**< lists more standard parameters as well as optional parameters, such as SpO_2 and pulse.

To display the Datalog:

– Press the >**Datalog**< button on the standby screen, data screen, or standard screen (**1** in Figure 96).

Page 1 of the Datalog is displayed (see Figure 97).

To display the second page:

– Press the >**Page 2**< button on the Datalog screen (**1** in Figure 97)

To return to the previous screen

– Press the >**Exit Datalog**< button (**2** in Figure 97)

or

– Press the >  < key on the side of the monitor screen

To delete the Datalog:

Datalog and trend memory are deleted simultaneously!

The Datalog will be maintained even after switching off the Apollo completely. It can only be deleted by using the "Delete Trend" functionality in **Standby**. Refer to "Deleting the trend memory" on page 152.

Figure 96. Datalog Button - Standard Screen

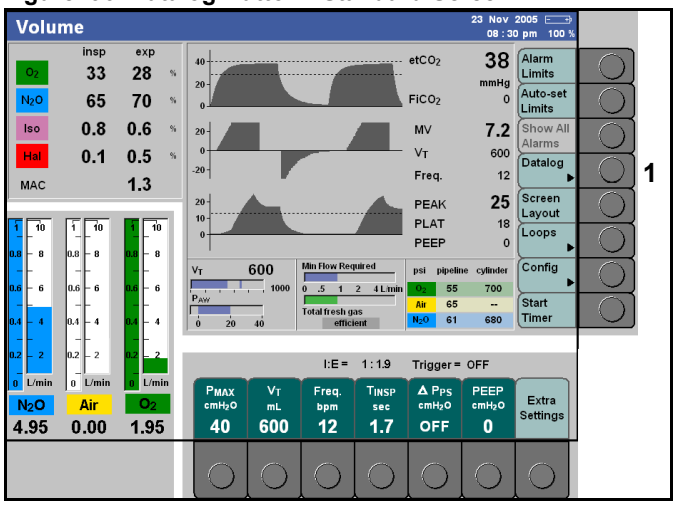
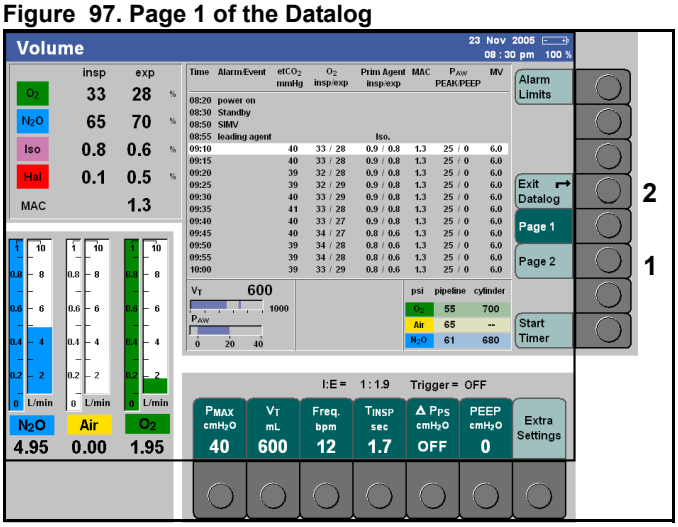


Figure 97. Page 1 of the Datalog



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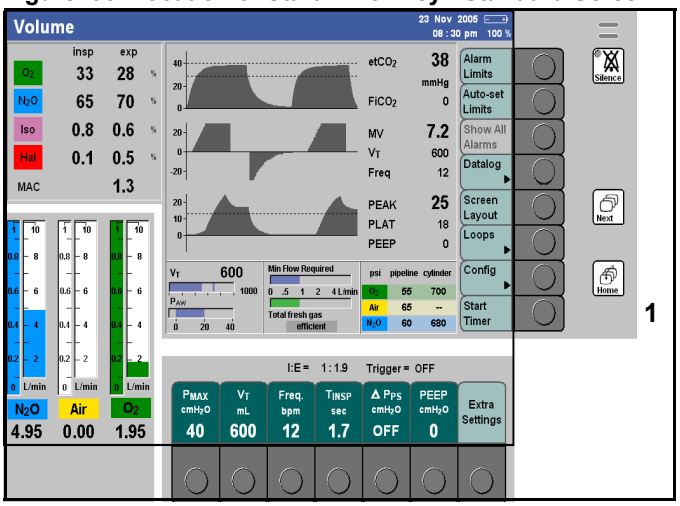
Screen timer

The timer function allows the user to time an event using a button available in any operating mode.

To start the timer:

– Press the >**Start timer**< button (**1** in Figure 98) on the standard, data, or trend screen.

Figure 98. Location of Start Timer Key - Standard Screen

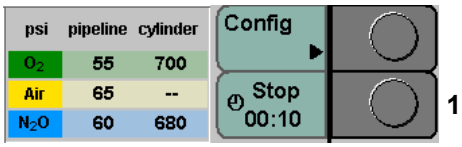


To stop the timer:

– Press the >**Stop**< button (**1** in Figure 99).

The measured time is displayed on the key.

Figure 99. Stop Timer Soft Key

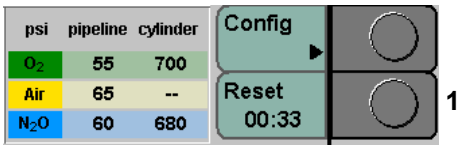


To reset the timer:

– Press the >**Reset timer**< button (**1** in Figure 100).

The time is reset and the key label changes back to >**Start timer**<.

Figure 100. Reset Timer Soft Key



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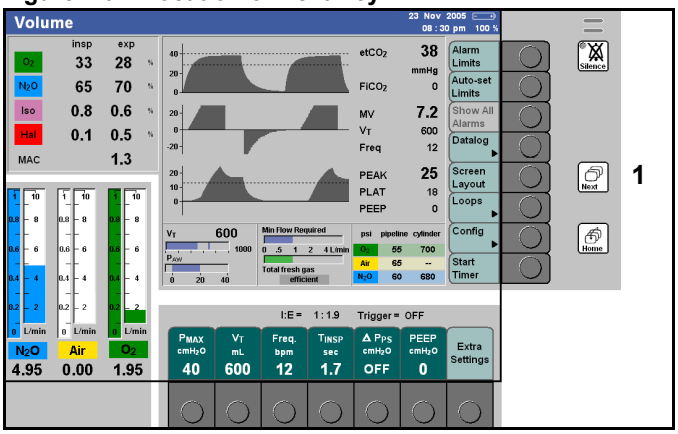
Data screen

1. Press the > Next < key repeatedly until the data screen appears (**1** in Figure 101).

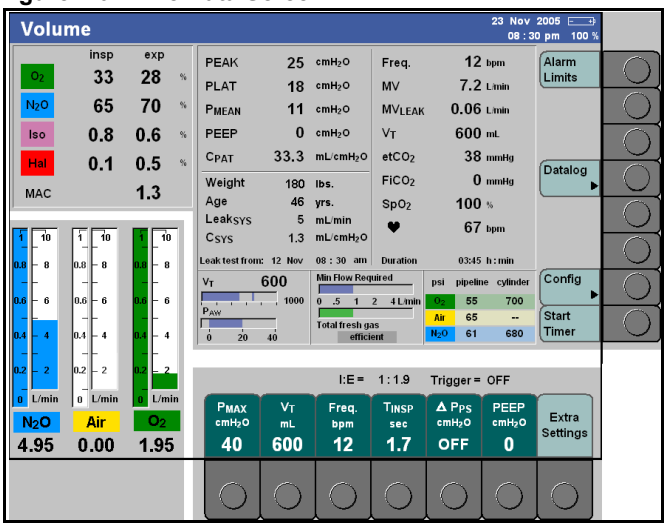
Figure 101. Location of Next Key



All numerical values are displayed on the data screen with their units of measurement (see Figure 102).

It shows patient data for all monitored parameters, including data for optional SpO_2 and pulse (if available). System compliance C_{SYS} and leakage $Leak_{SYS}$, along with the date and time of the last leak test, are displayed in the middle left part of the data screen. The modules displayed below and the numerical values are the same as those configured for the standard screen (see “Screen layout” on page 136).

Figure 102. The Data Screen



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Trend screen

Displays the measured values over an interval beginning with the start of the measurement.

The maximum storage time is eight hours, data older than eight hours is erased.

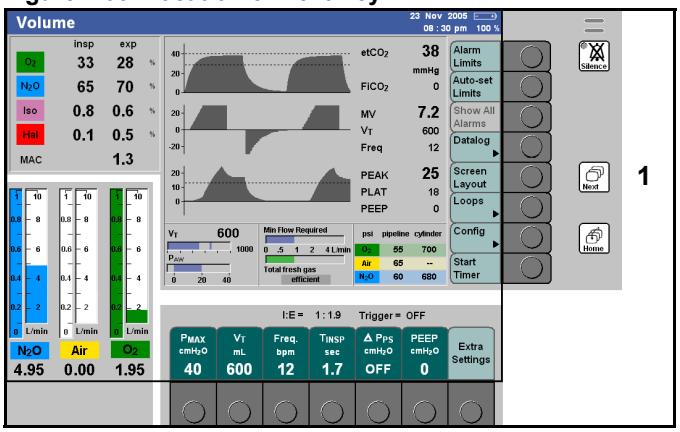
It displays up to four graphical trends on the screen at one time (see Figure 104).

The following trend combinations can be selected:

– **Agents** (MAC, N_2O, primary agent, secondary agent)
– **MV/CPAT/CO_2/O_2**
– **SpO_2 pulse** (optional)

1. Press the >Next< key repeatedly until the trend screen is displayed (**1** in Figure 103).

Figure 103. Location of Next Key



Selecting other display combinations

1. Press the required button:

   >**Agents**< (**1** in Figure 104),

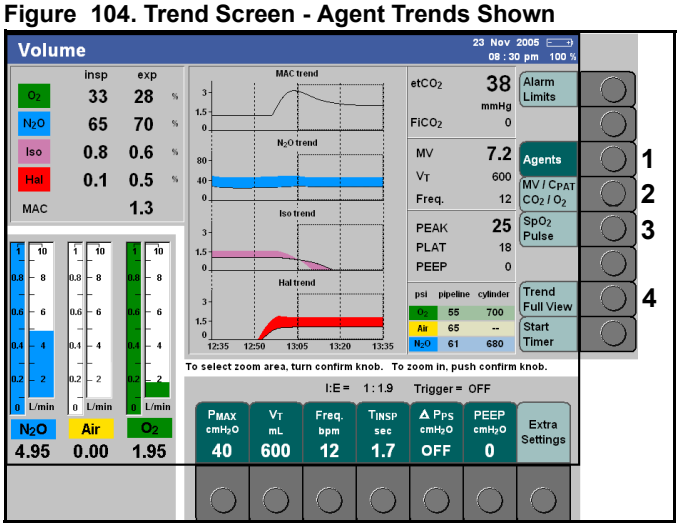
   >**MV/CPAT/CO_2/O_2**< (**2** in Figure 104),

   or

   >**SpO_2 Pulse**< (**3** in Figure 104)

   The >**SpO_2 Pulse**< button appears only if the data is available.

Figure 104. Trend Screen - Agent Trends Shown



The trend for inspiratory and expiratory values is represented by bar graphs. The expiratory value is always indicated by a black line.

The trends for agents, N_2O, and O_2 are displayed with the relevant color coding.

Zoom function

The zoom function allows the user to magnify a portion of the trend display. It becomes available after 30 minutes of trend data is collected.

The zoom window appears as a rectangle on the trend. The rectangle can be moved by the user to select the area to magnify.

To select the area:

1. Turn the rotary knob = the dashed frame moves.

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To enlarge the selected area to the full width of the display:

1. Press the rotary knob.

A new dashed frame appears after a corresponding period of operation which can also be enlarged.

To return to the trend overview:

1. Press the >**Trend Full View**< button (**4** in Figure 104) and the complete trend is displayed again.

This button is ineffective if there is insufficient trend data available (e.g. less than 30 minutes of operation).

Deleting the trend memory

Deleting trend memory is only possible in **Standby**.

Trend memory and Datalog are deleted simultaneously!

1. Press the standby key >Standby< located on the side of the monitor screen, and press the rotary knob to confirm.
2. Press the >**Delete Trend**< button on the standby screen (**1** in Figure 105).

A confirmation screen appears with new buttons and the prompt: “Press >**Delete**< to delete trend curves and Datalog entries.” (refer to Figure 106).

3. Press the >**Delete**< button to delete all trend and Datalog data (**1** in Figure 106).

or

Press the >**Cancel Delete**< button to cancel the deletion (**2** in Figure 106).

Figure 105. Delete Trend Key on Standby Screen

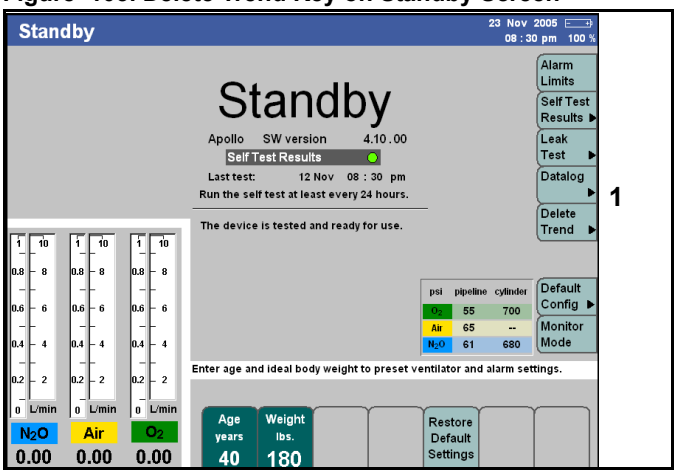
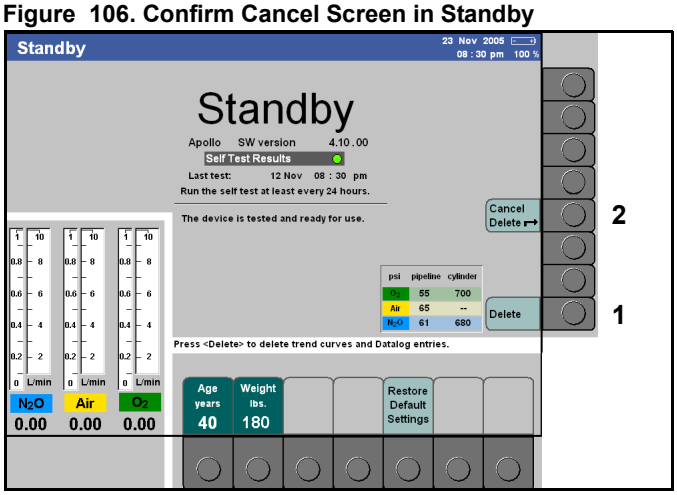


Figure 106. Confirm Cancel Screen in Standby



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Monitoring mode

The monitoring mode is a special mode that can be activated only in **Standby** and is used for specific types of monitoring, e.g., sidestream CO_2 monitoring during supplemental O_2 via nasal cannula with SpO_2 monitoring. There is no fresh-gas delivery in monitoring mode and the machine is not in any ventilation mode.

The alarms that are active in monitoring mode are comparable to those in Man/Spont mode (see the chapter “Alarms” for more information.)

If fresh-gas flow is activated while in monitoring mode, the system switches to Man/Spont mode.

Start monitoring mode from Standby

1. Press the >**Monitor Mode**< button on the standby screen (**1** in Figure 107).

or

1. Press the standby key >⏻< (**2** in Figure 107).

The monitoring screen appears (see Figure 108). Its format is the same as the standard screen, but no ventilation buttons are displayed and the indication “Monitoring” is shown in the status field.

Exit monitoring mode and return to Standby

1. Press the standby key >⏻< (**1** in Figure 108), and confirm by pressing the rotary knob (**2** in Figure 108).

Exit monitoring mode and begin ventilation

1. Press any of the ventilation keys at bottom of the display panel (**3** in Figure 108), and confirm by pressing the rotary knob (**2** in Figure 108).

Figure 107. Standby screen

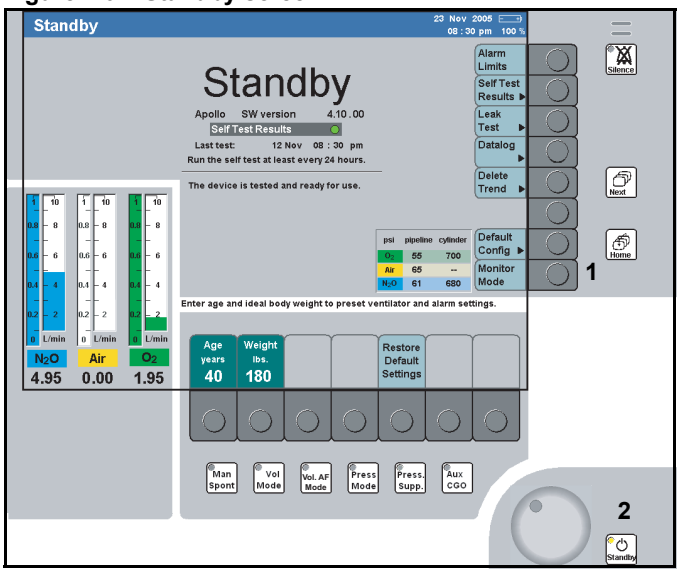
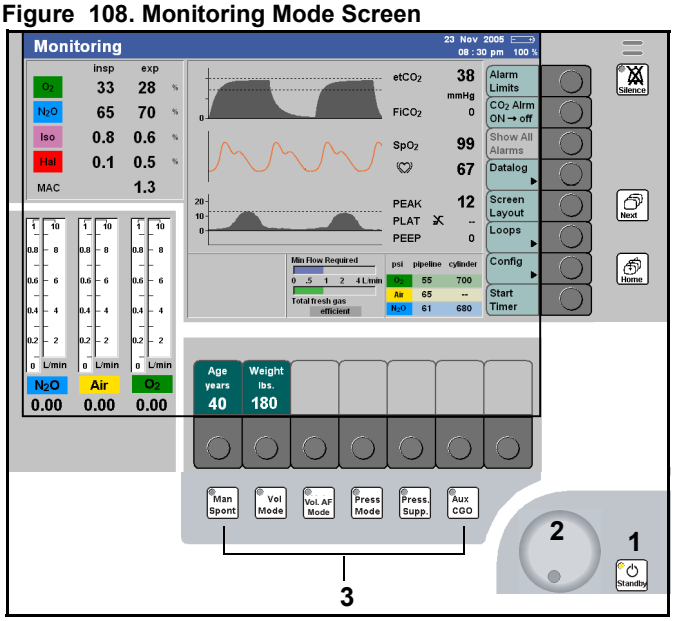


Figure 108. Monitoring Mode Screen



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SpO_2 measurement (Optional)

Selecting a sensor

Only OxiMax sensor from Nellcor may be used (see the accessories list, P/N 8603528, for a list of available sensors).

The OxiMax modules implemented in the Apollo are only compatible with the OxiMax sensors (purple probe or white probe for MAX FAST).

Only the DEC-8 or DEC-4 extension lead (purple plug connector) may be used.

The new sensors are downward-compatible with all modules already used in the field in older Dräger machines.

Note the Instructions for Use of the sensors.

1. Select a sensor in accordance with the following criteria:

– Patient weight
– Patient mobility
– Possible application point
– Perfusion of the patient
– Duration of use

The following table provides a guideline for selecting specific sensors shown here with their characteristic values.

Sensor type	**OxiMax MAX N**	**OxiMax MAX I**	**OxiMax MAX P**	**Durasensor DS-100 A**	**OxiMax MAX A**	**OxiMax™ MAX R**	**OxiMax MAX FAST**
Age group	Neonates/ Adults	Infants	Children	Adults			
Weight of the patient	<6.6 to >88 lb (<3 to >40 kg)	2.2 lb to 44 lb (1 kg to 20 kg)	22 lb to 110 lb (10 kg to 50 kg)	>88 lb (>40 kg)	>66 lb (>30 kg)	>110 lb (>50 lb)	>88 lb (>40 kg)
Duration of use	Short and long-term monitoring			Short-term monitoring	Short and long-term monitoring		
Mobility of the patient	Limited activity			Inactive patients only	Limited activity	Inactive patients only, must be checked at least every 8 hours	Limited activity
Preferred measuring point	Ball of the foot	Toe	Finger			Nose	Forehead
Sterility[a]	Sterile packaging	Sterile packaging	Sterile packaging	———	Sterile packaging	Sterile packaging	Sterile packaging

a. In unopened and undamaged packaging

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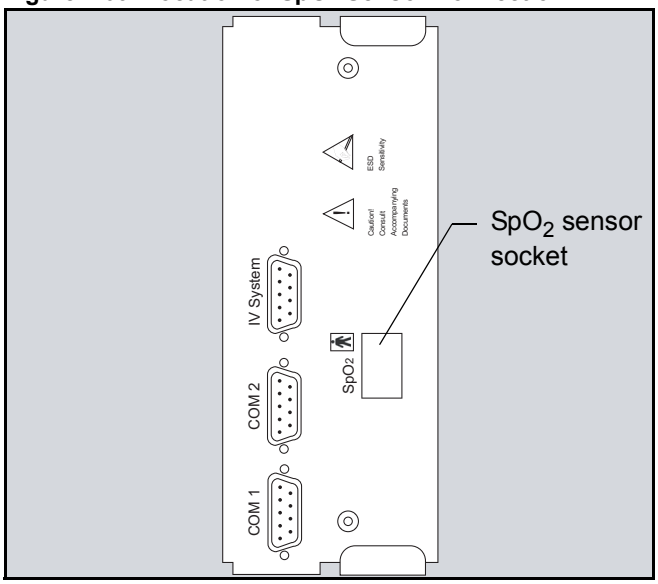
Connecting the SpO_2 sensor to the Apollo

At the back of the machine:

1. Plug the sensor connector into the socket marked >**SpO_2**< (see Figure 109).

Figure 109. Location of SpO_2 Sensor Connection



Safety-relevant information

WARNING!

Risk of electric shock.

If the SpO_2 sensor becomes damaged during use, discontinue use, especially if there are uncovered electrical contacts.

WARNING!

Risk of patient injury.

Incorrectly positioned sensors may result in incorrect measurements which may lead to patient injury.

Only use Nellcor sensors in the recommended positions.

CAUTION!

Risk of patient injury.

The Apollo anesthesia machine has been verified to function with Nellcor pulse oximeter probes. The use of other probes may result in patient injury.

Use only verified probes with the Apollo.

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WARNING!

Risk of patient injury.

High intrathoracic pressure, pressure on the thorax and other consecutive impairments of the venous flow canlead to venous pulsation and pulse signal failure.

Do not position the SpO_2 sensor where it might be affected in this way.

WARNING!

Risk of patient injury.

If the SpO_2 sensor is used in the presence of significant concentrations of dyshemoglobins, such as carboxyhemoglobin or methemoglobin, measurement accuracy may be reduced.

Do not rely on measurement data if the SpO_2 sensor is used under these conditions.

WARNING!

Risk of patient injury.

If the SpO_2 sensor is used in the presence of intravascular dyes, such as methylene blue, measurement accuracy may be inaccurate.

Do not rely on measurement data if the SpO_2 sensor is used under these conditions.

CAUTION!

Risk of misleading data.

Immersing the SpO_2 sensor in liquid may lead to a malfunction and thus misleading data.

Do not immerse the SpO_2 sensor in liquid.

CAUTION!

Risk of failure or inaccurate data.

If positioned close to a bright light source, the pulse signal may fail or the results may be inaccurate.

The sensor must be protected from exposure to bright light (e.g. surgical lamps and direct sunlight).

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CAUTION!

Risk of failure or inaccurate data.

If the sensor is positioned on limbs together with an arterial catheter, sphygmomanometer cuff or intravascular venous infusion, the pulse signal may fail and measurements may be inaccurate.

Do not position the SpO_2 sensor where it might be affected in this way.

CAUTION!

Risk of failure or inaccurate data.

Electrocautery can influence the measuring accuracy.

Leads and the SpO_2 sensor should be positioned as far away from the electrocautery and its neutral electrode as possible.

CAUTION!

Risk of inaccurate data.

Sensor performance may be impaired and lead to inaccurate results if the patient moves violently.

The sensor should be positioned at a quite/stable site in order to reduce the risk of artifacts due to movements.

CAUTION!

Risk of inaccurate data.

If incorrectly used, the adhesive strips may cause the pulse signal to fail. The adhesive strips must not be stretched unduly.

Never use two adhesive strips as this can lead to venous pulsation, causing the pulse signal to fail.

CAUTION!

Risk of inaccurate data.

In the presence of shock, low blood pressure, severe vasoconstriction, major anemia, hypothermia, arterial occlusion proximal to thesensor, and asystolia, the pulse signal may fail.

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Note: The displayed plethysmogram is a relative indicator of the pulse amplitude. Its scale is not absolute and it should only be used to judge the quality of the SpO_2 measurement.

Applying the Durasensor DS-100 A

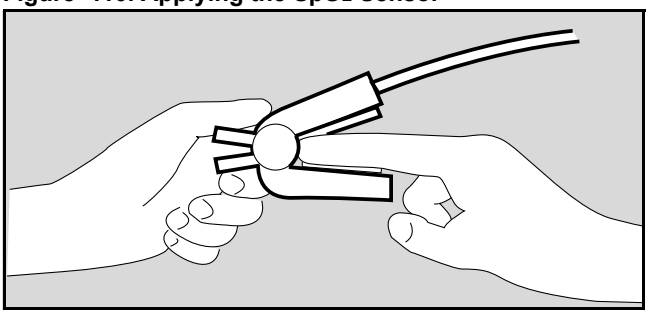
Reusable sensor for short-term monitoring of relatively quiet patients weighing over 88 lbs (40 kg).

The sensor is ideally positioned on the index finger, although any of the other fingers may also be used, if required. The little finger should be used if the patient is particularly large or obese.

1. Open the clip slightly and slide the sensor onto the finger. The tip of the finger must touch the end of the sensor and the soft padding should rest on the nail and tip of the finger. The lead should be on top of the finger.
2. Make sure that the finger is not compressed or hurt by the clip.
3. Change the application site after not more than 4 hours in order to avoid a build-up of blood pressure (blocked circulation).

Follow the specific Instructions for Use when using other Nellcor sensors!

Figure 110. Applying the SpO_2 Sensor



Test considerations and oximeter accuracy

Functional testers and patient simulators

Some models of commercially available bench-top functional testers and patient simulators can be used to verify the proper functionality of pulse oximeter sensors, cables and monitors. See the Operators Manual of the individual testing devices for the procedures specific to the model of tester being used.

While such devices may be useful for verifying that the pulse oximeter sensor, cable, and monitor are functional, they are incapable of providing the data required to properly evaluate the accuracy of a system's SpO_2 measurement.

Fully evaluating the accuracy of the SpO_2 measurements requires, at a minimum, accomodating the wavelength characteristics of the sensor and reproducing the complex optical interaction of the sensor and the tissue of the patient. These capabilities are beyond the scope of known

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bench-top functional testers, including known devices, which claim to measure sensor LED wavelength.

SpO_2 measurement accuracy can only be evaluated in vivo by comparing pulse oximeter readings with values traceable to SpO_2 measurements obtained from simultaneously sampled arterial blood using a laboratory CO oximeter.

CAUTION!

Risk of inaccurate data.

If simulators are used as calibrators, the SpO_2 module may produce incorrect data.

Simulators must not be used as calibrators.

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Alarms

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Alarm priorities and alarm signals

Alarm messages are color-coded and assigned to three priority classes by the Apollo, depending on their urgency:

Warning

– Message with highest priority.
– Text flashes on red background.
– Red LED (**2** in Figure 111) flashes, accompanied by a repetitive 10-tone sequence (the standard tone sequence).
– A warning message requires immediate action.

Caution

– Message with medium priority.
– Text flashes on yellow background.
– Yellow LED (**3** in Figure 111) flashes, accompanied by a repetitive 3-tone sequence (the standard tone sequence).
– A caution message requires immediate action.

Advisory/technical message

– Message with lowest priority.
– Text displayed on cyan background.

Advisory

– Yellow LED (**3** in Figure 111) illuminates continuously, accompanied by a single 2-tone sequence (the standard tone sequence).

Technical message

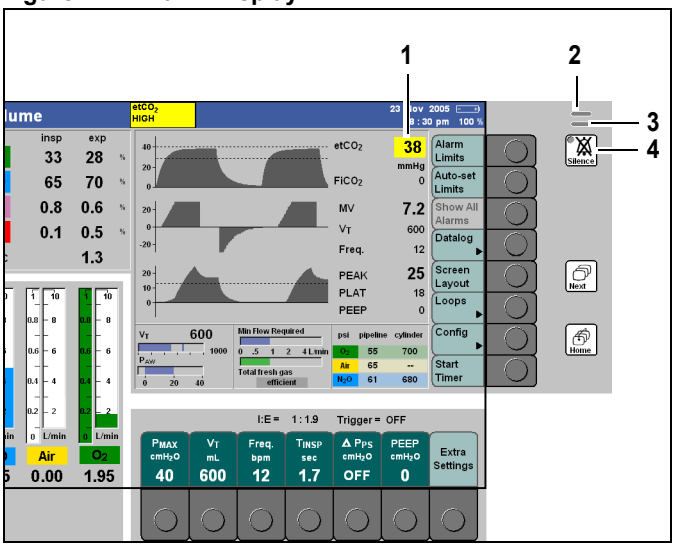
– Yellow LED (**3** in Figure 111) illuminates continuously without any acoustic tone.
– These messages must be noted and action taken if necessary.

Dräger recommends the user to remain close to the anesthesia machine, i.e. within a range of up to 12 feet (4 meters), to allow for quick recognition and action in the event of an alarm.

Whenever an alarm message is displayed, the alarm LED flashes or lights up continuously and an acoustic tone sequence indicates the alarm priority class.

In addition, a flashing help text is displayed in the prompt field.

Figure 111. Alarm Display



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If alarm limits are violated, the corresponding measured values will be highlighted by a colored background (**1** in Figure 111) and will flash.

The color of the background reflects the color-coding of the alarm priority (red, yellow, cyan).

For a complete list of Apollo alarm messages, see “Alarm - Cause - Remedy” on page 239.

Downgrading alarm priorities

Selected technical alarms can be downgraded to a lower priority, or deleted completely once acknowledged.

1. Press the >Silence< key on the side of the monitor screen (**4** in Figure 111).

Setting the alarm tone and volume

The alarm tone sequence and volume can be set by the user in the standby configuration screen. See page 181 for complete instructions.

The alarm volume can also be set during operation (see page 196).

Alarms in Standby mode

Machine-related alarms, e.g. failure of equipment components and a number of special operating states, are indicated to the user in **Standby** mode. A message is displayed in the alarm message field in the status field, but no acoustic tone is annunciated.

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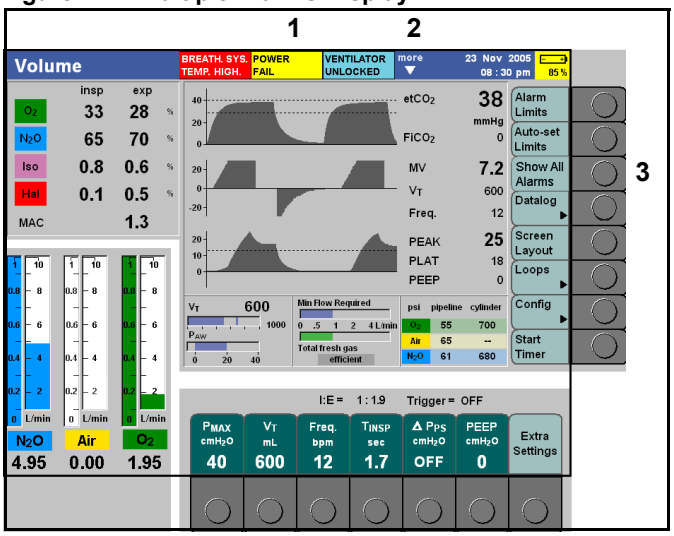
Alarm displays

Alarm messages are displayed in the alarm message field (**1** in Figure 112) in order of priority.

All displayed alarms are sorted according to the three classes defined on page 163. Within these classes, the alarms are sorted and displayed according to an internal priority system. A priority of 31 indicates the highest, a priority of 1 the lowest priority. The priority numbers are given in the table in the chapter "Alarm - Cause - Remedy" on page 239. The internal priorities are not displayed.

Up to three messages can be displayed simultaneously. In some cases, the corresponding measured values are highlighted on the screen by a flashing background in addition to the alarm message.

Figure 112. Multiple Alarms Display



If more than three alarms occur simultaneously, the symbol >more< appears to the right of the alarm message field (**2** in Figure 112), and the button **>Show All Alarms<** is activated on the right side of the screen (**3** in Figure 112).

When this button is pressed, the upper curve display is replaced by up to six additional alarm message fields for 15 seconds (see Figure 113).

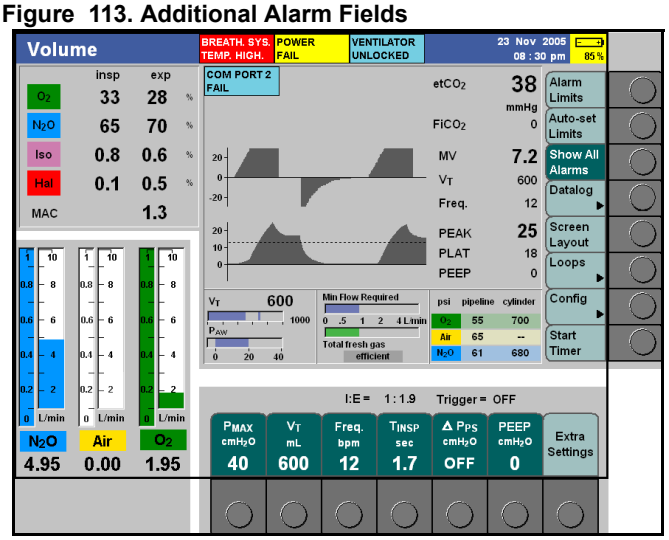
If more than nine alarm messages are simultaneously active, the lowest priority alarms will not be displayed until the total number of active alarm messages falls below nine.

The alarm tone sequence accompanying a displayed alarm message with the highest priority will always be sounded at least once completely. The alarm tone sequences of alarm messages with lower priorities will not sound if a higher priority alarm is activated, i.e. the tone sequence thereof will sound.

If an alarm message of the same class as an active alarm message is generated, the alarm tone of the new alarm only sounds if the priority is higher than the priority of the previously active alarm.

The upper curve display reappears when the button **>Show All Alarms<** is pressed again or when the 15 seconds have expired.

Figure 113. Additional Alarm Fields



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Suppressing alarms

Silencing audible alarms

The audible alarms can be silenced for 2 minutes.

To silence all audible alarms:

– Press the >Silence< key on the side of the monitor screen (**1** in Figure 114).

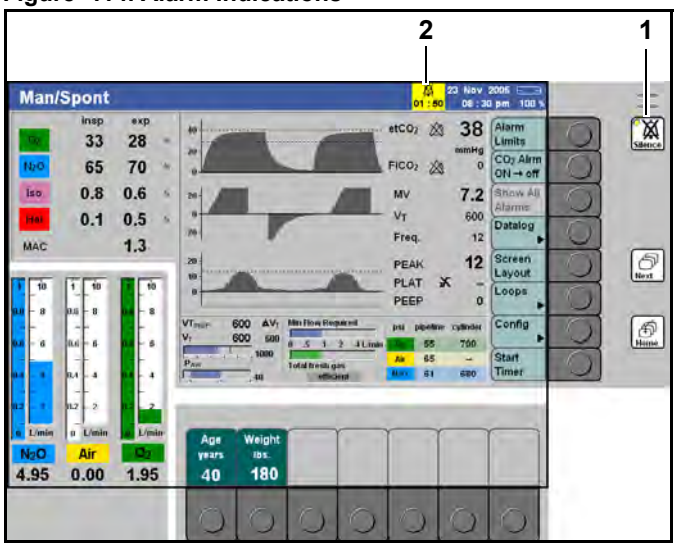
  The yellow LED on the key lights up, and the symbol >🔕< appears on a yellow background in the system information field next to the date with an indication of the silence time remaining (mm:ss) (**2** in Figure 114).

To enable the audible alarms again:

– Press the >Silence> again.

  The yellow LED on the key turns off, the indication is removed from the system information field, and all audible alarms are enabled.

Figure 114. Alarm Indications



Disabling alarms

CAUTION!

Risk of inadequate monitoring.

National standards require a minimum monitoring with some alarm functions. These standards may not be met if the alarm function of the $etCO_2$ monitoring parameter is disabled.

Only disable this monitoring parameter after consulting national standards.

CAUTION!

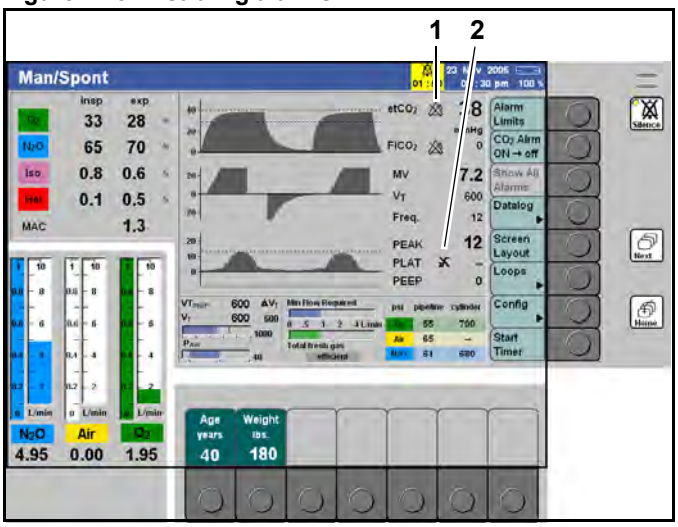
Risk of inadequate monitoring.

National standards require a minimum monitoring with some alarm functions. These standards may not be met if the alarm function of the SpO_2 monitoring parameter is disabled.

Only disable this monitoring parameter after consulting national standards.

Audio and visual alarms can be disabled by adjusting the default alarm limits in the standby configuration screen. Certain alarms can also be disabled automatically, based on ventilation mode. See the chapter “Configuration” for complete information.

Figure 115. Disabling alarms



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During operation certain alarms can be disabled globally (see “Enabling/disabling alarms globally during operation” on page 169) or individually in the alarm limits menu (see “Displaying and setting alarm limits” on page 173).

If all the alarms connected to a measurement function have been disabled, the measured value will be marked with the symbol > < (**1** in Figure 115).

If only certain alarm limits have been disabled for a monitoring parameter, one symbol > < or > < appears next to the parameter (**2** in Figure 115).

If the upper and lower alarm limits of a monitoring parameter have been disabled, but the respective apnea monitoring feature is still active, the symbol > < appears next to the parameter.

If an apnea monitoring feature derived from a specific monitoring parameter has been disabled, that parameter will be marked with the symbol > <.

A monitoring parameter is always marked with the symbol > < if, after switching from **Standby** into a ventilation mode, a valid CO_2 breathing phase has not yet been detected for the parameters O_2, N_2O, MV, or inspiratory and expiratory CO_2, or respectively a valid pulse signal for SpO_2. As soon as a breathing phase has been detected or valid pulse signals are available for SpO_2, the symbol disappears.

Alarm behaviour when changing ventilation modes

The Apollo has an automatic suppression of active MV low and apnea alarms implemented, when changing ventilation modes.

This suppression applies when the user changes from a ventilation mode with a low mandatory ventilation support, such as **ManSpont**, to a ventilation mode with a higher mandatory ventilation, such as **Volume Mode**. After this timeout the alarms will only be generated again if the preconditions are valid.

If the ’**MV low**’ alarm is active during such a change, the alarm is suppressed for 45 sec (no alarm display and no audible tone). The apnea alarms can be suppressed for a certain time, depending on the ventilation settings in the new ventilation mode.

If the settings for Freq/$Freq_{MIN}$ are < 6 bpm the apnea alarms will be suppressed for 30 sec, otherwise the timeout is 15 sec.

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Limit-based alarms activated in respective ventilation modes

When a ventilation mode is changed, the Apollo sets the alarms ON or OFF as indicated in the table below. Some alarms can be then be enabled or disabled manually by the user.

WARNING!

Risk of patient injury.

As anesthesia machines within one care area might have different alarm limit configurations, make sure that the preset alarm limits are appropriate for the new patient. Also make sure that the alarm system has not been rendered useless by setting the alarm limits to extreme values or by their alarm tone being disabled.

See "Configuring the default settings in Standby" on page 179.

Mode / Alarm	Volume, Volume AF, Pressure, Press. Support	Press. Support CPAP	Aux CGO	Monitoring, Man/Spont	Default value upon delivery
SpO_2 ↗	ON	ON	ON	ON	– –
[%] ↘	ON	ON	ON	ON	92
Pulse ↗	ON	ON	ON	ON	120
[bpm] ↘	ON	ON	ON	ON	50
$etCO_2$ ↗	ON	ON	*)	*)	50
[mmHg] ↘	ON	ON	*)	*)	– –
$FiCO_2$ ↗	ON	ON	*)	*)	5
[mmHg]					
MV ↗	ON	ON	OFF	*)	12
[L/min] ↘	ON	ON	OFF	*)	3.0
FiO_2 ↗	ON	ON	*)	*)	– –
[Vol.%] ↘	ON	ON	ON	ON	20
inHal. ↗	ON	ON	ON	ON	1.5
[Vol.%] ↘	ON	ON	*)	*)	– –
inIso. ↗	ON	ON	ON	ON	2.3
[Vol.%] ↘	ON	ON	*)	*)	– –
inEnf. ↗	ON	ON	ON	ON	3.4
[Vol.%] ↘	ON	ON	*)	*)	--
inDes. ↗	ON	ON	ON	ON	12.0
[Vol.%] ↘	ON	ON	*)	*)	– –

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Mode / Alarm	Volume, Volume AF, Pressure, Press. Support	Press. Support CPAP	Aux CGO	Monitoring, Man/Spont	Default value upon delivery
inSev. ↑	ON	ON	ON	ON	4.2
[Vol.%] ↓	ON	ON	*)	*)	– –
Paw ↑	ON	ON	ON	ON	40
[cmH2O] ↓	ON	ON	OFF	OFF	8
APNEA PRESSURE	ON	ON	OFF	OFF	8
APNEA FLOW	ON	ON	OFF	OFF	——
Apnea CO2	ON	ON	ON†)	ON†)	——

*) The alarms for etCO2 ↓↑, FiCO2 ↑, MV ↓↑, FiO2 ↑ and inAgent ↓ can be configured ON or OFF in Standby config. for switching to Man/Spont., Aux. CGO, and Monitoring mode. When the alarm limits are set to ON in Standby config., the value is adopted from the automatic ventilation mode. The default value for this configuration is OFF. (Exception: in Aux. CGO the MV alarms are always OFF.)

†) In Man/Spont, Aux CGO, and Monitoring, the alarm is active after 65 seconds.

– – : The default value set upon delivery is outside the monitored range; the corresponding alarm limit is disabled.

All apnea, apnea pressure, apnea flow, and apnea CO_2 alarms are active after 35 seconds in the mechanical ventilation modes with a frequency of less than 6 bpm and in **Pressure Support** mode with a minimum frequency $Freq_{MIN}$ of less than 6 bpm or when set to **OFF**.

All apnea and limit-based O_2, CO_2, N_2O, and agent alarms are only active if a breath has already been detected (AutoWakeUp).

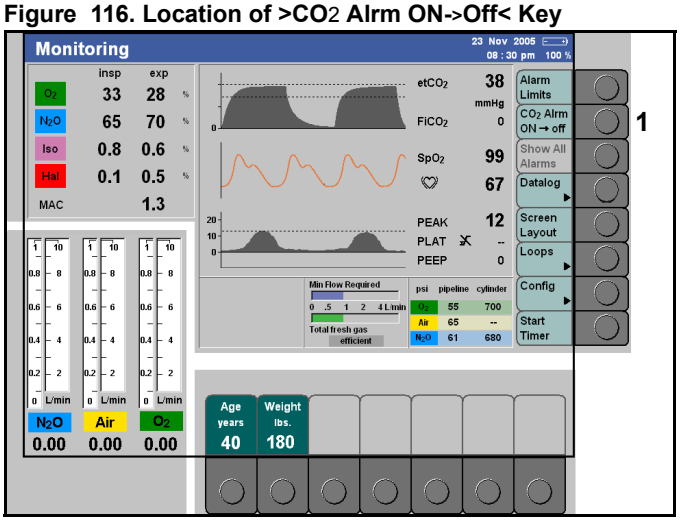
Enabling/disabling alarms globally during operation

Enabling/disabling CO_2 alarms

The alarm limits for inCO_2, etCO_2, and CO_2 apnea monitoring can be disabled via the button **>CO2 Alrm ON→off<**. This key is effective in the following ventilation modes:

- **Man/Spont**
- **Monitoring**
- **Aux CGO**

Figure 116. Location of >CO2 Alrm ON->Off< Key



Disabling CO_2 alarms:

1. Press the **>CO2 Alrm ON→off<** key (**1** in Figure 116).

The symbol >⚠< appears beside the measured values for end-expiratory and inspiratory CO_2 concentration. The button label changes to **>CO2 Alrm OFF→on<**.

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Enabling CO_2 alarms:

1. Press the >**CO_2 Alrm OFF→on**< key (**1** in Figure 116).

Disabled CO_2 alarms are enabled automatically when changing to another ventilation mode.

The alarms for **$etCO_2$** and **$FiCO_2$** can be activated or deactivated in **Standby** for switching to **Man/Spont**

When the alarm limits are enabled the value is adopted from the automatic ventilation mode, see page 186.

CO_2 alarms can also be enabled and disabled globally for all ventilation modes:

1. Press the >**Config**< key (**1** in Figure 117) in the standard or data screen.

   The submenu Volumes/Alarms is opened (refer to Figure 118).

2. Select and confirm the column "**Alarms On/Off**" via the rotary knob.
3. Select and confirm the line "**CO_2**" via the rotary knob.
4. Select and confirm "**On**" or "**Off**" via the rotary knob.

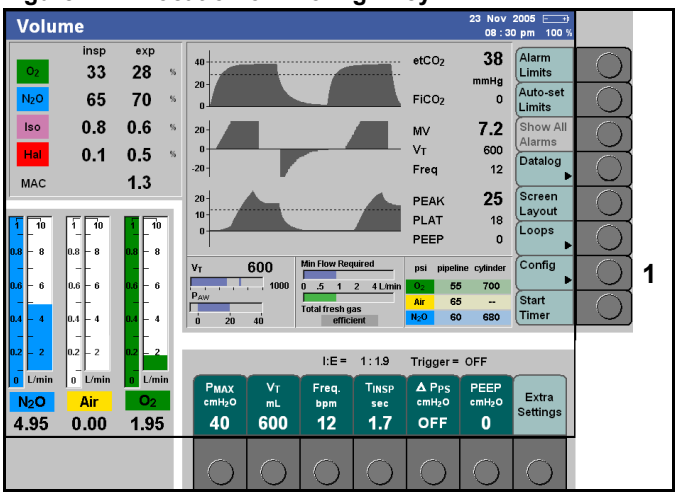
CAUTION!

Risk of inadequate monitoring.

National standards require a minimum monitoring with some alarm functions. These standards may not be met if the alarm function of the $etCO_2$ monitoring parameter is disabled.

Only disable this monitoring parameter after consulting national standards.

Figure 117. Location of >Config< Key



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Enabling/disabling SpO_2 alarms (Optional)

The SpO_2 alarms can also be enabled and disabled during operation, see page 195.

1. Press the >**Config**< key (**1** in Figure 117) on the standard or data screen.

   The submenu Volumes/Alarms is opened (refer to Figure 118).

2. Select and confirm the column "**Alarms On/Off**" via the rotary knob.
3. Select and confirm the line "**SpO_2**" via the rotary knob.
4. Select and confirm "**On**" or "**Off**" via the rotary knob.

   Suppressed alarm limits are identified by the symbol > ⚠ < in the parameter field.

Note: Changes in SpO_2 alarms are valid globally.

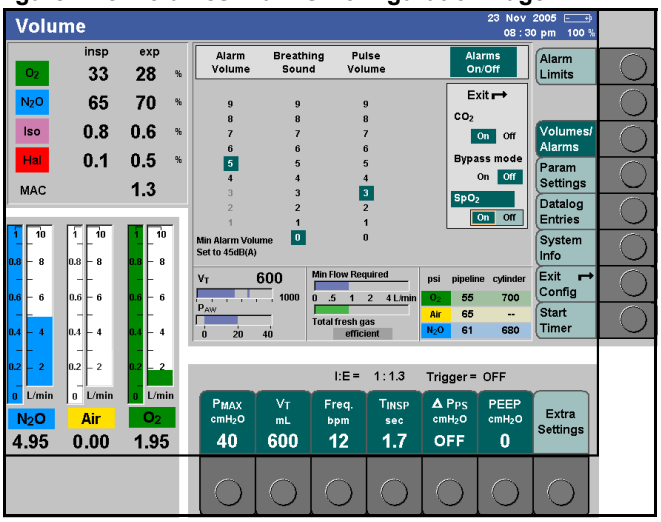
CAUTION!

Risk of inadequate monitoring.

National standards require a minimum monitoring with some alarm functions. These standards may not be met if the alarm function of the SpO_2 monitoring parameter is disabled.

Only disable this monitoring parameter after consulting national standards.

Figure 118. Volumes/Alarms Configuration Page



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Bypass mode

The bypass mode permits patient monitoring without unnecessary alarms during extra-corporal oxygenation of the patient by a heart lung machine.

In the **bypass mode**:

– All gas concentrations are measured independently of the breathing phase.
– CO_2 apnea and pressure apnea alarms are inactive.
– SpO_2 monitoring alarms are inactive.
– The “MAC LOW?” alarm is inactive.

The bypass mode can be used in all active ventilation modes.

Enabling/disabling bypass mode

1. Press the >**Config**< key (**1** in Figure 117) on the standard or data screen.

The submenu volumes/Alarms is opened (refer to Figure 119).

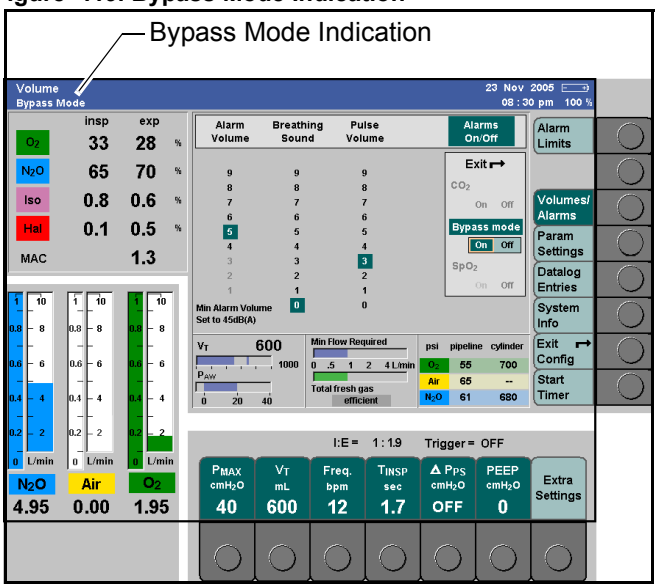
2. Select and confirm the column “**Alarms On/Off**” via the rotary knob.
3. Select and confirm the line “**Bypass Mode**” via the rotary knob.
4. Select and confirm “**On**” or “**Off**” via the rotary knob.
5. The bypass mode can also be deactivated by pressing the button “**Exit mode Bypass**”.

The bypass mode remains activated when changing ventilation modes; it is deactivated when changing to **Standby**.

Deactivating the bypass mode immediately reactivates the CO_2 alarms and pressure apnea alarm, but SpO_2 measurement (optional) is only reactivated when pulse signals have been detected again.

Deactivating the bypass mode has no effect on the “**On**” or “**Off**” status of SpO_2 measurement; the last status set is retained.

Figure 119. Bypass Mode Indication



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Displaying and setting alarm limits

Alarms can be displayed and set from all three basic screens (standard, data, and trend screens) during operation.

There are standard alarm limits configured for the ventilation modes which may be used as is, see "Configuring the default settings in Standby" on page 179 or adjusted individually for the patient concerned.

For this purpose, the alarm limits menu can be selected in **Standby** via the button >**Alarm Limits**<.

To display alarm limits during operation:

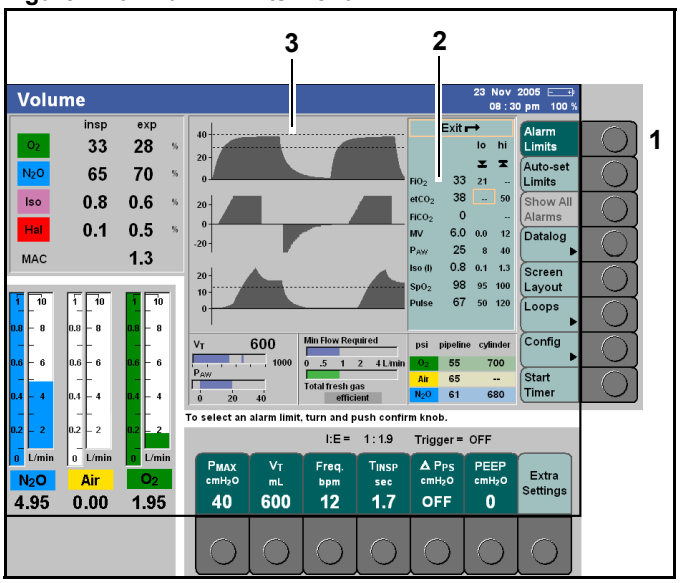
1. Press the >**Alarm Limits**< button (**1** in Figure 120).

When the alarm limits menu appears, the standard screen is automatically displayed, regardless of which screen was displayed previously. The alarm limits menu is displayed on the right side of the screen next to the curves (**2** in Figure 120). The menu lists the parameters, their current measured values, and the current low and high alarm limits. The alarm limits also appear on the curves as dashed lines (**3** in Figure 120).

A disabled alarm limit is indicated by two dashes (--). Alarm limits that have been disabled globally by the user (see page 166) are indicated in the alarm limits menu by the symbols > ⊼ < and > ⊻ <. These symbols cannot be selected with the cursor.

Note: If configured, the alarm limits menu is opened automatically whenever an alarm limit is violated. See the chapter "Configuration" of this Operating Instructions for information on enabling/disabling this function.

Figure 120. Alarm Limits Menu



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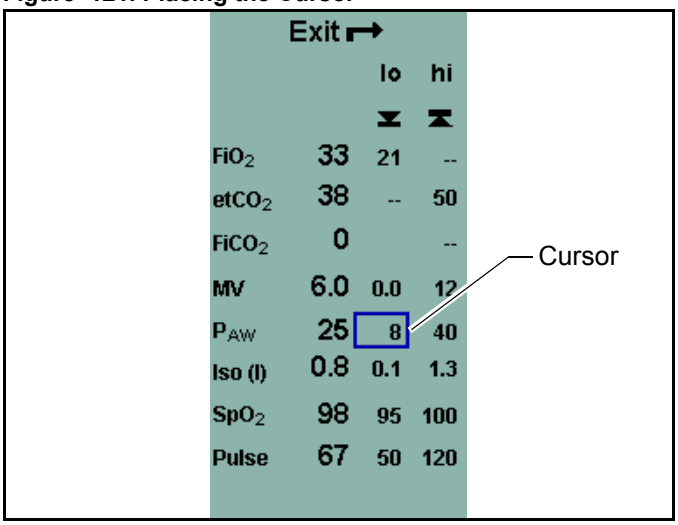
To set an alarm limit

1. Place the cursor on the alarm limit by turning the rotary knob (Figure 121 shows the cursor on the PAW low alarm limit) and push to confirm. The alarm limit becomes highlighted in yellow.
2. Set the new value by turning the rotary knob and push to confirm.

The new alarm limit is now active. The cursor returns to the >⟶< symbol.

Figure 121. Placing the Cursor



Adjustment range of the alarm limits during operation

Alarm	Adjustment range
SpO2 ⌐▲	51 to 99; --
[%] ⌐▼	50 to 98
Pulse ⌐▲	21 to 250
[bpm] ⌐▼	20 to 249
etCO2 ⌐▲	1 to 75; --
[mmHg] ⌐▼	0 to 74; --
FiCO2 ⌐▲	1 to 10; --
[mmHg]	
MV ⌐▲	0.1 to 20.0; --
[L/min] ⌐▼	0 to 19.9; --
FiO2 ⌐▲	19 to 99; --
[Vol.%] ⌐▼	18 to 98
inHal. ⌐▲	0.1 to 8.4
[Vol.%] ⌐▼	0 to 8.3; --
inIso. ⌐▲	0.1 to 8.4
[Vol.%] ⌐▼	0 to 8.3; --
inEnf. ⌐▲	0.1 to 9.9
[Vol.%] ⌐▼	0 to 9.8; --
inDes. ⌐▲	0.1 to 21.9
[Vol.%] ⌐▼	0 to 21.8; --
inSev. ⌐▲	0.1 to 9.9
[Vol.%] ⌐▼	0 to 9.8; --
PAW ⌐▲	5 to 99
[cmH2O] ⌐▼	0 to 35

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To exit the alarm limits menu:

1. Place the cursor on >⟶< and confirm with the rotary knob.

or

1. press the >Home< key.

Auto-Set of alarm limits

When ventilation settings have been made, Apollo can automatically adapt the alarm limits for minute volume MV and the airway pressure PAW to the current parameters in **Volume Mode**, **Volume AF**, **Pressure Mode**, and **Pressure Support** (optional).

1. Press the >**Auto-set Limits**< button (**1** in Figure 122).

The alarm limits menu opens automatically. The MV and PAW limits are adapted and highlighted by a dark green background.

To quit the alarm limits menu:

1. Press the rotary knob or the >Home< key.

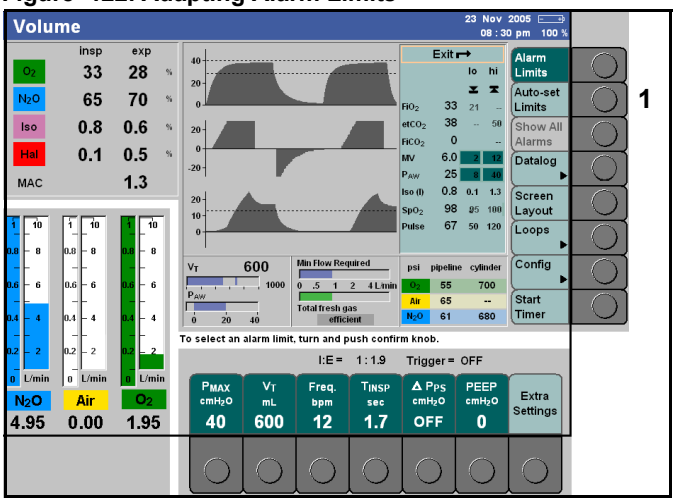
The new alarm limits for MV are calculated by the Apollo from the measured value for the minute volume MV in **Volume Mode**, **Volume AF**, **Pressure Mode**, and **Pressure Support** (optional) as shown below:

	Volume Mode, **Volume AF**, **Pressure Mode**, **Pressure Support**
MV high alarm limit [L/min]	measured MV x 1.4; at least 2.0
MV low alarm limit [L/min]	measured MV x 0.6; at least 0.3

The displayed value may differ marginally due to rounding errors, since Apollo calculates the values internally with much greater accuracy.

The new alarm limits for PAW are calculated by the Apollo on the basis of the mean values for PEAK, PLAT, and PEEP over the last four machine strokes. Spontaneous breaths by the patient and triggered Pressure Support strokes are not taken into account.

Figure 122. Adapting Alarm Limits



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If the mean of the last (up to four) measured breaths cannot be calculated, the measured value of the last breath is used instead.

	Volume Mode, **Volume AF**, **Pressure Mode**, **Pressure Support**
PAW high alarm limit [cmH2O]	PEAK + 5 cmH2O or PLAT + 10 cmH2O, whichever is greater
PAW low alarm limit [cmH2O]	0.6 x (PLAT – PEEP) + PEEP – 1, but at least 3

To restore individual alarm limits for MV and PAW:

– see “Setting alarm limits” on page 186.

To restore all default alarm limits:

– see “Loading default settings” on page 91.

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Configuration

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Overview

The user can configure settings on the Apollo in **Standby** mode as well as during operation. Standby configuration allows the user to save a complete set of defaults that are invoked automatically when the machine is switched on (see "Configuring the default settings in Standby" below). The configuration settings that can be made during operation are more limited and are valid only until the machine is switched off (see "Configuration during operation" on page 195).

Configuring the default settings in Standby

Default settings describe settings which the anesthesia machine starts with when it is switched on.

The default settings for ventilation, fresh-gas delivery, and monitoring can be activated while in **Standby** by pressing the >**Restore Default Settings**< button (**1** in Figure 123) on the standby screen.

The default settings can be configured in **Standby** as follows:

1. Press the standby key >Standby<, and confirm by pushing the rotary knob.
2. Press the >**Default Config**< button (**2** in Figure 123).

   The user is requested to enter a four-digit password in order to prevent unauthorized changes to the basic functions (see Figure 124). The four-digit password is assigned at the factory. If desired, the password can be changed or the password function can be disabled altogether by DrägerService.
3. Select and confirm the figures successively from the line displayed using the rotary knob. The password is represented by asterisks (****) below the line of numbers

The menu **Standby Conf.** for selecting the default values is displayed when the password has been entered correctly, see Figure 125.

Figure 123. Location of Standby Config Key

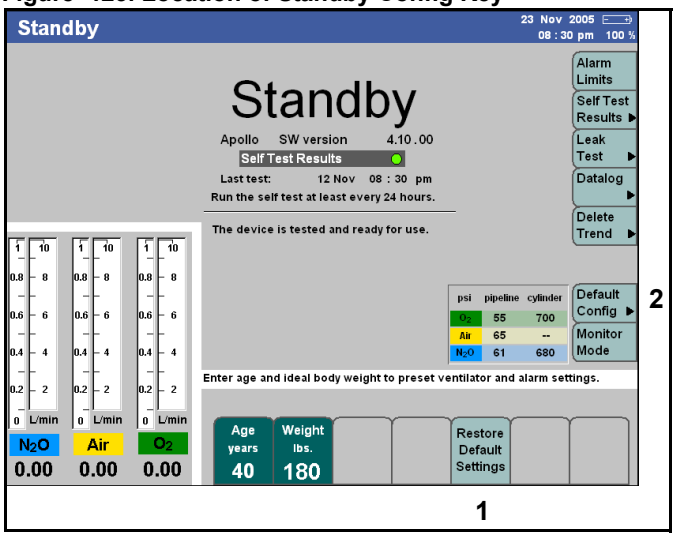
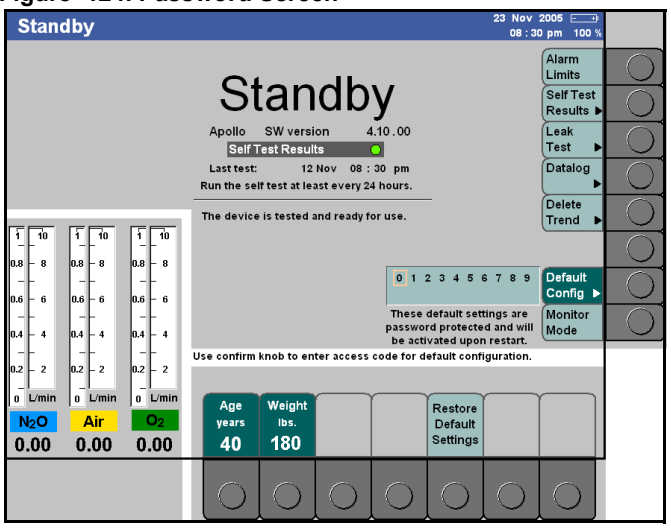


Figure 124. Password Screen



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Default settings are selected in the same way as described in the chapter "User Interface":

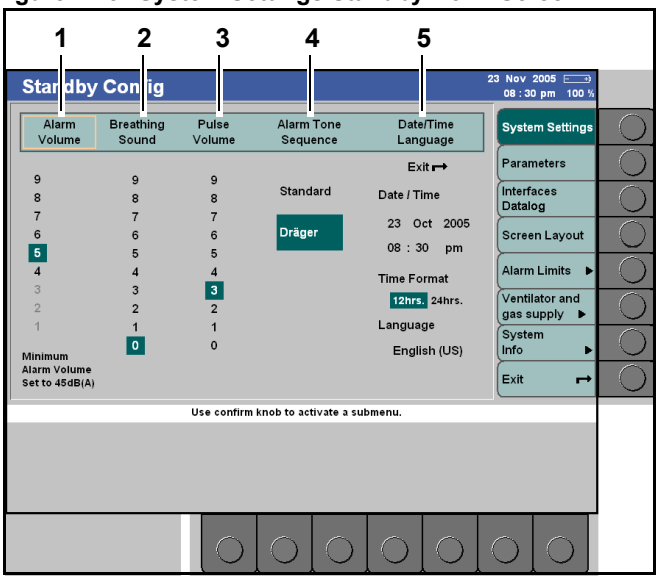
– Active buttons appear in dark green.
– The current settings are highlighted dark green.
– Settings are selected by pressing the rotary knob and will be highlighted in yellow: these values can be adjusted using the rotary knob.
– The exit arrow >⟶< is used to exit the menu or to return the user to the preceding level.

The following settings can be selected via the vertical buttons, see Figure 125.:

– System Settings
– Parameters
– Interfaces Datalog
– Screen Layout
– Alarm Limits
– Ventilator and gas supply
– System Info

A dark green key indicated which screen is currently active. Light green keys indicate which screens are available for selection. Each configuration screen is described in the following paragraphs.

Figure 125. System Settings Standby Conf. Screen



Exiting the standby configuration:

1. Press the button >**Exit** ⟶< or key > Home < or > Next <.

System settings

The following settings can be selected in the System Settings standby configuration screen:

Alarm volume

See **1** in Figure 125.

4 = minimum volume (>45 dB(A))

to

9 = maximum volume (<75 dB(A))

Note: Settings 1 through 3 are not available per U.S. standards.

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WARNING!

Risk of use error.

If using features like the 'breathing sound' or when operating under loud ambient conditions, the auditory alarm signals may not be heard.

Always set the alarm tone to a sufficiently loud volume.

The alarms **NO O_2 DELIVERY** and **NO O_2 SUPPLY** are always announced at the maximum volume, regardless of the setting.

Breathing sound

See **2** in Figure 125.

0 = off

to

9 = maximum volume

The breathing sound is produced by the Breathing Sound Emulator (BSE) module. This module converts the measured inspiratory and expiratory flow values into audible sounds similar to a breathing sound.

The volume depends on the set patient age. This dependency allows optimal volume at all flow levels.

All alarms are still audible with the breathing sound volume set to the maximum.

Pulse volume (for SpO_2, optional)

See **3** in Figure 125.

0 = off

to

9 = maximum volume

Alarm tone sequence

See **4** in Figure 125.

Standard (complies with IEC 60601-1-8)

or

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Date/Time/Language

See **5** in Figure 125.

Date/Time

– day, month, year
– hh:mm

Time format

– 12 hrs.
– 24 hrs.

Language

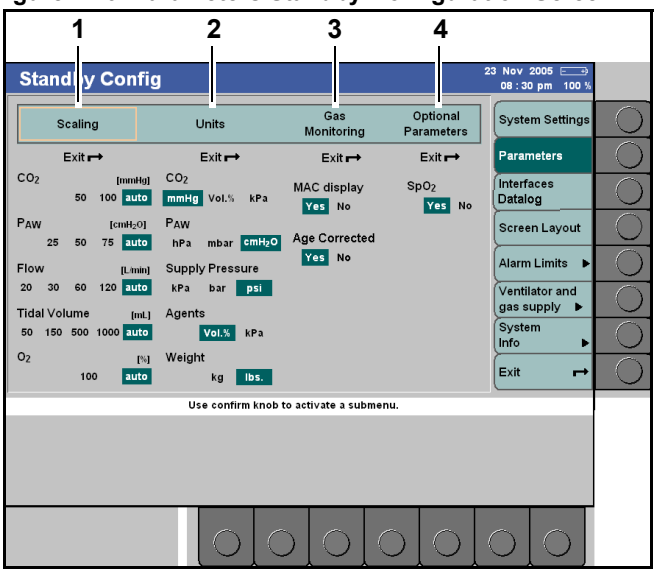
Selects the language of the display text.

– English (US)

Parameters

The following settings can be selected in the Parameters standby configuration screen (refer to Figure 126):

Figure 126. Parameters Standby Configuration Screen



Scaling

See **1 in Figure 126.**

– **CO_2**
– **PAW**
– **Flow**
– **O_2**

  The setting is made automatically or by selecting a pre-set scale.

  auto: Automatic adjustment to the next higher or lower scale after two passes if the scaling frame is exceeded.

– **Tidal Volume**

  The setting is made automatically or by selecting a pre-set scale.

  auto: A suitable scale is selected automatically in accordance with the set age:

  – <1 year: 50 mL
  – 1 to 2 years: 150 mL
  – >2 years to 10 years: 500 mL
  – >10 years: 1000 mL

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Units

See **2** in Figure 126.

– **CO_2:** mmHg, Vol.%, kPa
– **P_{AW}:** hPa, mbar, cmH_2O
– **Supply Pressure**: kPa, bar, psi
– **Agents**: Vol.%, kPa
– **Weight**: kg, lbs.

Gas monitoring

See **3** in Figure 126.

– **MAC display:** Yes or No

  This setting determines whether the MAC factor is displayed or not.

– **Age corrected:** Yes or No

  This setting determines whether the MAC factor is corrected for patient age or not. See page 145 for a detailed explanation of the MAC definition and calculation.

Optional parameters

See **4** in Figure 126.

This setting determines whether SpO_2 values are displayed or not (if available).

– **SpO_2**: Yes or No

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Interfaces datalog

The following settings can be selected in the interfaces logbook standby configuration screen.

Datalog entries triggered by

See **1** in Figure 127.

These settings determine when automatic entries will be made in the Datalog.

– **Time Interval**: 1, 2, 5, 10 (minutes)

  Entries are made after a fixed time interval in minutes.

– **Warning Alarms**: Yes or No

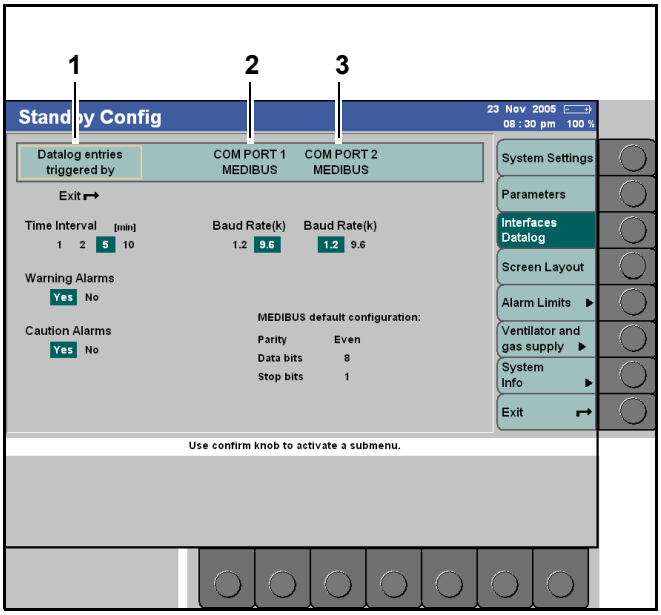
  Entries are made when a warning is issued.

– **Caution Alarms**: Yes or No

  Entries are made when a caution message is issued.

The Datalog stores up to 600 entries. If the Datalog is full and new entries are to be stored, the Datalog deletes the oldest entries. When the Apollo is switched off, all Datalog entries are saved and are available upon the next start-up of the Apollo.

Figure 127. Interfaces Logbook Standby Configuration Screen



COM PORT 1 MEDIBUS, COM PORT 2 MEDIBUS

See **2** and **3** in Figure 127.

These settings are used for communication with external devices. Medibus is the Dräger medical equipment communications protocol.

– **Baud Rate (k)**

  This is the data transmission rate (settings variable; refer to the Instructions for Use for the devices to be connected).

MEDIBUS default configuration

– **Parity, data bits, and stop bits**

  These values cannot be configured; this is information only.

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Screen layout

The menu screen layout contains three default layouts of the home screen: Layout 1, Layout 2, and Layout 3.

The layouts comprising the following elements which can be freely configured:

– Three curves with the associated numerical modules (**1** in Figure 128).
The available curves are displayed when a curve module is selected (**1** in Figure 129).
– Three modules which may be assigned to parameters or status displays (**2** in Figure 128).
The available modules are displayed when a module is selected (**1** in Figure 129).

Each curve/module can also be configured as being blank.

Each curve/module can only be displayed once. If a curve/module is selected twice, the preceding selection automatically becomes “blank”.

To configure Layout 1, Layout 2, or Layout 3:

1. Select and confirm a layout via the rotary knob.
2. Select and confirm a curve or a module.
3. Change and confirm the selection via the rotary knob.

CAUTION!

Risk of inadequate monitoring.

Certain monitoring options are mandatory depending on the applicable national requirements. Some monitoring options may not be covered by certain screen layout configurations.

Always take national standards into account when configuring the screen layout.

Figure 128. Screen Layout Standby Configuration Screen

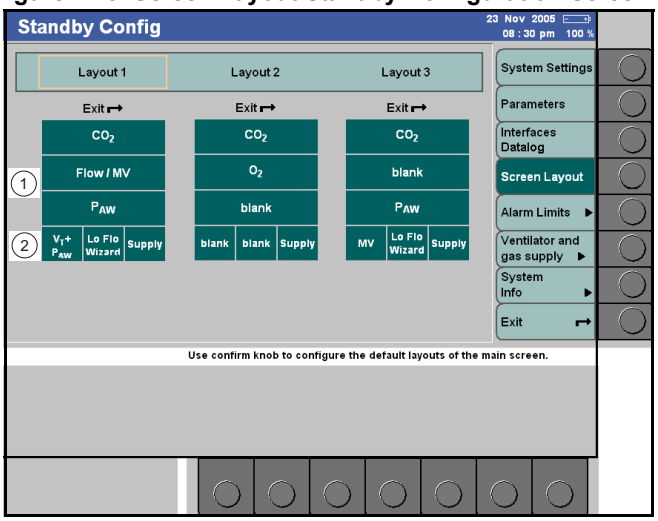
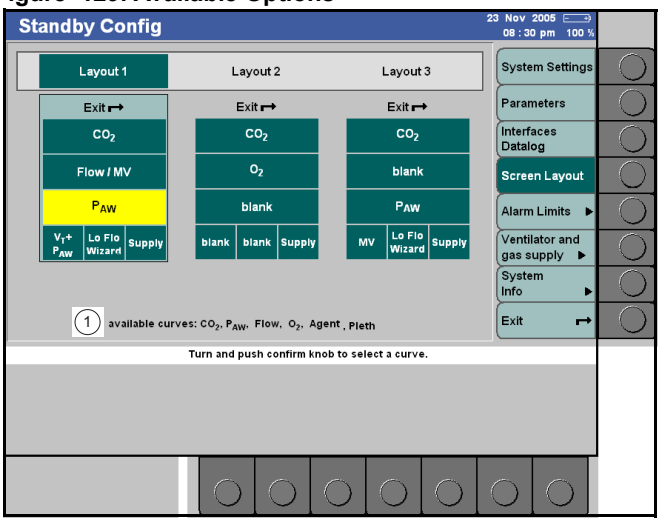


Figure 129. Available Options



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Setting alarm limits

The following limits may be configured in the menu **Alarm Limits** > **Alarm Limits** (refer to Figure 130).

Default alarm limits

See **1** in Figure 130.

- **FiO_2**
- **$etCO_2$**
- **MV**
- **P_{AW}**
- **SpO_2**
- **Pulse**

The high and low alarm limits for patient parameters can be adjusted within the ranges provided in table “Adjustment ranges for default alarm limits” on page 189.

Note: The new default alarm limits are effective whenever the anesthesia machine is switched on and after selecting >**Restore default settings**< in **Standby**.

Default agent limits

See **2** in Figure 130.

- **Hal (I)**
- **Iso (I)**
- **Enf (I)**
- **Sev (I)**
- **Des (I)**

The high and low alarm limits for agent can be adjusted within the ranges provided in table “Adjustment ranges for default alarm limits” on page 189.

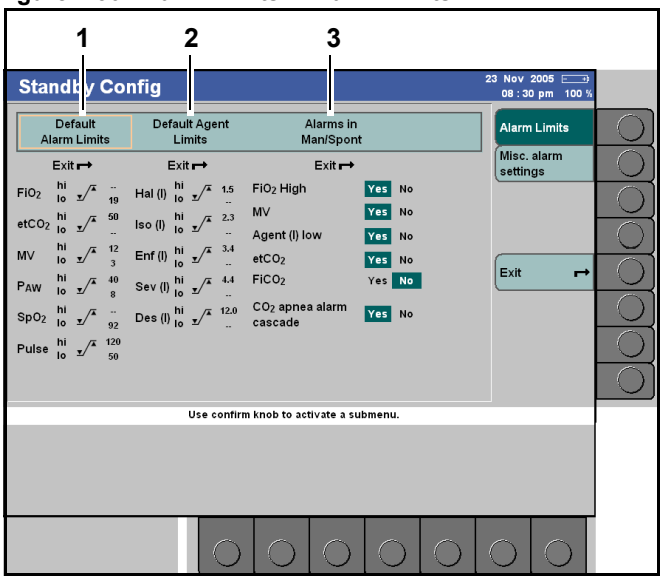
Alarms in Man/Spont

See **3** in Figure 130.

These alarms can be activated or deactivated in **Standby** for switching to **Man/Spont** When the alarm limits are set to >**yes**<, the value is adopted from the automatic ventilation mode. For further information, see “Troubleshooting” on page 229.

- **FiO_2 High**
- **MV**
- **Agent (I) low**

Figure 130. Alarm Limits > Alarm Limits



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- **etCO2**
- **FiCO2**
- **CO2 apnea alarm cascade**

When the FiO2 High, etCO2, FiCO2, MV, and Agent (I) low settings are set to “Yes”, the alarm value is adopted from the automatic ventilation mode. When they are set to “No”, the alarms are disabled in **Man/Spont**, **Aux CGO**, or **Monitoring** mode.

When the CO2 apnea alarm cascade setting is set to >**Yes**<, the priority of the alarm changes depending on how long the alarm condition has been active:

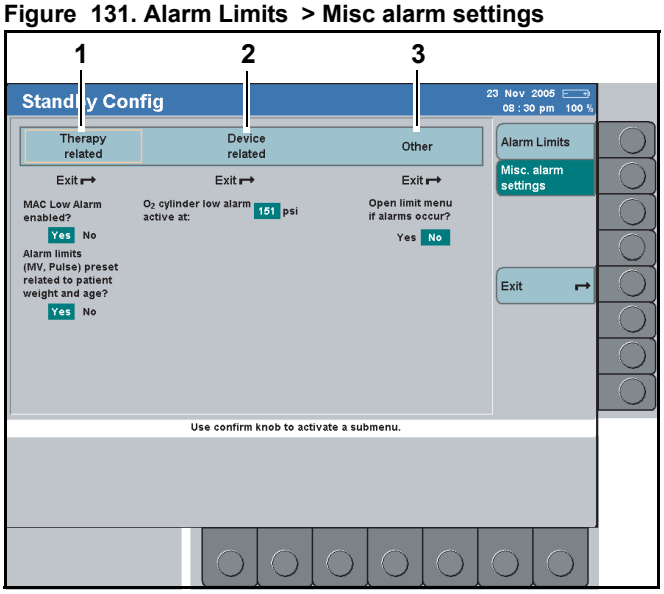
Duration of CO2 Apnea Alarm	**Alarm priority (in Man/Spont, Pressure Support, Aux CGO, or Monitoring mode)**
0 seconds to 30 seconds	Advisory
31 seconds to 60 seconds	Caution
more than 60 seconds	Warning

When the CO2 apnea alarm cascade setting is set to >**No**<, the alarm is always a Warning in **Man/Spont**, **Pressure Support**, **Aux CGO**, or **Monitoring** mode.

1. Press the >**Exit**< key to exit the Alarm Limits > Alarm Limits menu.

The following limits may be configured in the menu **Alarm Limits** > **Misc alarm settings** (refer to Figure 131).

Figure 131. Alarm Limits > Misc alarm settings



Therapy related

See **1** in Figure 131.

- **MAC Low Alarm enabled?**: Yes or No
  (For more information please see “Automatic agent alarm activation” on page 146.)
- **Alarm limits (MV, Pulse) preset related to patient weight and age?**: Yes or No
  (For more information, please see “Entering the patient’s ideal body weight (Optional)” on page 92.)

Device related

See **2** in Figure 131.

- **O2 cylinder low alarm active at:**

  Determine the pressure at which the warning **O2 CYLIND. LOW** is to be issued. This menu item only appears if the O2 cylinder has been configured as gas supply, see page 191.

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Other

See **3** in Figure 131.

– **Open limit menu if alarm occurs?**: Yes or No

  Determine whether or not the alarm limits menu should appear automatically when an alarm limit is violated.

  Regardless of this setting, the alarm limit menu is always opened in case of a **MAC LOW?** alarm.

– **Apnea ventilation low priority only?**: Yes or No

  If set to “**no**” this enables a cascade for the alarm **APNEA VENTILATION**, see page 241.

1. Press the >**Exit**< key to exit the Alarm Limits > Misc alarm settings menu

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Adjustment ranges for default alarm limits

Alarm	Adjustment range	Default value upon delivery
SpO_2 ↑	81 to 99, --	--
[%] ↓	80 to 98	92
Pulse ↑	21 to 250	120
[bpm] ↓	20 to 249	50
$etCO_2$ ↑	1 to 75, --	50
[mmHg] ↓	0 to 74, --	--
MV ↑	0.1 to 20.0, --	12
[L/min] ↓	0 to 19.9, --	3.0
FiO_2 ↑	19 to 99, --	--
[Vol.%] ↓	18 to 98	20
inHal. ↑	0.1 to 8.4	1.5
[Vol.%] ↓	0 to 8.3, --	--
inIso. ↑	0.1 to 8.4	2.3
[Vol.%] ↓	0 to 8.3, --	--
inEnf. ↑	0.1 to 9.9	3.4
[Vol.%] ↓	0 to 9.8, --	--
inDes. ↑	0.1 to 21.9	12.0
[Vol.%] ↓	0 to 21.8, --	--
inSev. ↑	0.1 to 9.9	4.2
[Vol.%] ↓	0 to 9.8, --	--
PAW ↑	5 to 99	40
[cmH_2O] ↓	0 to 35	8

Two dashes > -- < indicate that the corresponding alarm is disabled.

Apnea alarm trigger times:

Apnea pressure	after 20 seconds
Apnea flow	after 20 seconds
Apnea CO_2	after 20 seconds (after 65 seconds in **Man.Spont**, the **Monitoring** mode, and **Aux CGO**)

All apnea, apnea pressure, apnea flow, and apnea CO_2 alarms are active after 35 seconds in the mechanical ventilation modes with a frequency of less than 6 bpm and in **Pressure Support** mode with a minimum frequency $Freq_{MIN}$ of less than 6 bpm or when set to "**OFF**".

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Note: The new default alarm limits are effective whenever the anesthesia machine is switched on and after selecting >**Restore default settings**< in **Standby**.

Certain alarms can be disabled automatically in **Man.Spont**, **Monitoring**, and **Aux CGO** (see page 186).

Ventilator and gas supply

The following parameters can be set in the menu **Ventilator and gas supply** (refer to Figure 132).

Parameter Default Values

These settings allow the user to set default ventilation parameters for the following ventilation modes (see **1** in Figure 132).

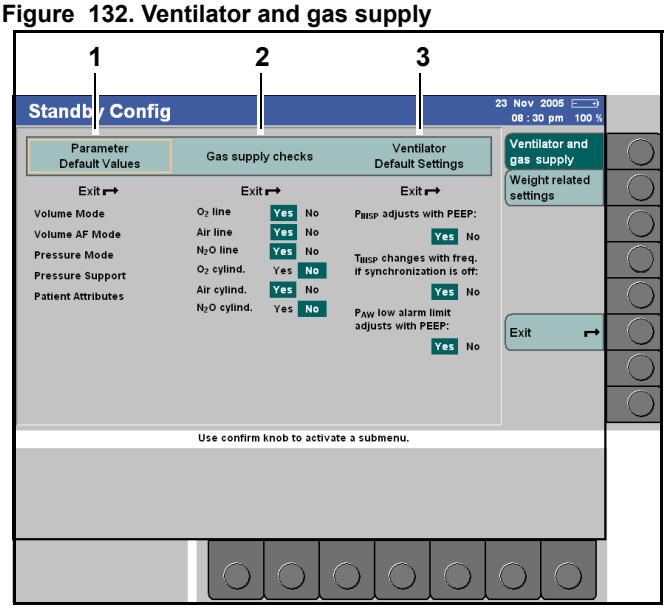
- **Volume Mode**
- **Volume AF Mode**
- **Pressure Mode**
- **Pressure Support**
- **Patient Attributes**

1. Select mode via rotary knob and confirm. Buttons for ventilation parameters appear. Set ventilation parameters, see “Setting/Selecting Ventilation Parameters” on page 39.

The trigger sensitivity can be set separately in the available ventilation modes.

If the trigger has been pre-set to “**OFF**” in **Volume Mode**, **Volume AF Mode**, or **Pressure Mode**, the value configured under Pressure Support will automatically be adopted when synchronization is activated during operation. The same also applies with regard to adopting the value for ΔPPS, although this cannot be configured in the **Volume Mode**, **Volume AF Mode**, and **Pressure Mode**.

Figure 132. Ventilator and gas supply



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Gas supply checks

The settings that can be selected in this menu determine which gas supplies will be checked during the self test and normal operation (see **2** in Figure 132).

- **O_2 line**
- **Air line**
- **N_2O line**
- **O_2 cylind.**
- **Air cylind.**
- **N_2O cylind.**

Note: Only the gas supply defined as being present in the configuration will be included in the self test.

WARNING!

Risk of device failure.

The anesthesia machine does not operate without at least one oxygen supply.

Either the O_2 pipeline supply or the O_2 cylinder supply must be configured for the O_2 supply.

Ventilator Default Settings

See **3** in Figure 132.

- **PINSP adjusts with PEEP**: Yes or No

  When >**Yes**< is set:
  Changes in the set PEEP parameter automatically changes the parameter value PINSP so that the difference between PEEP and PINSP remains constant.

  When >**No**< is set:
  Parameter value PINSP remains unaffected by changes inthe ventilation parameter PEEP.

- **TINSP changes with Freq. if synchronization is off**: Yes or No

  When >**Yes**< is set:
  TINSP is automatically adjusted when the frequency is changed so that the ratio of inspiration to expiration I:E remains constant. This only applies if synchronization has not been set.

  When >**No**< is set:
  TINSP remains independent of the change in frequency and the ratio of inspiration to expiration I:E changes accordingly.

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– **PAW low alarm limit adjusts with PEEP**

When >**Yes**< is set:
The low alarm limit for airway pressure (PAW) will be automatically changed when the PEEP value is changed.

When >**No**< is set:
The low alarm limit for airway pressure (PAW) will be unaffected by changes in the PEEP value.

In the Pressure Mode, the PAW low alarm limit will not exceed the PINSP - 2. This is also true for changes to PINSP.

In the Pressure Support Mode, PEEP + ΔPPS - 2 will not be exceeded. This is also true for changes to ΔPPS.

The following parameters can be set in the menu **Weight related settings** (refer to Figure 133).

Body Weight Related Ventilator Settings

See **1** in Figure 133.

– **VT and Freq. presetting related to ideal body weight**: Yes or No

If the settings for VT and Freq. are to be referred to the patient's body weight, the initial value for VT can be selected in accordance with the Radford nomogram.

– **Preset configuration**

Select, edit, and confirm the VT to be changed via the rotary knob.

The settings for VT are interpolated for weights between the four predetermined classes.

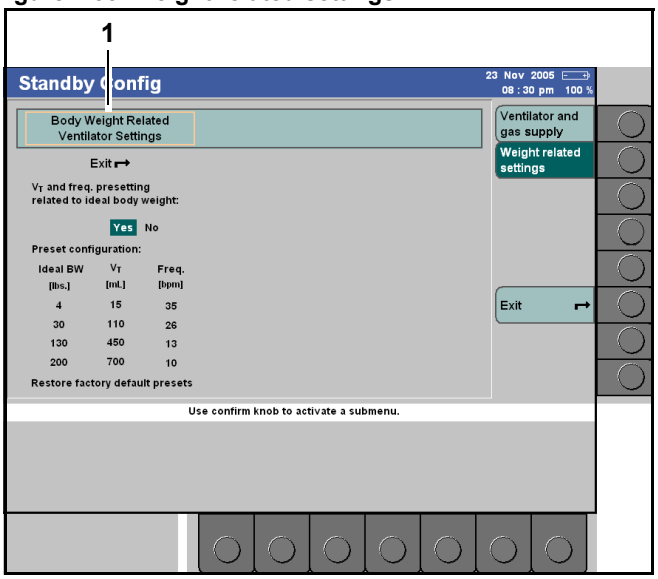
Weight (ideal BW)	VT [mL]		Freq.
[lbs]	Range of settings	Factory settings	[bpm]
4	10 to 25	15	35
30	60 to 150	110	26
130	300 to 500	450	13
200	550 to 800	700	10

– **Restore factory default presets**

Select and confirm to restore the factory default setting.

The default settings are activated immediately upon exiting the configuration menu.

Figure 133. Weight related settings



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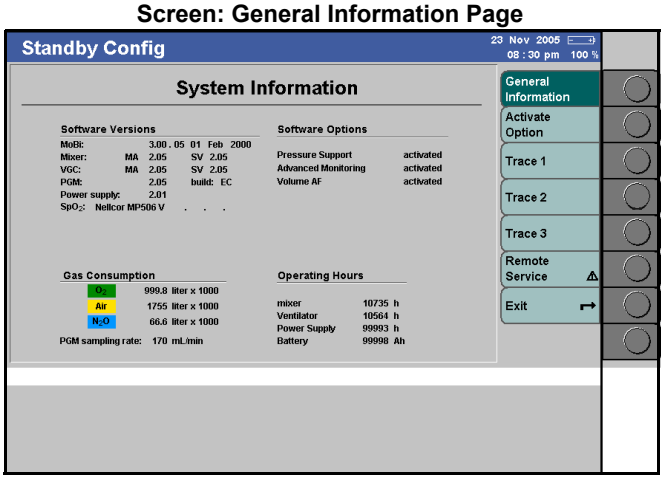
System information

The system information standby configuration screens display useful information and allow the activation of software options by an authorized DrägerService representative. It also allows access to the Remote Service Box (see Figure 134).

General Information

- **Software Versions** of the individual components
- Enabled **Software Options**
- **Gas Consumption** and sampling rate of the patient gas module
- **Operating Hours** of individual components

Figure 134. System Settings Standby Configuration Screen: General Information Page



Activate Option

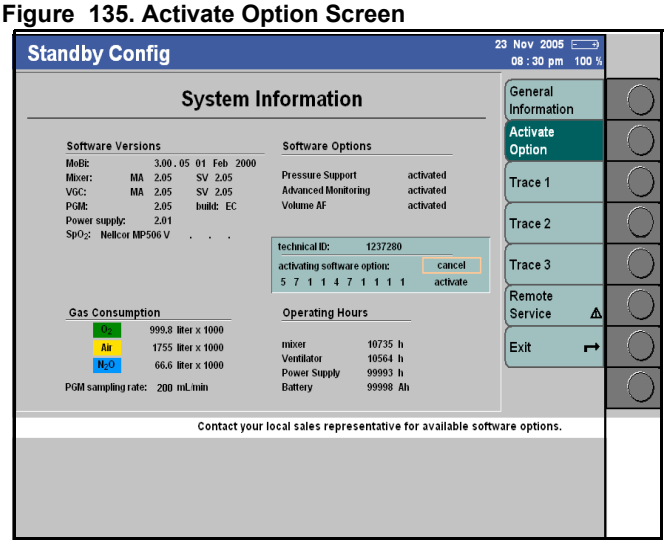
Software options can be activated by entering a multi-digit code.

Options and the associated activation codes are available from the respective Dräger sales organization.

To activate an option:

1. Select and confirm the figures successively from the line displayed via the rotary knob (refer to Figure 135).
2. When the complete code is entered, activate, select, and confirm the menu item via the rotary knob.

Figure 135. Activate Option Screen



Trace 1, Trace 2, Trace 3

Description of internal equipment states and parameters.

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Remote Service

Before activating the **Remote Service**:

1. Carry out a self test.

WARNING!

Risk of patient injury.

The patient may be injured if connected to the device when the remote service function is active. While servicing the device, automatic ventilation and all monitoring functions are not available.

Only use the remote service box on medical devices which are not otherwise in use.

2. Press the key >**Remote Service**< (**1** in Figure 136).

The **Remote Service** screen is displayed with a prompt advising the operator how to continue (see Figure 137).

3. Connect the remote service box to the COM 1 interface.

The service data of the Apollo can now be transferred. For further operation, see the Instructions for Use for the remote service box (P/N 90 37 569).

After exiting the **Remote Service**:

4. Switch off the Apollo.

Figure 136. Remote Service key

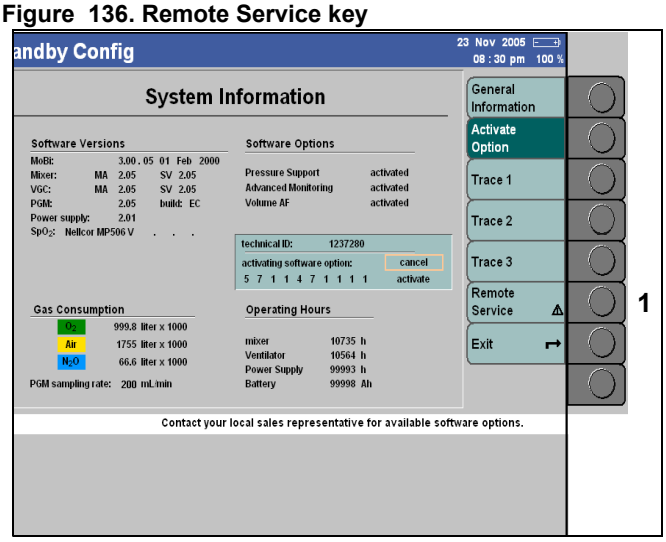
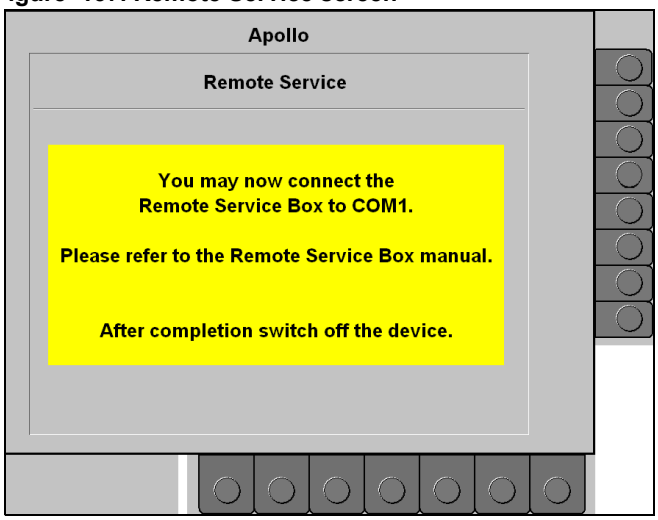


Figure 137. Remote Service screen



Exiting standby configuration

1. Press the >⟶< button on the main configuration menu.

The default settings are effective immediately upon exiting standby configuration and remain in effect over a power cycle.

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Configuration during operation

Certain monitoring functions can be selected or changed via configuration menus for ongoing operation.

The settings made here remain valid until the anesthesia machine is switched off.

On the standard screen or data screen:

1. Press the >**Config**< key (**1** in Figure 138).

The first of the configuration screens is displayed, overlaying the three curves and corresponding numeric data (see Figure 139).

The settings are selected/changed during operation in the same way as described in the chapter "User Interface":

- active buttons appear in dark green
- the current settings are highlighted in dark green; these values can be adjusted using the rotary knob
- settings are selected by pressing the rotary knob
- fields highlighted in yellow return the user to the preceding menu level
- the Exit >⟶< arrow is used to exit the menu

There are four configuration screens that can be selected by touching the corresponding button on the right side of the screen:

- **Volume/Alarms** (**1** in Figure 139)
- **Param Settings** (**2** in Figure 139)
- **Datalog Entries** (**3** in Figure 139)
- **System Info** (**4** in Figure 139)

A dark green button indicates which screen is currently active. Light green buttons indicate which screens are available for selection. Each configuration screen is described in the following paragraphs.

Figure 138. Location of Config Soft Key

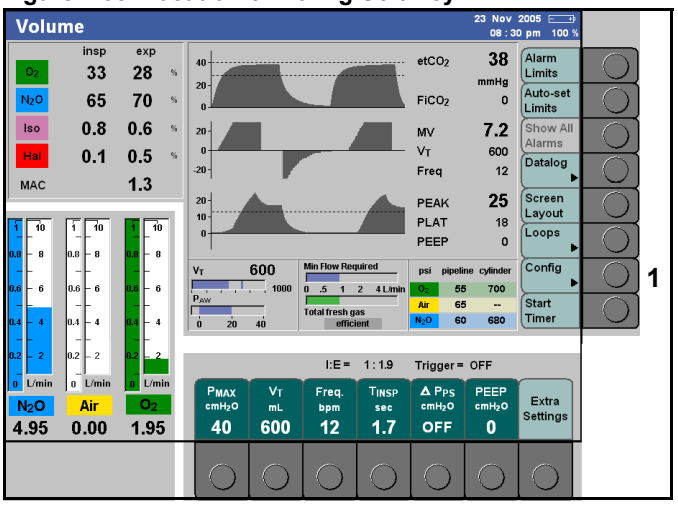
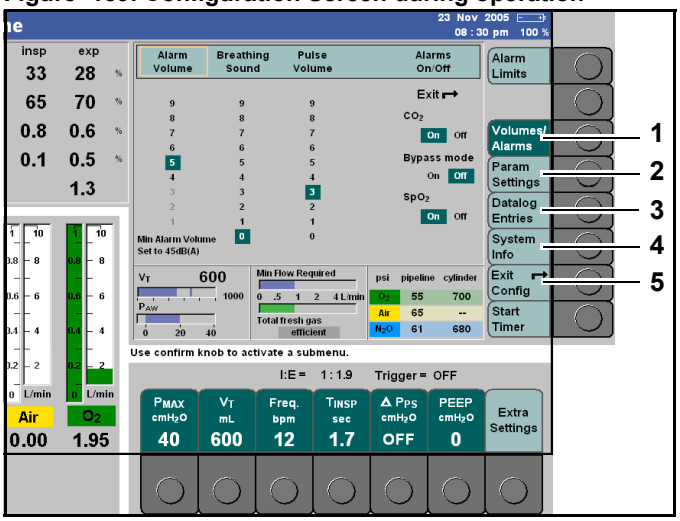


Figure 139. Configuration Screen during operation



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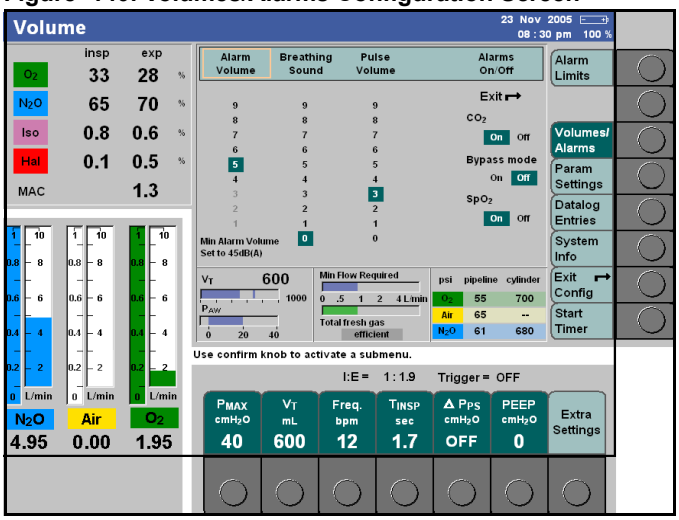
Volumes/Alarms

The following settings can be selected in the Volumes/Alarms configuration screen (refer to Figure 140).

Figure 140. Volumes/Alarms Configuration Screen



Alarm volume

4 = minimum volume (>45 dB(A))

to

9 = maximum volume (<75 dB(A))

Note: Settings 1 through 3 are not available per U.S. standards..

WARNING!

Risk of use error.

If using features like the 'breathing sound' or when operating under loud ambient conditions, the auditory alarm signals may not be heard.

Always set the alarm tone to a sufficiently loud volume.

The alarms **NO O_2 DELIVERY** and **NO O_2 SUPPLY** are always announced at the maximum volume, regardless of the setting.

Breathing sound

0 = off

to

9 = maximum volume

The breathing sound is produced by the Breathing Sound Emulator (BSE) module. This module converts the measured inspiratory and expiratory flow values into audible sounds similar to a breathing sound.

The sound volume depends on the set patient age. This dependency allows optimal volume at all flow levels.

All alarms are still audible with the breathing sound volume set to the maximum.

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Pulse volume (for SpO_2, optional)

0 = off

to

9 = maximum volume

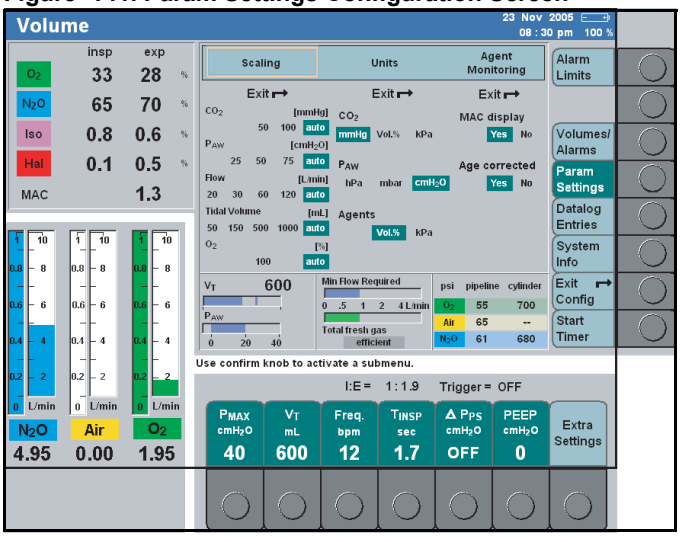
Alarms on/off

This setting is used to enable/disable CO_2 alarms, optional SpO_2 alarms, and bypass mode (for further information see page 169 and page 171).

Param Settings

The following settings can be selected in the Param Settings configuration screen (refer to Figure 141).

Figure 141. Param Settings Configuration Screen



Scaling

- **CO_2**
- **P_{AW}**
- **Flow**
- **O_2**

  The setting is made automatically or by selecting a pre-set scale.

  auto: Automatic adjustment to the next higher or lower scale after two passes if the scaling frame is exceeded.

- **Tidal volume**

  The setting is made automatically or by selecting a pre-set scale.

  auto: A suitable scale is selected automatically in accordance with the set age:.

  - <1 year: 50 mL
  - 1 to 2 years: 150 mL
  - >2 years to 10 years: 500 mL
  - >10 years: 1000 mL

Units

- **CO_2:** mmHg, Vol.%, kPa
- **P_{AW}:** hPa, mbar, cmH_2O
- **Agents**: Vol.%, kPa

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Agent monitoring

– **MAC display:** Yes or No

  This setting determines whether the MAC factor is displayed or not.

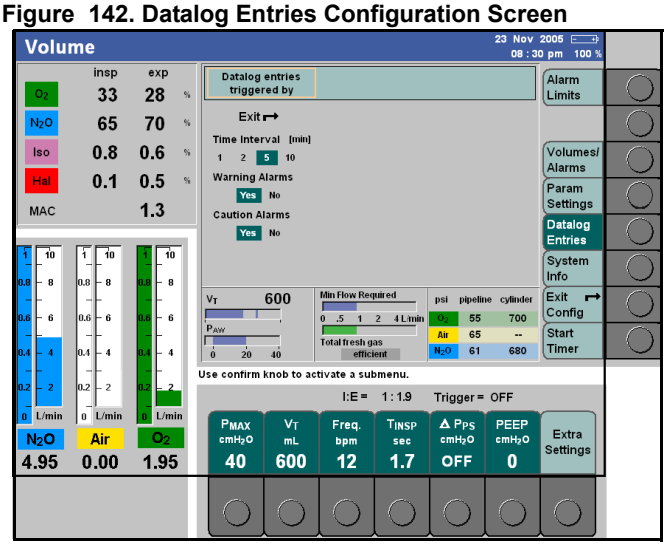
– **Age corrected:** Yes or No

  This setting determines whether the MAC factor is corrected for patient age or not. See page 145 for a detailed explanation of the MAC definition and calculation.

Datalog entries

The following settings can be selected in the Datalog Entries configuration screen (refer to Figure 142).

Figure 142. Datalog Entries Configuration Screen



Datalog entries triggered by

These settings determine when automatic entries will be made in the Datalog.

– **Time Interval**: 1, 2, 5, 10 (minutes)

  Entries are made after a fixed time interval in minutes.

– **Warning Alarms**: Yes or No

  Entries are made when a warning is issued.

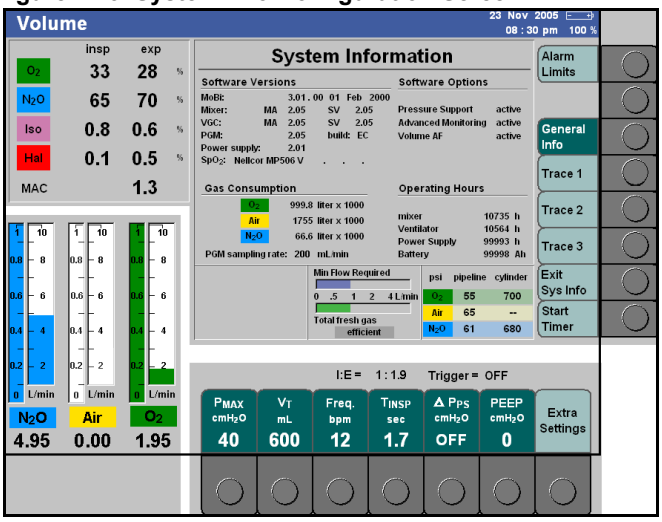
– **Caution Alarms**: Yes or No

  Entries are made when a caution message is issued.

System information

The system info configuration screens display the following information:

Figure 143. System Info Configuration Screen



General information

– **Software Versions** of the individual components

– **Software Options**

– **Gas Consumption** and sampling rate of the patient gas module

– **Operating Hours** of individual components

Trace 1, Trace 2, Trace 3

Description of internal equipment states and parameters.

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Exit SysInfo

1. Press the >**Exit SysInfo**< to exit the System Information menu and return to the configuration screen.

Exiting configuration during operation

1. Press the >**Exit Config**< button on the configuration menu (**5** in Figure 139).

   The settings are effective immediately and remain in effect until the machine is switched off.

Setting the patient's age and weight during operation

The patient's age and weight can be changed at any time via the buttons **Age** and **Weight**.

In automatic ventilation modes (**Volume Mode**, **Volume AF**, **Pressure Mode**, **Pressure Support**):

1. Push the button >**Extra Settings**< (**1** in Figure 144).
2. Push the button >**Age**< or >**Weight**< (refer to Figure 145) to change and confirm with the rotary knob.

In the modes **Man.Spont**, **Aux CGO**, and **Monitoring**, the keys are directly accessible.

1. Push the button >**Age**< or >**Weight**< (refer to Figure 145) to change and confirm with the rotary knob.

Figure 144. Extra Settings key

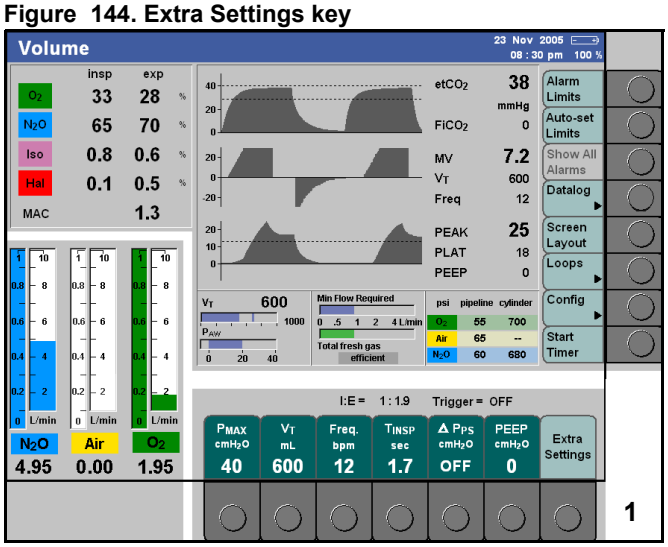
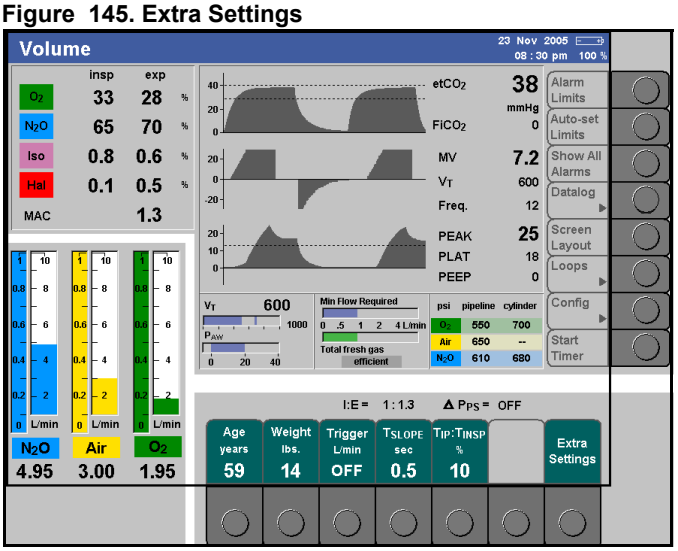


Figure 145. Extra Settings



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Cleaning and Maintenance

Contents

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Overview

This chapter of the Operating Instructions provides complete instructions for the disassembly and cleaning of the Apollo anesthesia machine.

Note: Set the Apollo to **Standby** before disassembly.

Disassembling components

Removing the sample line

1. Disconnect the sample line from the Y-piece and the fitting on the water trap (see Figure 146).

CAUTION!

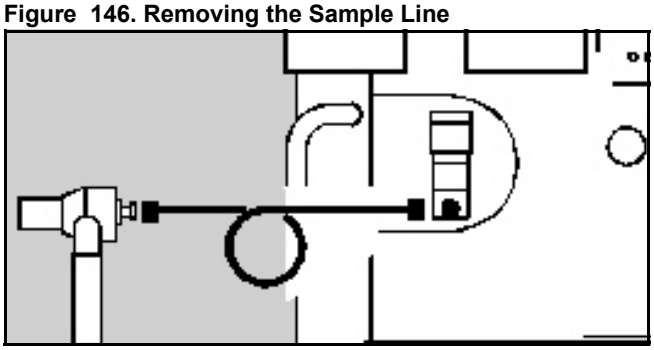
Risk of gas measurement failure and device failure.

Disinfectants can damage the sample gas line and the diaphragm of the water trap.

Sample gas lines are single-use articles and must be replaced, not disinfected.

The sample gas line can be disposed of with ordinary domestic waste.

Figure 146. Removing the Sample Line



Removing the water trap

1. Pull the water trap straight out of its holder.

WARNING!

Risk of measurement failure and device failure.

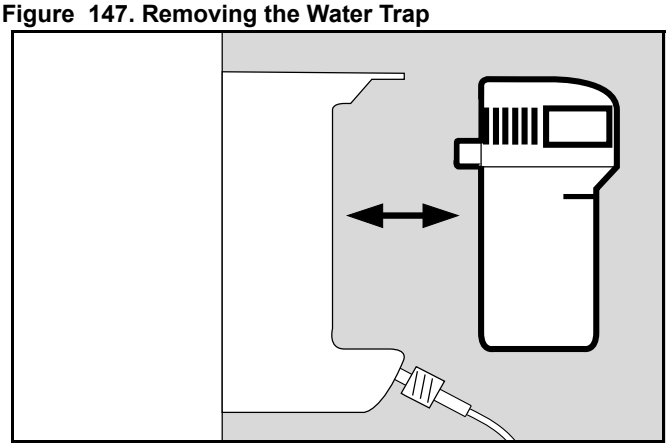
If the water trap is used longer than intended, the diaphragm may become brittle and allow water and bacteria to enter the measurement system. Such contamination affects the gas measurement which may fail as a result.

The water trap must be replaced at least every four weeks.

The old water trap can be disposed of with ordinary domestic waste.

Note the Instructions for Use of the water trap WaterLock.

Figure 147. Removing the Water Trap



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Removing the patient system hoses

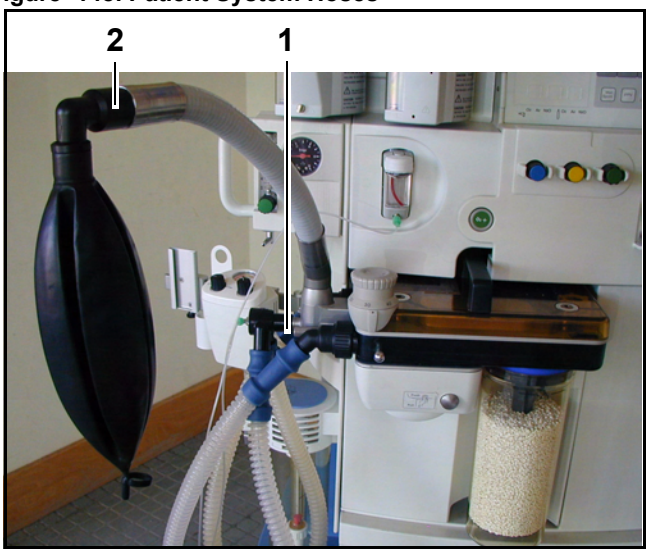
1. Disconnect the breathing hoses from the breathing system (**1** in Figure 148).
2. Disconnect the various parts of the hose system (breathing hoses, Y-piece, connector, and optional Y-piece filter). The filter on the Y-piece is not reusable and can be disposed of with ordinary domestic waste.

Note the regulations of the hospital for infectious patients!

Note the Instructions for Use.

3. Disconnect the breathing bag and arm (**2** in Figure 148) by loosening the two thumb screws.
4. Prepare the parts for conditioning in a cleaning and disinfection machine.

Figure 148. Patient System Hoses



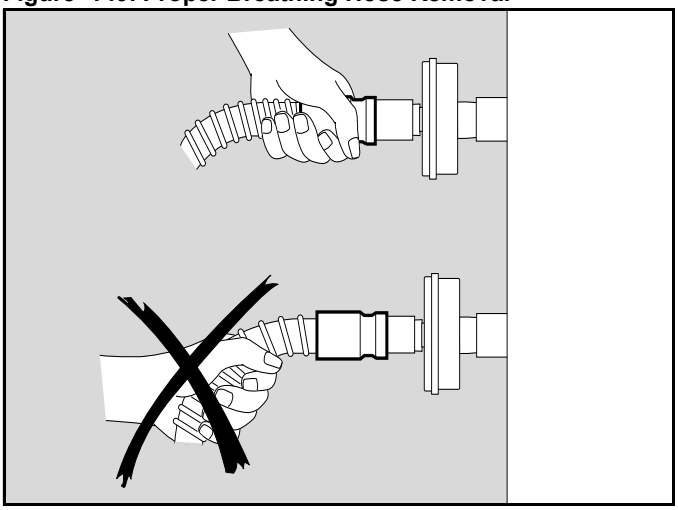
CAUTION!

Risk of component damage and patient injury.

If mishandled, the spiral ribbing on the breathing hoses can become detached from the sleeve. Breathing hoses with damaged spiral ribbing can easily be kinked and interrupt the flow of gas!

When attaching or removing the breathing hoses, always hold them by the connection sleeve and not by the spiral ribbing! Always check the breathing hoses for damage prior to use. Damaged breathing hoses must be replaced.

Figure 149. Proper Breathing Hose Removal



Removing the microbial filter (optional)

On the sleeve of the nozzle:

1. Pull the filter off the nozzle.
2. Prepare the microbial filter for conditioning according to the corresponding Instructions for Use.

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Removing the absorber

A reusable absorber or the disposable CLIC absorber can be used.

Reusable absorber

1. Swing the writing table out of the way.
2. Press the release button on the ventilator unit and pull it out.
3. Turn the absorber canister clockwise and pull it down (**1** in Figure 150).
4. Following the Instructions for Use of the absorber, empty the soda lime from the canister.

WARNING!

Risk of injury.

Absorbent is caustic and is a strong eye, skin, and respiratory tract irritant.

Use care when handling the absorbent to avoid spills.

5. Remove the insert from the absorber (**2** in Figure 150). The inner and outer sealing rings remain on the absorber insert.
6. Prepare the absorber for conditioning in a cleaning and disinfection machine.

Disposable CLIC absorber (optional)

1. Press the button (**1** in Figure 151); the mounting swings open.
2. Slide the disposable absorber off the mounting (**2** in Figure 151).

Note the Instructions for Use of the CLIC absorber.

Figure 150. Removing Absorber and Breathing System

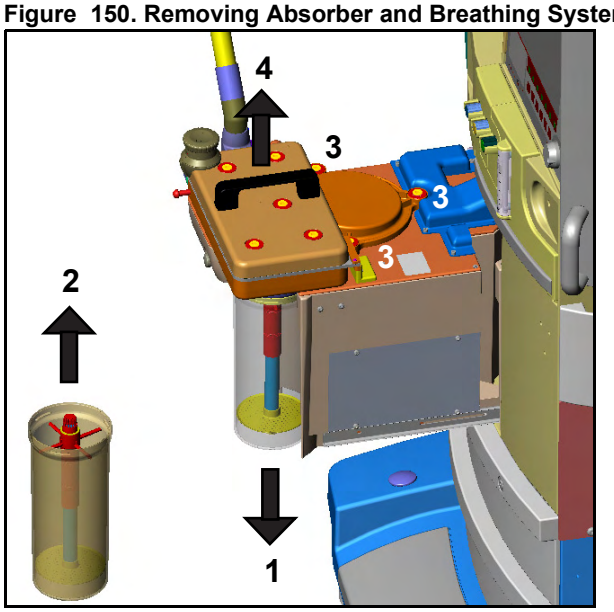
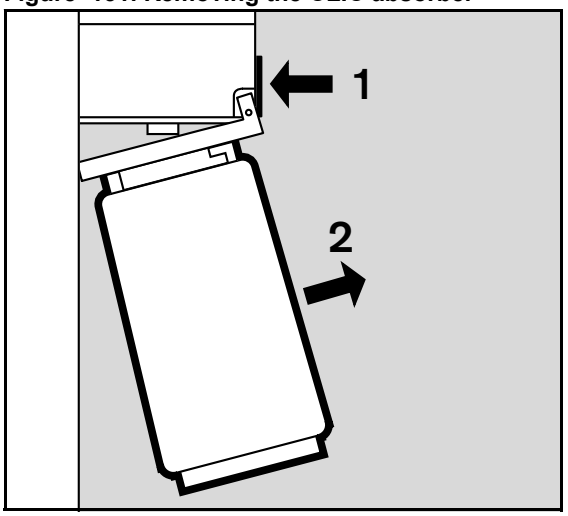


Figure 151. Removing the CLIC absorber



Removing the breathing system

Note: Before removing the breathing system, allow it to cool 5 minutes, if the anesthesia machine has just been used. The surface may otherwise be too hot to touch.

1. Loosen the three sealing screws on the ventilator (**3** in Figure 150) a quarter turn counterclockwise with the wrench supplied.
2. Pull the breathing system up and out by the handle (**4** in Figure 150).

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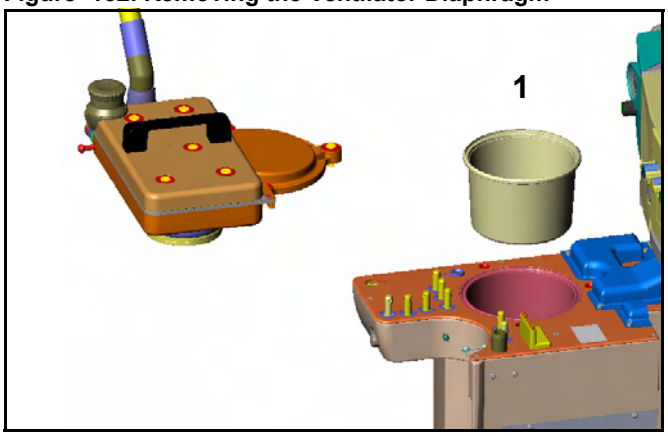
Removing the ventilator diaphragm

1. Remove the upper diaphragm (**1** in Figure 152) and prepare it for conditioning in a cleaning and disinfection machine.

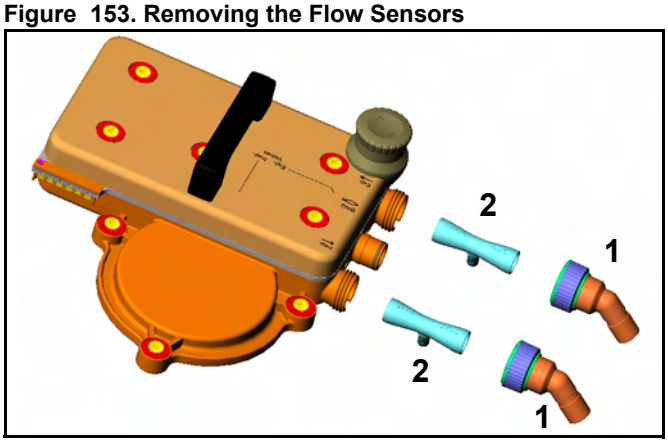
Figure 152. Removing the Ventilator Diaphragm



Removing the flow sensors

1. Remove the inspiratory and expiratory ports (**1** in Figure 153) by turning counterclockwise.
2. Remove the flow sensors (**2** in Figure 153).

Figure 153. Removing the Flow Sensors



CAUTION!

Risk of flow measurement failure.

Disinfecting or cleaning the flow sensors by machine will damage them and cause the flow measurement to fail.

Disinfect and clean the flow sensors as described on page 214 (Spirolog) and page 215 (SpiroLife). Note the Instructions for Use of the Spirolog and SpiroLife flow sensors.

CAUTION!

Risk of flow measurement failure.

Sterilizing the Spirolog flow sensors in high-temperature steam will damage them and cause the flow measurement to fail.

Disinfect and clean the Spirolog flow sensor as described on page 214. Note the Instructions for Use of the Spirolog and SpiroLife flow sensors.

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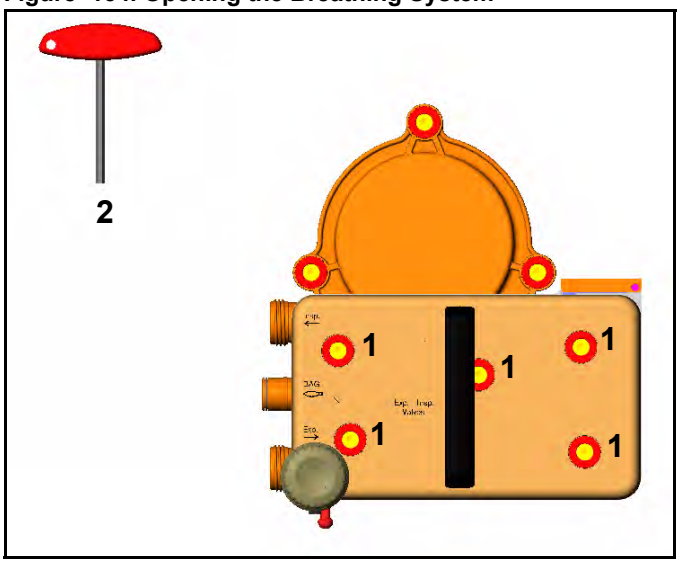
Opening the breathing system

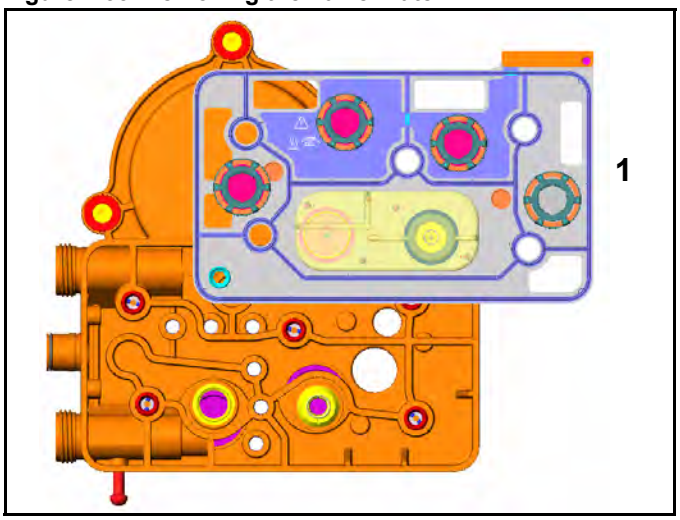
1. Loosen the five sealing screws (**1** in Figure 154) a quarter turn counterclockwise with the key (**2** in Figure 154) supplied.
2. Remove the cover.

Figure 154. Opening the Breathing System



3. Lift off the metal valve plate (**1** in Figure 155).
4. Prepare the housing parts for conditioning in a cleaning and disinfection machine.
5. Place the metal valve plate in the cleaning and disinfection machine.

Figure 155. Removing the Valve Plate



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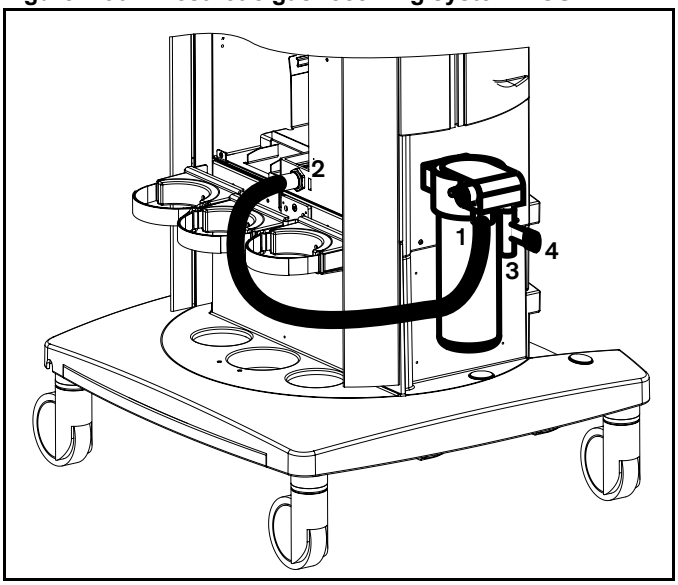
Removing the anesthetic gas receiving system AGS (optional)

1. Remove the waste-gas vacuum hose connected between the hospital waste-gas disposal system and the output connection (**3** in Figure 156) on the receiving system.
2. Remove the transfer hose connected between the receiving system and the scavenger connection on the back of the anesthesia machine (**1** and **2** in Figure 156).
3. Remove the receiving system from the machine.
4. Prepare the individual parts for conditioning in a cleaning and disinfection machine.

Figure 156. Anesthetic gas receiving system AGS

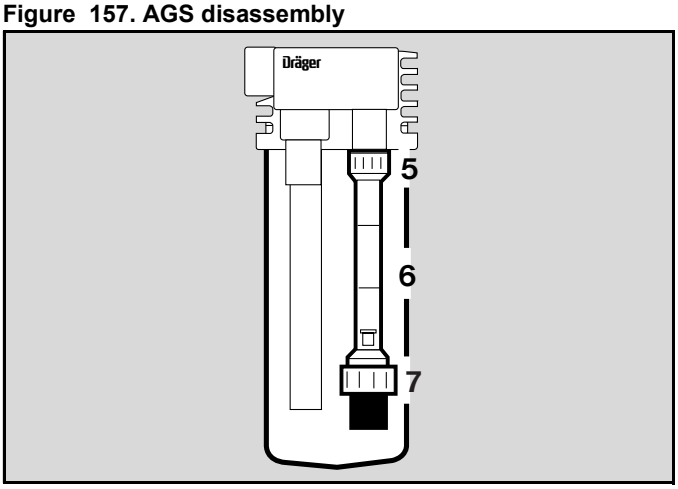


5. Disassemble the anesthetic gas receiving system:
   - Remove the buffer volume container.
   - Unscrew the union nut (**5** in Figure 157).
   - Remove the flow tube (**6** in Figure 157).
   - Unscrew the union nut and remove the particle filter (**7** in Figure 157).

The particle filter can be disposed of with ordinary waste after being sealed (see “Maintenance intervals” on page 226).

Note the Instructions for Use of the anesthetic gas receiving system AGS.

Figure 157. AGS disassembly



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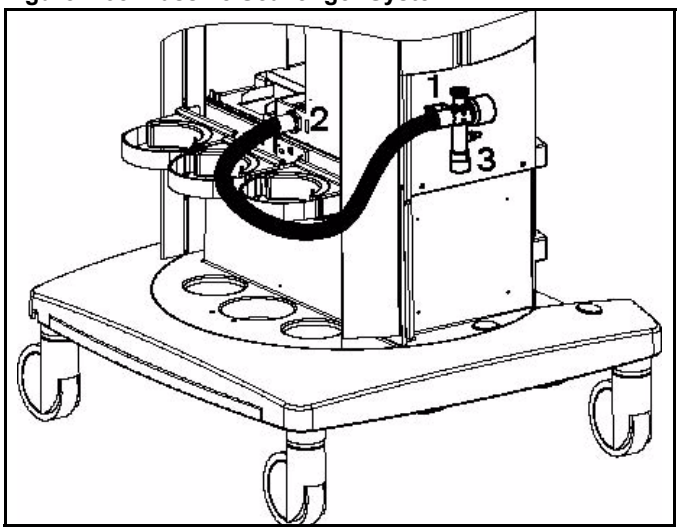
Removing the passive scavenger system (optional)

1. Remove the waste-gas hose connected between the hospital waste-gas disposal system and the bottom connection on the scavenger (**1** in Figure 158).
2. Remove the scavenger hose connected between the scavenger and the scavenger connection on the back of the anesthesia machine (**2** in Figure 158).
3. Remove the scavenger system from the machine.
4. Prepare the parts for conditioning in a cleaning and disinfection machine.

Note: For cleaning/disinfection instructions for the passive scavenger system, refer to its Instructions for Use.

Figure 158. Passive Scavenger System



Removing the endotracheal aspiration system (optional)

1. Remove the suction bottle from the slide mount (**1** in Figure 159).
2. Remove the suction regulator from the bracket (**2** in Figure 159).
3. Remove the endotracheal aspiration system bracket from the side rail on the side of the anesthesia machine.
4. If using a disposable suction bottle, dispose of the bottle with infectious waste.
5. If using a reusable suction bottle, empty the bottle and dispose of contents with infectious waste.

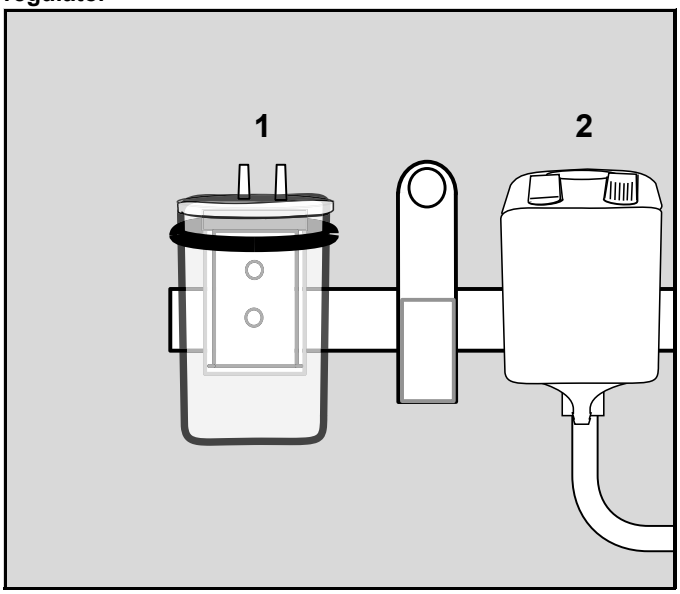
WARNING!

Risk of infection.

Fluids gathered in the suction bottle may be infectious and therefore dangerous for hospital personnel.

Always wear gloves when emptying the suction bottle.

Figure 159. Endotracheal aspiration system bracket and regulator



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Note: For cleaning/disinfection instructions for the reusable suction bottle, refer to its Instructions for Use.

Note: For cleaning/disinfection instructions for the suction regulator, refer to its Instructions for Use.

Cleaning and Disinfection Guidelines

Applies to inhalation anesthetic machines after use with all patients. Governmental regulations must be observed in those cases where patients have notifiable diseases.

Material properties have been taken into account in the specified cleaning/disinfection instructions. Correct functioning of the anesthesia machine is not impaired by the recommended measures. They can be incorporated into the hospital's own hygiene schedules.

Follow the institution’s policies regarding specific methods and agents for cleaning and sterilization, subject to the criteria listed below. Determination of the need and frequency of sterilization of any particular component is the responsibility of the institution.

Sterilization procedures should be performed according to procedures established by the institution, following the specific instructions provided by the manufacturer of the sterilizing equipment or agent to be used. Such policies, procedures, and instructions should ultimately be consistent with established principles of clinical microbiology and infection control.

Proper Cleaning/Disinfection Sequence

If equipment parts are to be cleaned by hand, they must always be disinfected first for personal protection.

When equipment parts are to be cleaned and disinfected by machine, they should always be cleaned first and then disinfected.

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Cleaning/Disinfection Objective and Methods

The purpose of the described cleaning/disinfection measures is to provide each patient with a reliably disinfected anesthetic machine, i.e. a machine free from all unhealthy micro-organisms. Sterility is required only for the intubation tube and bronchial aspiration catheter.

The following disinfection methods may be used:

– Disinfection by wiping the surface of the device (see “Choice of disinfectant” on page 212)
– Mechanical cleaning with high-temperature disinfection (≥199 °F (93 °C) , ≥10 min). This is the preferred method for many Apollo components; a suitable cleaning agent must be added.
– Manual disinfection in a bath. Extensive personal protection is required due to inhalation of vapors.

Equipment parts should be cleaned and disinfected by machine for hygienic conditioning purposes (EN ISO 15883, in preparation).

Complex, thermally stable functional components, such as the breathing system, can be easily cleaned and disinfected by machine, but are not always dried sufficiently. Subsequent vacuum disinfection in hot steam or steam sterilization is recommended to dry off the remaining water.

– Vacuum disinfection in hot steam at 167 °F (75 °C) for 20 minutes or 221 °F (105 °C) for 1 minute, for example.
– Steam sterilization, for example at 250 °F (121 °C) for max. 20 minutes or 273 °F (134 °C) for max. 8 minutes. Higher temperatures may impair the service life of the functional components.

High-temperature disinfection does not have any cleaning effect. Such methods should therefore only be used on functional components which have already been cleaned by hand or by machine.

Machines, associated components, and equipment parts must be inspected visually and packaged for storage or transport. Simple packaging with corresponding labeling is sufficient for this purpose. This is not necessary if the components and equipment parts are not to be stored and/or transported.

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WARNING!

Risk of injury.

If incorrectly handled, the anesthesia machine may become top-heavy and tip over causing injury to patients and/or operators.

Remove any monitoring equipment mounted on the machine before transport. The writing table should also be free of all objects and folded down completely.

CAUTION!

Risk of physical injury.

To avoid physical injury, e.g. pinching, pay special attention to edges, moving parts, and corners when working with

– drawers,
– the ventilator module,
– doors,
– the writing tray,
– swivel arms for mounted devices,
– gas cylinders,
– vaporizer units,
– CLIC absorbers and CLIC adapters,

as well as other accessories.

Disinfecting/Cleaning/Sterilizing

Choice of disinfectant

Only products from the list of surface disinfectants may be used for disinfection. To ensure material compatibility, products based on the following agents may be used:

– Aldehydes
– Quaternary ammonium compounds

All users are advised to use these agents.

Note: Testing was performed with Incidin Extra N and Incidur (wiping), and Gigasept FF and Korsolex Extra (disinfection by immersion).

The following products are *not* suitable and should not be used:

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– Compounds containing phenols
– Halogen-releasing compounds
– Strong organic acids
– Oxygen-releasing compounds

In addition to the main agents, disinfectants frequently also contain additives which may damage the materials used. The supplier/manufacturer of the cleaning agent/disinfectant should be contacted if there is any doubt as to the suitability of a product.

Surfaces

Surfaces of the Apollo, compressed gas hoses, and cables:

– Wipe off impurities with a damp disposable cloth.
– Disinfect with a wipe disinfectant. (Note the manufacturer's Instructions for Use.)

WARNING!

Risk of electric shock.

Fluids entering the device can damage it causing malfunctions and endangering the patient. Wipe the device with only moist, not dripping wet, objects, e.g. sponges or rags. Do not place canisters with liquids on or over the device.

Do not allow any liquids to enter openings in the device.

WARNING!

Risk of fire.

To prevent a fire hazard, drugs or other substances based on flammable solvents, such as alcohol, must not be introduced into the patient system.

Adequate ventilation must be ensured if highly inflammable substances are used for disinfection.

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Breathing system, absorber, and AGS

– All parts of the breathing system, including ventilator diaphragm, Y-piece, breathing hoses, breathing bag (but *not* including the Spirolog or SpiroLife flow sensors)

– Parts of the absorber
– Parts of the endotracheal aspiration system
– Parts of the AGS receiving system

These parts can be thermally disinfected in an automatic cleaning and disinfection machine at 199 °F (93 °C) for 10 minutes.Only neutral cleaning agents and fully demineralized water may be used. Chemical disinfectants need not to be added for thermal disinfection; they may cause corrosion.

WARNING!

Risk of device failure and patient injury.

Correct operation of the anesthesia machine may be impaired and lead to failure of the anesthesia machine if the control areas in the valve plate are not dried completely.

The valve plate must be sterilized after washing in order to dry it.

Wipe the heating contacts of the metal valve plate and their counterparts on the ventilator module with a cloth to remove detergent residue.

Spirolog flow sensors

– Disinfect approx. 1 hour in 70% ethanol or isopropanol solution. Leave the sensor to dry in air for at least 30 minutes, otherwise the sensor may be damaged by remaining alcohol when calibrated.
– The flow sensor can be reused as long as it can be calibrated successfully.
– Do not clean the Spirolog flow sensor in a cleaning and disinfection machine or with compressed air, water jets, brushes, etc. These methods would damage the thin sensor wires inside.

CAUTION!

Risk of flow measurement failure.

Disinfecting or cleaning the flow sensors by machine will damage them and cause the flow measurement to fail.

Disinfect and clean the flow sensors as described on page 214 (Spirolog) and page 215 (SpiroLife). Note the Instructions for Use of the Spirolog and SpiroLife flow sensors.

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CAUTION!

Risk of flow measurement failure.

Sterilizing the Spirolog flow sensors in high-temperature steam will damage them and cause the flow measurement to fail.

Disinfect and clean the Spirolog flow sensor as described on page 214. Note the Instructions for Use of the Spirolog and SpiroLife flow sensors.

SpiroLife flow sensors

– Disinfect approx. 1 hour in 70% ethanol or isopropanol solution. Leave the sensor to dry in air for at least 30 minutes, otherwise the sensor may be damaged by remaining alcohol when calibrated.
– The SpiroLife flow sensor may be sterilized at 273 °F (134 °C) in hot steam.
– Do not clean the Spirolog flow sensor in a cleaning and disinfection machine or with compressed air, water jets, brushes, etc. These methods would damage the thin sensor wires inside.
– The flow sensor can be reused as long as it can be calibrated successfully.
– The flow sensor is not suitable for plasma or radiation sterilization.

CLIC Adapter

In the event of major condensation in the adapter (e.g. during minimum flow operation), disinfect the adapter in moist heat together with the disassembled breathing system after not more than 24 hours of operation. This will ensure that the adapter is cleaned, disinfected, and dried.

WARNING!

Risk of device failure.

The correct operation of the anesthesia machine will be impaired if condensation enters the breathing system and/or the ventilator diaphragm.

If condensation is a frequent problem, install water traps in the breathing hoses.

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Care list for Apollo components

The following tables list Apollo components with recommended conditioning intervals and processing methods. Processing refers to cleaning, disinfection, and/or sterilization, as appropriate for a given component.

The table is intended as a guide. Follow the institution's policies regarding specific methods and agents for cleaning and sterilization.

Component	Processing Method			
	Disinfection and cleaning			Sterilization in steam
	Cleaning/disinfection machine[1)] 199°F (93°C) 10 minutes	Wiping[2)]	Disinfection by immersion[2)]	273°F (134°C) 8 minutes
Apollo anesthesia machine	No	Outside[3)]	No	No
Power cable, pressurized gas hoses, grounding cable/wire	No	Yes	No	No
Breathing hoses and Y-piece	Yes	No	Yes	Yes
Breathing bag with connector and hose	Yes	No	Yes	Yes
Breathing bag arm	Yes	No	Yes[8)]	Yes
Ventilator diaphragm[4)]	Yes	No	Yes	Yes
Cover of breathing system with APL valve	Yes[5)]	No	Yes	Yes[6)]
Middle and bottom part of breathing system	Yes[5)]	No	Yes	Yes[6]
Expiratory port/inspiratory port	Yes	No	Yes	Yes
Absorber and insert	Yes	No	Yes	Yes
Spirolog flow sensors	No	No	Yes[7)]	No
SpiroLife flow sensors	No	No	Yes[7)]	Yes
AGS housing	Yes	Yes	Yes	No
AGS flow tube (without filter)	No	Yes	No	No
Buffer volume container for AGS	Yes	Yes	Yes	No
AGS transfer hose	Yes	Yes	Yes	No
Scavenging hose with connector	Yes	Yes	Yes	No
Endotracheal aspiration system, regulator, and bottle assembly	Yes	(Follow manufacturer's instructions)		Yes

1. Only use neutral cleaning agents. Do not use disinfectants due to risk of corrosion.
2. Use disinfectants based on aldehydes and quaternary ammonium compounds, see page 212.
   Note: Testing was performed with Incidin Extra N and Incidur (wiping), and Gigasept FF and Korsolex Extra (disinfection by immersion).
3. Do not use any agents containing alcohol.
4. Remove any water which may have accumulated in the ventilator diaphragm.
   Larger quantities of condensation may impair operation of the anesthesia machine and/or lead to failure of the equipment.
5. Only with fully demineralized water.
6. The valve plate must be sterilized after washing in order to dry it. Correct operation of the anesthesia machine may be impaired and lead to failure of the anesthesia machine if the control areas in the valve plate are not dried completely.
7. Disinfect the flow sensor in 70% ethanol or isopropanol solution for approx. 1 hour and leave to dry in air for at least 30 minutes.
8. Use disinfectants based on gluteraldehyde and ortho phthaldehyde compounds.
   Note: testing was performed with Cidex and Cidex OPA (disinfection by immersion).

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The parts should be cleaned and disinfected by machine. If not, they must be disinfected by immersion and then cleaned.

CAUTION!

Risk of device failure.

If inappropriate substances are used for hygienic preparation, the device and its components may be damaged (corrosion, condensation).

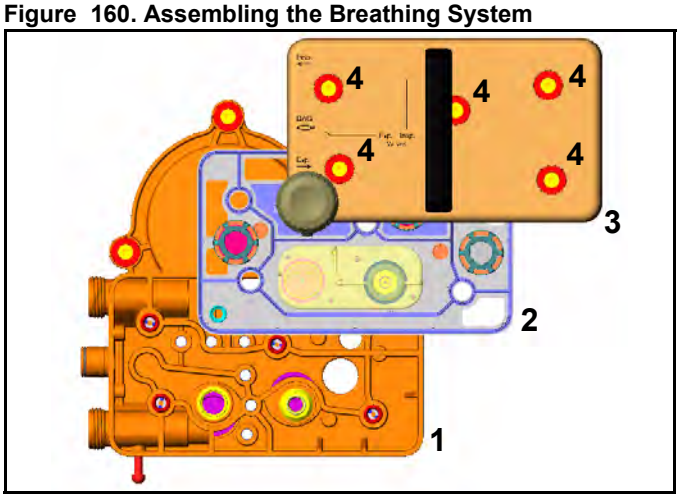
Apollo and its components must not be treated with formaldehyde vapors or ethylene oxide.

Reassembling components

Assembling the breathing system

1. Place the bottom section on a flat surface (**1** in Figure 160).
2. Fit the metal valve plate onto the bottom section (**2** in Figure 160).
3. Fit the cover securely on top of the valve plate (**3** in Figure 160).
4. Tighten the five sealing screws a quarter turn clockwise (**4** in Figure 160).

Figure 160. Assembling the Breathing System

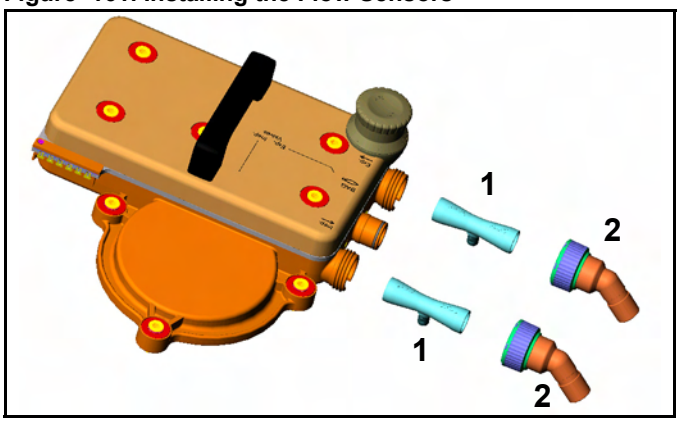


Inserting the flow sensors

1. Insert the flow sensors (**1** in Figure 161) into the two port connections on the breathing system, with the electric connection on each sensor facing down in the slot.
2. Orient the inspiratory and expiratory ports (**2** in Figure 161) so that the key on each port lines up with the slot. Install the ports and tighten them by turning clockwise.

Note: Flow sensors must be recalibrated after replacement by performing the power-on self test (see chapter “Pre-use Checkout”).

Figure 161. Installing the Flow Sensors



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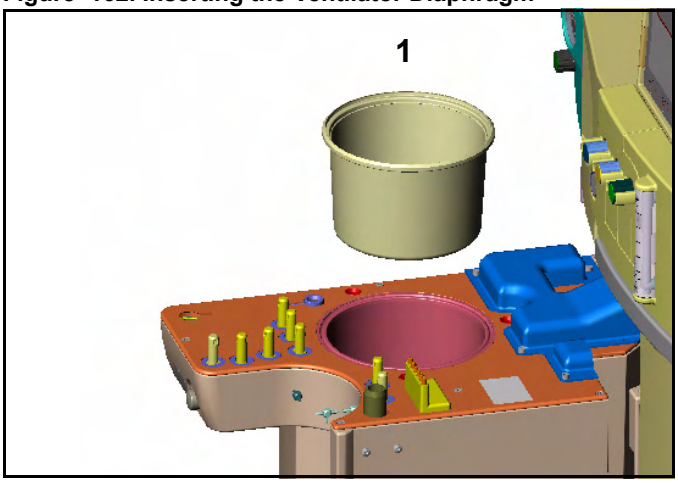
Installing the ventilator diaphragm

1. Insert the ventilator diaphragm so that the Dräger legend is visible (**1** in Figure 162).

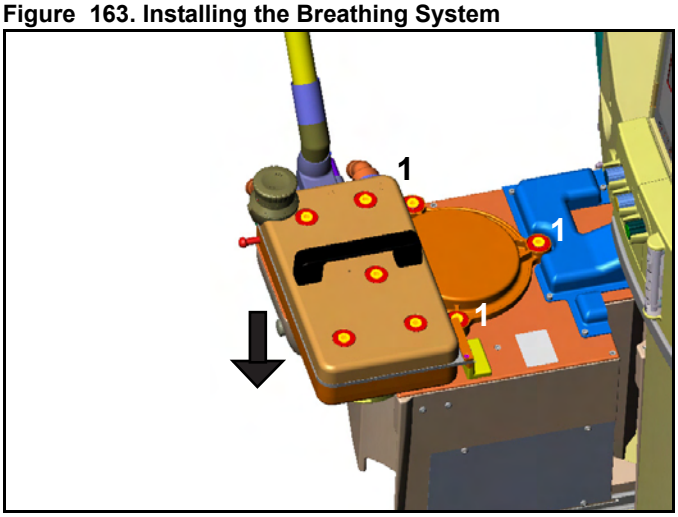
Figure 162. Inserting the Ventilator Diaphragm



Installing the breathing system

1. Carefully seat the breathing system onto the ventilator module.
2. Tighten the three sealing screws (**1** in Figure 163) on the ventilator cover.

Figure 163. Installing the Breathing System



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Filling and installing the absorber

A reusable absorber or the disposable CLIC absorber can be used.

Reusable absorber

1. Push the insert fully into the absorber canister (**1** in Figure 164).
2. Fill the absorber canister with fresh soda lime up to the **MAX** mark.

WARNING!

Risk of injury.

Absorbent is caustic and is a strong eye, skin, and respiratory tract irritant.

Use care when handling the absorbent to avoid spills.

CAUTION!

Risk of device failure.

It is recommended that Drägersorb 800 + or Drägersorb Free is used. Do not use powdered soda lime, as a higher dust load may impair functionality of the Apollo anesthesia machine.

3. Fit the canister into position below the breathing system, and turn counterclockwise as far as possible (**2** and **3** in Figure 164).
4. Slowly push in the ventilator module until it engages.
5. Reset the soda lime change log to current date by pressing the >**soda lime changed**< button, see page 77.

If the breathing system is not to be used within the next 24 hours:

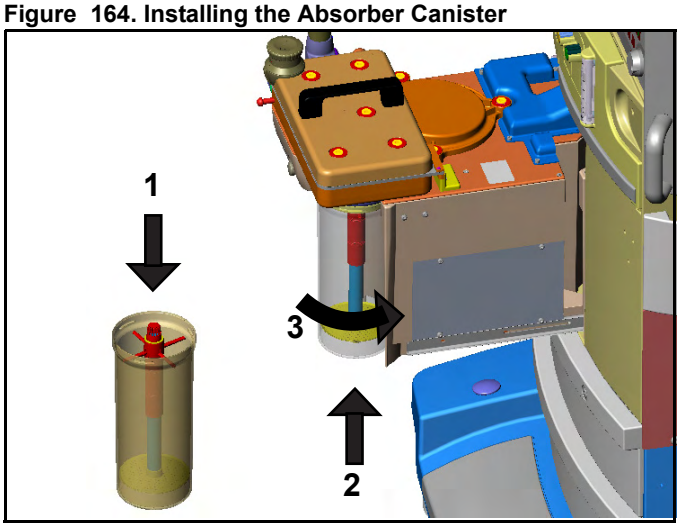
– Only fill with soda lime immediately before use.

Disposable CLIC absorber (optional)

The appropriate adapter must be installed by trained personnel, e.g. DrägerService.

Note: The disposable absorber must be clicked into place before switching on the Apollo. This ensures that the absorber is included in the leak and compliance test for the anesthesia machine.

Figure 164. Installing the Absorber Canister



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To click the absorber into place:

1. Press the button (**1** in Figure 165); the mounting swings open.
2. Before fitting, shake the disposable absorber, e.g. by turning it upside down several times in order to loosen the soda lime.
3. Remove the seal from the new disposable absorber.
4. Slide the new disposable absorber onto the mounting (**2** in Figure 165).
5. Push the absorber into the anesthesia machine until it engages.
6. Reset the soda lime change log to current date by pressing the >**soda lime changed**< button, see page 77.

WARNING!

Risk of patient injury.

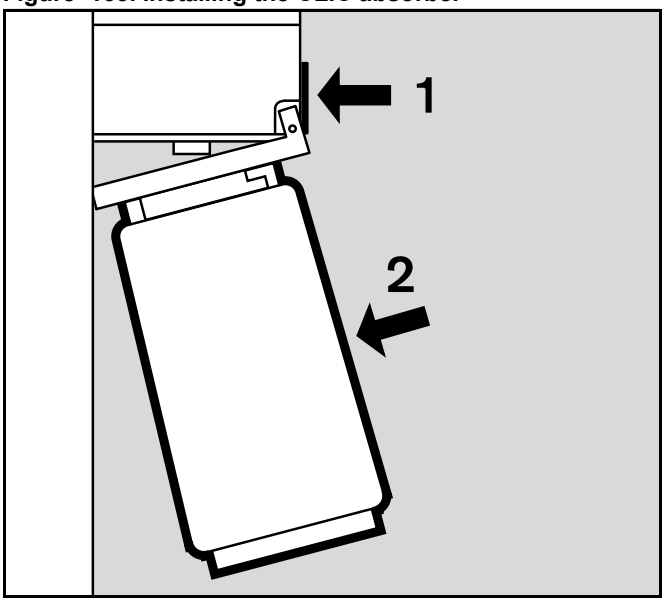
The soda lime loses humidity. Generally, if the humidity falls below a minimum set point, the following undesirable reactions can occur, independent of the type of lime and the inhalation anesthetic being used:

- **reduced CO_2 absorption;**
- **increased heat build-up in the absorber and thus, an increased breathing gas temperature;**
- **formation of CO;**
- **absorption and/or decomposition of the inhalation anesthetic.**

These reactions could pose a danger to the patient.

If using dry gases, only briefly flush the anesthesia system and only if necessary.

Figure 165. Installing the CLIC absorber



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Installing the manual breathing bag and arm

WARNING!

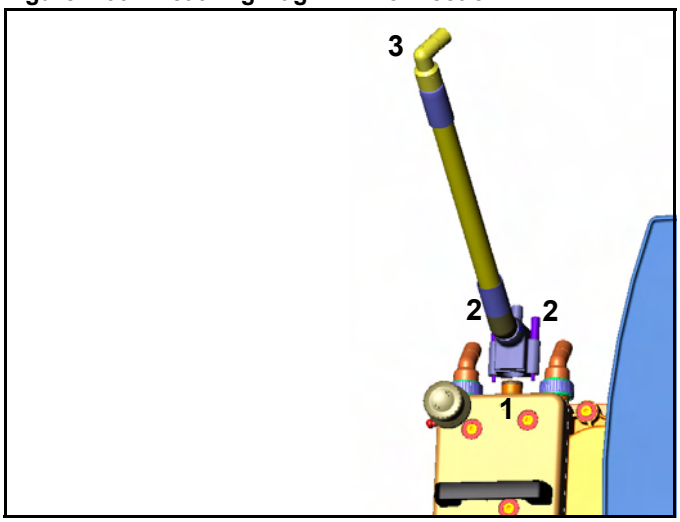
Risk of patient injury.

If incompatible materials are used in the patient circuit, metabolic products may build up.

Breathing bags used on the Apollo must comply with current ANSI standards.

1. Slide the bag arm assembly onto the breathing bag port on the side of the breathing system (**1** in Figure 166).
2. Tighten the two thumb screws (**2** in Figure 166) to secure.
3. Attach the 90° fitting to the end of the bag arm (**3** in Figure 166), and attach the breathing bag to the other end of the fitting.

Figure 166. Breathing Bag Arm Connection



Connecting the breathing hoses

WARNING!

Risk of patient injury.

If incompatible materials are used in the patient circuit, metabolic products may build up.

Breathing hoses used on the Apollo must comply with current ANSI standards.

WARNING!

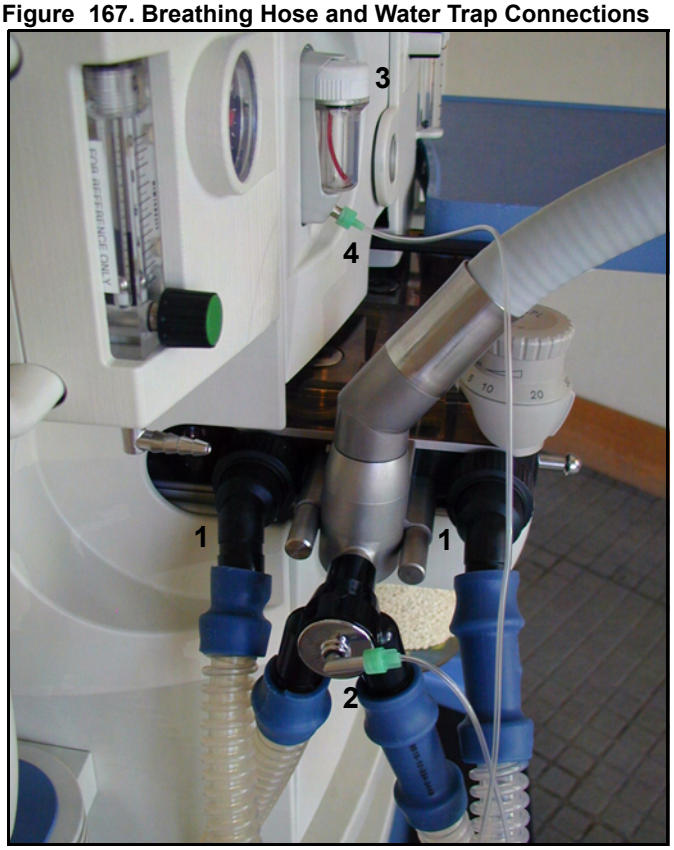
Risk of burns.

Conductive breathing hoses or face masks may cause burns during HF surgery.

Do not use these types of hoses and masks in combination with HF surgery.

1. Connect 22 mm (0.87 in) breathing hoses to the inspiratory and expiratory ports on the breathing system (**1** in Figure 167).
2. Connect the other end of the breathing hoses to a Y-piece (**2** in Figure 167), or to the optional filter on the Y-piece.

Figure 167. Breathing Hose and Water Trap Connections



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Installing the water trap and sample line

1. Push the new or empty water trap into its holder on the front of the machine (**3** in Figure 167) until it clicks into place.
2. Connect one end of the sample line to the Luer fitting on the water trap (**4** in Figure 167).
3. Connect the other end of the sample line to the Luer fitting on the Y-piece (**2** in Figure 167). Ensure that all Luer fittings are securely connected.
4. Make sure that the sample line is guided correctly by using the sample line clip. This clip should be attached to the expiratory port of the breathing system.

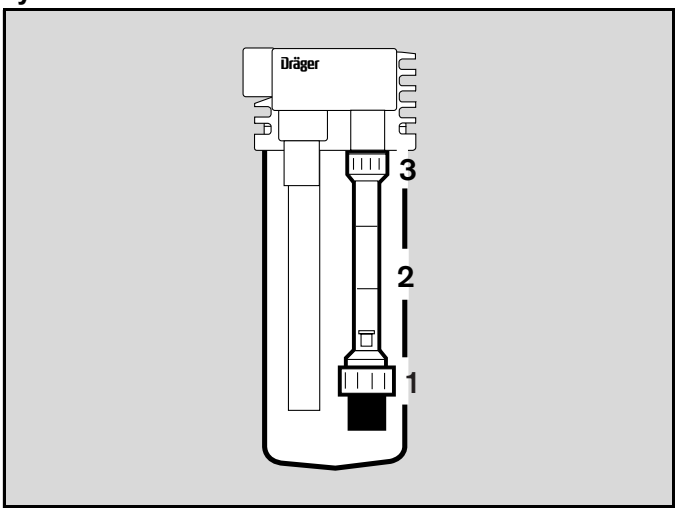
Note: Apollo (without accessories) has no components containing latex.
For latex-free use:
Use latex-free breathing bag and breathing hoses.

Note: Only use original sample line - other lines may change the technical data of the device.

Reassembling the anesthetic gas receiving system AGS (Optional)

1. Install the particle filter and tighten the union nut (**1** in Figure 168).
2. Reinstall the flow tube (**2** in Figure 168) with the scale facing the front of the machine, and tighten the union nut (**3** in Figure 168).
3. Reinstall the buffer volume container into the scavenger body.

Figure 168. Reassembling the anesthetic gas receiving system AGS



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Connecting the anesthetic gas receiving system AGS (Optional)

The anesthetic gas receiving system is used with vacuum waste-gas disposal systems.

CAUTION!

Risk of increased ambient gas concentration.

Ambient air may become contaminated with anesthetic agent if the scavenger hoses are functionally inhibited.

The scavenger hoses must not be pinched, kinked, or blocked in any manner.

1. Install the anesthetic gas receiving system on the machine by sliding its bracket onto the two shoulder screws on the side of the machine.
2. Connect one end of the transfer hose to the fitting on the receiving system (**1** in Figure 169).
3. Connect the other end of the transfer hose to the scavenger connection on the back of the anesthesia machine (**2** in Figure 169).
4. Connect the waste-gas vacuum hose to the output connection on the receiving system (**3** in Figure 169).
5. Connect the other end of the vacuum hose to the hospital waste-gas disposal system.

Note: Activate hospital vacuum system before using receiving system.

Note: During use, the float indicator in the flow indicator should stay between the upper and lower marks. If necessary, regulate flow using the flow adjustment valve (**4** in Figure 169).

WARNING!

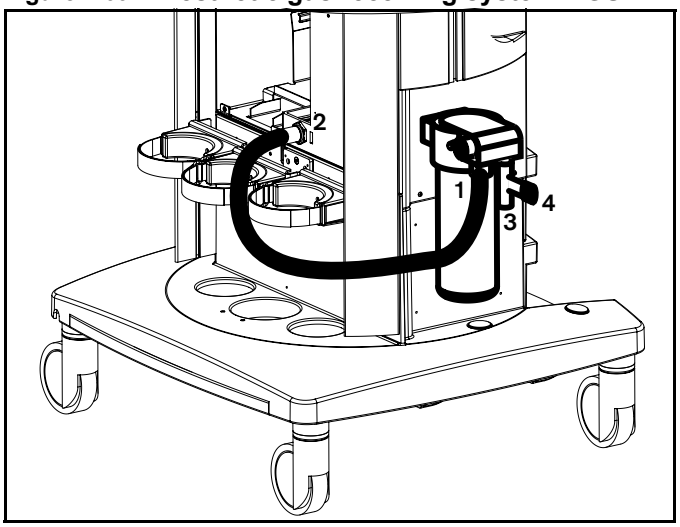
Risk of patient injury.

If the AGS manifold is blocked, negative pressure may result in the breathing system and the patient's lungs.

Always make sure the manifold is not blocked.

Note the Instructions for Use of the anesthetic gas receiving system AGS.

Figure 169. Anesthetic gas receiving system AGS



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Connecting the passive scavenger system (Optional)

The passive scavenger system is used only with non-recirculating exhaust systems. It is not meant to be used with vacuum disposal systems.

CAUTION!

Risk of increased ambient gas concentration.

Ambient air may become contaminated with anesthetic agent if the scavenger hoses are functionally inhibited.

The scavenger hoses must not be pinched, kinked, or blocked in any manner.

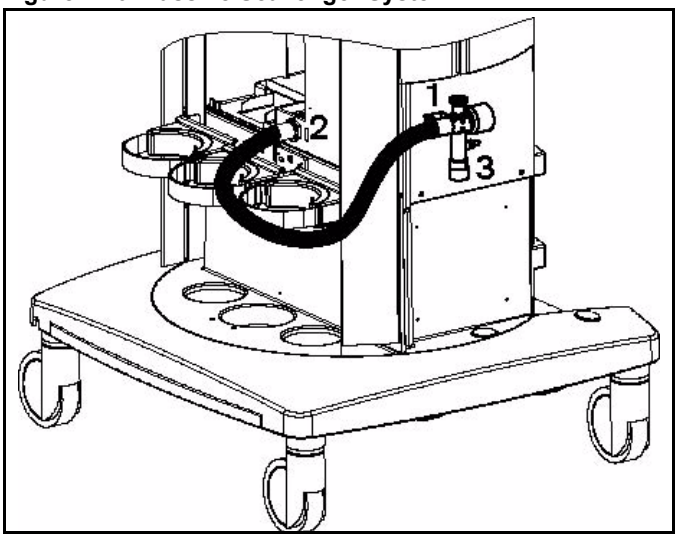
1. Install the passive scavenger on the machine by sliding its bracket onto the two shoulder screws on the side of the machine.

Note: Remove the socket from the scavenger hose before connecting.

2. Connect one end of the transfer hose to the side fitting on the scavenger (**1** in Figure 170).
3. Connect the other end of the transfer hose to the scavenger connection on the back of the anesthesia machine (**2** in Figure 170).
4. Connect the waste-gas hose to the bottom connection on the scavenger (**3** in Figure 170).
5. Connect the other end of the hose to the hospital waste-gas disposal system.

For detailed information on the passive scavenger system, refer to separate Instructions for Use.

Figure 170. Passive Scavenger System



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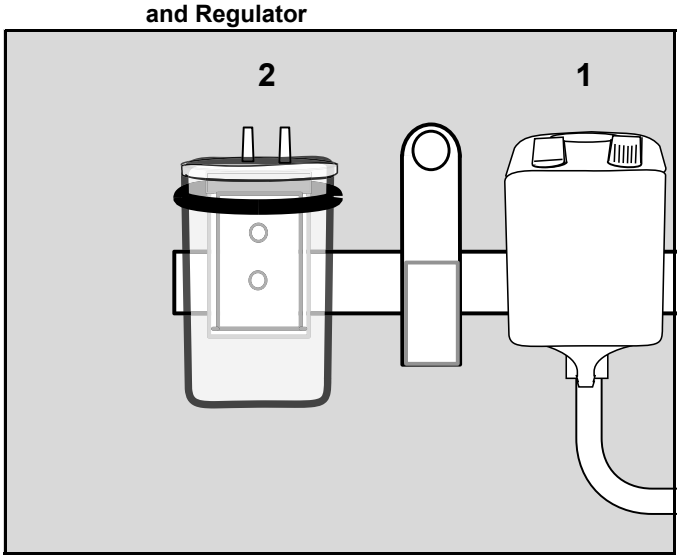
Connecting the endotracheal aspiration system (Optional)

The optional endotracheal aspiration system for the Apollo consists of a suction regulator and a bracket that attaches to the side of the anesthesia machine. The bracket is used to hold the regulator and a suction bottle assembly of the customer's choice.

1. Attach the endotracheal aspiration system bracket to the side rail on the left side of the anesthesia machine.
2. Mount the suction regulator (**1** in Figure 171) onto the bracket.
3. Prepare the suction bottle assembly according the Instructions for Use provided with the bottle.
4. Install the bottle assembly in the slide mount (**2** in Figure 171) on the bracket.
5. Make all necessary connections between the suction bottle, suction regulator, and pipeline vacuum system as specified in the Instructions for Use provided with the bottle assembly.

Figure 171. Endotracheal aspiration system Bracket and Regulator



Apollo maintenance

Definitions

Inspection:	Examination of actual condition
Service:	Measures to maintain specified condition
Repair:	Measures to restore specified condition
Maintenance:	Inspection, service, and repair, where necessary
Preventive Maintenance:	Maintenance measures at regular intervals

The anesthesia machine and its components must be cleaned and disinfected before every maintenance operation, especially before returning for repair.

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Maintenance intervals

Organizational intervals	
Inspection and service	Every six months.
User-specific intervals	
AGS filter	Replace when blocked.
Filter of the endotracheal aspiration system	Replace every two weeks.
Upper diaphragm of ventilator unit	Replace after one year.
Water trap	Replace when dirty or when the message **WATER TRAP SAMPL. LINE?** is displayed (if the sample line is free of blockages and not kinked) and at least every four weeks.
O_2 sensor	Replacement of O_2 sensors is not necessary in conjunction with consumption-free O_2 measurement.
Flow sensors	**Note:** Replace when calibration is no longer possible or if an alarm message is displayed. Observe the Instructions for Use of the flow sensors.
Replacement by trained personnel	
Filter mat, patient gas module	Must be replaced every 12 months by trained personnel.
Filter mat, power pack	
Dust filter, ventilator unit	
O-rings, Vapor plug system	
Nafion hose on patient gas module with bacterial/viral filter	Must be replaced every two years by trained personnel.
Filter mat, housing cover	
Sintered filter, gas supply block	
PEEP diaphragm, breathing system	
Man/Spont – Automatic reversing diaphragm	
O-rings between valve plate and diaphragm cover of breathing system	
Lower diaphragm of ventilator unit + O-ring	Must be replaced every three years by trained personnel.
Lead gel battery in UPS	Must be replaced by trained personnel when the message **BATTERY LOW** is displayed or every three years. Must be disposed of in accordance with local waste disposal regulations.
Technical customer documentation according to IEC/EN 60601 is available upon request.	

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Routine maintenance

The purpose of the water trap on the front of the device is to prevent condensation and bacterial contamination of the gas monitoring unit.

WARNING!

Risk of gas measurement failure and device failure.

If alcohol or cleaning agents/disinfectants come in contact with the inside of the water trap, they can damage the diaphragm and the measurement system.

Do not use these substances and do not wash, flush, or sterilize the water trap.

CAUTION!

Risk of misleading data.

Aerosols can damage the diaphragm and the measurement system may fail as a result.

Do not use aerosols in the breathing system. The water trap must not be used in combination with a medical nebulizer.

Emptying the water trap

The water trap must be drained when it becomes full or when a **WATER TRAP SAMPL. LINE?** alarm is posted (with the sample line correctly installed and free of any blockage).

1. To avoid damage, grip the water trap only by its ribbed surface as shown in Figure 172, and pull it out of its holder.
2. Insert an empty syringe (capacity 20 mL) without needle into the connection port as shown in Figure 173.
3. Draw off the water in the reservoir. Remove the syringe and dispose of it in an appropriate manner.
4. Push the water trap back into its holder until it clicks into place.

Figure 172. Removing the Water Trap

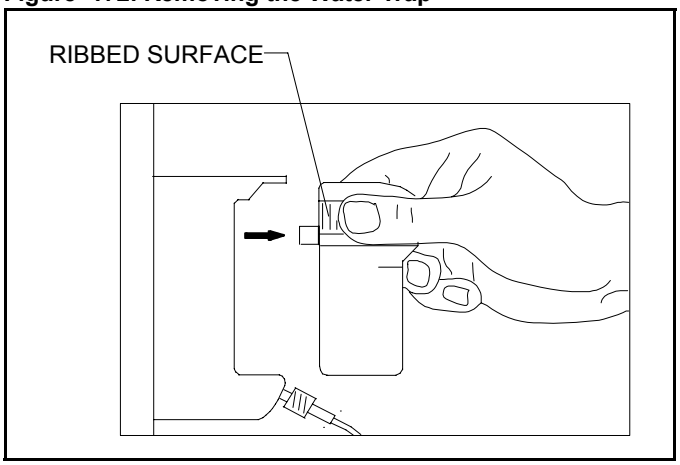

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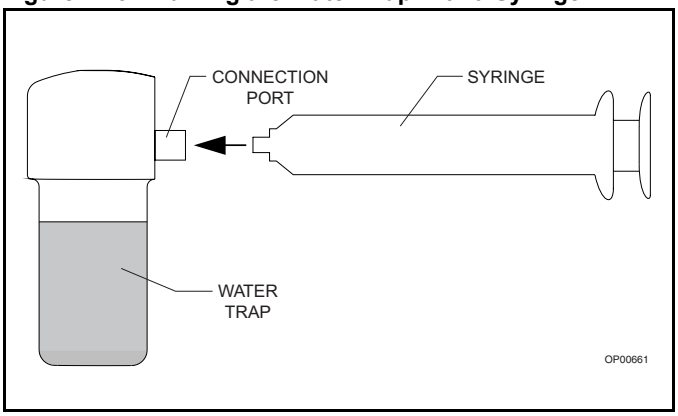
Figure 173. Draining the Water Trap with a Syringe



Replacing the water trap

The water trap must be replaced under any of the following conditions:

– It becomes severely soiled.
– The **WATER TRAP SAMPL. LINE?** alarm message persists even after the water trap has been drained (with the sample line correctly installed and free of any blockage).
– The water trap has been in use for its maximum life of four weeks.

WARNING!

Risk of gas measurement failure and device failure.

If the water trap is used longer than intended, the diaphragm may become brittle and allow water and bacteria to enter the measurement system. Such contamination affects the gas measurement which may fail as a result.

The water trap must be replaced at least every four weeks.

1. To avoid damage, grip the water trap only by its ribbed surface as shown in Figure 172, and pull it out of its holder. Dispose of it in an appropriate manner.
2. Mark the new water trap with the current date.
3. Push the new water trap into the holder until it clicks into place.

Disposing of the used device

Do not dispose of the used device at municipal collection points. To initiate take-back or for further information, visit us on the internet at www.draeger.com or contact your local Dräger organization.

Observe the hospital’s hygiene regulations.

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Troubleshooting

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Overview

This chapter discusses several types of failure that may occur on the Apollo and provides courses of action following the failure. An alphabetical list of all Apollo alarms and their causes and remedies is provided on page 239.

Note: If the remedies suggested in this chapter do not resolve a fault that may impair the proper functioning of the Apollo, use another device.

Power failure

In the event of power failure the Apollo automatically switches to the built-in uninterruptible power supply UPS (battery backup).

If the battery is fully charged, operation will be continued for at least 30 minutes (up to 90 minutes, depending on the ventilation parameters).

The message **POWER FAIL** is displayed in the status field on the screen (**1** in Figure 174), together with the remaining battery capacity in percent (**2** in Figure 174).

If the battery is almost empty, the message **BATTERY LOW** is displayed.

Apollo permits manual ventilation with 100% O_2 in the event of a power failure and empty batteries. The fresh-gas measurements, ventilator, and monitoring are inactive.

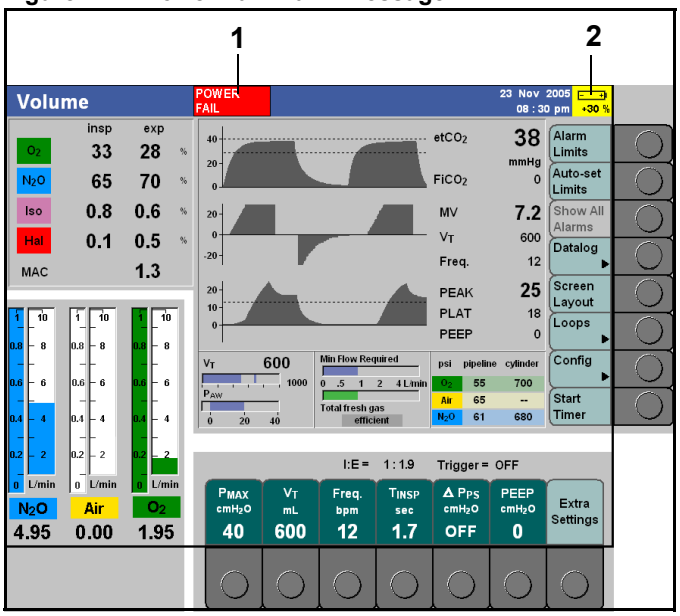
If all electrical power fails, all individual settings, including alarm limits which are not saved in the default settings, will be lost.

If the power supply is recovered, the anesthesia machine behaves as described in “Ventilator failure” on page 234 and “Fresh-gas delivery failure” on page 235; see also the alarm message **GAS + VENT. FAIL** on page 242. To continue operation for emergency situations, switch the anesthesia machine off and then on again and refer to page 87 of these Operating Instructions.

In case of power failure:

1. Close N_2O and Air flow valves.
2. Check vaporizer setting.
3. Set O_2 flow to the desired level using the total flow meter.
4. Ventilate the patient manually.
5. Ensure adequate substitute monitoring.

Figure 174. Power Fail Alarm Message



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WARNING!

Risk of patient injury.

If all power supplies fail, the screen display will be blank and automatic ventilation will cease.

The patient must be ventilated manually.

Note: If a D-Vapor is in use and a power failure occurs, refer to the Instructions for Use of the D-Vapor for a description of system behavior in a power fail situation.

Note: Refer to the total flow meter for approximate flow (see the chapter "Specifications" of the Operating Instructions for accuracy).

Gas failure

If the gas supply fails, the Apollo displays a corresponding message in the status field at the top of the screen (**1** in Figure 175):

NO AIR SUPPLY, **NO N_2O SUPPLY**, or **NO O_2 SUPPLY**

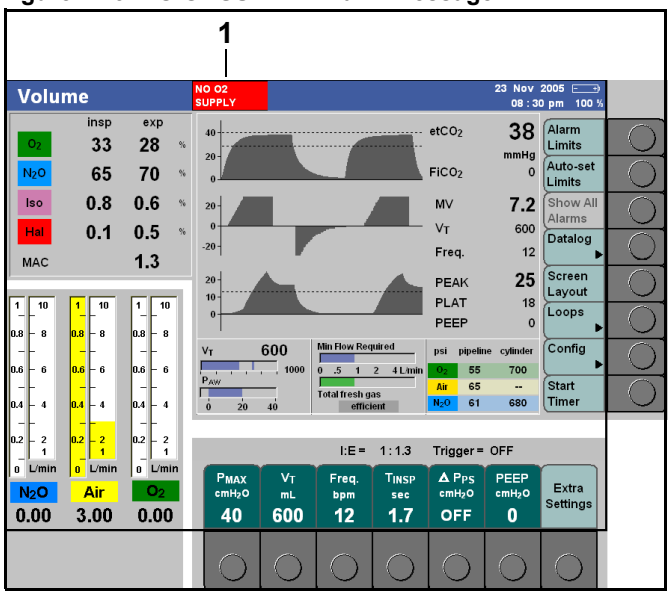
1. Open the valve on the corresponding backup cylinder at the back of the machine (see Figure 176).
2. Restore the pipeline supply.

If there is no cylinder backup supply for the failed gas, the corresponding LED on the front panel of the machine will flash red.

In case of N_2O or air failure, 100% O_2 should be delivered; be sure to set the O_2 to an appropriate flow.

In case of O_2 failure, the SORC prevents hypoxic gas mixtures. Oxygen must be restored immediately.

Figure 175. NO O_2 SUPPLY Alarm Message



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If the pipeline gas supply for O_2 and Air fails, and there is no cylinder backup supply for the failed gas, operation of the ventilator is still possible in automatic ventilation modes as the electrically driven piston ventilator does not need drive gas for operation.

Disconnecting the breathing bag from the breathing bag arm enables the entrainment of ambient air, thus substituting the failed fresh gas.

1. Disconnect breathing bag from breathing bag arm.
2. Continue ventilation using an automatic ventilation mode.

WARNING!

Risk of patient awareness.

If a complete gas supply failure occurs, further operation may continue by supplying the anesthesia machine with ambient air. Anesthetic agents will no longer be delivered and the inspiratory gas composition will be diluted thereby raising the issue of patient awareness.

Therefore carefully monitor the gas mixture and, if necessary, use IV anesthetics.

WARNING!

Risk of gas supply contamination.

If the gas supply hoses remain connected to the wall outlets, minor internal leaks may lead to contamination of the supply gases.

Disconnect the pipeline gas supply hoses if the pipeline gas supply fails during operation.

The failure of the pipeline gas supply may lead to the failure of connected devices.

CAUTION!

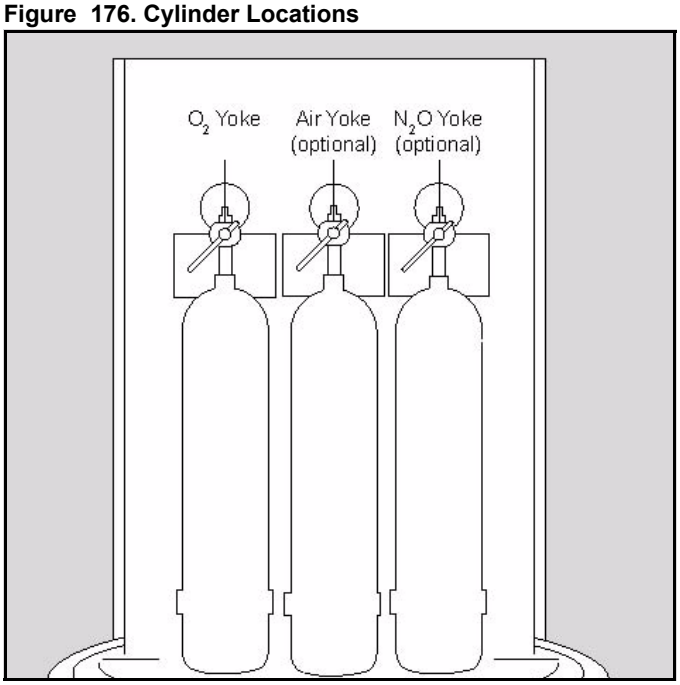
Risk of increased ambient gas concentrations.

If the breathing bag is not attached, expiratory anesthetic agents can escape from the breathing system.

Make sure the breathing bag is attached and ensure sufficient ambient air circulation.

The cylinder valve of the corresponding backup gas cylinder must be closed again after restoring the pipeline gas supply.

Figure 176. Cylinder Locations



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CAUTION!

Risk of gas supply failure.

If the valves remain open when connected to the pipeline gas supply, gas may be withdrawn from the backup gas cylinders.

Close cylinder valves whenever the pipeline gas supply is sufficient.

Ventilator failure

If the ventilator fails, the following message is displayed in the status field on the screen (**1** in Figure 177):

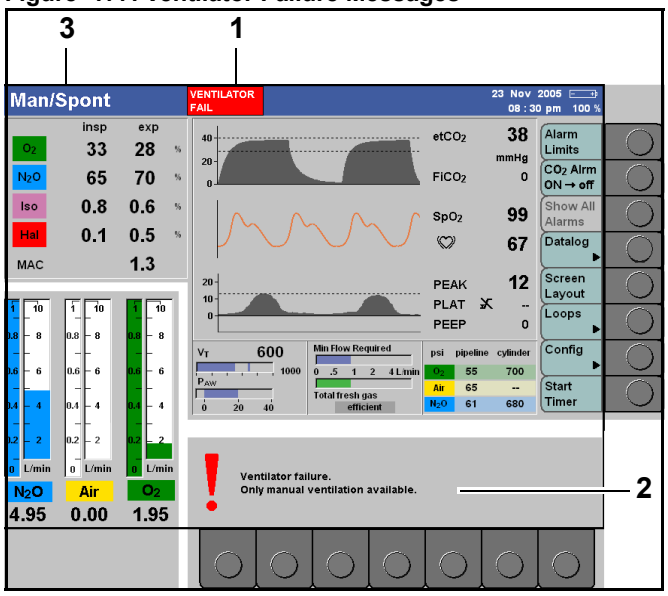
VENTILATOR FAIL

The ventilation buttons are removed from the screen and a prompt appears advising the user how to proceed (**2** in Figure 177):

"**Ventilator failure!**
Only manual ventilation available."

The machine automatically switches to Man/Spont mode (**3** in Figure 177).

Figure 177. Ventilator Failure Messages



WARNING!

Risk of patient injury.

If the ventilator fails, the anesthesia machine automatically switches to the ventilation mode Man/Spont.

Set the APL valve to the correct pressure limiting value and ventilate the patient manually.

WARNING!

Risk of patient injury.

If pressure or volume monitoring fails, the patient cannot be adequately monitored.

Ensure adequate substitute monitoring.

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Fresh-gas delivery failure

If the fresh-gas mixer fails, the following message is displayed in the status field on the screen (**1** in Figure 178):

GAS MIXER FAIL

In addition the numerical values for the fresh-gas flows appear grayed out to indicate that they may be inaccurate.

The current ventilation mode remains active.

1. Close N_2O and Air flow control valves.
2. Check vaporizer setting.
3. Set O_2 flow to the desired level using the total flow meter.

WARNING!

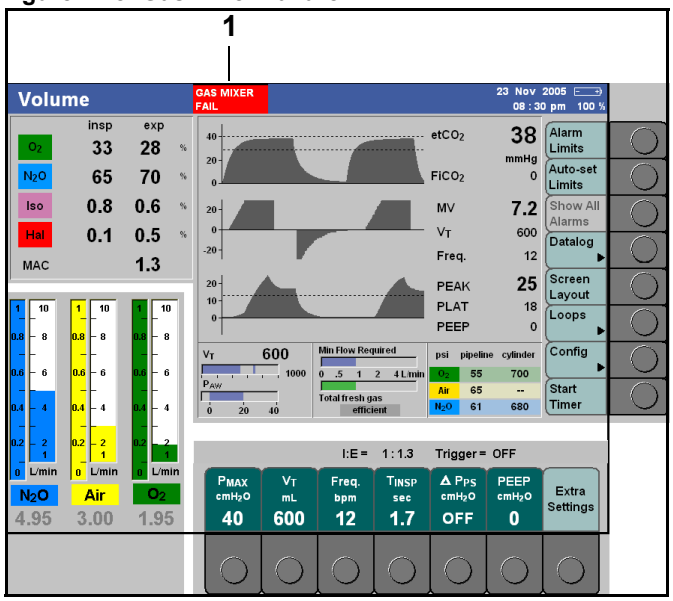
Risk of patient injury.

If the fresh-gas delivery fails, the anesthesia machine automatically discontinues the fresh-gas flow. An O_2 flow must be delivered to the patient.

Check vaporizer setting and set the O_2 flow to a sufficient level.

Note: Refer to the total flow meter for approximate flow (see the chapter "Specifications" of the Operating Instructions for accuracy).

Figure 178. Gas Mixer Failure



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Ventilator and fresh-gas delivery failure

If both the ventilator and fresh-gas mixer fail, the following message is displayed in the status field on the screen (**1** in Figure 179):

GAS + VENT FAIL

The ventilation buttons are removed from the screen and a prompt appears advising the user how to proceed (**2** in Figure 179):

"**Ventilator failure!**
Only manual ventilation possible."

The Apollo automatically switches to the **Monitoring** mode.

1. Check the vaporizer setting.
2. Ventilate the patient manually.

WARNING!

Risk of patient injury.

If the ventilator and the fresh-gas delivery fail, the anesthesia machine switches to the ventilation mode Monitoring.

An O_2 flow must be delivered to the patient and the patient must be ventilated manually. Check the vaporizer setting, set the O_2 flow to a sufficient level, and set the APL valve to an adequate pressure limiting value, and ventilate the patient manually.

WARNING!

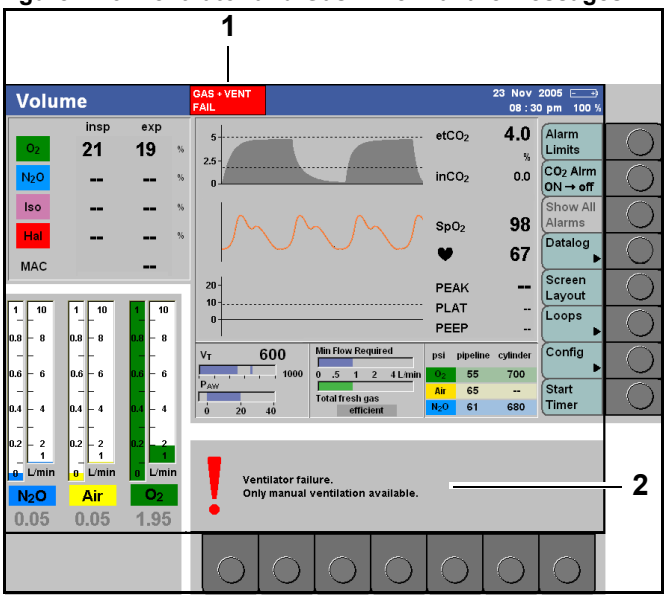
Risk of patient injury.

If pressure and volume monitoring fails, the patient cannot be adequately monitored.

Ensure adequate monitoring.

Note: Refer to the total flow meter for approximate flow (see the chapter "Specifications" of the Operating Instructions for accuracy).

Figure 179. Ventilator and Gas Mixer Failure Messages



Gas measurement failure

1. Ensure adequate substitute monitoring.

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Display failure

If the screen display fails:

1. Switch off the machine.
2. Set O_2 flow to the desired level using the total flow meter.
3. Check the vaporizer setting.
4. Ventilate the patient manually.
5. Ensure adequate substitute monitoring.

User interface failure

If the keypads, rotary knob, or flow control knobs are not operational:

1. Select the monitoring mode (see page 153).
2. Ventilate the patient manually.

Note: Observe the total flow meter for approximate flow (see the chapter "Specifications" of the Operating Instructions for accuracy).

System failure

If the system no longer responds to an action:

1. Ventilate the patient by hand.
2. Switch the machine off and on again.
3. Cancel the self test.

If the system has failed completely:

1. Switch the Apollo off.

In both cases, to ensure alternative delivery of 100 % O_2 and anesthetic agent:

1. Check the vaporizer setting.
2. Close all flow controls (except O_2), and run 100% O_2

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WARNING!

Risk of patient injury.

If the breathing bag does not fill with fresh gas, the patient cannot be adequately ventilated.

Check the oxygen supply, open cylinder valves if necessary.

If fresh gas is still not delivered or manual ventilation is not possible, close all flow controls.

Disconnect the anesthesia machine from the patient and use an alternative method of ventilation.

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Alarm - Cause - Remedy

Apollo divides alarm messages into three priority classes identified by different colors:

Warning - message with high priority (red)

Caution - message with medium priority (yellow)

Advisory- message with low priority (cyan)

Machine-related alarms identified by an asterisk (*****) can be downgraded to a lower priority or canceled altogether by pressing the > Silence < key. For these alarms the lower priority is shown following the "/" (if a dash (–) is shown, it means that alarm can be canceled).

The alarm messages are listed below in alphabetical order. The list is intended to help identify the cause of an alarm message and to remedy the fault rapidly.

Internal priority numbers for ranking alarms within a class (see page 165) are written in parentheses, e.g. (23/31), in the table below.

Priority	Message	Cause	Remedy
Advisory (7)	**2 MIXED AGENTS**	A second anesthetic agent has been detected.	Wait for the transition phase to end after changing anesthetic agents. Check vaporizer filling level. Flush system if necessary. Check fresh-gas settings.
Caution (15)	**3 MIXED AGENTS**	A mixture of more than two anesthetic agents has been detected (see page 144).	Check vaporizer filling level. Flush system if necessary. Check fresh-gas settings. Wait for transition phase to end.
Advisory (1)	**AGENT SENSOR FAIL** (in **Standby** only)	Anesthetic gas measurement system has failed.	Use external gas measuring system. Call DrägerService.
Advisory/ – (8/–)	**AIR CYLIND. CONNECT?***	Pressure sensor of backup cylinder not connected.	Check pressure sensor connection.
Caution/ Advisory (24/7)	**AIR CYLIND. EMPTY***	Backup Air cylinder empty and central Air supply not available or not connected.	Use a new backup Air cylinder. Use the pipeline supply.
Caution (11)	**AIR FLOW MEAS. FAIL**	Fresh-gas flow measurement for Air has failed.	Use only oxygen as fresh gas and observe total flow meter. Check fresh-gas flow settings using total flow meter and set a fresh-gas flow greater than or equal to measured or set minute volume. Call DrägerService.

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Priority	Message	Cause	Remedy
Advisory (10)	**AIR PIPELINE FAIL**	Compressed Air supply has failed.	Open optional backup Air cylinder. Check piped medical Air supply.
		Pipeline supply hose not connected or kinked.	Check connection to piped medical Air supply.
		Optional Air cylinder is empty or closed.	Connect a full Air cylinder or open the cylinder valve.
		Compressed Air compressor has failed.	Check compressor.
Caution (24) Warning (31)	**APNEA**	Priority in accordance with maximum priority of the individual alarms.	
		Breathing/ventilation has stopped (detected by pressure, volume, and CO_2 monitoring).	**Patient must immediately be ventilated manually!** Check patient's spontaneous breathing ability. Check ventilator settings. Check fresh-gas setting. Maske sure everything is connected. Check hose system and tube.
Advisory (10) Caution (24) Warning (31)	**APNEA CO_2**	Apnea alarms are graded in time (see page 186). In automatic ventilation modes: Caution = 0 to 30 sec. Warning = >30 sec. In ventilation modes **Man/Spont**, **Pressure Support**, **Aux CGO**: Advisory = 0 to 30 sec. Caution = 31 to 60 sec. Warning = >60 sec.	
		Sample line not connected.	Check sample line.
		No spontaneous breathing.	**Patient must immediately be ventilated manually!** Check patient's spontaneous breathing ability. Make sure everything is connected. Check hose system and tube.
		Breathing/ventilation has stopped.	**Patient must immediately be ventilated manually!** Check ventilator setting.
Caution (24) 0 to 30 sec.	**APNEA FLOW**	Breathing/ventilation has stopped.	**Patient must immediately be ventilated manually!**
Warning (31) >30 sec.			Check patient's spontaneous breathing ability. Check ventilator setting.

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		Insufficient fresh-gas supply.	Check fresh-gas setting.
		Tube kinked. Leak in hose system.	Check hose system and tube.
Caution (24) 0 to 30 sec.	**APNEA PRESSURE**	Breathing/ventilation has stopped.	**Patient must immediately be ventilated manually!**
Warning (31) >30 sec.		Insufficient fresh-gas supply.	Check fresh-gas setting.
		Leak or blockage in tube or hose system.	Check hose system, tube, and microbial filter.
		Patient not connected.	Connect patient correctly.
Caution/ Advisory (see page 188) (11/9)	**APNEA VENTILATION**	No spontaneous breathing efforts by the patient during **Pressure Support** mode.	Check the patient's trigger capability.
			Set an adequate trigger.
Caution (13) Advisory (7)	**BATTERY LOW**	The battery capacity (Advisory = 10 to 20 %; Caution = <10%) of the uninterruptible power supply is almost exhausted.	Connect to mains power. Check patient's condition! Prepare manual ventilation with 100% O_2.
Warning (26)	**BREATH. SYS. TEMP. HIGH**	Breathing system temperature is too high.	Check breathing system and breathing gas temperatures. Call DrägerService.
Warning/ Advisory (30/10)	**CHECK AUX CGO***	Fault when switching over to auxiliary common gas outlet (Aux CGO).	Check fresh-gas flow at Aux CGO. Switch Aux CGO on and off several times. If bag not inflated, switch to internal breathing system. Call DrägerService.
		Fault when switching over from auxiliary common gas outlet (Aux CGO) to another ventilation mode.	Switch Aux CGO on and off several times. Use functional outlet. Call DrägerService.
Advisory (7)	**CIRCUIT LEAK**	Leak in patient circle system.	Check tube, hoses, and filter.
Advisory (7)	**CLOSE AIR CYLIND?***	Cylinder valve is open although pipeline supply is available.	Close cylinder valve to avoid unintentionally drawing gas from the cylinder.
Advisory (7)	**CLOSE N_2O CYLIND?***	Cylinder valve is open although pipeline supply is available.	Close cylinder valve to avoid unintentionally drawing gas from the cylinder.
Advisory (7)	**CLOSE O_2 CYLIND?***	Cylinder valve is open although pipeline supply is available.	Close cylinder valve to avoid unintentionally drawing gas from the cylinder.
Advisory (1)	**CO_2 SENSOR FAIL** (in **Standby** only)	CO_2 gas measurement system has failed.	Use external gas measuring system. Call DrägerService.

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Advisory (1)	**COM PORT 1 FAIL** **COM PORT 2 FAIL**	Communication via the corresponding COM port has been interrupted.	Check the plug connection on Apollo and the on-line equipment.
Warning (31)	**CONTINUOUS PRESSURE**	The breathing pressure exceeds the set limit for more than 15 seconds.	Check ventilation and/or spontaneous breathing of the patient. Check breathing hoses, breathing system, and gas scavenging system for correct functionality. Check alarm limit for correct setting.
Caution (18)	**ET CO_2 HIGH**	The upper alarm limit for the end-expiratory CO_2 concentration has exceeded for at least two breaths.	Check ventilation.
Caution (18)	**ET CO_2 LOW**	The lower alarm limit for the end-expiratory CO_2 concentration has been fallen short for at least two breaths.	Check ventilation.
Advisory (8)	**EXP. FLOW SENSOR FAIL** (in **Standby** only)	Expiratory flow sensor has failed.	Replace flow sensor (see page 217).
Advisory (6)	**FAN FAIL**	Fan for evacuating gases inside the device is defective.	**Anesthesia machine must be switched off as quickly as possible!** Defective fans in combination with an internal leakage may lead to elevated O_2 concentrations inside the anesthesia machine. **Risk of fire!** Call DrägerService.
Caution (14)	**FG FLOW TOO HIGH**	Total fresh-gas flow is above 19 L/min.	Reduce fresh-gas flow. Check vaporizer setting.
Caution (16) Warning (31)	**FG LOW OR LEAK**	Fresh-gas setting too low. The priority of the warning depends on the extend of the fresh-gas shortage.	Increase fresh-gas flow. Check anesthetic gas receiving system AGS.
		Leak.	Repair leak.
Advisory (1)	**GAS SENSOR FAIL** (in **Standby** only)	Complete gas measurement system failure.	Use external gas measuring system. Call DrägerService.
Warning/ Advisory (29/10)	**GAS MIXER FAIL***	Fresh-gas measurement is probably inaccurate or failed. Switch over to Aux CGO may have failed.	Check setting of vaporizer unit. Use only oxygen as fresh gas and check total flow meter. Call DrägerService.
Warning/ Advisory (30/10)	**GAS + VENT FAIL.***	Ventilator failed. Fresh-gas measurement is probably inaccurate or failed. Switch over to Aux CGO may have failed.	**Patient must immediately be ventilated manually!** Use only oxygen as fresh gas and check total flow meter. Check setting of vaporizer unit. Call DrägerService.
Warning (27)	**HIGH AIRWAY PRESSURE**	Upper alarm limit for the airway pressure has been exceeded.	
		Ventilation hose kinked.	Check hose system and tube.
		Stenosis.	
		Ventilation settings are not correct.	Correct the ventilation settings.

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Caution/ Advisory (14/10)	**INCORRECT FG FLOW**	Set fresh-gas flow cannot be delivered.	Reduce fresh-gas flow for each gas below 12 L/min. Check total flow meter. Call DrägerService.
Caution (11)	**INSP CO_2 HIGH**	Soda lime in circle system exhausted.	Increase fresh-gas flow. Replace soda lime.
		Leak or fault in breathing system.	Replace breathing system.
		High ventilation frequencies. At high ventilation frequencies, the measured value cannot keep up completely with the gas concentration for reasons due to the system.	Adjust alarm limits if necessary.
		Dead space ventilation.	Check ventilation settings.
Advisory (8)	**INSP. FLOW SENSOR FAIL**	Inspiratory flow sensor is defective.	Replace flow sensor (see page 206).
Advisory (10) Caution (24) Warning (31)	**INSP. HAL. HIGH** **INSP. ISO. HIGH** **INSP. ENF. HIGH** **INSP. DES. HIGH** **INSP. SEV. HIGH**	Caution (24) = insp. MAC value >3 MAC for >180 seconds. Warning (31) = insp. MAC value >5 MAC Warning (31) = insp. MAC value >3 MAC and exp. MAC value >2.5 MAC for >30 seconds. Inspiratory anesthetic gas concentration exceeds 5 MAC.	Check vaporizer and fresh-gas settings.
		Inspiratory anesthetic gas concentration exceeds 3 MAC for more than 180 seconds.	
		Inspiratory anesthetic gas concentration exceeds 3 MAC and the expiratory concentration exceeds 2.5 MAC for more than 30 seconds.	
		Advisory (10) = insp. gas concentration > upper alarm limit for 0 to 30 seconds. Caution (24) = insp. gas concentration > upper alarm limit for 31 to 180 seconds. Warning (31) = insp. gas concentration > upper alarm limit for >180 seconds. Inspiratory anesthetic gas concentration exceeds the high alarm limit for at least two breaths.	Check vaporizer and fresh-gas settings.

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Caution (15)	**INSP. HAL. LOW** **INSP. ISO. LOW** **INSP. ENF. LOW** **INSP. DES. LOW** **INSP. SEV. LOW**	Inspiratory anesthetic gas concentration has fallen short of the low alarm limit for at least two breaths.	Check vaporizer and fresh-gas setting. Check breathing system and breathing bag for large leaks. Check soda lime (dried out?)
Caution (12)	**INSP. N_2O HIGH**	Inspiratory N_2O concentration exceeds the upper alarm limit of 82%.	Check N_2O concentration in the fresh-gas flow. Flush.
Caution (12)	**INSP. O_2 HIGH**	Inspiratory O_2 concentration exceeds the upper alarm limit.	Check O_2 concentration in the fresh-gas flow.
Warning (31)	**INSP. O_2 LOW**	Inspiratory O_2 concentration is below the low alarm limit.	Check O_2 concentration and fresh-gas setting.
			Check O_2 supply.
			Check breathing system and breathing bag for large leaks.
Warning/ Advisory (29/10)	**INTERNAL TEMP. HIGH***	Temperature inside the device is too high.	Check ambient conditions. Ensure air circulation at back of device.
		Fan is defective.	Call DrägerService.
		Extreme, non-physiological ventilation settings.	Check ventilation settings.
Caution/ – (14/–)	**LOSS OF CONFIG DATA***	Loss of settings and/or configuration data.	Check the current settings and default settings. Repeat settings if necessary. Call DrägerService. Alarm can be reset by pressing > Silence <.
Caution/ Advisory (14/7)	**MAC LOW?***	The expiratory MAC value has fallen below the lower alarm limit of the automatic agent alarm.	Check patient condition. Confirm alarm, if case is closed.
			Check vaporizer fill level.
			Check correct position of vaporizer.
			Check for leaks in breathing system and breathing bag.
Caution (13)	**MINUTE VOL. HIGH**	Upper alarm limit for the minute volume has been exceeded.	Correct the tidal volume or breathing rate.
			Check spontaneous breathing.
			Correct the trigger level if necessary when using **Pressure Support** mode.
Caution (22)	**MINUTE VOL. LOW**	Lower alarm limit for the minute volume has been fallen short of.	Check breathing system. Check ventilation settings.
			Correct the trigger level if necessary when using **Pressure Support** mode.
			Check the patient's trigger capability.
		Tube sealed/kinked.	Check tube.
		Leak.	Check tube, hoses, filters, bellows, absorber.

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		Reduced tidal volume due to pressure limitation.	Correct ventilation settings.
		Insufficient fresh-gas flow.	Increase fresh-gas flow.
Advisory/ – (8/–)	**N_2O CYLIND. CONNECT.?***	Pressure sensor for backup cylinder not connected.	Check pressure sensor connection.
Warning/ Advisory (25/7)	**N_2O CYLIND. EMPTY***	N_2O backup cylinder empty or closed and central N_2O supply not available or not connected.	Use a new N_2O backup cylinder or open the cylinder valve. Use the pipeline supply.
Caution (11)	**N_2O FLOW MEAS. FAIL**	Fresh-gas flow measurement for N_2O has failed.	Use only oxygen as fresh gas and observe total flow meter. Check fresh-gas flow settings using total flow meter and set a fresh-gas flow greater than or equal to measured or set minute volume. Call DrägerService.
Advisory (1)	**N_2O SENSOR FAIL** (in **Standby** only)	N_2O gas measurement system has failed.	Use external measuring system. Call DrägerService.
Advisory (10)	**N_2O PIPELINE FAIL**	N_2O supply has failed.	Open N_2O backup cylinder. Check pipeline supply.
		Pipeline supply hose not connected or kinked.	Check connection to pipeline supply.
		N_2O cylinder empty or closed.	Connect a full N_2O cylinder or open the cylinder valve.
Warning (30)	**NEGATIVE PRESSURE**	Insufficient supply of fresh gas.	Set adequate fresh-gas flow on anesthesia machine. Flush system if necessary.
		Endotracheal aspiration during ventilation.	Check endotracheal aspiration system.
		Negative pressure due to fault in ventilator.	Make sure upper diaphragm is fitted correctly. Call DrägerService.
		Anesthetic gas receiving system defective.	Check anesthetic gas receiving system. Call DrägerService.
Warning/ Advisory (25/10)	**NO AIR SUPPLY***	Compressed Air supply has failed.	Open optional backup Air cylinder. Check pipeline supply.
		Pipeline supply hose not connected or kinked.	Check connection to piped medical Air supply.
		Optional Air cylinder is empty or closed.	Connect a full Air cylinder or open the cylinder valve.
		Compressed Air compressor has failed.	Check compressor.
Warning/ Advisory (26/9)	**NO FRESH GAS***	This alarm can be deactivated by trained service personnel at customer request.	
		No fresh-gas flow set.	Open flow control valves and adjust flow.

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Warning/ Advisory (25/10)	**NO N_2O SUPPLY***	N_2O supply has failed.	Open N_2O backup cylinder. Check pipeline supply.
		Pipeline supply hose not connected or kinked.	Check connection to pipeline supply.
		N_2O cylinder empty or closed.	Connect a full N_2O cylinder or open the cylinder valve.
Warning (31)	**NO O_2 SUPPLY**	O_2 supply has failed.	Open O_2 backup cylinder. Check central supply.
		Pipeline supply hose not connected or kinked.	Check connection to pipeline supply.
		O_2 cylinder empty or closed.	Connect a full O_2 cylinder or open the cylinder valve.
Warning (31)	**NO SPO_2 PULSE**	No pulse signal detected with the SpO_2 measurement for approx. 10 seconds.	**Check patient's condition!**
			Check application of the SpO_2 sensor.
		NiBP measurement on the same arm.	Measure blood pressure on other arm.
Advisory/ – (8/–)	**O_2 CYLIND. CONNECT.?***	Pressure sensor of backup cylinder not connected.	Check pressure sensor connection.

Warning/ Advisory (28/7)	**O_2 CYLIND. EMPTY***	O_2 backup cylinder empty or closed and pipeline O_2 supply not available or not connected.	Use a new O_2 backup cylinder or open the cylinder valve. Use the pipeline supply.
Advisory (10)	**O_2 CYLIND. LOW**	Pressure has dropped below the pressure limit set for the O_2 cylinder.	Use a new O_2 backup cylinder. Use the pipeline supply.
Caution (11)	**O_2 FLOW MEAS. FAIL**	Fresh-gas flow measurement for O_2 has failed.	Use only oxygen as fresh gas and observe total flow meter. Check fresh-gas flow settings using total flow meter and set a fresh-gas flow greater than or equal to measured or set minute volume. Call DrägerService.
Caution (11)	**O_2 PIPELINE FAIL**	O_2 supply has failed.	Open O_2 backup cylinder. Check pipeline supply.
		Pipeline supply hose not connected or kinked.	Check connection to pipeline supply.
		O_2 cylinder empty or closed.	Connect a full O_2 cylinder or open the cylinder valve.
Caution (11)	**O_2 SENSOR FAIL***	O_2 sensor is defective.	Ensure adequate substitute monitoring. Call DrägerService.
Caution (14)	**PEEP HIGH**	Exp. pressure 5 cmH_2O above PEEP for 2 breaths, or Exp. pressure 5 cmH_2O above PEEP in **Pressure Support** mode for more than 30 seconds.	In automatic ventilation modes: Check the ventilation parameters, Check the anesthetic gas scavenging line.

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Caution (12)	**PINSP NOT ACHIEVED**	The inspiratory pressure set in **Pressure Mode** is not achieved.	Check set ventilation parameters; repair leak if applicable.
		Fresh-gas shortage.	Check fresh-gas setting.
Caution/ Advisory (12/7)	**POWER FAIL***	Power failure.	Restore pipeline supply. Observe battery capacity. Prepare manual ventilation.
		Short-circuit in one of the devices connected to an auxiliary outlet.	Unplug appliance connector from auxiliary outlet. Restore pipeline supply.
Advisory (1)	**POWER SPLY ERROR**	Internal fault in the power supply.	Call DrägerService. Operation of the anesthesia machine can continue for the time being.
Advisory (8)	**PRESS SENS ERROR** (in **Standby** only)	Pressure sensor is defective.	Perform self test. Call DrägerService.
Caution (13)	**PRESSURE LIMITING**	Ventilator is operating with pressure limitation.	Check ventilation setting.
		Tube kinked/stenosis.	Check tube, hoses, and filter.
		Microbial filter soiled on inspiration side.	Check microbial filter.
Advisory (10)	**PRESSURE RELIEF**	Internal pressure relief valve opened due to high system pressure.	Check APL valve settings. Check fresh-gas settings.

Caution (21)	**PULSE RATE HIGH**	Upper alarm limit for pulse has been exceeded.	**Check patient's condition!** Correct alarm limit if necessary.
Warning (31)	**PULSE RATE LOW**	Pulse below lower alarm limit.	**Check patient's condition!** Check ventilation.
Warning/ Caution (31/15)	**REINSTALL VENTILATOR**	If the Cautions APNEA PRESSURE and APNEA FLOW also occur, the priority changes from Caution to Warning.	
		Breathing system installed incorrectly or incompletely.	Check correct installation of breathing system.
			Check that upper diaphragm has been installed correctly.
		Breathing system is defective.	Use another breathing system.
Caution/ – (14/–)	**SETTING CANCELLED***	The last settings have not been accepted due to temporary errors.	Repeat settings. Alarm can be reset by pressing > Silence <.
Advisory (1)	**SPEAKER FAIL**	Speaker is defective.	No alarm tone. Call DrägerService.
Advisory (1)	**SPO_2 FAIL** (in **Standby** only)	SPO_2 measurement system has failed.	Use external measuring system. Call DrägerService.
Caution (21)	**SPO_2 HIGH**	Measured oxygen saturation value has exceeded upper alarm limit.	Check ventilation.
Warning (31)	**SPO_2 LOW**	Measured oxygen saturation value is below lower alarm limit.	Check ventilation. Check application of SpO_2 sensor.
			Check O_2 concentration of fresh-gas flow.

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Advisory (10)	**SpO_2 SENS. DISCONNECT.**	SpO_2 sensor not connected.	Check sensor connection.
Caution (13)	**STOP FG FLOW**	Flow valve(s) still open during **Standby**.	Close flow valve(s).
Warning/ Advisory (28/10)	**VENTILATOR FAIL***	Ventilator is no longer operational.	**Patient must immediately be ventilated manually!** Adequate substitute monitoring must be ensured if pressure and volume monitoring has failed. Switch back to the desired ventilation mode after approx. 30 sec. Make sure that the rise time for **Pressure Support** is set to an adequate value. Call DrägerService.
Warning/ Advisory (27/10)	**VENTILATOR UNLOCKED***	Ventilator unit has not been locked correctly.	Push the ventilator in until it engages in the right position. Anesthetic gas receiving system is not active when the ventilator unit is disconnected The ambient air may become contaminated with anesthetic agents.
Caution (12)	**VT NOT ACHIEVED**	Set volume is not delivered.	Repair leak. Correct pressure limitation or inspiration time if necessary.
			Check fresh-gas flow setting.
Advisory (7)	**WATER TRAP SAMPL. LINE?**	Sample line blocked or not connected. Water trap or gas measurement system blocked or not connected.	Check sample line, water trap, gas measurement system, and filter in Y-piece, if applicable; replace if necessary.

	Condition	Cause	Remedy
	"INOP" displayed instead of measured values	Values cannot be measured, sensor defective.	Replace sensor if necessary. Ensure adequate substitute monitoring. Call DrägerService.
	"CAL" displayed instead of measured values	Sensors are being calibrated.	Wait until calibration is complete.
	" – – " displayed instead of values	Measurement currently not possible.	Ensure adequate substitute monitoring. Call DrägerService.
		Alarm limit disabled.	Set alarm limits, see page 173.
	"⚠" displayed beside measured values	All alarms for the measured values concerned have been disabled.	Enable alarms in configuration menu (see page 166).
	"⚠" displayed beside measured values	All alarms for the measured values concerned have been temporarily disabled. The alarm system is waiting for automatic measurement wake-up (AutoWakeUp)	Connect sample line. Connect SpO_2 sensor. Connect patient. For more details, see page 168.

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	“ displayed beside measured values	The apnea alarm for the measured value concerned has been disabled. Some apnea alarms are disabled automatically in some ventilation modes.	For more details see page 168.
	Symbol , , or displayed beside measured values	One or both alarm limits for the measured value concerned has/have been disabled.	Set alarm limits, see page 173.
	Grayed out values	The set value differs from the delivered value.	
	Grayed out measured values	The specified accuracy cannot be maintained.	

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Specifications

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Specifications

All measurements and delivery data apply at 68 °F (20 °C) and 14.69 psi (1013 hPa).

Ambient conditions

Depending on the type of anesthetic agent delivery unit used, this data may vary.

During operation

Temperature	59 °F to 104 °F (max. 95 °F for charging the battery)
Air pressure	7.25 to 15.37 psi (500 to 1060 hPa)
Relative humidity	25% to 85% (no condensation)
CO_2 concentration of the ambient air	300 ppm to 800 ppm

During storage/transportation

Temperature	–4 °F to 140 °F Battery: 5 °F to 104 °F
Air pressure	7.25 to 15.37 psi (500 to 1060 hPa)
Relative humidity	25% to 85% (no condensation)

Physical dimensions

(Variations may occur depending on the configuration)

Machine dimensions (W x H x D)	approx. 31.5 x 59.1 x 31.5 in. (85 x 150 x 80 cm)
Top shelf dimensions (W x D)	approx. 24 x 20.9 in. (61 x 53 cm)
Writing surface (W x D)	approx. 13 x 18 in. (33 x 46 cm)
Breathing system dimensions (W x H x D)	approx. 14.8 x 15.9 x 13.6 in. (37.5 x 40.5 x 34.5 cm)
Machine weight (ready for operation, without vaporizers and backup gas cylinders)	approx. 363 lbs. (165 kg)
Weight of breathing system without soda lime	approx. 9.7 lbs. (4.4 kg)

Monitor screen

Flat screen, color, TFT, 12.1” diagonal, 800 x 600 pixels

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Operating data

Operating voltage	100 to 127 VAC, 50-60 Hz, 12.4 A max.
Power input	200 W typically, max. 1.5 kW with power drawn from auxiliary outlets
Uninterruptible power supply	Fully charged batteries: at least 30 minutes; Up to 90 minutes depending on ventilation parameters (auxiliary outlets are not powered)
Auxiliary outlets	2 outlets with automatic circuit breakers rated at 4 A each, 1 outlet for desflurane vaporizer rated 2 A; combined current for all outlets is 6 A. The outlets are isolated against mains to reduce leakage current.
Connection for optional halogen lamp	12 V max. 20 W
Compressed gas supply at pipeline supply inlet	
O_2	39 psi to 100 psi at max. 78 L/min (including max. output flow)
N_2O	39 psi to 100 psi at max. 18 L/min
Air	39 psi to 100 psi at max. 18 L/min
Dew point	>41 °F below ambient temperature
Oil content	<0.1 mg/m^3
Particles	Dust-free air (filtered with pores <1 µm)
Driving gas consumption	None
Noise emission in normal operation with ventilation (breathing sound set to OFF)	<45 dB(A)

Electrical data

Protection class	
Anesthesia machine	I, in accordance with IEC 60601-1
IP	X0
SpO_2 sensor	Type BF  electrically isolated from protective conductor
Electromagnetic compatibility (EMC)	Tested to IEC 60601-1-2

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Fresh-gas delivery

Settings:	
O_2 concentration	21 to 100 Vol.%
Fresh-gas flow, delivery	0 to min. 12 L/min per gas (O_2, N_2O, Air)
Fresh-gas flow, electrical measuring	0 to 12 L/min volumetric flow per gas (O_2, N_2O, Air)
Accuracy	±10% or 0.12 L/min, whichever is greater
Resolution	0.01 L/min (from 0 to 0.2 L/min)
	0.02 L/min (from >0.2 to 0.5 L/min)
	0.05 L/min (from >0.5 to 1.0 L/min)
	0.10 L/min (from >1 - 12 L/min)
Fresh-gas flow, total flow meter	0 to 10 L/min
Accuracy	±10% of the max. displayed value for 50% O_2 and 50% N_2O calibrated at 5 L/min
Resolution	0.5 L/min (from 0.5 to 2 L/min)
	1.0 L/min (from 2 to 10 L/min)
O_2 flush	>35 L/min

Auxiliary O_2 flow meter

Connection	Staged connector for use with various hose diameters
Fresh-gas flow	0 to 10 L/min
Accuracy of the flow display	± 10% of full scale
Resolution of the display	0.5 L/min
	The auxiliary O_2 flow meter is not pressure monitored; this monitoring must be ensured by the connected device.

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Breathing system

Total gas volume	Without breathing hoses, incl. absorber			
in Man/Spont	typically 3.7 L			
in automatic mode	typically 4.0 L (incl. piston volume)			
Compliance	Without breathing hoses, flexible bag arm			
in Man/Spont	typically 3.7 mL/cmH_2O			
in automatic mode	typically 2.3 mL/cmH_2O			
Absorber volume				
Reusable absorber canister, filled	1.5 L			
CLIC absorber (Drägersorb 800 +)	1.3 L			
CLIC absorber (Drägersorb Free)	1.2 L			
Flexible arm for manual breathing bag				
Volume	0.13 L			
Compliance	0.13 mL/cmH_2O			
Total system leakage (as per ISO 8835-2)	<150 mL/min at 30 cmH_2O			
Pressure limitation valve APL				
Adjustment range	5 to 70 cmH_2O			
Accuracy between 5 and 15 L/min	±15% of set value or ±3 cmH_2O, whichever is greater			
Pressure drop at 30 L/min	2.8 cmH_2O (wet and dry)			
Resistance	Reusable absorber or CLIC absorber, normal operation (filled with Drägersorb 800 +)			
	With standard bag tube		With flexible bag arm	
	Inspiratory	Expiratory	Inspiratory	Expiratory
As per ISO 8835-2, dry, max. ±6 cmH_2O, with hose set for adults M30146	-4.4 cmH_2O	4.2 cmH_2O	-4.6 cmH_2O	4.2 cmH_2O
As per ISO 8835-2, dry, sole breathing system without patient hoses	-3.0 cmH_2O	3.0 cmH_2O	-3.3 cmH_2O	3.3 cmH_2O
Minimal Limited Pressure (as per ISO 8835-5)	-3 cmH_2O			

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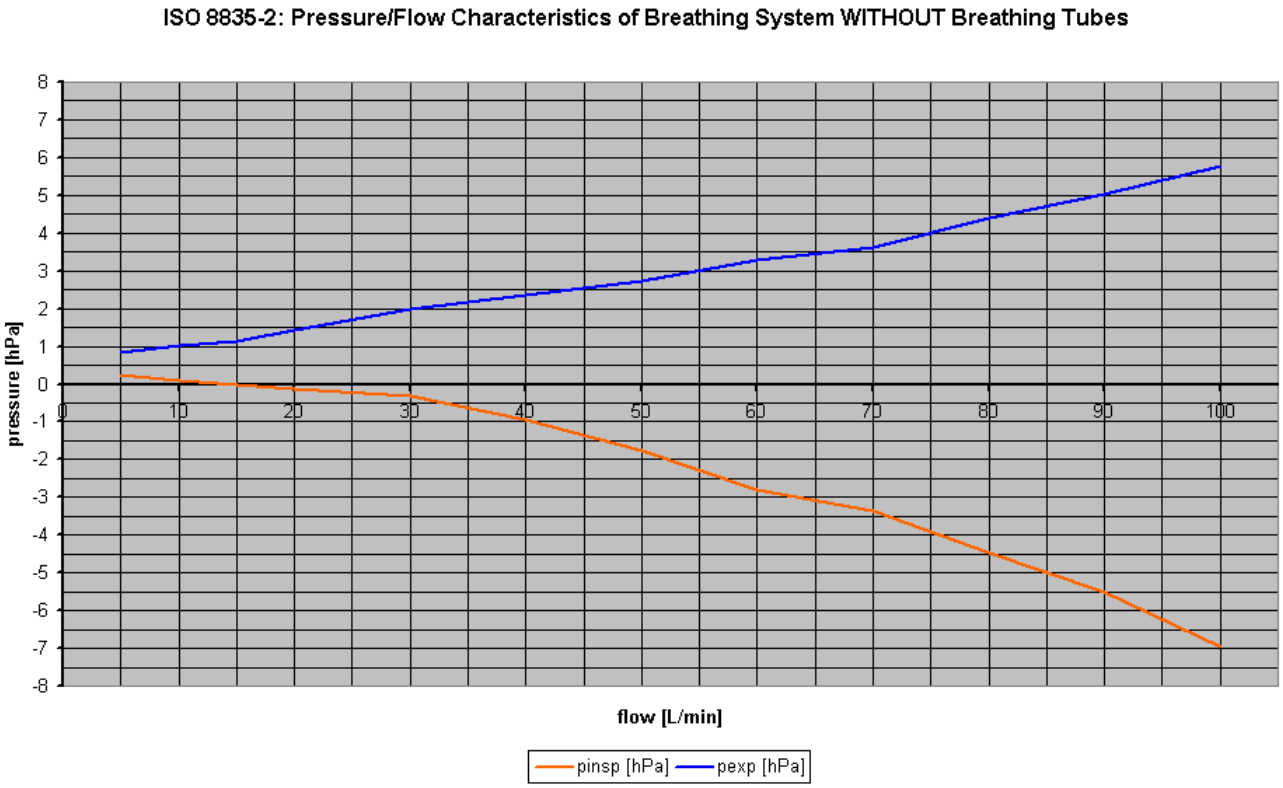

Auxiliary common gas outlet (CGO) (Optional)

Connection	Dia 22 mm ISO cone (male) with diameter 15 mm ISO cone (female)
Pressure limitation	max. 80 cmH_2O at 18 L/min
Fresh-gas flow	0 to 18 L/min (see "Fresh-gas delivery" for tolerances)

Ventilator

(electronically controlled, electrically driven piston ventilator, fresh gas decoupled)

Ventilation modes	Volume Mode, Pressure Mode, Volume AF (optional), CPAP (optional), and Pressure Support mode (optional), synchronized volume and pressure modes
Settings:	
Pressure limitation P_{MAX} in Volume and Volume AF Mode	(PEEP+10) to 70 cmH_2O
Accuracy	±10% of set value or ±3 cmH_2O, whichever is greater
Inspiration pressure P_{INSP} in Pressure Mode	(PEEP+5) to 70 cmH_2O

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Accuracy	±10% of set value or ±3 cmH_2O, whichever is greater
Tidal volume V_T (compliance-compensated) in Volume and Volume AF Mode	20 mL to 1400 mL*
with optional Pressure Support	5 mL to 1400 mL*
Accuracy (5 mL to 150 mL)	±10% of set value or ±10 mL, whichever is greater
Accuracy (over 150 mL)	±5% of set value or ±15 mL, whichever is greater
Frequency	3 to 100 bpm
Accuracy	±10% of set value or ±1 bpm, whichever is lower
$Frequency_{MIN}$	
in Pressure Support Mode	3 to 20 bpm or “OFF”
in Pressure Support CPAP Mode	“OFF”
Accuracy	±10% of set value or ±1 bpm, whichever is lower
T_{INSP}	0.2 seconds to 6.7 seconds
Insp./exp. time ratio I:E	max. 5:1
Inspiration pause T_{IP} : T_{INSP}	0 % to 60%
Inspiration flow	Derived from V_T and T_{INSP}
in Volume Mode	0.1 to 100 L/min ±10%
in Volume AF Mode	max. 150 L/min +10%
in Pressure Mode	max. 150 L/min +10%
PEEP	
in Volume and Volume Mode	0 to 20 cmH_2O (max. P_{MAX} - 10 cmH_2O)
in Pressure and Pressure Support Mode	0 to 20 cmH_2O (max. P_{INSP} - 5 cmH_2O)
Accuracy	±10% of set value or ±2 cmH_2O, whichever is greater**
ΔPPS	
in Volume, Volume AF and Pressure Modes	3 to 50 cmH_2O (max. P_{INSP})
in Pressure Support	3 to 50 cmH_2O (max. P_{INSP}); 0 to 2 cmH_2O = Pressure Support CPAP
Trigger	0.3 to 15 L/min or “OFF”

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TSLOPE	
in Pressure Mode, Volume AF Mode and Pressure Support Mode	0 seconds to 2 seconds

* Due to gas measurement sampling, leaks (both at the patient and in the device) and patient resistance/compliance, the maximum delivered tidal volume may be limited.
** Due to gas measurement sampling and leaks (both at the patient and in the device), the end-expiratory PEEP value may be lower than specified at the end of long expiratory phases.

Measuring systems

Pressure Measurement
(piezo-resistive)

Respiratory pressure	
Range	–20 to 99 cmH_2O
Resolution of the measurement	0.1 cmH_2O
Accuracy	±4% of the measured value or ±2 cmH_2O, whichever is greater
PPEEP, PPEAK, PPLAT, PMEAN	
Range	–20 to 99 cmH_2O
Resolution of the display	1 cmH_2O
Accuracy	±4% of the measured value or ±2 cmH_2O, whichever is greater
Respiratory pressure at auxiliary common gas outlet (Aux CGO)	
Range	–20 to 99 cmH_2O
Resolution of the measurement	0.1 cmH_2O
Accuracy	±8% of the measured value or ±3 cmH_2O, whichever is greater
PPEAK, PMEAN at auxiliary common gas outlet (Aux CGO)	
Range	–20 to 99 cmH_2O
Resolution of the display	1 cmH_2O
Accuracy	±8% of the measured value or ±3 cmH_2O, whichever is greater
Central supply pressure	
Range	0 psi to 140 psi
Resolution of the display	1.5 psi

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Accuracy	±4% or ±3 psi

Cylinder pressure
(applies for Silverline pressure regulators)

Range	0 psi to 3600 psi
Resolution of the display	14 psi
Accuracy	±4% or ±87 psi

Pressure Measurement
(pressure indicator, dial type)

Range	–20 to 80 cmH_2O
Resolution of the display	5 cmH_2O
Accuracy	±5% of the measured value or ±2 cmH_2O, whichever is greater

Flow measurement
(hot wire anemometry)

Flow

Range	–180 to 180 L/min
Resolution of the measurement	0.1 L/min
Accuracy at 60 L/min	±8% of measured value

Tidal volume V_T

Range	0 mL to 9999 mL
Resolution of the display	1 mL
Accuracy	±8% of the measured value or ±5 mL, whichever is greater

Delta V_T

Range	0 mL to 9999 mL
Resolution of the display	1 mL
Accuracy	±16% or ±10 mL, whichever is greater

Volume VT_{INSP}

Range	0 mL to 9999 mL
Resolution of the display	1 mL
Accuracy	±8% of the measured value or ±5 mL, whichever is greater

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Minute volume MV	
Range	0 to 99.9 L/min
Resolution of the display	0.1 L/min
Accuracy	±8% of the measured value or ±0.1 L/min, whichever is greater
Compliance C_{PAT}	
Range	0 to 250 mL/cmH_2O
Resolution of the display	0.1 mL/cmH_2O
Accuracy	±15% of the measured value or ±0.5 mL/cmH_2O, whichever is greater
MV_{LEAK}	
Range	0 to 9.99 L/min
Resolution of the indication	0.01 L/min
Accuracy	±15% of (MV_{EXP} + MV_{LEAK}) or ±0.01 L/min, whichever is greater

Frequency measurement

Frequency (Freq.)

Range	1 to 100 bpm
Resolution of the display	1 bpm
Accuracy	±10% or ±1 bpm, whichever is lower (6 to 100 bpm); ±0.3 bpm (<6 bpm)

O_2, CO_2, and anesthetic gas measurement

Side-stream sampling (the sampled flow is returned to the breathing system and taken into account for measurement and delivery). All values measured under calibration conditions ATPS, sampling rate in NTPD.

Sampling rate[1]	150 mL/min ±20 mL/min	200 mL/min ±20 mL/min
Delay for sampling (typical value, depends on sample line)	less than 4 seconds	less than 4 seconds
Response time $t_{10..90}$ O_2		
gas measurement module with consumption-free O_2 measuring	not available	less than 500 ms
Response time $t_{10..90}$ CO_2	less than 500 ms	less than 350 ms
Response time $t_{10..90}$ anesthetic agents	less than 500 ms	less than 500 ms

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O_2 Measurement (consumption-free, paramagnetic measurement)

Measuring range	0 to 100 Vol.%
Resolution of the measurement	0.1 Vol.%
Resolution of the indication (for ins. O_2, exp. O_2)	1 Vol.%
Accuracy	±3 Vol.% in the measuring range 0 to 100 Vol.%

CO_2 Measurement (infrared spectrometry)

Measuring range	0 to 76 mmHg (at an ambient pressure of 760 mmHg)
Resolution of the measurement	1 mmHg
Resolution of the indication (for inCO_2, etCO_2)	1 mmHg
Accuracy	±3.8 mmHg or ±12% of measured value, whichever is greater

Anesthetic Gas Measurement (infrared spectrometry)
All values in Vol.% refer to ambient pressure 760 mmHg

Measuring range, anesthetic agent	
Halothane	0 to 8.5 Vol.%
Isoflurane	0 to 8.5 Vol.%
Enflurane	0 to 10 Vol.%
Sevoflurane	0 to 10 Vol.%
Desflurane	0 to 20 Vol.%
Resolution of the measurement	0.1 Vol.%
Resolution of the displayed value (for insp. and exp. anesthetic agent)	0.1 Vol.%
Accuracy (at respiration rates of up to 60 bpm and I:E ratio of 1:1)	±(0.15 Vol.% + 15% rel.)
Measuring range, N_2O	0 to 100 Vol.%
Resolution of the measurement	0.1 Vol.%
Resolution of the indication (for insp. and exp. N_2O)	1 Vol.%
Accuracy	±(2 Vol.% + 8% rel.)

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MAC (xMAC)	
Range	0 to 9.9
Resolution of the displayed value	0.1
Accuracy	derived value from gas measurement values
Anesthetic gas detection	Automatic
Primary agent	Min. 0.3 Vol.% (typically 0.15 Vol.%)
Secondary agent	At no later than 0.4 Vol.%[2]; becomes primary agent if expiratory xMAC is more than 0.2 MAC above former primary agent.
Cross-sensitivity	None referred to alcohol (<3000 ppm), acetone (<1000 ppm), methane, water vapor, NO, and CO
Drift of accuracy	Compensated by cyclic zeroing of gas analyzer.

Fresh-gas and Agent Consumption Measurement

Fresh-gas consumption per case	0 L to 9999 L per gas (O_2, N_2O, Air) (O_2 value not including gas used for the O_2 flush and the auxiliary O_2 flow meter)
Accuracy	±10% or ±1 L, whichever is greater
Resolution	1 L
Total agent consumption per case (liquid agent)	0 mL to 3000 mL per agent (Halothane, Isoflurane, Enflurane, Sevoflurane, Desflurane)
Accuracy	Typ. ±25% or ±2 mL, whichever is greater
Resolution	1 mL
Agent consumption due to patient uptake per case (liquid agent)	0 mL to 3000 mL per agent (Halothane, Isoflurane, Enflurane, Sevoflurane, Desflurane)
Accuracy	Typ. ±25% or ±2 mL, whichever is greater
Resolution	1 mL
Soda lime consumption	0 to 1000 L (pure gas CO_2)
Accuracy	Typ. ±30% or ±15 L, whichever is greater
Resolution of limit setting	10 L

[1] The respective value depends on the PGM used which is displayed on the System Information page.

[2] Exception: If a measured desflurane concentration of at least 4 Vol.% is present, a mixed agent identification is available as soon as the measured concentration of the secondary agent reaches at least 10% of the desflurane concentration.

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SpO_2 Measurement (optional) (light absorption)

Measuring range SpO_2	1 % to 100%
Resolution of the displayed value	1%
Accuracy	Depending on the sensor model, applies to DS-100 A.
Adults, within a range of 70 to 100% SpO_2	±3%
Neonates, within a range of 70 to 100% SpO_2	±4%
Actualization time	Once per pulse
Pulse rate	20 to 250 bpm
Resolution of the displayed value	1 bpm
Accuracy	±3 bpm
Sensors	
Type	Nellcor sensors with Oximax technology
Wavelengths	660 nm (red) 920 nm (infrared)
Light energy	Infrared 1.5 to 4 mW Standard red 0.8 to 3 mW
Acoustic pulse signal	A tone is generated for each pulse detected. The pitch of the tone proportional to the oxygen saturation. Increasing saturation increases the pitch.
Pitch of tone	The pitch of the tone is according to Nellcor specifications.

The displayed plethysmogram is a relative indicator of the pulse amplitude. Its scale is not absolute and it is only used to judge the quality of the SpO_2 measurement.

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Interfaces

2 serial interfaces: COM1 and COM2

Protocol	MEDIBUS[1] (COM 2 without real-time data)	
Plug connector	9-pin sub-D, galvanic separation, 1.5 kV	
Pin allocation		
1	NC	not connected
2	TX	transmit
3	RX	receive
4	DTR	data terminal ready
5	GND	ground
6	DSR	data set ready
7	RTS	request to send
8	CTS	clear to send
9	NC	not connected
Shields	DTR and DSR, as well as RTS and CTS are internally connected. Hardware handshake is not supported.	
Settings	1200 or 9600 Baud even parity 8 data bits 1 stop bit	
Dräger Base IV system (not sold in the U.S.)	Power supply for IV systems	
SpO_2	For connecting an SpO_2 sensor	

[1] Typical delay time of system alarms: 600 ms

CLIC adapter technical data

Resistance	Reduced by approx. 1 mbar in the bypass mode, depending on the breathing system of the anesthesia machine
Compliance	
Normal mode:	typically 1.3 mL/mbar
Bypass mode:	typically 0.4 mL/mbar
Leakage:	<5 mL/min

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Anesthetic gas receiving system AGS

Technical Data of AGS Scavenger

Ambient conditions

During operation:

Temperature	59 °F to 86 °F
Atmospheric pressure	525 to 795 mmHg
Rel. humidity	0 to 98%, without condensation

During storage:

Temperature	–4 °F to 158 °F
Atmospheric pressure	375 to 825 mmHg
Rel. humidity	0 to 98%, without condensation

Performance data

Effect on the anesthetic system/ventilator:

Increase in exhalation resistance	<0.5 cmH_2O at 30 L/min <3.6 cmH_2O at 75 L/min
Generated vacuum pressure	<1 Pa (0.01 cmH_2O)
Generated flow	<50 mL/min

Effect on the environment:

Gas loss,
dependent on fresh gas flow & ventilation parameters <25 mL/min typical)

Operating data

Operating capacity of scavenging flow	30 to 50 L/min
Setting with service flow indicator	65 to 75 L/min
Particle filter pore width	0.1 mm
Particle filter resistance	5.1 cmH_2O at 50 L/min

Supply performance requirements

across a flow resistance of 20 cmH_2O	min. 25 L/min suction
across a flow resistance of 10 cmH_2O	max. 50 L/min suction
Dimensions (W x H x D)	4.7 in. x 13.8 in. x 7.9 in.
Weight, without hoses	approx. 2.1 lbs.

Latex use

The Apollo is latex-free.

Latex-free breathing bags and breathing hoses must be used for latex-free use.

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EMC declaration

General information

The EMC conformity of Apollo includes the use of following external cables, transducers, and accessories:

Description	Order-No.
Mains power cable	8601449
RS-232 cable	8601474
SpO_2 extension cable 2.4m	8600859
SpO_2 sensor DS100A	8201001
Halogen lamp	8605361
Pressure reducer O_2	8603705
Pressure reducer AIR	8603714
Pressure reducer N_2O	8603514
Dräger Base connection cable	8602718

Additionally, accessories may be used which do not affect EMC compliance, if no other reasons interdict the use of them. The non-observance may result in increased emissions or decreased immunity of the Apollo.

The Apollo should not be used adjacent to or stacked with other equipment; if adjacent or stacked use is inevitable, the Apollo should be observed to verify normal operation in the configuration in which it will be used.

Electromagnetic emissions

The Apollo is intended for use in the electromagnetic environment specified below. The user of the Apollo should assure that it is used in such an environment.

Emissions	Compliance according to	Electromagnetic environment
RF emissions (CISPR 11)	Group 1	The Apollo 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.
	Class A	The equipment is suitable for use in all establishments including domestic establishments 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	Not applicable
Voltage fluctuations / flicker (IEC 61000-3-3)	Complies	Not applicable

Information regarding electromagnetic emissions (IEC 60601-1-2: 2001, table 201)

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Electromagnetic immunity

The Apollo is intended for use in the electromagnetic environment specified below. The user of the Apollo should assure that it is used in such an environment.

Immunity against	**IEC 60601-1-2 test level**	**Compliance level (of Apollo)**	**Electromagnetic environment**
Electrostatic discharge, ESD (IEC 61000-4-2)	Contact discharge: ±6 kV Air discharge: ±8 kV	±6 kV ±8 kV	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 transients / bursts (IEC 61000-4-4)	Power supply lines: ±2 kV Longer input / output lines: ±1 kV	±2 kV ±1 kV	Mains power quality should be that of a typical commercial or hospital environment.
Surges on AC mains lines (IEC 61000-4-5)	Common mode: ±2 kV Differential mode: ±1 kV	±2 kV ±1 kV	Mains power quality should be that of a typical commercial or hospital environment.
Power frequency magnetic field 50/60 Hz (IEC 61000-4-8)	3 A/m	3 A/m	In close vicinity to the Apollo, no equipment with extraordinary power frequency magnetic fields (power transformers, etc.) should be operated.
Voltage dips and short interruptions on AC mains input lines (IEC 61000-4-11)	Dip >95 %, 0.5 periods Dip 60 %, 5 periods Dip 30 %, 25 periods Dip >95 %, 5 seconds	>95 %, 0.5 per. 60 %, 5 per. 30 %, 25 per. >95 %, 5 sec.	Mains power should be that of a typical commercial or hospital environment. If user requires continued operation during power mains interruptions, it is recommended to power the Apollo from an uninterruptible supply or a battery.
Radiated RF (IEC 61000-4-3)	80 MHz to 2.5 GHz: 10 V/m	10 V/m	Recommended separation distance from portable and mobile RF transmitters with transmission power P_{EIRP} to the Apollo including its lines: (1.84 m x $\sqrt{P_{EIRP}}$)[a]
RFcoupled into lines (IEC 61000-4-6)	150 kHz to 80 MHz: 10 V within ISM bands 150 kHz to 80 MHz: 3 V outside ISM bands[b]	10 V 3 V	Recommended separation distance from portable and mobile RF transmitters with transmission power P_{EIRP} to the Apollo including its lines: (1.84 m x $\sqrt{P_{EIRP}}$)[1)]

Information regarding electromagnetic immunity (IEC 60601-1-2: 2001, tables 202, 203, 204)

a. For P_{EIRP} the highest possible "equivalent isotropic radiated power" of the adjacent RF transmitter has to be inserted (value in Watt). Also in the vicinity of equipment marked with the symbol (( )) interference may occur. Field strengths from fixed, portable or mobile RF transmitters at the location of the Apollo should be less than 3 V/m in the frequency range from 150 kHz to 2.5 GHz and less than 1 V/m above 2.5 GHz.

b. ISM bands in this frequency range are: 6.765 MHz to 6.795 MHz, 13.553 MHz to 13.567 MHz, 26.957 MHz to 27.283 MHz, 40.66 MHz to 40.70 MHz.

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Recommended separation distances

Recommended separation distances between portable and mobile RF-Telecommunication devices and the Apollo:

max. P_{EIRP} (W)	3 V/m distance[a] (m)	1 V/m distance[1)] (m)	Hint
0.001	0.06	0.17	
0.003	0.10	0.30	
0.010	0.18	0.55	
0.030	0.32	0.95	e.g. WLAN 5250/ 5775 (Europe)
0.100	0.58	1.73	e.g. WLAN 2440 (Europe), Bluetooth
0.200	0.82	2.46	e.g. 5250 (not in Europe)
0.250	0.91	2.75	e.g. DECT devices
1.000	1.83	5.48	e.g. GSM 1800-/ GSM 1900-/ UMTS-mobiles, WLAN 5600 (not in Europe)
2.000	2.60	7.78	e.g. GSM 900 mobiles
3.000	3.16	9.49	

Information regarding separation distances (IEC 60601-1-2: 2001, tables 205 and 206)

a. 3 V/m distance to transmitters with frequencies from 150 kHz to 2.5 GHz, otherwise 1 V/m distance.

Relevant standards

IEC 60601-1:1988, +A1:1991, + A2:1995: Medical electrical equipment - Part 1: General requirements for safety

IEC 60601-1-1:2000: Medical electrical equipment - Part 1: General requirements for safety - Collateral standard: Safety requirements for medical electrical systems

IEC 60601-1-2:2001: Medical electrical equipment - Part 1-2: General requirements for safety - Collateral standard: Electromagnetic compatibility - Requirements and tests

IEC 60601-1-8:2006: Medical electrical equipment - Part 1-8: General requirements for safety - Collateral standard: General requirements, tests and guidance for alarm systems in medical electrical equipment and medical electrical systems

ISO 8835-1 / IEC 60601-2-13: 2003-07 Medical electrical equipment - Part 2-13: Particular requirements for safety and essential performance of anesthetic workstations

ISO 8835-3:2007: Inhalational anesthesia systems - Part 3: Transfer and receiving systems of active anaesthetic gas scavenging systems

ISO 8835-5:2005-03: Inhalational anesthesia systems - Part 5: Anesthetic ventilators

DIN EN ISO 8835-2:2007-08: Inhalational anesthesia systems - Part 2: Anesthetic breathing systems for adults

JIS T 7201-90 Anaesthetic machines

Universal Medical Device Nomenclature System (UMDNS) Code: 10-134

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Make sure to note the operating conditions for any supplementary equipment used; these may restrict the area of use for the system as a whole.

Vaporizers and anesthetic agents used may restrict the area of use of the workstation as regards temperature range and fresh-gas flow.

If supplementary equipment is used with the anesthesia machine, the corresponding operator's manuals for this equipment must be consulted.

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These Operating Instructions apply only to
Apollo SW 4.n
with Serial No.:

If no Serial No. has been filled in by Dräger, these Operating Instructions are provided for general information only and are not intended for use with any specific machine or device.

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