Instructions for use

Savina 300

WARNING
To properly use this medical device, read and comply with these instructions for use.

Ventilator Software 5.n

Information about this document

Typographical conventions

1 Consecutive numbers indicate steps of action, with the numbering restarting with "1" for each new sequence of actions.

- Bullet points indicate individual actions or different options for action.

– Dashes indicate the listing of data, options, or objects.

(A) Letters in parentheses refer to elements in the related illustration.

A Letters in illustrations denote elements referred to in the text.

> The greater-than symbol indicates the navigation path in a dialog window.

Bold, italicized text indicates labels on the device and texts that are displayed on the screen.

Illustrations

Illustrations of products and screen content in this document may differ from the actual products depending on configuration and design.

Use of terms

Dräger uses the term "accessories" not only for accessories in the sense of IEC 60601-1, but also for consumables, removable parts, and attached parts.

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Safety information 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 medical device or other property.

NOTE

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

User group requirements

The term "user group" describes the personnel responsible who have been assigned by the operating organization to perform a particular task on a product.

Duties of the operating organization

The operating organization must ensure the following:

– Every user group has the required qualifications (e.g., has undergone specialist training or acquired specialist knowledge through experience).

– Every user group has been trained to perform the task.

– Every user group has read and understood the relevant chapters in this document.

User groups

Clinical users

This user group operates the product in accordance with the intended use.

Users have medical specialist knowledge in the field of ventilation. Users have knowledge of device monitoring and ventilation care.

Reprocessing personnel

This user group carries out the necessary activities to reprocess the product.

Reprocessing personnel has specialist knowledge in the reprocessing of medical devices.

Service personnel

This user group installs the product and performs the service activities.

Service personnel has specialist knowledge in electrical and mechanical engineering and experience in the servicing of medical devices.

Where product specific knowledge or tools are required, the service activities must be carried out by specialized service personnel. The specialized service personnel was trained by Dräger for these service activities on this product.

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Contents

For your safety and that of your patients

General safety information

The following WARNING and CAUTION statements apply to general operation of the medical device.

WARNING and CAUTION statements specific to subsystems or particular features of the medical device appear in the respective sections of these instructions for use or in the instructions for use of another product being used with this medical device.

Strictly follow these instructions for use

WARNING

Risk of incorrect operation and of incorrect use

Any use of the medical device requires full understanding and strict observation of all sections of these instructions for use. The medical device must only be used for the purpose specified under "Intended use" on page 18 and in conjunction with appropriate patient monitoring (see page 11).

Strictly observe all WARNING and CAUTION statements throughout these instructions for use and all statements on medical device labels. Failure to observe these safety information statements constitutes a use of the medical device that is inconsistent with its intended use.

Service

WARNING

Risk if service is not performed regularly

If service is not performed regularly, malfunctions may occur, which can result in personal injury and property damage.

Perform the service in accordance with the chapter "Service".

Accessories

WARNING

Risk due to incompatible accessories

The use of incompatible accessories may adversely affect the functional integrity of the product. Personal injury and property damage may occur as a consequence.

Use only compatible accessories. The accessories that are compatible with this product are listed in the list of accessories supplied with the product.

Not for use in areas of explosion hazard

WARNING

Risk of fire

The medical device is not approved for use in areas where combustible or explosive gas mixtures are likely to occur.

Connected devices

WARNING

Risk of electric shock and of device malfunction

Electrical connections to equipment not listed in these instructions for use or these assembly instructions must only be made when approved by each respective manufacturer.

Before operating the medical device, strictly comply with the instructions for use of all connected devices or device combinations.

Patient safety

The design of the medical device, the accompanying documentation, and the labeling on the medical device are based on the assumption that the purchase and the use of the medical device are restricted to persons familiar with the most important inherent characteristics of the medical device.

Instructions and WARNING and CAUTION statements are therefore largely limited to the specifics of the Dräger medical device.

The instructions for use do not contain any information on the following points:

– Risks that are obvious to users
– Consequences of obvious improper use of the medical device
– Potentially negative effects on patients with different underlying diseases

Medical device modification or misuse can be dangerous.

CAUTION

Risk of patient injury

Do not make therapeutic decisions based solely on individual measured values and monitoring parameters.

Patient monitoring

The user of the medical device is responsible for choosing a suitable patient monitoring system that provides appropriate information on medical device performance and patient condition.

Patient safety can be achieved by a wide variety of means ranging from electronic surveillance of medical device performance and patient condition to direct observation of clinical signs.

The responsibility for selecting the best level of patient monitoring lies solely with the user of the medical device.

Electromagnetic compatibility (EMC)

Medical electrical equipment is subject to special precautionary measures concerning electromagnetic compatibility. During installation and before initial operation, follow the information in section: "EMC declaration" (page 219).

This device can be affected by other electrical devices.

WARNING

Risk due to electrostatic discharge

Malfunctions that endanger the patient may occur if no protective measures against electrostatic discharge are employed in the following situations:

– When touching the pins of connectors that carry the ESD warning symbol.
– When establishing connections with these connectors.

To prevent malfunctions, observe the following measures and train the relevant personnel:

– Observe the ESD protective measures. Such measures may include wearing antistatic clothing and shoes, touching a potential equalization pin before and while making the connection, or using electrically insulating and antistatic gloves.
– Observe the requirements for the electromagnetic environment. Observe the following section: "Electromagnetic environment" (page 219).

WARNING

Risk due to electromagnetic disturbance

Wireless communication devices (e.g., cellular phones) and medical electrical equipment (e.g., defibrillators, electrosurgical devices) emit electromagnetic radiation. When such devices are operated too close to this device or its cables, the functional integrity of this device may be compromised by electromagnetic disturbances. As a result, the patient could be put at risk.

Maintain a distance of at least 0.3 m (1.0 ft) between this device and wireless communication devices, to ensure that the essential performance of this device is fulfilled.

Maintain an adequate distance between this device and other medical electrical equipment.

Disposable products

WARNING

Risk of patient injury due to failure of accessories

Disposable products are developed, tested and manufactured for disposable use only. Reuse, reprocessing, or sterilization can lead to a failure of accessories and cause injury to the patient.

Do not reuse, reprocess, or sterilize disposable products.

Sterile-packaged accessories

CAUTION

Risk of medical device failure and of patient injury

Do not use sterile-packaged accessories if the packaging has been opened, is damaged, or if there are other signs of non-sterility.

Installing accessories

CAUTION

Risk of device failure

Install accessories to the basic device in accordance with the instructions for use of the basic device. Make sure that there is a safe connection to the basic device.

Strictly observe instructions for use and assembly instructions.

Storing the instructions for use

CAUTION

Risk of incorrect use

Instructions for use must be kept accessible to the user.

Product-specific safety information

WARNING

Risk of incorrect use

This medical device is only intended to be used by the user group "users".

WARNING

Risk of not hearing alarm signals

If the alarm volume is too low, alarm signals may not be heard.

- **Set the alarm volume loud enough so that the alarm signals can be heard in the environment where the device is located.**
- **The user must remain within hearing distance of the alarm signals.**

WARNING

Risk due to modifications

Modifications to the product may lead to malfunctions and unforeseen risks. This may result in injury to the patient or the user or in property damage.

Do not modify this product.

WARNING

Risk of electric shock

If the connectors of the interfaces and the patient are touched simultaneously, there is a risk of electric shock.

Do not simultaneously touch the connectors of the interfaces and the patient.

WARNING

Risk of patient injury

Penetrating liquid may cause malfunction of the device, which may endanger the patient.

Do not place any containers with liquid on or above the device.
During surface disinfection, make sure no liquids penetrate into the device.

WARNING

Risk of fire

The flow sensor can ignite medications or other substances based on highly flammable substances.

- **Do not nebulize medications or other substances that are easily flammable or spray them into the device.**
- **Do not use substances containing alcohol.**
- **Do not allow flammable or explosive substances to enter the breathing system or the breathing circuit.**

WARNING

Risk of failure of flow measurement

Deposits that were not removed during reprocessing can damage the measuring wires in the flow sensor or cause a fire.

- **Before inserting the flow sensor check for visible damage, soiling, and particles. Repeat this check regularly.**
- **Replace flow sensors when damaged, soiled, or not particle-free.**

WARNING

Risk of fire

When using O_2 pressure reducers that are not approved, excess pressure can cause a fire.

When supplying the ventilator with oxygen from a compressed gas cylinder, only use pressure reducers that comply with ISO 10524.
Open pressure reducers slowly by hand.
Do not use tools.

WARNING

Risk of fire

Do not use the medical device in conjunction with flammable gases or flammable solutions that can mix with air, oxygen, nitrous oxide, or other sources of ignition since the medical device could ignite.

Do not allow the medical device to come into contact with sources of ignition.

WARNING

Risk of patient injury

Magnetic resonance imaging (MRI, NMR, NMI) may impair correct functioning of the medical device.

Do not use the medical device during magnetic resonance imaging.

WARNING

Risk of patient injury

Hyperbaric chambers may impair correct functioning of the medical device.

Do not use the medical device in hyperbaric chambers.

WARNING

Risk of electric shock

There are live components under the housing cover.

Do not remove the cover.

WARNING

Risk of fire

Due to oxygen enrichment in the ambient air and overheating, the medical device can ignite.

A distance of at least 10 cm (3.9 in) must be maintained between the rear of the medical device and walls or large-scale obstacles.
Do not cover the rear during operation or standby mode so that air circulation is ensured.
Only use the medical device in adequately ventilated rooms.

CAUTION

Risk of unnoticed change in the inspiratory O_2 concentration

If an additional flow (e.g., NO, nitrous oxide) is delivered from an external flow source, the actual O_2 concentration may deviate from the displayed values.

If required, use additional monitoring, e.g., external SpO_2 monitoring.

CAUTION

Risk of overheating of the medical device

Sources of heat such as direct sunlight, heat radiators or spotlights may cause the medical device to overheat.

Keep sources of heat away from the medical device. Only use the medical device in adequately ventilated rooms.

CAUTION

Risk of patient injury

Positive-pressure ventilation can lead to negative effects, such as barotrauma or strain on the circulatory system.

Monitor the patient's condition.

CAUTION

Risk of malfunction

The touch screen has a sensitive surface. Damage to the surface results in malfunctions of the touch-sensitive controls.

Never use sharp objects to operate the screen. Do not damage the surface of the screen during cleaning or transport.

CAUTION

Risk of electric shock

If a faulty device without safety extra-low voltage (SELV) is connected to the medical device, there is a risk of electric shock when the housing is touched.

Only connect devices with safety extra-low voltage (SELV) to the connections for the serial port and the nurse call.

Functional safety

The essential performance consists in a controlled and monitored patient ventilation with user-defined settings for the monitoring functions
– minimum ventilation flow,
– maximum airway pressure,
– minimum and maximum O_2 concentration in the breathing gas,

or, if a set limit is exceeded, an appropriate alarm.

The integrated monitoring also generates an alarm in the following situations:
– Failure of the external power supply
– Discharge of the internal battery
– Failure of the O_2 supply (HPO mode)

The medical device is equipped with basic safety features to reduce the possibility of patient injury while the cause of an alarm is remedied.

Monitoring ventilation

The following parameters are monitored by the integrated monitoring:
– Airway pressure
– Expiratory minute volume
– Respiratory rate
– Apnea
– Inspiratory O_2 concentration
– Inspiratory breathing gas temperature
– Inspiratory tidal volume
– End-expiratory CO_2 concentration

Changes in these parameters may be caused by:
– Acute changes in the patient's condition
– Incorrect settings and faulty handling
– Device malfunctions
– Failure of power and gas supplies

If the built-in monitoring fails, use substitute monitoring.

During O_2 therapy, the monitoring functions of the medical device are limited.

Backup ventilation with an independent manual ventilation device

WARNING

Risk of patient injury

If a fault is evident at the medical device, its life-support functions may be affected.

Ventilation of the patient using an independent ventilation device must be started without delay, if necessary with PEEP and/or an increased inspiratory O_2 concentration (e.g., with the manual resuscitator MR-100).

Additional information

Training

Training for users is available from the Dräger organization responsible, see www.draeger.com.

Mandatory reporting of adverse events

Serious adverse events with this product must be reported to Dräger and the responsible authorities.

Application

Intended use

Savina 300 is a ventilator intended for the ventilation of adults and pediatric patients.

Savina 300 offers mandatory ventilation modes, ventilation modes supporting spontaneous breathing, and airway monitoring.

Contraindications

When using small minute volumes, it takes longer for a modified oxygen concentration to reach the patient.

For the ventilation of neonates, the use of special neonatal ventilators is therefore recommended.

Environments of use

Savina 300 is intended for the following environments of use:

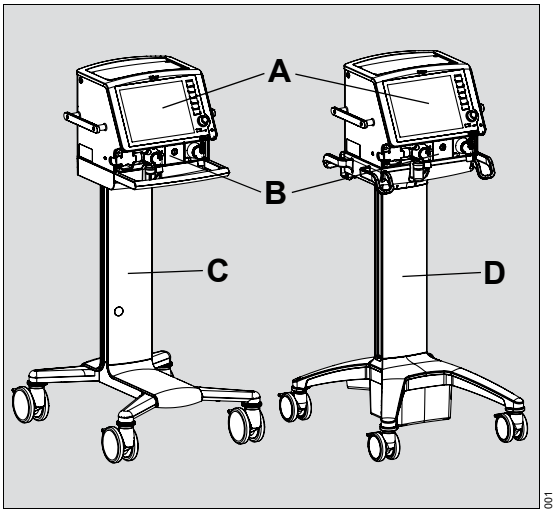
– In intensive care wards, in recovery rooms and generally for hospital use

– During the transfer of patients within the hospital

Overview

Savina 300

Ventilator with trolley



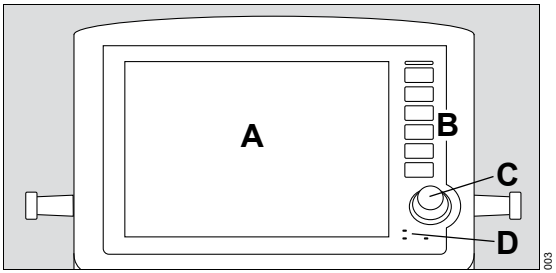
A Control and display unit

B Patient connection panel

C Dräger Savina 300 trolley

D Dräger Savina 300 compact trolley

Control and display unit



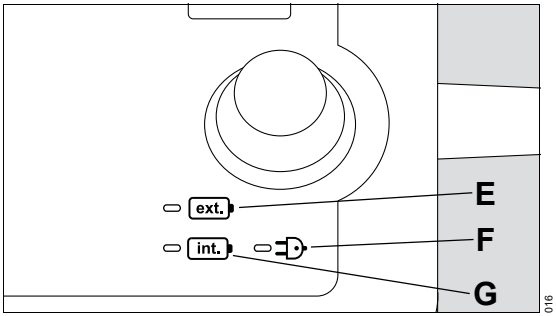
A Touch screen

B Fixed function keys

C Rotary knob

D Power supply display

Power supply display



E External battery

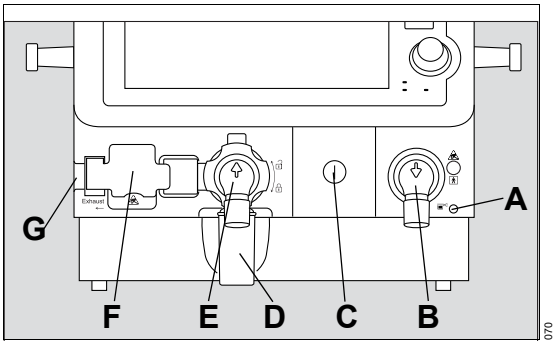
F Mains power

G Internal battery

Meaning of the LED colors:

	Each LED lights up:			
	Green	**Yellow**	**Red**	**Off**
Mains power	Present	–	–	Not present
External battery	Battery operation or battery charge at least 75 %	Charging	Overheated or defective	Not present
Internal battery	Battery operation or battery charge at least 75 %	Charging	Overheated or defective	Not being charged

Patient connection panel



A Nebulizer port (nebulizer gas outlet for pneumatic medication nebulizer)

B Inspiratory valve with inspiratory port ***Insp.*** (GAS OUTPUT)

C Fastening screw for cover plate (behind cover: O_2 sensors)

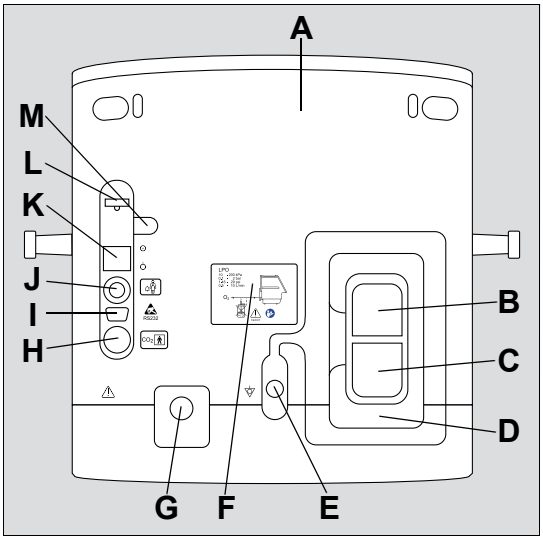
D Water trap of expiratory valve

E Expiratory valve with expiratory port ***Exp.*** (GAS RETURN)

F Flow sensor flap (behind flap: flow sensor)

G Gas outlet ***Exhaust***, non-conical connection (EXHAUST – NOT FOR SPIROMETER)

Rear



A Filter cover

B Rating plate

C Labels for options

D Cable guide and holder for power cable

E LPO port for connecting a low-pressure oxygen source, e.g., an O_2 concentrator

F Label for LPO

G HPO port for O_2 compressed gas hose ***O2***

H Port for CO_2 sensor

I COM port (serial RS232 interface)

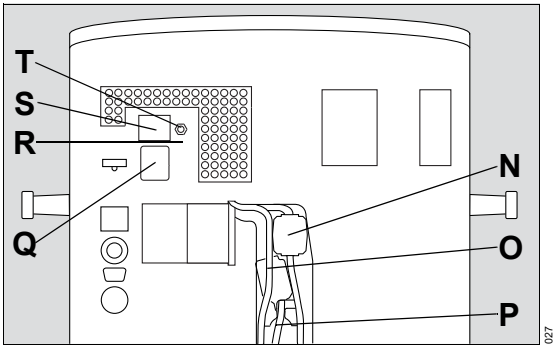
J Connection for nurse call

K Main switch for switching on ⊙ or off ⏻

L Fuse for the internal battery

M Storage recess for fuse

Rear without filter cover



N Cable for external battery

O Potential equalization cable

P Power cable

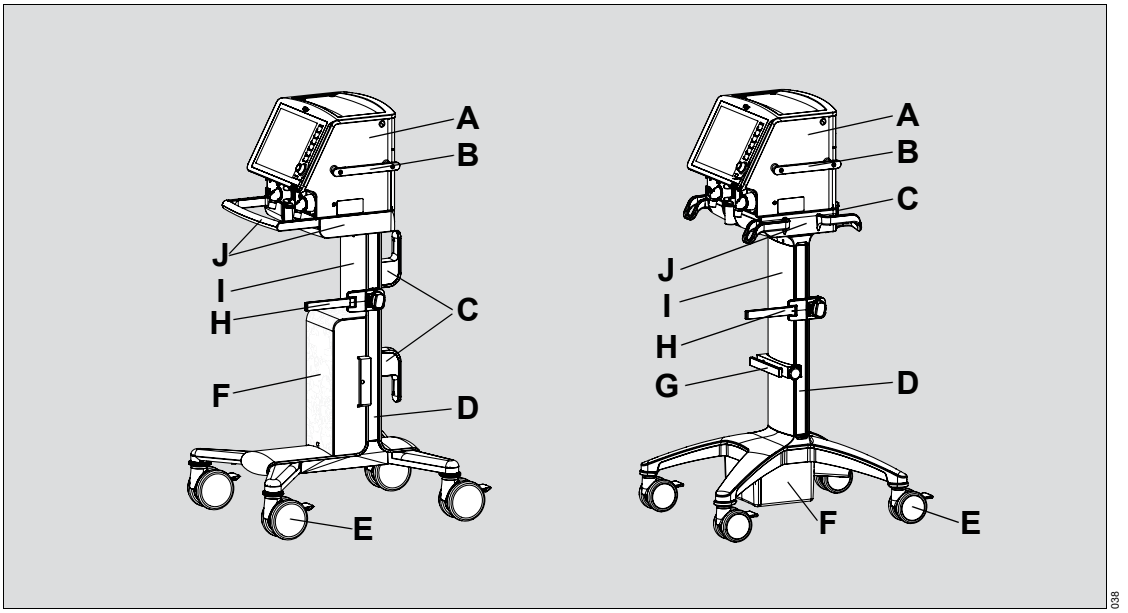
Q Connection for power cable, mains power fuse

R Power supply unit

S Connection for external battery

T Potential equalization pin

Trolley



	Dräger Savina 300 trolley	Dräger Savina 300 compact trolley
A	Ventilator	Ventilator
B	Lateral standard rail	Lateral standard rail
C	Hose holder	Hose holder
D	Groove	Groove
E	Double castors with locking brake, set of 4	Double castors with locking brake, set of 4
F	External battery	External battery
G	If no external battery is attached to the trolley, a universal holder with standard rail can be fitted.	Universal holder with standard rail
H	Holder for breathing gas humidifier	Holder for breathing gas humidifier
I	Trolley column	Trolley column
J	Mounting with handle	Mounting with 4 handles

Range of functions

The functions described correspond to the overall functionality of Savina 300. Some functions are only optional and may not be included in the individual device configuration. The optional functions and the part numbers of the accessories are listed in the separate list of accessories.

Not all options are available for the product variant Classic.

Therapy types

- Invasive ventilation (Tube)
- Non-invasive ventilation (NIV)
- O_2 therapy

Ventilation functions

For a detailed description of the ventilation modes and the additional settings, see page 223. For abbreviations, see page 27.

Ventilation modes

Volume-controlled ventilation:
- VC-CMV
- VC-AC
- VC-SIMV
- VC-MMV

Pressure-controlled ventilation:
- PC-AC
- PC-BIPAP
- PC-APRV

Support of spontaneous breathing:
- SPN-CPAP

Additional settings for ventilation

- Apnea ventilation
- Trigger settings
- Sigh
- AutoFlow
- Tube compensation (ATC)

Special maneuvers

- Suction maneuver with oxygenation
- Medication nebulization
- Manual inspiration – Inspiration hold
- Manual expiration – Expiration hold
- Intrinsic PEEP

Monitoring functions

Setting alarm limits for the following parameters:
- Expiratory minute volume ***MV***
- Maximum airway pressure ***Paw***
- Inspiratory tidal volume ***VT***
- Respiratory rate ***RR***
- Apnea alarm time T_{apn}
- End-expiratory CO_2 concentration $etCO_2$
- Time until disconnection alarm $T_{disconnect}$ (during NIV)
- Inspiratory O_2 concentration FiO_2 (in LPO mode)

In HPO mode, the alarm limits for the O_2 concentration FiO_2 are automatically linked to the FiO_2 set value.

During non-invasive ventilation and O_2 therapy, certain monitoring functions are switched off or can be switched off.

Displays on the screen

- Waveforms
- Graphical and numeric trends
- Loops
  - Pressure / Volume
  - Volume / Flow
  - Flow / Pressure
  - Volume / CO_2
  - P_{trach} / Volume
  - Flow / P_{trach}
- Logbook
- Alarm messages with information
- Configurable numerical parameters
- Lists of measured values and set values

Additional functions

- Day/Night screen switch-over
- Key lock

Power supply

Savina 300 is supplied with mains power or with power from the internal or external battery. The external battery also serves as power supply during patient transport.

Gas supply

An internal turbine supplies Savina 300 with ambient air.

O_2 supply

- High Pressure Oxygen (HPO) from the central gas supply system or from compressed gas cylinders
- Low Pressure Oxygen (LPO) from an external low-pressure oxygen source, e.g., O_2 concentrator

For supply from compressed gas cylinders, Savina 300 can be equipped as follows:
- Trolley with gas cylinder holder (see page 46)
- Compact trolley with gas cylinder holder (see page 47)
- Trolley with a transport supply unit (see instructions for use for "Transport Supply Unit")

Data transfer

The COM port (serial RS232 interface) can be used for data transfer via the MEDIBUS or MEDIBUS.X protocol.

Medication nebulization

For medication nebulization a pneumatic medication nebulizer can be connected.

Transport of patients

For transporting patients, the Savina 300 trolley can be coupled to a bed. For additional information, see instructions for use "Bed Coupling".

Abbreviations

Abbreviation	Explanation
% PIF	Percentage of the peak inspiratory flow Percentage of the peak inspiratory flow
Air	Gas inlet for air
Alarm reset	Resetting or dismissing alarm messages (key on device)
Apn. vent.	Apnea ventilation
ATC	Automatic Tube Compensation Automatic tube compensation
AutoFlow	Automatic optimization of inspiratory flow
BF	Insulation class Body Floating
BTPS	Body Temperature Pressure Saturated Measured values based on the condition of the patient's lungs, body temperature 37 °C (98.6 °F), water vapor saturated gas, ambient pressure
C	Compliance
CISPR	Comité International Spécial des Perturbations Radioélectriques International Special Committee on Radio Interference
cmH_2O	Unit of measurement for pressure 1 cmH_2O = approx. 1 mbar
ΔintPEEP	Additional intermittent PEEP for sigh (set value)
ΔP_{supp}	Pressure support relative (above PEEP) (set value)
DSSS	Direct-Sequence Spread Spectrum Direct-Sequence Spread Spectrum

Abbreviation	Explanation
EMC	Electromagnetic compatibility
Emergency air intake	Safety air inlet, inspiratory relief valve (EMERGENCY AIR INTAKE)
ESD	Electrostatic Discharge Electrostatic discharge
ET	Endotracheal tube
etCO_2	End-expiratory CO_2 concentration
Exhaust	Gas outlet (EXHAUST – NOT FOR SPIROMETER)
Exp.	Label on the device, expiratory port (GAS RETURN)
Exp.	Expiration
ext.	Label on the device, external battery
FHSS	Frequency-Hopping Spread Spectrum Frequency-Hopping Spread Spectrum
FiO_2	Inspiratory O_2 concentration
FiO_2	O_2 concentration (set value)
Flow	Flow (measured value)
FlowAcc	Flow acceleration (set value)
$Flow_{ipeak}$	Peak flow
HME	Heat Moisture Exchanger Heat and moisture exchanger
hPa	Hectopascal, unit of measurement for pressure 1 hPa = 1 mbar = approx. 1 cmH_2O
HPO	High Pressure Oxygen High-pressure O_2 supply from the central gas supply system or an O_2 compressed gas cylinder

Abbreviation	Explanation
I:E	Ratio of inspiratory time to expiratory time
IBW	Ideal Body Weight Ideal body weight (kg)
incl. PEEP	PEEP that is included in the intrinsic PEEP and is measured at the end of the ***Intrinsic PEEP*** maneuver
Insp.	Label on the device, inspiratory port (GAS OUTPUT)
Insp.	Inspiration
Insp. term.	Termination criterion in % from the peak inspiratory flow
Inspiration hold	Manual inspiration (key on the device)
int.	Label on the device, internal battery
kPa	Kilopascal, unit of measurement for pressure
LPO	Low Pressure Oxygen Low-pressure O_2 supply from external oxygen sources, e.g., O_2 concentrator
mbar	Millibar, unit of measurement for pressure 1 mbar = approx. 1 cmH_2O
MEDIBUS	Dräger communication protocol for medical devices
MEDIBUS.X	Dräger communication protocol for medical devices with simplified data definition across devices
mmHg	Millimeter of mercury column
MRI	Magnetic Resonance Imaging Magnetic resonance imaging
MV	Overall minute volume
MV_{leak}	Leakage minute volume
MV_{spon}	Spontaneous breathing portion of minute volume

Abbreviation	Explanation
NIV	Non-Invasive Ventilation Non-invasive ventilation
NMI	Nuclear Magnetic Imaging Nuclear magnetic imaging
NMR	Nuclear Magnetic Resonance Nuclear magnetic resonance
NTPD	Normal Temperature Pressure Dry 20 °C (68 °F), 1013 hPa, dry
O_2	Label on the device, port for O_2 compressed gas hose
Paw	Airway pressure
PC-AC	Pressure Control-Assist Control Assisted-controlled, pressure-controlled ventilation with backup respiratory rate
PC-APRV	Pressure Control-Airway Pressure Release Ventilation Spontaneous breathing under continuous positive airway pressure with brief pressure releases
PC-BIPAP	Pressure Control-Biphasic Positive Airway Pressure Spontaneous breathing under continuous positive airway pressure with 2 different pressure levels
PEEP	Positive end-expiratory pressure (set value)
PEEPi	Intrinsic PEEP
P_{high}	Upper pressure level in PC-APRV (set value)
P_{insp}	Inspiratory pressure (set value)
PIP	Peak Inspiratory Pressure Peak inspiratory pressure
Plateau	Inspiratory pause time

Abbreviation	Explanation
P_{max}	Maximum allowed airway pressure (set value)
P_{mean}	Mean airway pressure
P_{plat}	End-inspiratory airway pressure
PS	Pressure Support Pressure support
P_{supp}	Pressure support absolute
P_{low}	Lower pressure level in PC-APRV (set value)
P_{trach}	Tracheal pressure
R	Resistance
REF	Material and revision number of the medical device
RR	Respiratory rate (set value)
RR_{apn}	Respiratory rate of apnea ventilation (set value)
RR_{spon}	Spontaneous breathing portion of respiratory rate
RSB	Rapid Shallow Breathing Quotient of spontaneous respiratory rate and tidal volume
SELV	Safety Extra-low Voltage Safety extra-low voltage
SN	Device serial number
SPN-CPAP	Spontaneous-Continuous Positive Airway Pressure Spontaneous breathing with continuous positive pressure level
SpO_2	Peripheral O_2 saturation
T_{apn}	Apnea alarm time
$T_{disconnect}$	Time until disconnection alarm during non-invasive ventilation
T_e	Expiratory time
Temp	Inspiratory breathing gas temperature
T_{high}	Time of upper pressure level in PC-APRV (set value)

Abbreviation	Explanation
T_i	Inspiratory time (set value)
T_i	Inspiratory time (measured value)
T_{imax}	Maximum inspiratory time for flow during pressure support (set value)
T_{plat}	Plateau time
Trach.	Tracheostomy tube
Trigger	Trigger threshold, sensitivity (set value)
T_{low}	Time of lower pressure level in PC-APRV
Tube Ø	Inner diameter of the tube (set value)
UMDNS	Universal Medical Device Nomenclature System Nomenclature for medical devices
U_N	Rated voltage
VC-AC	Volume Control-Assist Control Assisted-controlled, volume-controlled ventilation with fixed inspiratory flow and backup respiratory rate
VC-CMV	Volume Control-Continuous Mandatory Ventilation Continuous volume-controlled ventilation
VC-MMV	Volume Control-Mandatory Minute Volume Ventilation Volume-controlled ventilation to ensure a mandatory minute volume
VC-SIMV	Volume Control-Synchronized Intermittent Mandatory Ventilation Intermittent, triggered, volume-controlled ventilation
Vol%	Percentage of gas, related to the total volume

Abbreviation	Explanation
VT	Tidal volume (set value)
VT	Patient's leakage-compensated tidal volume, measured on the inspiratory side
VT / IBW	Tidal volume relative to ideal body weight
VT_{apn}	Tidal volume of apnea ventilation (set value)
VT_{e}	Expiratory tidal volume
V_{trap}	Volume trapped in the lung by intrinsic PEEP and not exhaled during subsequent expiration
VT_{spon}	Tidal volume during a spontaneous breath

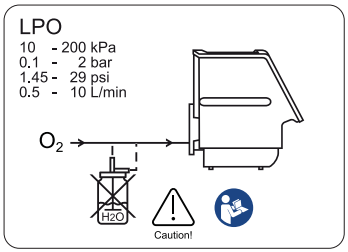
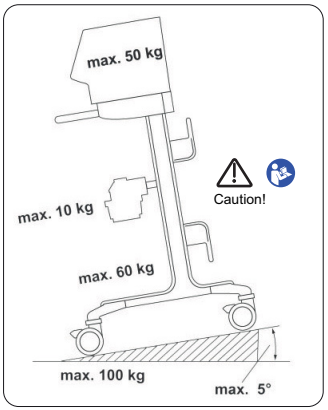
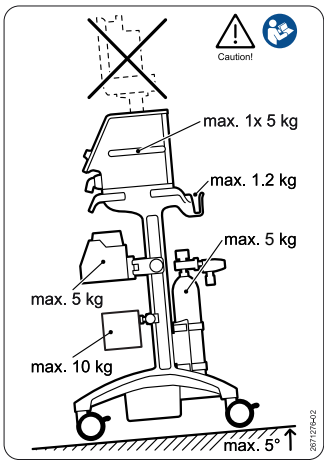
Symbols

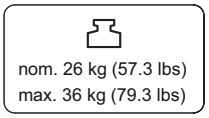
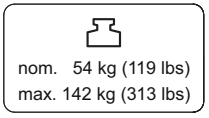
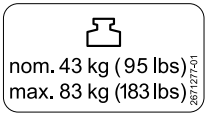
Symbol	Explanation
	***Audio paused 2 min.*** key suppresses the acoustic alarm for 2 minutes
	***Alarm reset*** key resets or confirms an alarm message
	***Suction*** key performs a suction maneuver
	***Nebul. on/off*** key switches the medication nebulizer on or off
	***Start/Standby*** key opens the page ***Start/Standby***
	Alarms group Setting of alarm limits
	Therapy group Setting ventilation modes and ventilation parameters
	Trends/data group Information on the course of ventilation
	View group Change to screen layout
	Special maneuvers group
	Configuration group System settings and settings for sensors
	Device switched on
	Device switched off
	Expiratory valve locked
	Expiratory valve unlocked
	Alarm limit deactivated
	Lower alarm limit
	Upper alarm limit
	In lists: One line up

Symbol	Explanation
	In lists: One page up
	In lists: One line down
	In lists: One page down
	Open ***Ventilation settings*** dialog window
	Close dialog window
	Adults patient category
	Pediatric patients patient category
	Spontaneous breathing activity by the patient
	NIV Non-invasive ventilation
	Mains power supply (AC voltage)
	Power supply from the internal battery
	Power supply from the external battery
	Charge state of internal battery >80 %
	Charge state of internal battery >60 %
	Charge state of internal battery >40 %
	Charge state of internal battery >20 %
	Charge state of internal battery >10 %
	Charge state of internal battery ≤10 %
	Gas outlet (EXHAUST – NOT FOR SPIROMETER)
	Potential equalization connector
	Protective earth
	Nurse call
	Applied part type BF
	Port for CO_2 sensor

Symbol	Explanation
	Caution: Observe important safety information and precautions in the instructions for use
	Instructions for use, observe
	Warning! Strictly follow these instructions for use
	General mandatory action
	Marking on device surfaces where the risk of tipping over is increased when pushed, leaned against, used as a support, etc.
	Do not cover housing
	The product contains hazardous substances
	Temperature range during storage
	Atmospheric pressure
	Relative humidity
	Use by
	Do not reuse
	Protect from moisture
	ESD warning symbol
	ESD warning symbol on device
	Information on disposal
	Manufacturer
 20XX	Manufacturing date
MD	The product is a medical device (CE conformity assessment procedure)

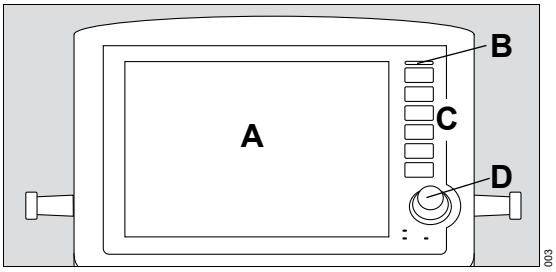
Product labels

Product label	Explanation
	LPO port O_2 flow: 0.5 to 10 L/min O_2 pressure: 0.1 to 2 bar / 1.45 to 29 psi Use only dry gas. Do not connect a humidifier to the LPO inlet.
	Maximum loads and conditions for the tipping stability when using the trolley
	Maximum loads and conditions for the tipping stability when using the compact trolley

Product label	Explanation
	Nominal weight and maximum weight for the basic unit
	Nominal weight and maximum weight for the basic unit with trolley
	Nominal weight and maximum weight for the basic unit with compact trolley

Operating concept

Control and display unit



A Screen with information and controls

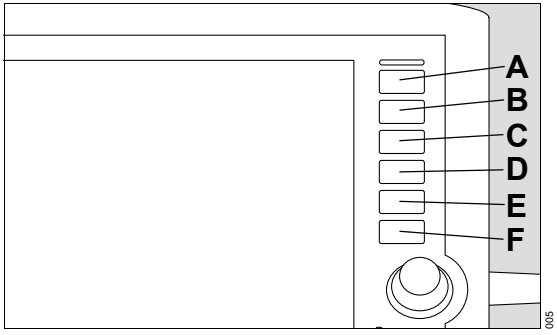
B LED flashes:
- Red for alarms with high priority
- Yellow for alarms with medium priority

C Fixed function keys

D Rotary knob for selecting and confirming settings

Fixed function keys

All the keys, except ***Alarm reset***, contain an LED, which lights up yellow when the key is pressed.



A ***Audio paused 2 min.***
Suppresses the acoustic alarm for 2 minutes

B ***Alarm reset***
Resets or dismisses alarm message

C O_2 ***Suction***
Starts or terminates the suction maneuver

D ***Nebul. on/off***
Switches the medication nebulizer on or off

E ***Inspiration hold***
Starts the manual inspiration

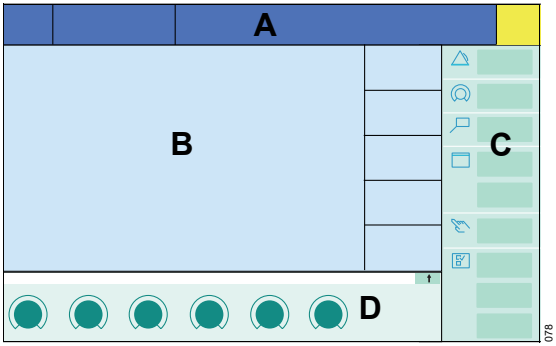
F ***Start/Standby***
Opens the ***Start/Standby*** page

Screen

This chapter describes the layout of the main screen and the basic operating features.

Main screen

The main screen displays the most important ventilation information at a glance.



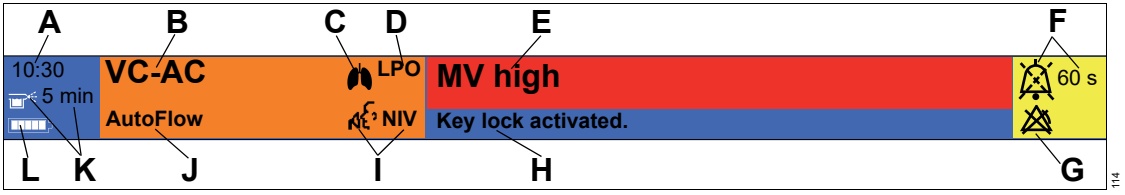
A **Header bar**, see page 37.

B **Monitoring area** for displaying parameters in the waveform field and in parameter fields, see page 118.

C **Main menu bar** with buttons for opening dialog windows and activating functions, see page 38.

D **Therapy bar** with the therapy controls for the ventilation parameters of the active ventilation mode, see page 39.

Header bar



A Time, e.g., ***10:30***

B Active ventilation mode, e.g., ***VC-AC***

C Spontaneous breathing activity by the patient

D LPO mode active

E Alarm messages, e.g., ***MV high***

F Acoustic alarm signal suppressed, remaining time, e.g., ***60 s***

G Alarm limit deactivated

H Information and instructions, e.g., ***Key lock activated.***

I Application mode ***NIV***

J Additional settings, e.g., ***AutoFlow***

K Medication nebulization active, remaining time, e.g., ***5 min***

L Charge state of the internal battery (during operation with an internal battery)

Main menu bar

The main menu bar contains buttons that are assigned to various groups. Touching a button opens the corresponding dialog window or activates the corresponding function.

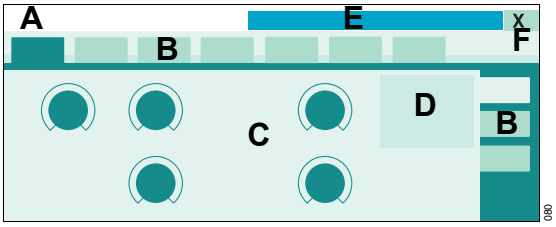
Group symbol	Button and meaning
	Alarms... Opens the dialog window for setting the alarm limits, see page 111
	Ventilation settings... Opens the dialog window for setting the ventilation mode, the additional settings, and the ventilation parameters, see page 86
	Trends/Data... Opens the dialog window for displaying all the measured and set values, the trend table, and the logbook, see page 113
	Day/Night Switches over the screen layout, see page 99
	Freeze waveforms Freezes waveforms, see page 119
	Special maneuvers... Opens the dialog window for selecting special maneuvers, see page 96
	Sensors... Opens the dialog window for calibrating the sensors and switching the monitoring on or off, see "Monitoring" on page 121
	System setup... Opens the dialog window for configuring the device functions, see page 133
	Key lock Locks all keys and buttons, see page 99

Dialog window

Dialog windows contain elements for operating the device and inform the user of current settings.

Dialog windows can be opened by touching a button in the main menu bar or by touching the monitoring area.

Example: Dialog window ***Ventilation settings***



A Dialog window title

B Tab to open a page

C Opened page of the dialog window

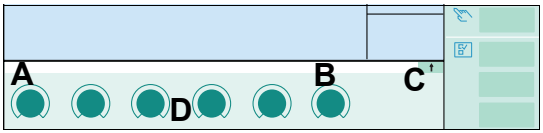
D Current additional settings

E Message field for dialog-specific information and instructions

F Button for closing the dialog window

Therapy bar

The therapy bar on the main screen contains the therapy controls for the active ventilation mode.



A Name of active ventilation mode

B Message field for specific messages on the active ventilation mode

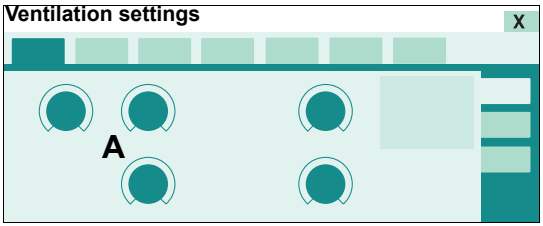
C Button for opening the dialog window for the ventilation settings of the active ventilation mode

D Therapy controls

Therapy controls

The therapy controls (A) are used to set the ventilation parameters.

Therapy controls are contained in the therapy bar of the active ventilation mode and in the dialog window for the ventilation settings.



Controls and color scheme

The following controls are available:
– Tab
– Therapy controls
– Buttons

Colors indicate the status of the controls and the availability of functions.

Meaning of the colors

Color	Example	Meaning
Dark green		Element is available Function is activated
Yellow		Element is selected but has not yet been confirmed with the rotary knob Function is not activated
Light green		Element is available Function is not activated
Gray		Element is not available Function is not activated

Selecting and making settings

Selecting a control

1 Touch the control.

The control turns yellow.

2 Press the rotary knob to confirm.

The selection is adopted, the control turns back to light green or dark green.

Some buttons are immediately active without any additional confirmation. The color immediately turns dark green.

Selecting a control and changing the setting

1 Touch the control.

The control turns yellow. For therapy controls, the unit is additionally displayed.

2 To make the setting, turn the rotary knob to the right or left.

3 Press the rotary knob to confirm.

The setting is adopted, the control turns back to light green or dark green.

Canceling the setting or changing process

Prerequisite: Control is still yellow

To cancel a change and keep the previous setting, do one of the following:

- Touch control again.
- Touch another control.
- Do not press the rotary knob. After 15 seconds, the change is reset.

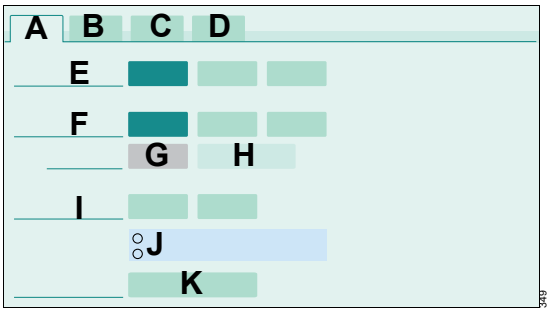
Savina 300 displays a low-priority alarm message.

- Press the ***Alarm reset*** key.

The previous setting continues to apply.

Start/Standby page

When the device is switched on or the ***Start/Standby*** key is pressed, Savina 300 opens the ***Start/Standby*** page.



Some functions may not be available on the ***Start/Standby*** (A) page depending on the device configuration. This changes the arrangement of the rows.

E ***Therapy type***

F ***Patient admission***

G Body height

H Ideal body weight ***IBW***

I ***Check settings***

J Results of the last device check and breathing circuit check performed since the device was last switched on.

Green dot	:	Check passed
Red dot	:	Check failed
Empty dot	:	No check performed or check canceled

K ***Start ventilation*** or ***Start O_2 therapy*** or ***Standby***

The following pages can be opened:

B ***Device check***

C ***Breathing circ. check***

D ***Check results***

Assembly and preparation

Safety information

WARNING

Risk of personal injury

If medical devices are not reprocessed, there is an increased risk of infection to both hospital staff and patients.

Before each use, reprocess the device and all accessories in accordance with the instructions for use, see "Reprocessing" on page 171. Observe the infection prevention policies of the hospital.

WARNING

Risk of personal injury and damage to the device

If the device is not securely fastened, it can fall down.

Fasten the device securely. Check for secure fit.

Preparing the trolley

The following chapter describes how to mount accessories onto the trolley.

Prerequisites:
– Required accessories must be mounted by service personnel.
– Assembly instructions and the maximum loads must be observed.

WARNING

Risk of personal injury due to damaged trolley

If, for instance, the double castors are faulty, the device may move unintentionally.

Do not use the trolley if there is visible damage. Contact specialized service personnel.

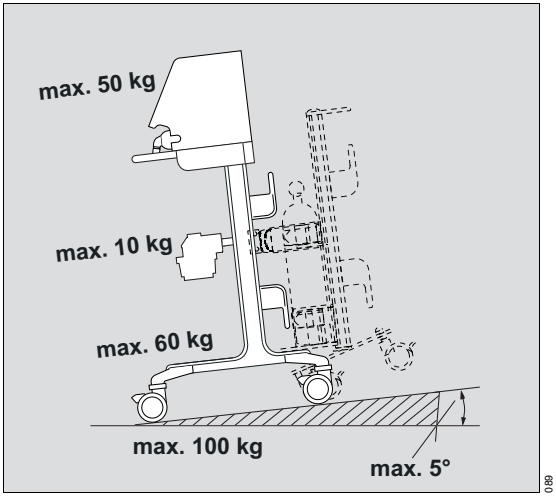
Load and tipping stability of the Dräger Savina 300 trolley

WARNING

Risk of personal injury and damage to the device

If Savina 300 is equipped with a transport supply unit and is used at inclinations >5°, there is a risk of tipping over.

On inclined surfaces, the combination must be arranged so that the transport supply unit is always at the upper end.



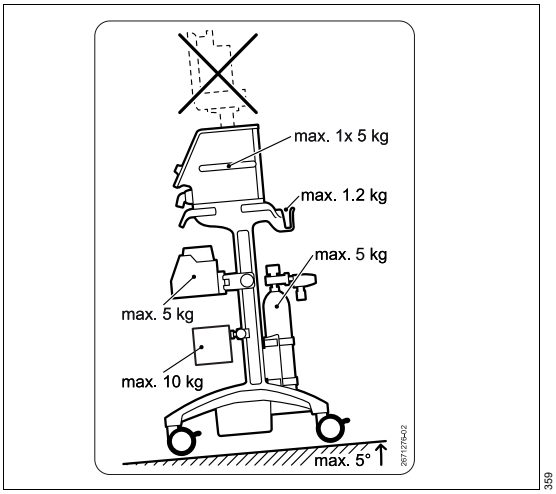
The maximum total load of the trolley must not exceed 100 kg (220.5 lb).

For the individual areas, the following load limits apply:

Range	Maximum load	Examples
Shelf	50 kg (110.2 lb)	Device, patient monitor with holder, hinged arm
Universal holder or	10 kg (22.0 lb)	Breathing gas humidifier or medication nebulizer
Humidifier holder	5 kg (11.0 lb)	
Base plate	60 kg (132.3 lb)	Compressed gas cylinders, external battery

See also chapter Technical data, "Maximum load" on page 213.

Load and tipping stability of the Dräger Savina 300 compact trolley



For the individual areas, the following load limits apply:

Range	Maximum load	Examples
Shelf	31 kg (68.3 lb)	Device: 26 kg (57.3 lb)
		Hinged arm: 5 kg (11.0 lb)
Universal holder	10 kg (22.0 lb)	Medication nebulizer
Humidifier holder	5 kg (11.0 lb)	Breathing gas humidifier
Cylinder holder	5 kg (11.0 lb)	Compressed gas cylinder: 4 kg (8.8 lb)
		Pressure regulator: 1 kg (2.2 lb)
At the bottom	17 kg (37.5 lb)	External battery

See also chapter Technical data, "Maximum load" on page 213.

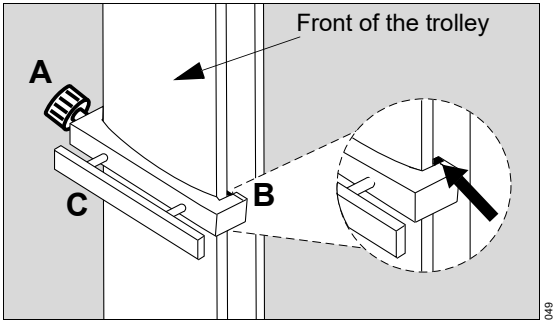
Fitting the holders for accessories

To secure the accessories, the following holders can be fitted to the front of the trolley:
– Universal holder with standard rail
– Humidifier holder with standard rail

The humidifier holder can be fastened on the left or right-hand side of the trolley column.

Fitting a universal holder

1 Unscrew the adjusting screw (A) completely.



2 Attach the right-hand side of the universal holder to the right-hand side of the rail (B). Make sure that the catch of the universal holder is completely in the groove.

3 Align the universal holder (C) horizontally and press the left-hand side of the universal holder onto the left-hand side of the column.

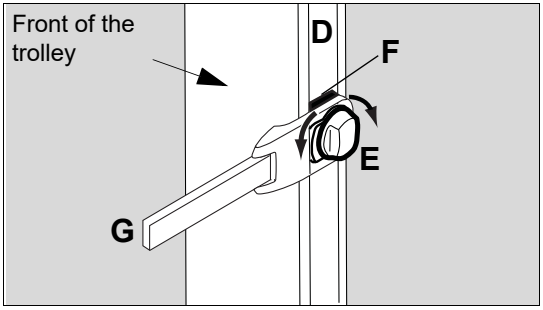
4 Tighten the adjusting screw (A). Make sure that the catch of the universal holder is completely in the groove.

5 Check that the universal holder is fixed securely.

When the universal holder is fitted and only the height must be adjusted, it is sufficient to loosen the adjusting screw (A).

Fitting a humidifier holder

1 Hold the humidifier holder at the desired height to the groove (D) of the trolley column.



2 Turn the clamping screw (E) to the left until the base (F) fits into the groove of the trolley column.

3 Turn the clamping screw (E) to the right until the humidifier holder is secured firmly in the groove.

4 Move the standard rail (G) to the desired position.

Mounting O_2 compressed gas cylinders to the trolley

Prerequisites:

– Gas cylinder holder option is available.

– Compressed gas cylinders have the following dimensions:

	Diameter	Length incl. pressure reducer
Trolley	80 to 176 mm (3.15 to 6.93 in)	420 to 760 mm (16.54 to 29.92 in)
Compact trolley	85 to 106 mm (3.35 to 4.17 in)	290 to 535 mm (11.42 to 21.06 in)

WARNING

Risk of personal injury and damage to the device

If the compressed gas cylinders are not securely fastened to the trolley, they can fall down.

Securely attach the compressed gas cylinders to the trolley using both hook-and-loop straps.

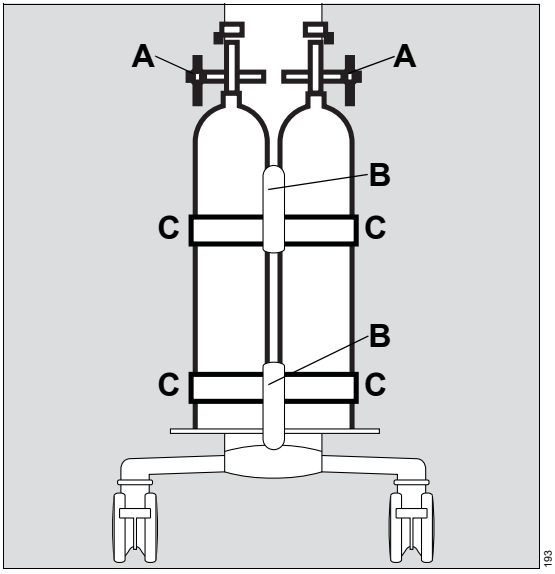
WARNING

Risk of personal injury and damage to the device

If the pressure reducers protrude beyond the device, they may be damaged during transport.

Position the compressed gas cylinders in a way that prevents damage being caused to the pressure reducers.

Trolley for Savina 300



A Pressure reducer

B Hose holder

C Hook-and-loop straps

Mount the compressed gas cylinders:

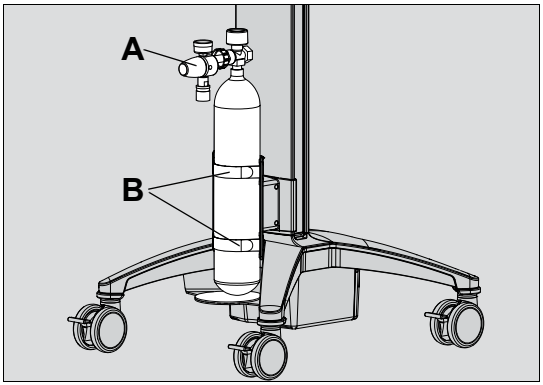
1 Place the compressed gas cylinders into the mountings on the trolley.

2 Secure each compressed gas cylinder with 2 hook-and-loop straps (C). If required, have service personnel perform the following adjustments:

- Adjust the height of the upper gas cylinder holder to the compressed gas cylinders to be used. The height must be adjusted so that the top half of the compressed gas cylinders is held firmly in place by the upper cylinder holder.
- Replace the hook-and-loop straps. The length of the hook-and-loop straps must match the circumference of the compressed gas cylinders.

3 Secure the compressed gas hoses by hanging them over the hose holders (B).

Compact trolley for Savina 300



A Pressure reducer

B Hook-and-loop straps

Mount the compressed gas cylinder:

1 Place the compressed gas cylinder into the mounting on the trolley.

2 Secure the compressed gas cylinder with 2 hook-and-loop straps (B). If required, have service personnel perform the following adjustments:

- Adjust the height of the upper gas cylinder holder to the compressed gas cylinder to be used. The height must be adjusted so that the top half of the compressed gas cylinder is held firmly in place by the upper cylinder holder.
- Replace the hook-and-loop straps. The length of the hook-and-loop straps must match the circumference of the compressed gas cylinders.

3 Hang the compressed gas hose over the hose holder.

Mounting the ventilator to the trolley

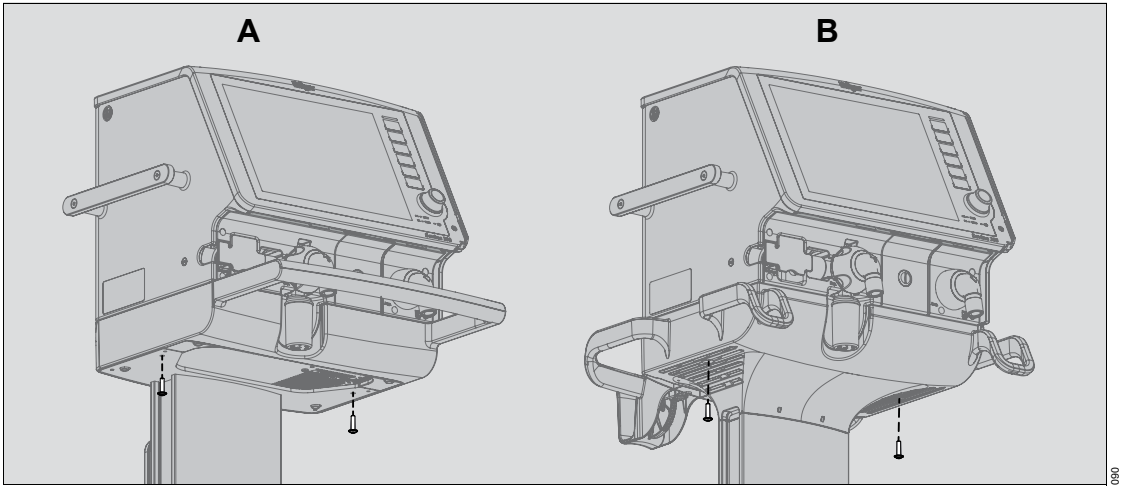
Prerequisite: The assembly instructions for the trolley to be used are observed.

WARNING

Risk of personal injury and damage to the device

If the device is not securely fastened to the trolley, it can fall down.

Fasten the device securely. Check for secure fit.



1 Insert the device into the mounting.

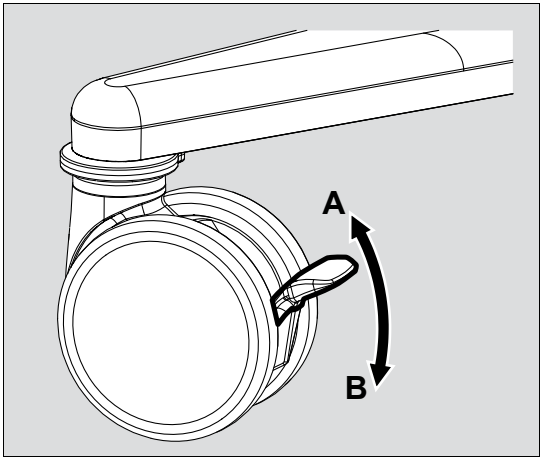
2 Fasten with 2 screws from underneath:
- Trolley (A): M5 x 12
- Compact trolley (B): M5 x 20

Parking the trolley

CAUTION
Risk of patient injury

If the brakes are not locked, the trolley can move on inclined surfaces, putting the patient at risk.

For stationary operation, lock all of the trolley's brakes and check the function of the brakes.



A Brake released

B Brake locked

Parking the trolley for stationary operation:

1 Lock all brakes of the trolley.

2 Check that the brakes are functioning correctly.

Fitting an additional monitor

Information on installation

Monitors can be mounted on the ventilator using the corresponding holder.

WARNING
Risk of tipping over

If a monitor is mounted onto Savina 300, there is a risk of tipping over.

The device combination is only permitted on the trolley for Savina 300.

If the compact trolley for Savina 300 is used, do not use an additional monitor.

Infinity monitors

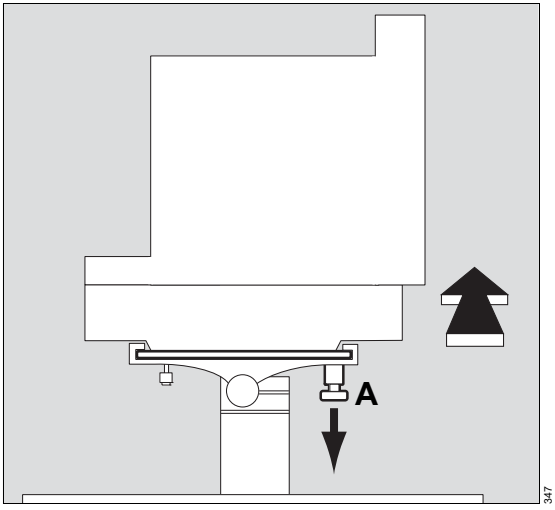
The following monitors can be mounted and connected to the MEDIBUS interface:

Infinity monitors	Mounting on Savina 300	Connection to MEDIBUS interface
Gamma	With docking station	No
Gamma XL		
Gamma XXL		
Delta	With docking station	Yes
Delta XL		
Vista	Mounted directly	No
Vista XL		
Vista 120		
Kappa	No	Yes
Kappa XLT		

Prerequisites:
The instructions for use for the relevant monitor must be observed. In particular:
– The conditions required for operation with Savina 300 (signal converter, cable, etc.)
– Which parameters can be displayed.

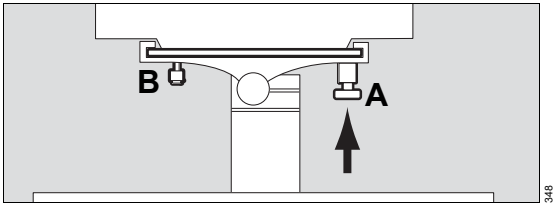
Mounting an Infinity monitor on Savina 300

Prerequisites:
– The corresponding holder is mounted on Savina 300.
– The insertion plate is mounted on the underside of the monitor or the docking station.



1 Pull out the locking bolt (A).

2 Push the monitor or docking station with the insertion plate into the holder.



3 Position the monitor in the middle so that the locking bolt (A) engages in the hole in the insertion plate.

4 Tighten the nylon screws (B) (2 pieces) by hand.

Preparing the ventilator

Preparing the expiratory valve

WARNING

Risk of patient injury

Expiratory valves that are damp or have not been reprocessed can impair the operation of the device and endanger the patient.

Only use properly reprocessed expiratory valves which have been sufficiently dried.

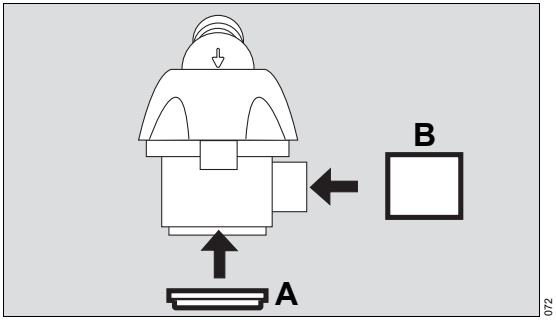
CAUTION

High airway pressures and auto-triggering

If the water trap container on the expiratory valve is missing, there is a danger of excessively high airway pressures and auto-triggering due to leakage overcompensation.

Always attach the water trap container.

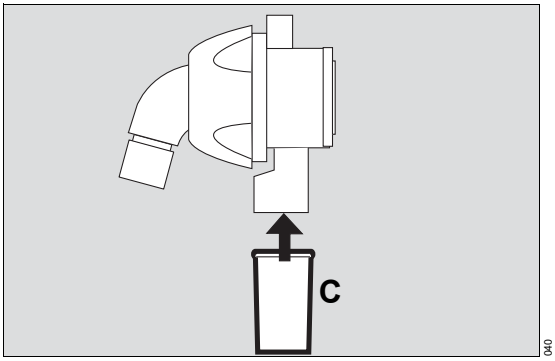
Assembling the expiratory valve



1 Fit the diaphragm (A) onto the edge of the expiratory valve housing.

2 Make sure that the diaphragm is fitted properly.

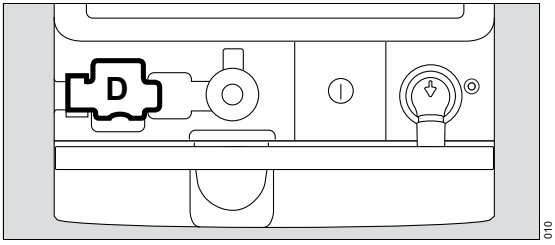
3 If the flow sensor sleeve (B) has been removed, fit the flow sensor sleeve.



4 Attach the water trap container (C).

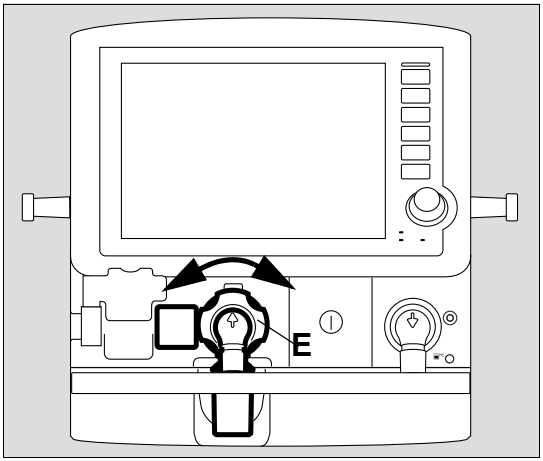
Opening the flap

Open the flap (D) before inserting the expiratory valve.



- Lift the flap (D) by the lower edge and pivot it upwards.

Fitting the expiratory valve



1 Turn the locking ring (E) as far as possible to the left.

2 Push the expiratory valve into the fitting.

3 Turn the locking ring (E) as far as it will go to the right until it clicks audibly into place.

4 Check that it is properly secured by gently pulling on the expiratory valve.

Additional information

Savina 300 can be equipped with the MP01781 expiratory filter.

Prerequisite: Savina 300 must be mounted on the trolley.

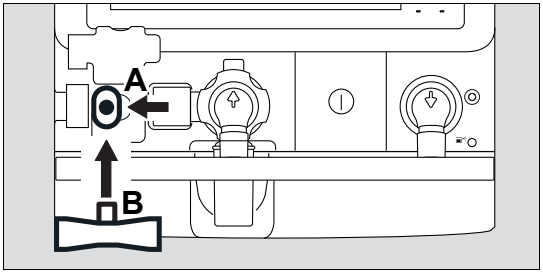
For more information, see the instructions for use for "Expiratory filter".

Fitting the flow sensor

WARNING
Risk of fire

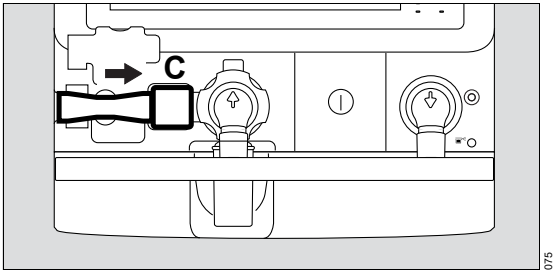
Residual vapors of highly flammable disinfectants (e.g., alcohols) and deposits that were not removed during reprocessing may ignite when the flow sensor is in use.
- **Ensure particle-free cleaning and disinfection.**
- **After disinfection, allow the flow sensor to air for at least 30 minutes.**
- **Before inserting the flow sensor check for visible damage and soiling, such as residual mucus, medication aerosols, and particles.**
- **Replace flow sensors when damaged, soiled, or not particle-free.**

Prerequisite: The flap is open.



1 Push the socket (A) as far to the left as it will go.

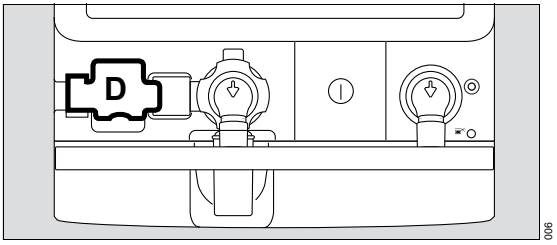
2 Insert the flow sensor (B) into the socket with the plug facing towards the device and push it into the socket as far as it will go.



3 Push the flow sensor as far to the right as it will go into the flow sensor sleeve (C) of the expiratory valve.

Closing the flap

When the expiratory valve and the flow sensor are fitted, tilt the flap (D) downwards.



Leave the flap closed during ventilation.

Information on breathing circuits and additional components

Additional components in the breathing circuit can increase the inspiratory and expiratory resistance values and exceed standard requirements.

Examples of additional components:
– Bacterial filters, inspiratory and expiratory
– HME
– CO_2 cuvette
– Coaxial hoses

CAUTION

Increased compliance or resistance

Additional components in the breathing circuit such as bacterial filters, HMEs, or CO_2 cuvettes increase dead space, compliance, and resistance of the breathing circuit. Depending on the ventilation mode, either the flow or the pressure rises.

When using additional components, particular care and monitoring are required.

Using bacterial filters or HMEs

Savina 300 is designed to minimize the patient's work of breathing. The use of bacterial filters or HMEs requires particular care and monitoring by the user. Especially during medication nebulization and humidification, the resistance of the expiratory bacterial filter may increase gradually.

CAUTION

Increased resistance

Medication nebulization and active humidification can increase the resistance of bacterial filters.

Regularly check bacterial filters for increased resistance.

If HME filters and additional bacterial filters are used, the resistance may be too high.

Consequences of high resistance

High resistance values lead to increased work of breathing and trigger effort in assisted ventilation. Under unfavorable conditions, this can lead to an undesirable intrinsic PEEP, which can be recognized by the fact that the expiratory flow does not return to "baseline" at the end of expiration. If the PEEP is unacceptably high, this is indicated by an alarm. The measured PEEP is then approx. 8 mbar (8 cmH_2O) above the set PEEP. Check the bacterial filter and replace it if it is the cause of the PEEP alarm.

Monitoring resistance

Savina 300 cannot directly monitor resistance in the patient port. For this reason:

1 Check the patient’s condition.

2 Monitor the device's measured values for volume and resistance.

3 Observe the instructions for use for the HMEs, bacterial filters, and breathing circuits in use.

NOTE

Operation of the device is ensured within the specified accuracy if the use of additional components does not cause the maximum values for resistance and compliance to be exceeded. For detailed information, refer to section "Performance characteristics" on page 201.

Using coaxial hoses and extendable hoses

Coaxial hoses and extendable hoses have a higher resistance than normal double-lumen breathing hoses. If the patient therapy requires very short expiratory times, an undesirably high intrinsic PEEP may occur as a result of the increased resistance of these breathing hoses. If the PEEP values are unacceptably high, this is indicated by an alarm.

CAUTION

Undesirable intrinsic PEEP

When using coaxial hoses or extendable hoses, an undesirable intrinsic PEEP may occur with very short expiratory times (<0.75 s).

Use double-lumen breathing hoses or set the expiratory time to a value above 0.75 s if the patient therapy allows this.

Fitting the bacterial filter

An HME filter can be used instead of a bacterial filter. If an HME without filter function is used, a bacterial filter must still be inserted.

CAUTION

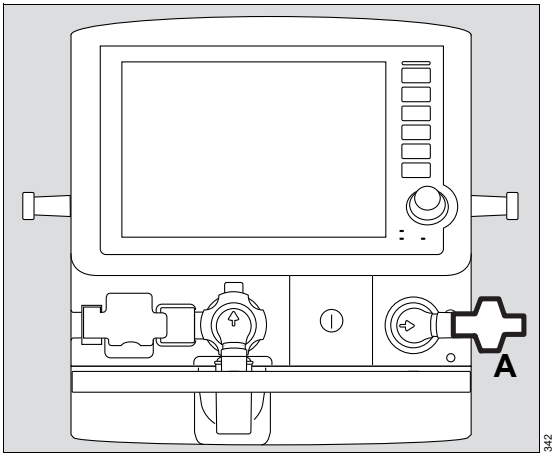
Risk of infection

If no inspiratory bacterial filter is used, the patient can be infected by aspirated ambient air.

Use an inspiratory bacterial filter.

The inspiratory bacterial filter can be placed on the inspiratory port or on the patient port of the breathing circuit.

Bacterial filter on the inspiratory port



- Fit the bacterial filter (A) onto the inspiratory port.

Fitting the breathing gas humidifier

Prerequisite: The breathing gas humidifier is prepared in accordance with the corresponding instructions for use.

CAUTION

High resistance

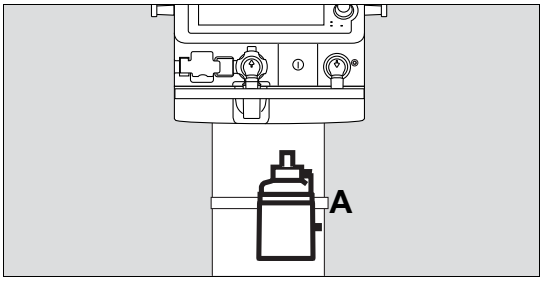
If an HME and a breathing gas humidifier are used at the same time, resistance can increase.

Use either HME or breathing gas humidifier.

The breathing gas humidifier can be fitted in the following ways:
– on the standard rail of the universal holder
– on the humidifier holder

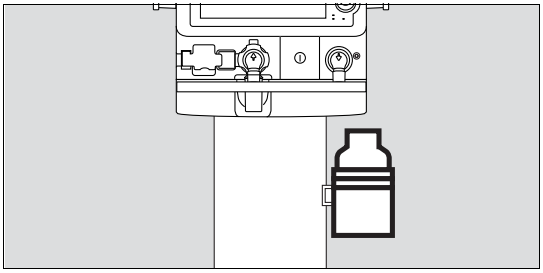
If the external battery is attached to the trolley, the humidifier holder must be used when fitting the breathing gas humidifier.

Fitting the breathing gas humidifier to the universal holder



- Hang the breathing gas humidifier onto the standard rail (A) under the ventilator using the clamp and screw firmly into place.

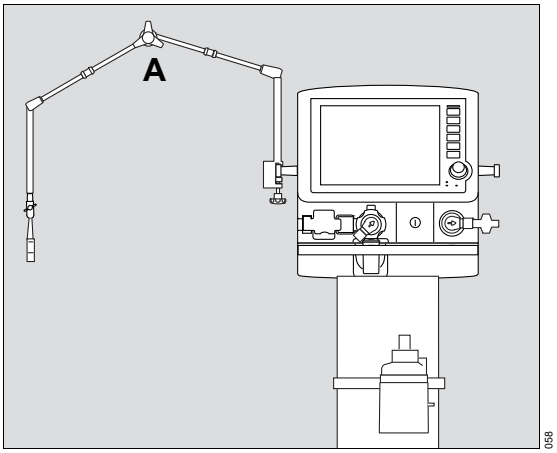
Fitting the breathing gas humidifier to the humidifier holder



1 Connect the breathing gas humidifier to the humidifier holder of the trolley.

2 Tilt the breathing gas humidifier into the correct position.

Fitting the hinged arm



- Hang the hinged arm (A) on the lateral standard rail of Savina 300 and tighten the screws. Depending on the position of the device in relation to the bed, the hinged arm can be fitted on the right side or the left side.

Fitting the breathing circuit

Prerequisite: The breathing circuit used is suitable for the respective patient.

WARNING

Risk of electric shock and of fire

The use of antistatic or conductive breathing hoses increases the risk of electric shock to the patient and the risk of fire in an oxygen-enriched environment.

Do not use antistatic or conductive breathing hoses.

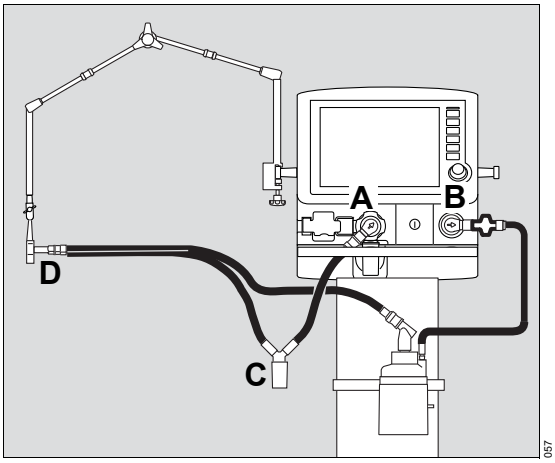
WARNING

Risk of patient injury

The inspiratory breathing gas is warmed by the turbine. If the total length of the inspiratory hoses is too short, the breathing gas temperature at the Y-piece may exceed the permissible limit.

To ensure appropriate cooling of the breathing gas, the total length of the inspiratory hoses must be at least 1.2 m (4 ft).

Fitting the breathing hoses for ventilation



1 Connect breathing hoses to the inspiratory port (B) and to the expiratory port (A).

CAUTION

If the inspiratory and expiratory ports are switched, humidification will have no effect.

Connect the breathing hoses correctly.

2 Turn the inspiratory port and expiratory port in the direction of hoses.

Depending on the breathing gas humidifier and the breathing circuit used, a water trap may be required.

3 If a water trap is required, install the water trap (C) in a vertical position.

4 Connect the Y-piece (D) to the breathing hoses.

5 Insert the Y-piece or the breathing hoses in the opening of the hinged arm.

6 Check the breathing circuit, see page 75.

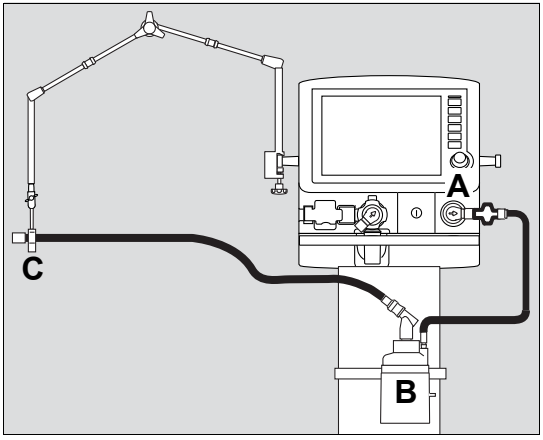
Fitting the breathing hoses for O_2 therapy

Special heated breathing circuits for O_2 therapy or heated breathing circuits for ventilation can be used for O_2 therapy. If breathing circuits for ventilation are used, observe the following:

– If necessary, use the adapters of connector set MP01940 or MP01942.
– Use only the inspiratory limb of the breathing circuit without the Y-piece.

Prerequisites:

– The Fisher & Paykel MR 850 breathing gas humidifier is used.



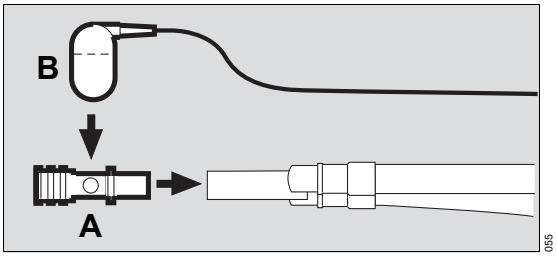
1 Connect both breathing hoses to the breathing gas humidifier (B).

2 Connect one breathing hose to the inspiratory port (A).

3 Insert the other breathing hose in the opening of the hinged arm (C).

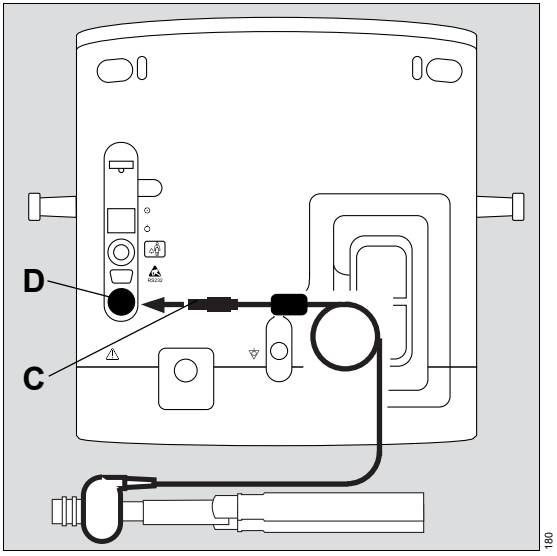
The expiratory port on the device remains open.

Fitting the CO_2 cuvette and CO_2 sensor



1 Insert the cuvette (A) into the patient port of the Y-piece. The cuvette windows are facing to the side.

2 Fit the CO_2 sensor (B) on the cuvette. The cable is facing towards the device.



3 Insert the connector (C) of the CO_2 sensor into the socket (D) at the rear of Savina 300.

4 Select the cuvette type, see page 126.

Additional information

Checking the CO_2 sensor, see page 127.

Connecting the power supply

Mains power supply

Savina 300 is designed for connection to the hospital's mains power supply.

WARNING

Risk due to incorrect mains voltage or missing protective ground

If the device is connected to a power socket with incorrect mains voltage or a power socket without a protective ground, an electric shock may occur.

Connect the device only to power sockets with correct mains voltage and a protective ground.

NOTE

In operation, the power socket used must be readily accessible.

Connecting the mains power supply

Prerequisites:
– Mains voltage: 100 V to 240 V, 50 Hz to 60 Hz
– The fuse for the internal battery has been inserted, see page 61.

- Insert the power plug into the power socket.

The LED lights up green.

Battery supply

WARNING

Risk of explosion

Electrolytic gas can occur when the batteries are charging. In a sufficient concentration, this can cause an explosion.

The device must always be placed in a well-ventilated area when connected to mains power.

Savina 300 has an internal battery and can additionally be powered from an external battery. The internal and external batteries differ as follows:

	Internal battery	**External battery**
Scope of delivery	Included	Not included
Operating time	See "Operating data" on page 210	
Charging time		

Operating time

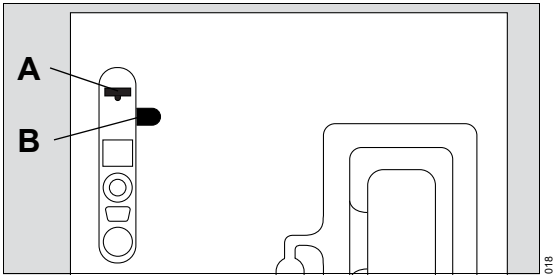
The maximum operating time is achieved when the battery is new and fully charged. The operating time depends on the following factors:
– State of charge
– Age
– Number of charging cycles
– Speed of the turbine (for increased loads, e.g., due to increases in ventilation pressure or flow acceleration, the operating time is reduced)

Charging time

The charging time increases significantly when the battery is warm, e.g., from high ambient temperatures or after a deep discharge.

Inserting the fuse for the internal battery

Before first use and after storage of Savina 300, the fuse for the internal battery must be inserted.



1 Take the fuse out of the storage recess (B).

2 Insert the fuse into the slot (A).

Connecting the external battery

Prerequisite:
The external battery may only be mounted and connected by service personnel.

CAUTION
Risk of damage to device
– Do not connect mains-operated devices to the connection for the external battery.
– Only connect external batteries which are contained in the list of accessories. Only use the specified connection cables.

Using the power supply

Power is supplied according to the following rules:

Mains power	External battery (optional)	Internal battery
Present	Not in use	Not in use
Insufficient	In use	Not in use
Insufficient	Discharged	In use

Power supply from the internal battery

If Savina 300 is powered from the internal battery, the charge state is indicated in the screen header bar during operation. Meaning of the symbols, see page 31.

If the operating time has nearly elapsed:

- Reestablish the mains power supply or power supply with a charged external battery to avoid an interruption of ventilation.

Charging the batteries

As soon as Savina 300 is connected to the mains power supply, the batteries are charged. The voltage of the connected external battery is automatically detected.

The internal battery is also charged when Savina 300 is powered by the external battery.

After using the batteries

- Connect the mains power supply.

It is not necessary to switch on Savina 300.

Additional information

Alarm messages, see "Alarm – Cause – Remedy" on page 147.

Technical Data, see "Operating data" on page 210.

Battery maintenance, see page 189.

Storing Savina 300, see page 106.

Connecting the gas supply

For ventilation, Savina 300 uses ambient air supplied by an internal turbine.

The O2 supply is provided by one of the following sources:
– Central gas supply system (HPO mode)
– Compressed gas cylinders (HPO mode)
– Low-pressure oxygen source, e.g., an O2 concentrator (LPO mode)

Connecting the O2 supply

WARNING
Risk of explosion

Pressurized oxygen in conjunction with oil or grease may spontaneously ignite.

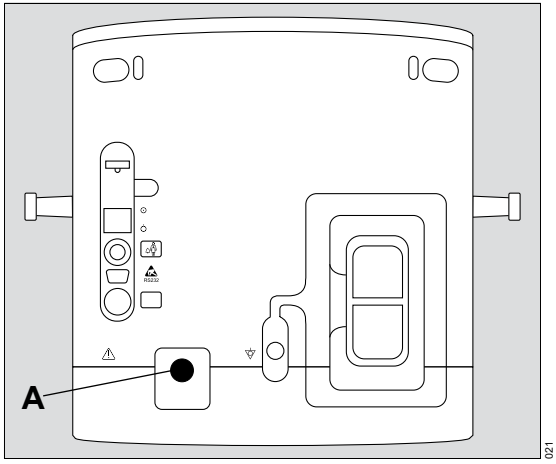
Do not bring any oxygen supply components into contact with oil and grease.

WARNING
Risk of patient injury

If compressed gases are used that are not approved for medical uses, the proper functioning of the device may be impaired.

Only use compressed gases approved for medical use. The compressed gases must be free of dust and oil particles and dry.

O2 supply from a central gas supply system



1 Screw the O2 compressed gas hose to the ***O2*** (A) connector of Savina 300.

2 Plug the gas probe into the wall terminal unit of the central gas supply system.

3 Secure the compressed gas hose by hanging it over the hose holders.

O2 supply from compressed gas cylinders

If the central gas supply fails or is not available, O2 can be supplied from compressed gas cylinders.

O2 supply from a low-pressure oxygen source (LPO mode)

O2 is supplied from an external low-pressure oxygen source, e.g., an O2 concentrator, see page 100.

Connecting the nurse call

Information on the nurse call

The nurse call is used for transmitting high-priority alarms to a central hospital alarm system. Medium-priority and low-priority alarms are not transmitted.

If the acoustic alarm signal of the device fails, the nurse call will be activated anyway.

If, in the event of an alarm, the ***Audio paused 2 min.*** key is pressed, the acoustic alarm signal on the device and the nurse call are suppressed for 2 minutes. During this time new alarms that occur are not signaled by the nurse call.

WARNING

Risk due to limited patient monitoring

The nurse call does not forward all alarms. Do not use the nurse call as the sole source of alarm information.

Pay attention to the alarms directly on the device.

WARNING

Risk of nurse call failure

A connection failure between the device and the central hospital alarm system may interrupt the transmission of information.

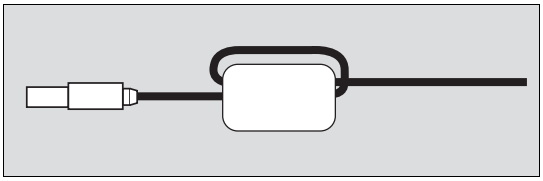
Pay attention to the alarms directly on the device.

Connecting the nurse call to the central hospital alarm system

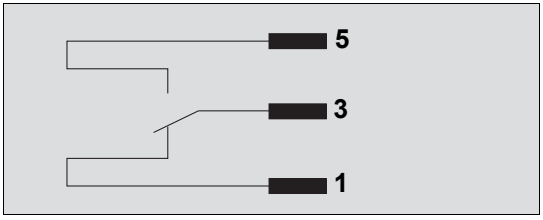
The kit must be installed by service personnel:

- Have the 6-pin circular connector (socket part) connected to the central hospital alarm system.

The connector is delivered with a ferrite core, through which the cable must be looped.



- Guide the cable, which has a shield at one end only, through the ferrite core in a loop.

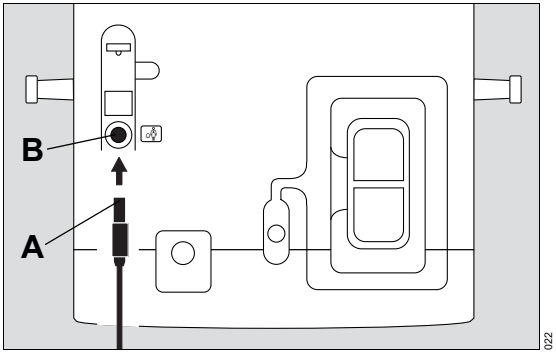


As soon as Savina 300 signals an alarm, the connection between cable 5 and cable 3 is closed and the nurse call is activated.

The connections to the central alarm system in the hospital are typically of a single-channel design. Consequently, the electronics of the nurse call are also of a single-channel design.

Connecting the nurse call to the ventilator

Prerequisite: Only connect safety extra-low voltage (SELV) devices to the connection for the nurse call.



1 Plug the nurse call connector (A) into the socket (B) and screw into place.

2 Check the correct operation of connected nurse call system.

Using the MEDIBUS or MEDIBUS.X protocol

Information on MEDIBUS and MEDIBUS.X

MEDIBUS and MEDIBUS.X are software protocols for the transfer of data between Savina 300 and other medical devices (e.g., patient monitors) or other devices (e.g., computers for data management systems).

For requirements for the combination of Savina 300 and an external device, see "Device combinations" on page 218.

WARNING

Risk of patient injury due to incorrectly transmitted data

All transferred data is intended for informational purposes only and is not intended to be used as the basis for diagnostic or therapeutic decisions.

Regularly check the displays on the screen of Savina 300. Pay direct attention to the alarms on Savina 300.

MEDIBUS.X is the MEDIBUS standard. If this software protocol is used, all data can be transmitted from Savina 300 SW 5.n. Observe the following documents:

MEDIBUS.X, Rules and Standards for Implementation	9052607
MEDIBUS.X, Profile Definition for data communication V1.n	9052608

MEDIBUS is the software protocol used by Savina 300 SW 3.5n. Observe the following documents:

MEDIBUS for Savina 300 SW 3.5n	9052411
Dräger RS 232 MEDIBUS, Protocol Definition	9028258

Information for using the correct software protocol

Dräger recommends the use of MEDIBUS.X.

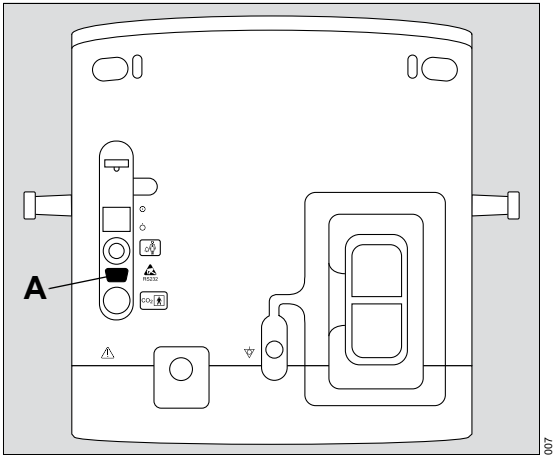
If MEDIBUS is used, the following restrictions must be noted:

– For functions available from SW 4.n, no data will be transmitted. This affects the VC-MMV, PC-AC, and PC-APRV ventilation modes as well as CO_2 measurement.

– For ventilation modes, the names from the Savina SW 3.n ventilator will be used.

Connecting an external device

Prerequisites:
– The corresponding MEDIBUS cable is used.
– Only devices with safety extra-low voltage (SELV) are connected to the COM port (serial RS232 interface).



- Connect an external device to the COM port (A).

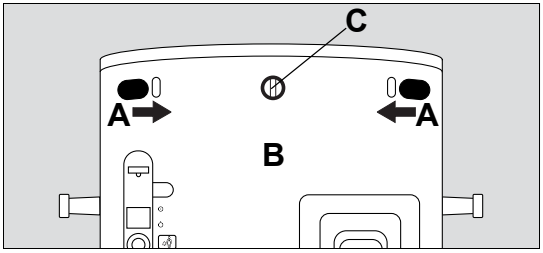
Configuring the interface

A description is given in chapter "Configuring the data interface" on page 143.

Removing and fitting the filter cover

The filter cover on the back of Savina 300 must occasionally be removed, e.g., for the following actions:
– Connecting a potential equalization cable
– Connecting the external battery
– Replacing the microfilter
– Replacing the dust filter set

Removing the filter cover

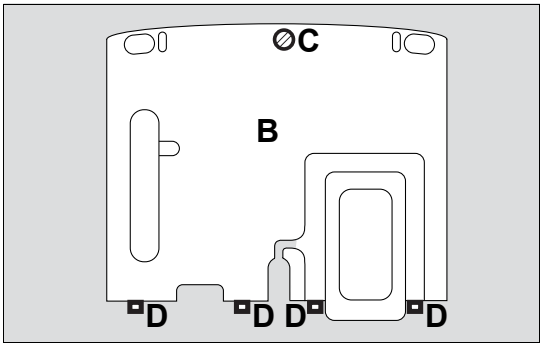


1 Use a coin to loosen the screw (C).

2 Reach into the openings (A) on both sides and press both catches inside towards each other simultaneously.

3 Detach and remove the filter cover (B).

Fitting the filter cover



1 Insert the filter cover (B) with the 4 lugs (D) in the rear panel.

2 Press the catches until they engage in the recess.

3 Use a coin to tighten the screw (C).

Connecting the potential equalization cable

Prerequisite: The potential equalization cable must only be installed by service personnel.

For more information about potential equalization pins and cable guide, see section "Rear without filter cover" on page 23.

1 Remove the filter cover.

2 Plug one end of the potential equalization cable onto the potential equalization pin of Savina 300 as far as it will go.

3 Firmly press the potential equalization cable into the groove of the cable guide. Keep the cable as short as possible between the pin and the cable guide.

4 Fit the filter cover.

5 Connect the other end of the potential equalization cable to the hospital's potential equalization socket.

NOTE

During operation, the hospital's potential equalization socket must be freely accessible and it must be possible to disconnect the connection without tools.

Intrahospital transport of the device

Transport is any movement of the medical device without the patient that is not carried out for the purpose of positioning the medical device.

Increasing the tipping stability

1 Set the hinged arm to minimum deflection.

2 Drain the water reservoir of the breathing gas humidifier.

3 Do not fasten additional parts to the lateral standard rails.

4 If present, turn the monitor to the middle position.

5 If present, push in the bed coupling to the smallest size available.

6 Grasp the handle of the trolley firmly and move the device in the longitudinal direction.

The safety information for patient transport also applies, see page 103.

Getting started

Safety information

WARNING

Risk of patient injury

Ventilation does not take place in standby mode. Patients connected to the device are endangered.

Only set the device to standby mode when no patient is connected to the device.

CAUTION

Malfunctions through condensation

When the device is moved from a cold storage location to a warm environment, condensation can form.

Only switch on the device when the condensation has dried.

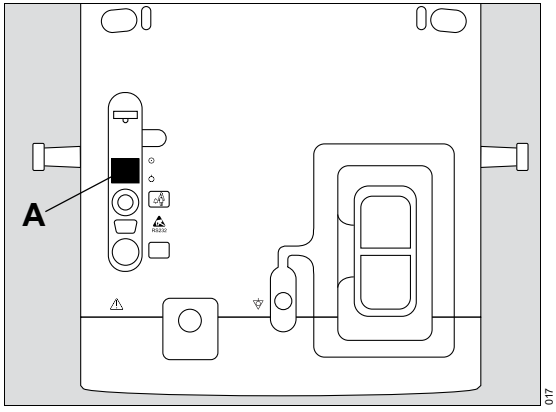
Switching on the ventilator

NOTE

When the device is switched on and no breathing circuit or test lung is connected, Savina 300 may not be able to perform automatic calibration of the flow sensor. The alarm message ***Flow sensor inoperable*** is displayed.

Prerequisites:
- Savina 300 is reprocessed and assembled ready for operation.
- The test lung is connected to the patient port of the breathing circuit.
- Mains power supply or power supply with a charged battery is established.
- O_2 supply is ensured.

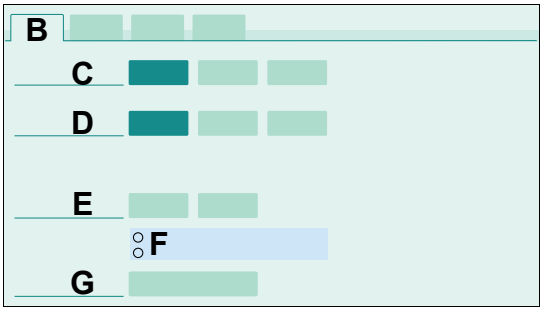
If the internal battery is discharged, Savina 300 does not provide any measured FiO_2 values for the first 10 to 20 minutes after it is switched on. The accuracy of the O_2 delivery is reduced during this period.



1 Set the main switch (A) to ⊙ (on).

The system start is performed.
The progress bar shows the progression of the system start.

Savina 300 is in standby mode. The ***Start/Standby*** page (B) is opened.



C ***Therapy type***

D ***Patient admission***

E ***Check settings***

F Empty dots indicate that no results are available for the device check and for the breathing circuit check.

G ***Start***

Before using the device on the patient

1 Select the breathing circuit and the humidification type, see page 72.

2 Check readiness for operation, see page 73.

3 Select the therapy type and the application mode, see page 79.

4 Select the start settings, see page 80.

5 Start the therapy, see page 82.

Selecting the breathing circuit and the humidification type

When the breathing circuit used and the type of humidification are selected, Savina 300 uses standard values for hose compliance and hose resistance. The actual values are determined during the breathing circuit check.

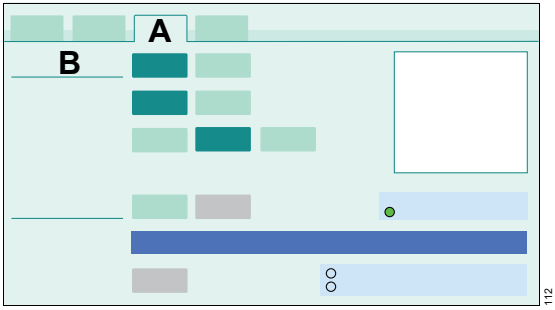
Active humidification is not possible when using a coaxial breathing circuit.

Prerequisite: Savina 300 is prepared and in standby mode.

1 Press the ⏻ ***Start/Standby*** key.

Savina 300 opens the ***Start/Standby*** page.

2 Touch the ***Breathing circ. check*** tab (A).



Select the breathing circuit used (B):

3 Touch the corresponding button:
- ***Standard***
- ***Coaxial***

4 Touch the corresponding button:
- ***22 mm Adult***
- ***15 mm Pediatric***

Select the humidification type:

5 Touch the corresponding button:
- ***Active humidifier***
- ***HME/Filter***
- ***None***

6 Check readiness for operation, see page 73.

Checking the operational readiness

Readiness for operation of Savina 300 is checked using the device check and the breathing circuit check. Additionally, the switch-over to battery operation must be checked.

WARNING

Risk of patient injury

The device check must be performed before using the device on a patient. If a malfunction is detected during the safety-relevant test steps, the patient may be endangered.

Only start ventilation once the device check has been successfully completed.

WARNING

Risk of patient injury due to CO_2 rebreathing

When using a coaxial breathing circuit, leakages between the inner hose and the outer hose cannot be detected by the device.
- **Test the coaxial breathing circuit, see page 77.**
- **If the test cannot be performed, use CO_2 monitoring.**

CAUTION

Gas dosage inaccurate

For small tidal volumes, the accuracy of the gas delivery is not ensured:
- If the breathing circuit used is not suitable for the respective patient.
- If the breathing circuit check is not performed.

Use a suitable breathing circuit and perform the breathing circuit check before using the device on the patient.

Performing a device check

Test steps of the device check

During the device check, the following test steps are performed:

Test step	Meaning
Alarm signals	Check of the alarm signals for all alarm priorities, see "Display of alarms" on page 108
Auxiliary acoustic alarm	Check of the auxiliary alarm/power supply failure alarm
Breathing circuit connected	Visual check of the breathing circuit and correct connection of the bacterial filter
Inspect humidifier	Visual inspection of breathing gas humidifier
Test lung connection	Check of the test lung
Expiratory valve	Check of the expiratory valve Check of the breathing circuit for leakages
Safety valve	Check of the pressure release function
Expiratory flow sensor	Check and calibration

Device check procedure

Savina 300 guides the user through the respective test step in the form of a question/answer dialog. The instruction field displays the questions or instructions on how to perform the test steps.

The test steps in the device check are displayed with the following symbols:

Green dot : Correct result

Red dot : Incorrect result

Check results

The check results determined in the device check will remain stored until the check is performed again. When the device is switched off, the results of the individual test steps are deleted, but the overall result of the last check with date and time is retained.

Automatic cancelation

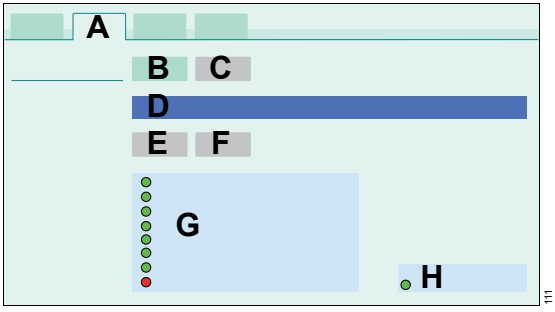
If the ***Device check*** page is exited, the check is canceled and has to be restarted.

Starting the device check

Prerequisites: Savina 300 is prepared and in standby mode.

1 Connect the test lung to the patient port of the breathing circuit.

2 Touch the ***Device check*** tab (A).



The overall result of the last check with date and time is displayed in the field (H):

Green dot : All test steps passed

Red dot : At least one test step failed

Empty dot : Check canceled

Savina 300 displays the individual test steps in a list (G).

3 Touch the ***Start*** button (B).

4 Confirm with the rotary knob.

5 Answer the questions in the instruction field (D) by touching the button ***Yes*** (E) or ***No*** (F).

6 After the device check was successful, perform a breathing circuit check.

7 Touch the ***Yes*** button (E).

Savina 300 opens the ***Breathing circ. check*** page.

Canceling the device check

1 Touch the ***Cancel*** button (C).

2 Confirm with the rotary knob.

Failed test steps and remedies

Faults in the test steps generate the medium-priority alarm message ***Device check failed***. The alarm can be dismissed. Do not start ventilation!

The following table shows the remedies for eliminating the faults in the safety-relevant test steps:

Test step	Remedy
Alarm signals Auxiliary acoustic alarm	Contact DrägerService.
Expiratory valve	Check if the water trap is connected. Check if the expiratory valve is properly fitted. Repeat device check. If the test step still fails, contact DrägerService.

Test step	Remedy
Safety valve	Connect the test lung. Check the breathing circuit for leakages. Check if the compressed gas hoses are connected. Check if the expiratory valve is properly fitted. Repeat device check. If the test step still fails, contact DrägerService.

Alarm causes and their remedies, see "Alarm – Cause – Remedy" on page 147.

Information on the breathing circuit check

The breathing circuit check must be performed after the following actions:
– Device check
– Replacing of the breathing circuit
– Replacing of the breathing gas humidifier

The following test steps are performed:
– Leakage of the breathing circuit
– Compliance of the breathing circuit
– Inspiratory resistance
– Expiratory resistance

The current leakage flow is determined and displayed. A leakage flow of up to 300 mL/min at a pressure of 60 mbar (60 cmH_2O) is permitted. The following leakage flows are permitted for a coaxial breathing circuit:
– 120 mL/min for the inner hose
– 300 mL/min for the total breathing circuit

When a coaxial breathing circuit is being used, a special test is required, see page 77.

Savina 300 uses the compliance determined to increase the accuracy of the tidal volume delivered. An accurate delivery is required especially for small tidal volumes (VT<100 mL).

The values for the inspiratory and expiratory resistance must lie within the specified ranges, see Technical data, "Performance characteristics" on page 201.

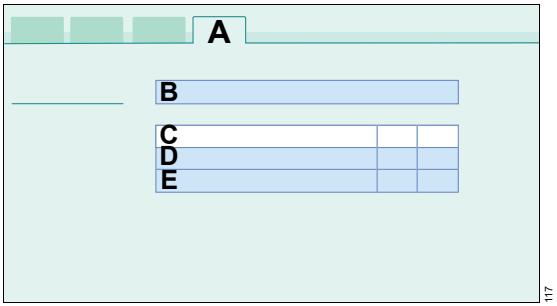
Check results

The check results determined in the breathing circuit check will remain stored until the check is performed again. When the device is switched off, the results of the individual test steps are deleted, but the overall result of the last check with date and time is retained.

Page *Check results*

The values for compliance and resistance of the last check are displayed. If a valid measurement has not yet been performed, the standard values are used but are not displayed.

Page ***Check results*** (A):



B Compliance
C Flow
D Inspiratory resistance
E Expiratory resistance

Automatic cancelation

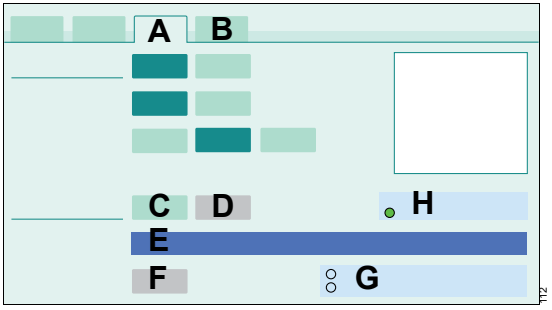
If the ***Breathing circ. check*** page is exited, the check is canceled and has to be restarted.

Performing the breathing circuit check

Preparing the breathing circuit check

Prerequisite: Savina 300 is prepared and in standby mode.

- Touch the ***Breathing circ. check*** tab (A).



The overall result of the last check with date and time is displayed in the field (H):

Green dot	:	All test steps passed
Red dot	:	At least one test step failed
Empty dot	:	Check canceled

Starting the breathing circuit check

Prerequisite: The breathing circuit and the humidification type are selected, see page 72.

1. Touch the ***Start*** button (C).
2. Confirm with the rotary knob.
3. When requested by Savina 300 in the instruction field (E), seal the patient port, e.g., with a sterile glove.
4. Confirm with ***OK*** (F).
5. Open the patient port when requested to do so.
6. Confirm with ***OK*** (F).

The breathing circuit check is continued. The results of the test steps are displayed in the field (G). The values for compliance and resistance are displayed on the page ***Check results*** (B).

Canceling the breathing circuit check

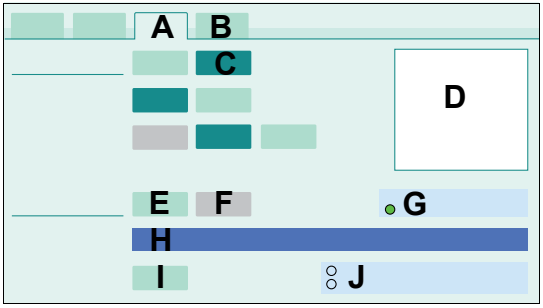
1. Touch the ***Cancel*** button (D).
2. Confirm with the rotary knob.

Performing the coaxial breathing circuit check

For coaxial breathing circuits, the leakage of the inner hose in measured as well.

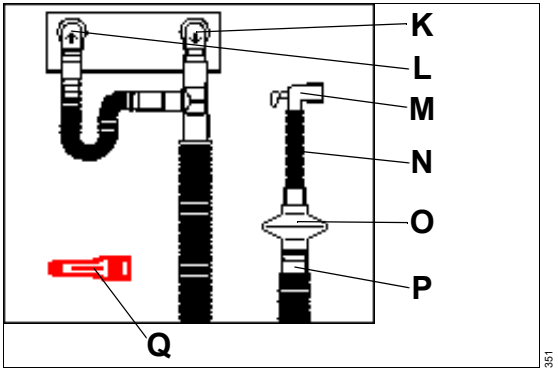
Preparing the coaxial breathing circuit check

Prerequisites:
- Savina 300 is prepared and in standby mode.
- The ***Breathing circ. check*** page (A) is opened.
- The breathing circuit ***Coaxial*** (C) is selected, see page 72.



The overall result of the last check with date and time is displayed in the field (G).

The procedure is described in the instruction field (H). The graphics (D) show the respective test setup.



K Inspiratory port

L Expiratory port

M Airway connector

N Catheter mount

O HME/filter

P Patient port of the coaxial breathing circuit

Q Red test adapter

1 Connect the inspiratory connector of the coaxial breathing circuit to the inspiratory port (K).

2 Connect the expiratory connector of the coaxial breathing circuit to the expiratory port (L).

3 Connect the HME/filter, catheter mount, and airway connector to the patient port of the coaxial breathing circuit (P).

Starting the coaxial breathing circuit check

1 Touch the ***Start*** button (E).

2 Confirm with the rotary knob.

3 Remove the HME/filter, catheter mount, and airway connector.

4 Plug the red test adapter (Q) onto the inner hose of the coaxial breathing circuit (P).

5 Seal the red test adapter, e.g., with a sterile glove.

6 Confirm with ***OK*** (I).

The leakage test for the inner hose is performed.

7 When requested by Savina 300 in the instruction field (H), remove the red test adapter. Connect the HME/filter, catheter mount, and airway connector.

8 Seal the airway connector, e.g., with a sterile glove.

9 Confirm with ***OK*** (I).

The leakage test for the total breathing circuit is performed.

10 Open the airway connector when requested to do so.

11 Confirm with ***OK*** (I).

The breathing circuit check is continued. The results of the test steps are displayed in the field (J). The values for compliance and resistance are displayed on the page ***Check results*** (B).

Canceling the coaxial breathing circuit check

1 Touch the ***Cancel*** button (F).

2 Confirm with the rotary knob.

Checking the CO_2 zero indication

If CO_2 monitoring is used, the CO_2 zero indication must be checked.

- Checking CO_2 zero indication, see page 128.

Checking batteries

Check that the capacity of the internal and external batteries is sufficient. The batteries could be deep discharged or destroyed by too long storage.

Checking switch-over to battery operation

- Disconnect the power plug.

If the external battery is connected, Savina 300 switches over to the external battery without interruption.

If the external battery is not connected or if it is discharged, Savina 300 switches over to the internal battery without interruption.

If the batteries are discharged, the acoustic power supply failure alarm is triggered.

- Re-connect the power plug.

Savina 300 switches back to mains operation.

Additional information

"Connecting the power supply" on page 60.

"Failure of the power supply" on page 146.

Selecting the therapy type and the application mode

Savina 300 offers a selection between the therapy types ventilation and O_2 therapy.

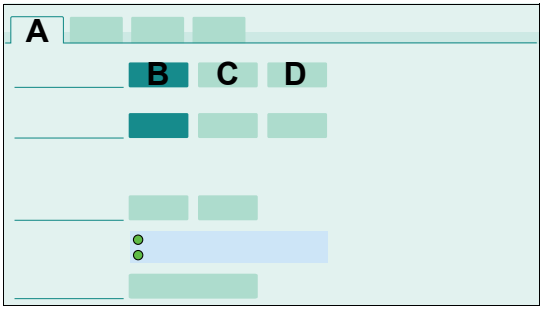
The ***Tube*** application mode is used for the ventilation of intubated patients. The ***NIV*** application mode is used for non-invasive ventilation.

The therapy type and the application mode can only be changed in standby mode.

Opening the dialog window

- Press the ⏻ ***Start/Standby*** key.

Savina 300 opens the ***Start/Standby*** (A) page.



B ***Tube*** application mode

C ***NIV*** application mode

D ***O_2 therapy***

Selecting O_2 therapy

Prerequisite: Savina 300 is in standby mode.

1 Touch the ***O_2 therapy*** button (D).

2 Confirm with the rotary knob.

3 Use O_2 therapy, see page 97.

Selecting the application mode for ventilation

WARNING

Risk of patient injury

If the alarm limits and ventilation settings are not adjusted after changing from application mode *NIV* to *Tube*, Savina 300 cannot fully monitor the ventilation.

Check alarm limits and ventilation settings and adjust if necessary.

CAUTION

Risk of patient injury

In the ***NIV*** application mode, Savina 300 cannot monitor intubated patients adequately.

For intubated patients, use the application mode ***Tube***.

CAUTION

Risk of patient injury

If a tube without a cuff is used, or if the cuff is not inflated, very high leakages may occur.

Activate the leakage compensation, see "Configuring the ventilation functions" on page 134.

Select an application mode

Prerequisite: Savina 300 is in standby mode.

1 Touch the button for the corresponding application mode.

2 Confirm with the rotary knob.

Additional information

For information about using the ***Tube*** application mode, see "Adjusting the ventilation settings" on page 86.

For information about using the ***NIV*** application mode, see "Non-invasive ventilation (NIV)" on page 89.

In application mode ***NIV***, the following symbol is displayed in the header bar: 

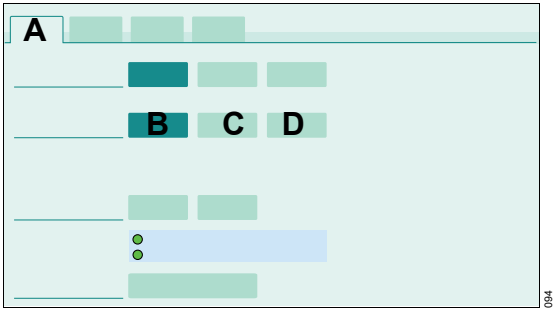
Selecting the start settings for ventilation

For ventilation, the settings for the current patient or the start settings for a new patient can be used.

Opening the dialog window

- Press the ⏻ ***Start/Standby*** key.

Savina 300 opens the ***Start/Standby*** (A) page.



B ***Current patient***

C ***New adult*** patient category

D ***New ped. pat.*** patient category

The ***Current patient*** (B) button is preselected.

Selecting the start settings for a new patient

The start values of the ventilation parameters are determined based on the patient category or the ideal body weight. The ideal body weight is calculated by entering the body height.

All previous settings and trend data are deleted.

The start settings can be changed, see "Defining start settings for a new patient" on page 136.

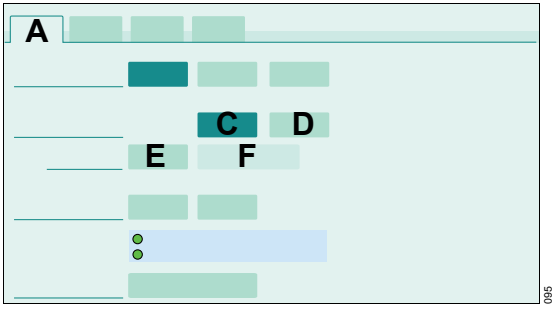
Selecting the patient category

1 Touch the button for the corresponding patient category.

C ***New adult***

D ***New ped. pat.***

2 Confirm with the rotary knob.



If the body weight is selected as the basis for calculating the start values, the following buttons are displayed:

E Body height

F Ideal body weight ***IBW***

Entering the body height

1 Touch the (E) button.

2 Set the body height with the rotary knob and confirm.

The ideal body weight ***IBW*** is displayed.

The start values for ***VT***, ***RR***, ***FlowAcc***, and ***Trigger*** are determined based on the ideal body weight.

Starting the therapy

Before using the device on the patient

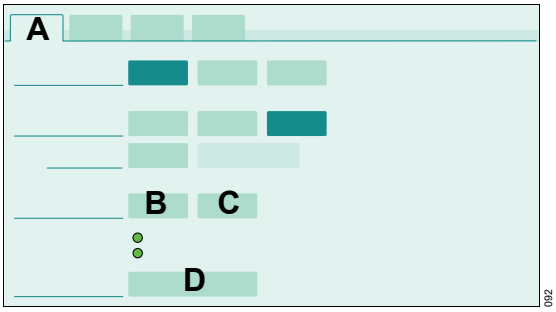
1 Check the operational readiness of the device, see page 73.

2 Select the therapy type and the application mode, see page 79.

Opening the dialog window

- Press the ⏻ ***Start/Standby*** key.

Savina 300 opens the ***Start/Standby*** (A) page.



B ***Ventilation settings...***

C Ventilation therapy type: ***Alarms...***

D The following is displayed depending on the selected therapy type:
- ***Start ventilation***
- ***Start O_2 therapy***

Setting the ventilation mode and ventilation parameters

1 Touch the (B) button.

The ***Ventilation settings*** dialog window is opened.

2 Set the ventilation, see page 86.

Setting the alarm limits

1 Touch the (C) button.

The ***Alarms*** dialog window is opened.

2 Set the alarm limits, see page 111.

The start settings can be changed, see "Defining the start setting for the alarm limits" on page 139.

Starting the therapy

1 Touch the (D) button.

2 Confirm with the rotary knob.

Savina 300 starts the therapy. The main screen is displayed.

Operation

Ventilation settings

A detailed description of the ventilation modes and ventilation parameters can be found in chapters "Ventilation modes" on page 224 and "Additional settings" on page 236.

Volume-controlled ventilation modes / Support of spontaneous breathing

Ventilation parameters	Ventilation mode			
	VC-CMV/VC-AC	VC-SIMV	VC-MMV	SPN-CPAP
FiO_2 [1]	X	X	X	X
VT	X	X	X	
T_{imax} [2]		X [3]	X [3]	X
T_i [4]	X	X	X	
RR	X	X	X	
FlowAcc	X	X	X	X
P_{max} [5]	X	X	X	
PEEP	X	X	X	X
ΔP_{supp}		X	X	X

1) The parameter is only displayed when ***LPO*** is deactivated.
2) In the ***Tube*** application mode, the parameter is only displayed when the ventilation function is configured.
3) The parameter is only displayed when ***Plateau*** and ***AutoFlow*** are deactivated.
4) The parameter is only displayed when ***Plateau*** or ***AutoFlow*** is activated.
5) The parameter is only displayed when ***Pressure limitation*** is activated and ***AutoFlow*** is deactivated.

Pressure-controlled ventilation modes

Ventilation parameters	Ventilation mode		
	PC-AC	PC-BIPAP	PC-APRV
FiO_2 [1]	X	X	X
T_i	X	X	
RR	X	X	
FlowAcc	X	X	X
P_{insp}	X	X	
PEEP	X	X	
ΔP_{supp}		X	
T_{high}			X
T_{low}			X

Ventilation parameters	Ventilation mode		
	PC-AC	PC-BIPAP	PC-APRV
P_{high}			X
P_{low}			X

1) The parameter is only displayed when ***LPO*** is deactivated.

Additional settings for ventilation

The ventilation modes can be combined with additional settings to optimize ventilation. The table shows the possible additional settings and the corresponding parameters for the respective ventilation mode.

		VC-CMV/VC-AC	VC-SIMV	VC-MMV	PC-AC	PC-BIPAP	PC-APRV	SPN-CPAP
Apnea ventilation	On/Off		X			X	X	X
	VT_{apn}		X			X	X	X
	RR_{apn}		X			X	X	X
	PEEP						X	
Sigh	On/Off	X		X	X			
	ΔintPEEP	X		X	X			
Flow trigger	On/Off	X[1)]						
	Trigger	X[1)]	X	X	X	X		X
	Insp. term.[2)]		X	X		X		X
AutoFlow	On/Off	X	X	X				
ATC[3)]	On/Off	X	X	X	X	X	X	X
	Tube type	X	X	X	X	X	X	X
	Tube Ø	X	X	X	X	X	X	X

1) When the additional setting ***Flow trigger*** is deactivated, Savina 300 displays the ***VC-CMV*** ventilation mode in the header bar.
2) The parameter is only displayed when the ***Insp. termination*** ventilation function is activated. See "Configuring the ventilation functions" on page 134.
3) The ***ATC*** ventilation function is not available in the ***NIV*** application mode.

CAUTION

Risk of patient injury

High trigger sensitivity may lead to auto-triggering of the ventilator.

Set the trigger threshold accordingly.

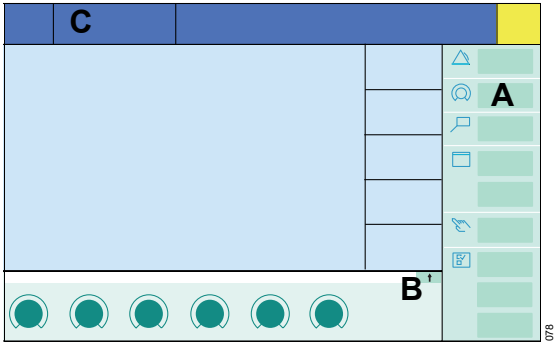
Additional ventilation functions

The following ventilation functions can be activated or deactivated, see "Configuring the ventilation functions" on page 134:

– ***Pressure limitation***
– ***Plateau***
– ***LPO***
– ***Insp. termination***
– ***Leakage compensation ("Tube")***
– ***Timax ("Tube")***

Adjusting the ventilation settings

Open *Ventilation settings* dialog window



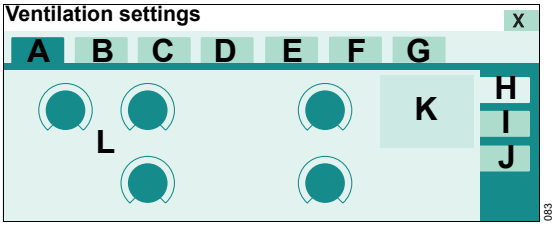
- Touch the ***Ventilation settings...*** button (A) in the main menu bar.

Or:

- Touch the ↑ button (B) in the therapy bar.

Or:

- Touch the displayed ventilation mode (C) in the header bar.



The tabs of the ventilation modes available are displayed:

A ***VC-CMV/VC-AC***

B ***VC-SIMV***

C ***VC-MMV*** (optional)

D ***PC-AC*** (optional)

E ***PC-BIPAP*** (optional)

F ***PC-APRV*** (optional)

G ***SPN-CPAP***

For the active ventilation mode, the following is displayed:

A Name of ventilation mode

H ***General settings*** tab

I ***More settings*** tab

J ***ATC settings*** tab

K Current additional settings

L Therapy controls

Selecting a ventilation mode

Prerequisite: The ***Ventilation settings*** dialog window is opened.

1 Touch the tab for the corresponding ventilation mode. The color of the tab turns yellow.

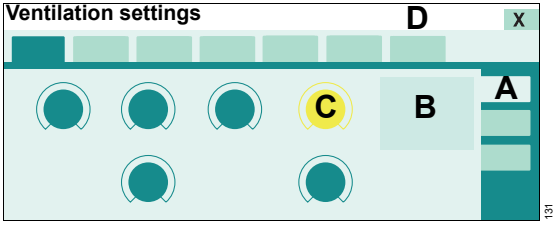
2 Preset the ventilation parameters if necessary. If the therapy control is displayed in dark green following confirmation with the rotary knob, the ventilation parameter setting is effective immediately, even if the new ventilation mode was not yet activated.

3 Confirm the ventilation mode with the rotary knob. The color of the tab changes to dark green.

The ventilation mode is active. The settings are applied to the patient.

Setting the ventilation parameters

Prerequisite: The ***Ventilation settings*** > ***General settings*** (A) page is opened.



1 Touch the therapy control of the ventilation parameter, e.g., (C).

The additional ventilation parameters derived from the ventilation parameter are calculated and displayed in the setting assistance field (B).

2 Set the value by turning the rotary knob and confirm.

Information is displayed in the message field (D), e.g., when the setting has to be confirmed or when a set limit of a parameter has been reached.

Setting ventilation parameters in the therapy bar

The ventilation parameters of the active ventilation mode can also be set with the therapy controls in the therapy bar.

Exceeding the set limit of a ventilation parameter

When the set limit of a parameter has been reached, Savina 300 displays a message.

- Press the rotary knob to exceed the set limit.

The set limit can be exceeded.

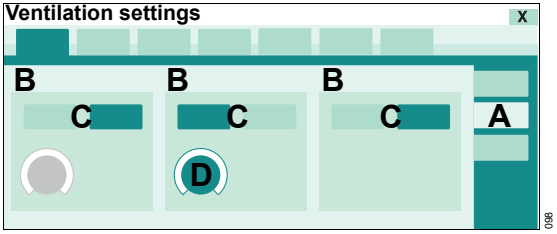
If the maximum set limit for a parameter has been reached, e.g., in relation to other parameters, it is not possible to exceed the set limit.

- Press the rotary knob. Savina 300 takes the maximum value that can be set.

Setting additional settings

Prerequisite: In the ***Ventilation settings*** dialog window, the page with the active ventilation mode is opened.

1 Touch the ***More settings*** (A) tab.



The additional settings (B) of the active ventilation mode are displayed.

2 Use the corresponding buttons (C) to activate or deactivate the additional setting.

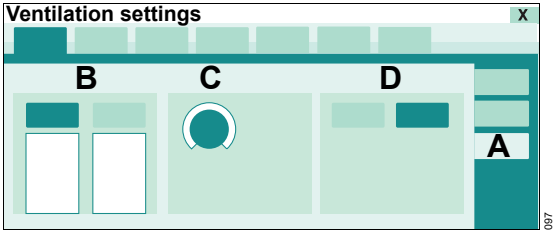
3 Touch the corresponding therapy control, e.g., (D).

4 Set the value by turning the rotary knob and confirm.

Setting tube compensation (ATC)

Prerequisite: In the ***Ventilation settings*** dialog window, the page with the active ventilation mode is opened.

1 Touch the ***ATC settings*** (A) tab.



B ***Tube type***:
- ***ET***
- ***Trach.***

C ***Tube diameter***

D ***ATC***

Specify the tube type (B):

1 Touch the corresponding button.

Enter the inner diameter of the tube (C):

2 Touch the therapy control.

3 Set the value by turning the rotary knob and confirm.

Activate ATC (D):

4 Touch the ***On*** button.

5 Confirm with the rotary knob.

Non-invasive ventilation (NIV)

The use of non-invasive ventilation is described below. For a detailed description, see chapter "Non-invasive ventilation (NIV)" on page 244.

In the ***NIV*** application mode, all the ventilation modes are selectable.

Safety information

WARNING
Risk of patient injury

Danger of aspiration due to high airway pressures.

Avoid high airway pressures.

WARNING
Risk of patient injury

If flow monitoring is switched off for SPN-CPAP with a nasopharyngeal tube, Savina 300 cannot completely monitor ventilation.

Use a separate monitoring device.

CAUTION
Risk of patient injury

In the ***NIV*** application mode, Savina 300 cannot monitor intubated patients adequately.

For intubated patients, use the application mode ***Tube***.

CAUTION
Risk of patient injury

The use of masks increases the dead space.

Observe the mask manufacturer's instructions.

CAUTION
Risk of patient injury

When using masks, leakages can cause the actual tidal volume to deviate from the measured value VT_e.

CAUTION
Risk of patient injury

An integrated CO_2 monitoring is only available optionally.

If necessary, use external monitoring.

NOTE
Use suitable masks. Otherwise, too high leakages may occur.

WARNING
Risk of patient injury

If the alarm limits and ventilation settings are not adjusted after changing from application mode *NIV* to *Tube*, Savina 300 cannot monitor ventilation adequately.

Check alarm limits and ventilation settings and change if necessary.

Using non-invasive ventilation

1 Select application mode ***NIV***. See "Selecting the therapy type and the application mode" on page 79.

2 Select ventilation mode and set ventilation parameters. See "Adjusting the ventilation settings" on page 86.

In ***SPN-CPAP*** ventilation mode, the ***Timax*** therapy control can be used to limit the maximum duration of supported breaths, because the inspiratory termination criterion may be ineffective in the case of very high leakages.

3 Set the alarm limits, see page 111.

The alarm limits ***MV***, ***VT***, ***Tapn*** can be switched off, see page 112. If required, use additional monitoring, e.g., external SpO_2 monitoring.

4 Start ventilation. See "Starting the therapy" on page 82.

Suction maneuver with oxygenation

For endotracheal suction, Savina 300 offers a program for oxygenation with the following phases:
– Preoxygenation to avoid any risk of hypoxia during the disconnection phase
– Disconnection for endotracheal suction
– Postoxygenation

During suction and for 2 minutes afterwards, the lower alarm limit for the minute volume is switched off.

Safety information

WARNING

Development of atelectasis

If a suction catheter is used that is too large, the air supply is impaired. Due to the negative pressure during suction, atelectasis can develop.

Select an appropriate suction catheter for suction.

WARNING

Risk to patients when using suction in a closed breathing circuit

With volume-controlled ventilation without AutoFlow and during the disconnection phase, flow delivery is limited. If suction is used in a closed breathing circuit, negative pressure is possible.

Only use suction in volume-controlled ventilation with AutoFlow or in pressure-controlled ventilation. Preoxygenation must be stopped before closed suction starts.

Performing oxygenation

Prerequisites:
– O_2 supply from the central gas supply system or from an O_2 compressed gas cylinder is ensured.
– O_2 supply pressure: 2.7 bar to 6 bar (39.2 psi to 87 psi)
– Flow sensor is functional
– Flow monitoring is activated

1 Press the $O_2\uparrow$ ***Suction*** key.

Savina 300 continues ventilating in the set ventilation mode at 100 Vol% O_2. The PEEP is increased to 4 mbar (4 cmH_2O), so that Savina 300 can detect the consecutive disconnection. Any PEEP set higher is retained.

Within 180 seconds, Savina 300 expects a disconnection for suction. In the header bar, the preoxygenation phase is displayed with the remaining time.

2 Disconnect patient and perform suction maneuver.

Savina 300 interrupts ventilation and delivers a minimal flow to detect reconnection automatically. The acoustic alarm signals are suppressed. 120 seconds are available for suctioning. In the header bar, the disconnection phase is displayed with the remaining time.

3 Reconnect patient.

Savina 300 ventilates again in the set ventilation mode, except that for 120 seconds 100 Vol% O_2 is delivered for postoxygenation. In the header bar, the postoxygenation phase is displayed with the remaining time.

Automatic discontinuation of oxygenation

Savina 300 cancels the oxygenation program in the following situations:
– The patient is not disconnected in the preoxygenation phase.
– The patient is not reconnected in the disconnection phase.

The set ventilation mode and the alarms are reactivated.

Terminating oxygenation prematurely

- Press the $O_2\uparrow$ ***Suction*** key.

Medication nebulization

Safety information

WARNING
Risk of fire

The flow sensor can ignite medications or other substances based on highly flammable substances.
- **Do not nebulize medications or other substances that are easily flammable or spray them into the device.**
- **Do not use substances containing alcohol.**
- **Do not allow flammable or explosive substances to enter the breathing system or the breathing circuit.**

CAUTION
Increased O_2 concentration

Savina 300 uses 100 Vol% O_2 for the medication nebulization. Therefore, the set inspiratory O_2 concentration is increased during medication nebulization.

CAUTION
Ventilation impaired

If unapproved pneumatic medication nebulizers are used, the actual tidal volume delivered and the O_2 concentration may deviate from the displayed values.

Use only medication nebulizers that are listed in the current list of accessories.

CAUTION
Ventilation impaired

If a bacterial filter is placed between the nebulizer and the tube during medication nebulization, flow resistance may increase and impair ventilation.

Place a bacterial filter between the inspiratory valve and the nebulizer.

CAUTION
Insufficient medication nebulization

If an HME is used on the Y-piece during medication nebulization, the medication will not be appropriately administered to the patient.

During medication nebulization, do not use an HME.

CAUTION
Ventilation impaired

If the nebulizer is left in the breathing circuit after use, ventilation may be impaired due to accidental medication nebulization.

Remove nebulizer after use.

CAUTION
Ventilation impaired

If medication nebulization is activated although no pneumatic medication nebulizer is connected, Savina 300 delivers a too small tidal volume.

Deactivate medication nebulization.

NOTE
Aerosols can impair the proper functioning of the expiratory valve.

When using medication nebulization, shorten the reprocessing cycles for the expiratory valve.

Information on pneumatic medication nebulization

Medication nebulization may be used in all ventilation modes.

Savina 300 applies the medication aerosol in synchronization with the inspiratory flow phase and maintains a constant minute volume.

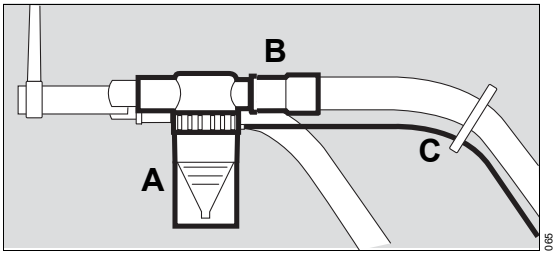
In the case of greater deviations between the inspiratory and expiratory minute volume, Savina 300 performs a calibration of the flow sensor during medication nebulization.

In small pediatric patients, medication nebulization may not be possible due to an insufficient inspiratory flow.

Installing the pneumatic medication nebulizer

Prerequisites:
- O_2 supply from the central gas supply system or from an O_2 compressed gas cylinder is ensured.
- O_2 supply pressure: 2.7 bar to 6 bar (39.2 psi to 87 psi)
- Inspiratory flow: at least 18 L/min
- Medication nebulizer is prepared in accordance with the corresponding instructions for use.

When using a breathing circuit for adults



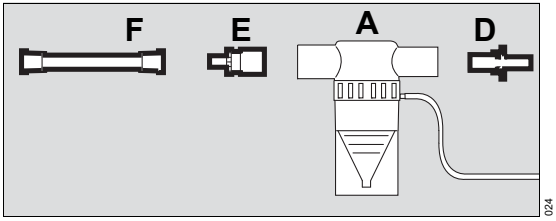
1 Connect the medication nebulizer (A) to the inspiratory side of the Y-piece.

2 Connect the inspiratory hose (B) to the medication nebulizer.

3 Place the medication nebulizer in the vertical position.

4 Run the nebulizer hose (C) back to Savina 300 along the inspiratory hose using clamps.

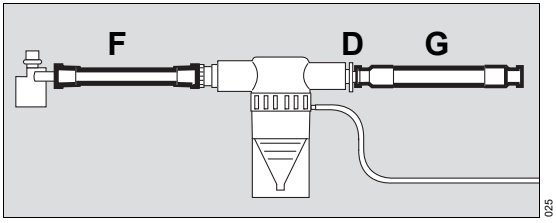
When using a breathing circuit for pediatric patients



1 Insert the catheter connector (D) into the inlet port of the medication nebulizer (A).

2 Insert the adapter (E) into the outlet port of the medication nebulizer.

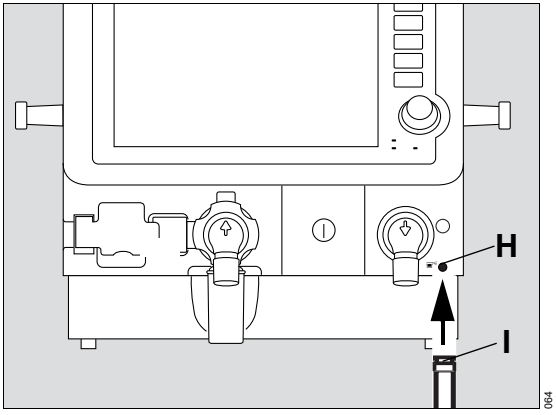
3 Connect one end of the corrugated hose (F), length 0.13 m (5.1 in), to the adapter (E).



4 Remove the corrugated hose of the breathing circuit (G) from the inspiratory port of the Y-piece and connect it to the catheter connector (D).

5 Connect the other end of the corrugated hose (F) to the inspiratory port of the Y-piece.

Connecting the nebulizer hose



- Connect the nebulizer hose (I) onto the nebulizer port (H).

Performing pneumatic medication nebulization

Prerequisites:
– Medication nebulizer is filled in accordance with the corresponding instructions for use.
– The correct functioning of the medication nebulizer is ensured.

CAUTION

Insufficient medication nebulization

A medication nebulizer malfunction is not detected by Savina 300.

Check the correct functioning of the medication nebulizer. Check whether aerosol is generated.

Switching on medication nebulization

- Press the ***Nebul. on/off*** key.

Savina 300 starts nebulization. The nebulization time is 30 minutes. The symbol and the remaining time are displayed in the header bar.

Terminating medication nebulization prematurely

- Press the ***Nebul. on/off*** key.

After medication nebulization

Savina 300 automatically switches off the medication nebulizer after the nebulization time has elapsed.

Savina 300 automatically cleans the flow sensor by heating and performs calibration following medication nebulization.

1 Remove any residual medication. Observe the instructions for use of the medication nebulizer.

2 If a bacterial filter is used to protect the expiratory valve, replace or remove the bacterial filter.

Performing medication nebulization with the Aeroneb Pro nebulizer

- Observe the instructions for use of the Aeroneb Pro nebulizer.
- Observe the section "Information on breathing circuits and additional components" on page 55.
- Observe the safety information on medication nebulization, see page 92.

NOTE

Do not switch on medication nebulization on Savina 300 as the Aeroneb Pro nebulizer does not require a nebulizer flow from Savina 300.

After nebulization with Aeroneb Pro

- If a bacterial filter is used to protect the expiratory valve, replace or remove the bacterial filter.

Manual inspiration – Inspiration hold

The ***Inspiration hold*** maneuver can be activated in all ventilation modes and offers the following options:

– Between two automatically delivered breaths, a breath can be manually started and held. The pattern of the manually started breath corresponds to the ventilation pattern of the currently active automatic ventilation mode.

– Regardless of the start time, an automatically delivered breath can be prolonged.

WARNING
Risk of patient injury due to negative pressure

If the *Inspiration hold* maneuver is used during endotracheal suction, negative pressure occurs.

Do not use the *Inspiration hold* maneuver during endotracheal suction.

Triggering manual inspiration

- Briefly press the ***Inspiration hold*** key.

Manually prolonging inspiration

- Press the ***Inspiration hold*** key and **hold** for the desired inspiratory time.

Savina 300 triggers a prolonged breath or prolongs an already triggered automatic breath.

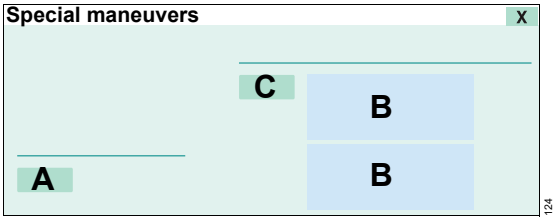
The maneuver is ended at the latest 15 seconds after pressing the ***Inspiration hold*** key.

Special maneuvers

Savina 300 offers the following maneuvers:
– Expiration hold
– Intrinsic PEEP

Opening the *Special maneuvers* dialog window

- Touch the ***Special maneuvers...*** button in the main menu bar.



Manual expiration – Expiration hold

Expiration hold can be activated in all ventilation modes.

WARNING
Risk of patient injury due to negative pressure

If the *Expiration hold* maneuver is used during endotracheal suction, negative pressure occurs.

Do not use the *Expiration hold* maneuver during endotracheal suction.

Activating Expiration hold

- Touch and hold the ***Exp. hold*** button (A) for the desired expiratory time.

After a maximum of 15 seconds, Savina 300 terminates the expiration.

Intrinsic PEEP – PEEPi

Intrinsic PEEP is the actual end-expiratory pressure in the lungs.

For a detailed description, see chapter "Intrinsic PEEP – PEEPi" on page 245.

This special procedure can be performed in all ventilation modes. Breathing activity by the patient during this maneuver can distort the measured values.

Savina 300 displays the following values (B) for the last two measurements, including the date and time:
– ***PEEPi***
– ***incl. PEEP***
– ***V_{trap}***

Starting a measurement maneuver

- Touch the ***Start*** button (C) and confirm with the rotary knob.

O_2 therapy

During O_2 therapy, only the O_2 concentration and the inspiratory pressure are monitored.

The alarm limits for FiO_2 monitoring are automatically set by the device.The alarm limits must be set in LPO mode, see page 111.

The alarm limits for the following parameters are not monitored:
- Expiratory minute volume ***MV***
- Maximum airway pressure ***Paw***
- Inspiratory tidal volume ***VT***
- Respiratory rate ***RR***
- Apnea alarm time ***T_{apn}***

Safety information

CAUTION

Risk of patient injury due to unsuitable masks

The masks for non-invasive ventilation (NIV) are not suitable for O_2 therapy.

Use oxygen masks.

CAUTION

Risk of patient injury if monitoring is deactivated

Certain monitoring functions are disabled during O_2 therapy. Any deterioration in the patient's condition will not be detected.

Use external SpO_2 monitoring for patients who are dependent on an increased defined O_2 concentration.

Performing O_2 therapy

Preparing O_2 therapy

1 Fit the breathing hoses, see page 58.

2 Switch Savina 300 on, see page 70.

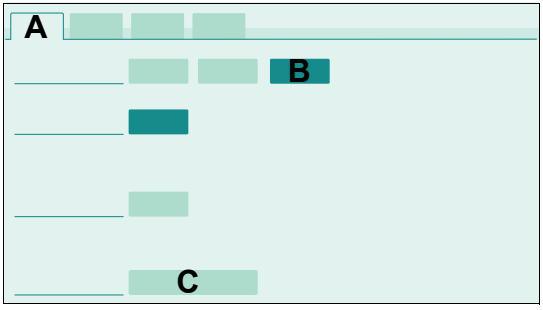
3 Switch Savina 300 to standby mode, see page 104.

4 Activate FiO_2 monitoring, see page 125.

Activating O_2 therapy

1 Press the ⏻ ***Start/Standby*** key.

Savina 300 opens the ***Start/Standby*** (A) page.



2 Touch the ***O_2 therapy*** button (B) and confirm with the rotary knob.

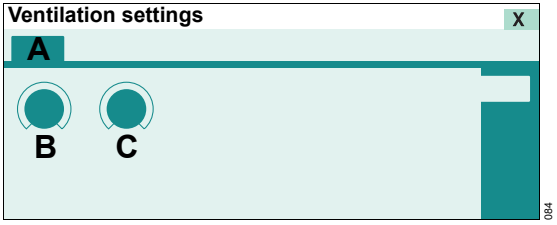
3 Connect the mask for O_2 therapy.

4 Touch the ***Start O_2 therapy*** button (C) and confirm with the rotary knob.

O_2 therapy is activated. The message ***O_2 therapy*** is displayed in the header bar. The page for setting ***FiO_2*** and ***Flow*** is displayed.

Setting FiO2 and flow

Prerequisite: The ***Ventilation settings*** > ***O2 therapy*** (A) page is opened.



B ***FiO2***

C ***Flow***

1 Touch the corresponding therapy control.

2 Set the value by turning the rotary knob and confirm.

Deactivating O2 therapy

1 Press the ⏻ ***Start/Standby*** key.

Savina 300 opens the ***Start/Standby*** (A) page.

2 Touch the ***Standby*** button (B) and confirm with the rotary knob.

Savina 300 is in standby mode. O2 therapy is deactivated. The therapy type can be changed to ventilation.

Day/Night screen switch-over

'Day' can be selected for good contrast and luminous colors and 'Night' can be selected for reduced screen illumination with a dark background color.

- Touch the ***Day/Night*** button in the main menu bar.

Savina 300 switches over the screen display.

Additional information

"Adjusting screen brightness" on page 141.

Key lock

The controls on the screen and the keys can be locked to prevent accidental changes from being made. The ***Audio paused 2 min.*** key can still be pressed.

Activating or deactivating key lock

1. Touch the ***Key lock*** button in the main menu bar.
2. Confirm with the rotary knob.

Low Pressure Oxygen (LPO)

The use of the Low Pressure Oxygen (LPO) mode is described below. For a detailed description, see chapter "Low Pressure Oxygen (LPO)" on page 246.

Safety information

WARNING

Risk of patient injury

Due to faulty installation of the LPO option, proper functioning of the device may be impaired.

Only have service personnel perform installation of the LPO option.

WARNING

Risk of infection and risk of insufficient O_2 supply

If the oxygen source is not suitable for direct supply to the patient, there is a risk of infection and the LPO supply may fail.

Only connect oxygen sources that are approved for medical use and that meet the following conditions:

- **O_2 flow: 0.5 to 10 L/min**
- **O_2 pressure: 10 to 200 kPa (0.1 to 2 bar, 1.45 to 29 psi)**

WARNING

Risk of patient injury

If prohibited hoses are used between Savina 300 and the oxygen source, the patient will be endangered.

Only use hoses approved for medical use and for use with oxygen.

CAUTION

Risk of patient injury

If a humidifier is used between Savina 300 and the oxygen source, correct functional integrity of the device may be impaired or the device may be damaged, and the patient may be endangered.

Use only dry gases.

WARNING

Risk of fire

Due to oxygen enrichment in the ambient air, the medical device can ignite.

Ensure sufficient ventilation at the rear of Savina 300.
Do not use oxygen sources which deliver a flow exceeding 10 L/min.
Switch off the oxygen source, e.g., O_2 concentrator, when Savina 300 is not ventilating.

WARNING

Risk of patient injury

The user is solely responsible for the ventilation and monitoring of the patient during O_2 calibration in LPO mode.

CAUTION

Insufficient O_2 supply

Patients who require an increased O_2 concentration will be endangered in the event of failure of the oxygen source.

Make sure there is an emergency oxygen supply, e.g., via an O_2 compressed gas cylinder.

NOTE

In LPO mode, medication nebulization is only possible if an HPO supply is additionally connected.

NOTE

In LPO mode, calibration of the O_2 sensors is performed with ambient air. The accuracy of the FiO_2 measurement is therefore reduced.

If a very accurate FiO_2 measurement is required, the O_2 sensors must be calibrated in HPO mode.

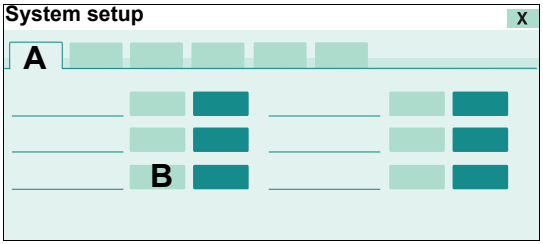
- Observe the instructions for use of the oxygen source used, e.g., O_2 concentrator.

Activating LPO mode

LPO mode can be activated during ventilation.

1 Touch the ***System setup...*** button in the main menu bar.

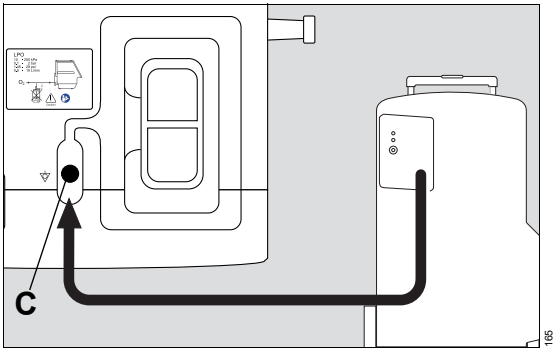
2 Touch the ***Ventilation*** tab (A).



3 Touch the ***On*** button (B) and confirm with the rotary knob.

The following information is displayed in the header bar: ***Connect concentrator. Check alarm limits.***

Connecting the O_2 concentrator to Savina 300



- Connect the O_2 supply hose of the oxygen source, e.g., O_2 concentrator, to the LPO inlet for low pressure (C).

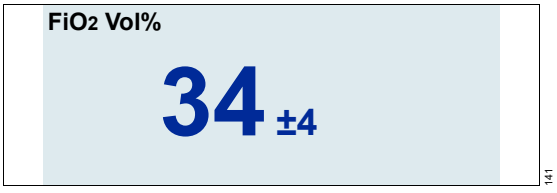
Setting the O_2 concentration

In LPO mode, the O_2 concentration cannot be set on Savina 300. The setting is made via the flow at the O_2 concentrator (LPO flow).

The O_2 concentration reaching the patient is influenced by the following factors:
– The O_2 concentration delivered by the O_2 concentrator used
– The flow set at the O_2 concentrator (LPO flow)
– The minute volume ***MV*** applied by Savina 300

1 Display the measured values for ***FiO_2*** and ***MV***, see "Displaying waveforms and measured values on the main screen" on page 118.

The parameter field for ***FiO_2*** displays a tolerance (±) in addition to the measured value. See page 246 for a detailed description.



2 Estimate the setting for the LPO flow, see "LPO flow setting diagram" on page 247.

3 Observe the measured values for ***FiO2*** for approx. 30 to 60 seconds and set the LPO flow accordingly:

- If ***FiO2*** is too low, set a higher value for the LPO flow.
- If ***FiO2*** is too high, set a lower value for the LPO flow.

4 Wait until the new measured value for ***FiO2*** is displayed steadily.

5 Set the alarm limits for ***FiO2***, see page 111.

Additional information

To calibrate the O2 sensors, see page 124.

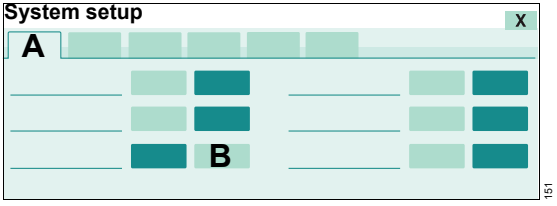
To switch off FiO2 monitoring, see page 125.

Deactivating LPO mode

LPO mode can be deactivated during ventilation.

1 Touch the ***System setup...*** button in the main menu bar.

2 Touch the ***Ventilation*** tab (A).



3 Touch the ***Off*** button (B) and confirm with the rotary knob.

The following information is displayed in the header bar: ***Disconnect concentrator.***

4 Disconnect O2 concentrator.

5 Connect HPO supply if necessary.

6 Calibrate O2 sensor 2 manually, see "Calibrating O2 sensors" on page 124.

Transporting patients

For transporting patients, the Dräger Savina 300 trolley can be coupled to a bed. For additional information, see instructions for use "Bed Coupling".

Safety information

WARNING

Risk of patient injury

Changes to the patient's condition or damage to the device during transport endanger the patient.

The patient must be monitored continuously by users.

WARNING

Risk of personal injury and damage to the device

If Savina 300 is equipped with a transport supply unit and is used at inclinations >5°, there is a risk of tipping over.

On inclined surfaces, the combination must be arranged so that the transport supply unit is always at the upper end.

WARNING

Risk of personal injury and damage to the device

If Savina 300 is placed on the bed when transporting patients, the device may fall down.

The device must not be placed on the bed when transporting patients.

CAUTION

Risk of patient injury

If the batteries are discharged, Savina 300 cannot ventilate.

Make sure that the batteries are adequately charged both before and after patient transport. Observe the following section: "Battery supply" (page 60).

CAUTION

Risk of patient injury

During patient transport, no breathing gas humidifier can be used and thus the patient’s airways may dry out.

Use an HME on the Y-piece.

CAUTION

Flow measurement inaccurate

The accuracy of the flow measurement may be impaired due to jolts during transport.

Check the patient’s condition.

Increasing the tipping stability

1. Set the hinged arm to minimum deflection.
2. Hoses and cables hooked as close as possible to the trolley.
3. Fold in the breathing gas humidifier if necessary.
4. If present, turn the monitor to the middle position.
5. If present, push in the bed coupling to the smallest size available.
6. Do not fasten additional parts to the lateral standard rails.
7. Grasp the handle of the trolley firmly and move the device in the longitudinal direction.

Interrupting the therapy – standby mode

If the standby mode is activated, ventilation is interrupted. Switch to standby mode for the following actions:
– Keeping Savina 300 ready for operation while the patient is absent
– Changing the application mode
– Changing the therapy type
– Performing a device check

WARNING
Risk of patient injury

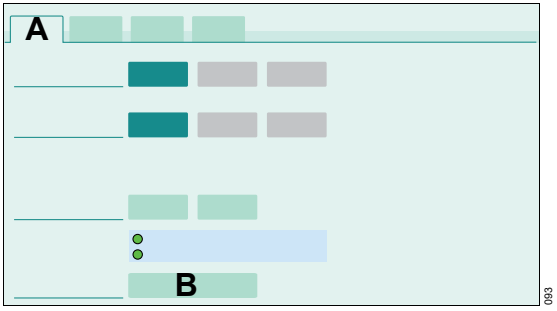
Ventilation does not take place in standby mode. Patients connected to the device are endangered.

Only set the device to standby mode when no patient is connected to the device.

Activating standby mode

1 Press the ⏻ ***Start/Standby*** key.

Savina 300 opens the ***Start/Standby*** (A) page.



2 Touch the ***Standby*** button (B) and confirm with the rotary knob.

The alarm message ***Standby mode activated*** is displayed in the header bar.

3 Press the ***Alarm reset*** key.

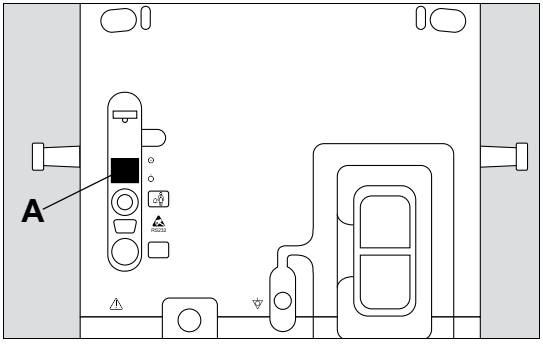
Savina 300 is in standby mode. ***Standby*** is displayed in the header bar of the screen instead of the ventilation mode. Information on the last ventilation settings continues to be displayed, e.g., ***AutoFlow***.

Additional information

For information on continuing the therapy, see "Starting the therapy" on page 82.

Ending operation

In standby mode



- Set the main switch (A) to ⏻ (off).

Savina 300 ends operation.

During ventilation

1 Set the main switch (A) to ⏻ (off).

The alarm message ***Main switch off*** is displayed.

2 Confirm the alarm message with the rotary knob.

If the main switch is switched back on without confirming the alarm message, ventilation is continued. The alarm message is no longer displayed.

Interrupting gas supply

- Remove the gas probe of the O_2 supply from the wall terminal unit of the central gas supply system.

CAUTION

Risk of personal injury

When the gas probe is in the wall terminal unit of the central gas supply system, the compressed gas hose is under pressure and may injure the user who unscrews it from the ventilator.

Do not unscrew the compressed gas hose from the ventilator until after the gas probe has been removed from the wall terminal unit.

Storing the device

Storing Savina 300 for less than 14 days

Connect the device to the mains power supply during storage so that the internal and external batteries can be charged.

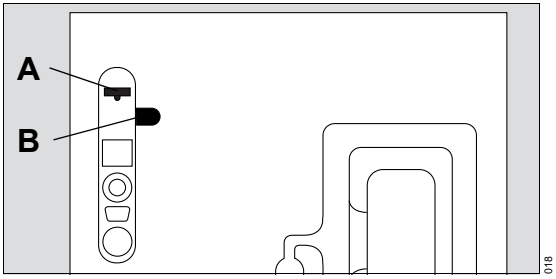
- Insert the power plug into the power socket.

Savina 300 can be stored.

Storing Savina 300 for more than 14 days

1 Insert the power plug into the power socket.

2 When the internal battery and the external battery are fully charged, pull the power plug from the mains power socket.



3 Remove the fuse (A) for the internal battery and place it in the storage recess (B).

Savina 300 can be stored.

Even when the fuse is removed, the internal battery continues to self-discharge and the external battery discharges, so that the internal and external battery must be recharged after 6 months at the latest.

Storage at an increased ambient temperature reduces the life span of the batteries.

Alarms

Display of alarms

Alarms are signaled optically and acoustically according to their alarm priority.

Optical alarm signals

Savina 300 displays the following optical alarm signals:

– The system displays the relevant alarm message in the alarm message field of the header bar.

– For alarms with high priority, the red LED flashes.

– For alarms with medium priority, the yellow LED flashes.

– For alarms with low priority, the yellow LED lights up.

Other displays

– The parameter field of the parameter triggering the alarm flashes.

– In the ***Alarms*** dialog window, the corresponding measured value flashes.

Perceptibility of alarm signals

The optical alarm signals are designed as follows:

– The device that has generated an alarm can be identified at a distance of 4 m (157 in).

– The alarm message can be clearly read at a distance of 1 m (39 in).

Acoustic alarm signals

The alarm with the highest priority is signaled acoustically. The alarm signal continues to sound until either the cause for the alarm has been resolved or the alarm signal is suppressed.

The alarm volume can be adjusted, see page 141.

Failure of the acoustic alarm signal

If the loudspeaker for the alarm signal (main alarm) fails due to a defect, an intermittent tone will be generated by the loudspeaker for the auxiliary alarm.

This intermittent tone is also used for the power supply failure alarm, see page 146.

Alarm priorities

The background color of the alarm message field indicates the priority of the active alarm. If several alarms occur simultaneously, the alarm with the highest priority is displayed first. High-priority alarm messages that are no longer active are displayed in the background color of the alarm message field.

The parameter box of the parameter triggering the alarm flashes in the color of the corresponding alarm priority.

On the ***Trends/Data*** > ***Logbook*** page, the priority of the alarm messages is additionally indicated by exclamation marks.

Color	**Priority of the alarm message**		**Action required**
Red	Alarm with high priority	!!!	Immediate action required to avert acute danger
Yellow	Alarm with medium priority	!!	Quick action required to avert danger
Cyan	Alarm with low priority	!	Attention and action required

For a list of causes and remedies, see chapter "Alarm – Cause – Remedy" on page 147.

Alarm silence

The acoustic alarm signal can be suppressed for a maximum of 2 minutes.

If an alarm with a higher priority occurs during this time, the alarm signal sounds once.

If the fault triggering the alarm is not eliminated after 2 minutes, the alarm signal sounds again.

The alarm signal cannot be suppressed in the following situations:
– During the alarm ***Standby mode activated***
– During the device check when testing the alarm signals

Suppressing the alarm signal

- Press the ***Audio paused 2 min.*** key.

Savina 300 displays the symbol and the remaining time for the suppressed alarm signal in the header bar.

Reactivating the alarm signal

- Press the ***Audio paused 2 min.*** key.

Dismissing alarm messages

After the fault has been eliminated, the alarm signal stops. High-priority alarm messages continue to be displayed and need to be dismissed.

- Press the ***Alarm reset*** key.

Setting the alarm limits

WARNING

Risk of patient injury

If the alarm limits are not adapted to the patient and the required therapy, the patient may be endangered.

Set the alarm limits accordingly.

CAUTION

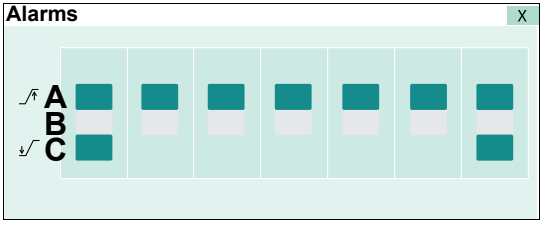
Risk of patient injury due to incorrect settings

If several identical or similar devices are used in the care areas, the alarm limits of the devices can be configured differently and therefore be unsuitable for the current patient.

Check the alarm limits and adapt them to the current patient and the required therapy.
Make sure that extreme or disabled alarm limits do not render the alarm system useless.

Opening the *Alarms* dialog window

- Touch the ***Alarms...*** button in the main menu bar.



The alarm limit settings and the current measured value are displayed.

A ↗ : Upper alarm limit

B Current value : Current measured value

C ↘ : Lower alarm limit

Alarm limits and setting ranges

In the following table, the alarm limits are listed with the setting ranges.

Alarm limit	Setting range
↗ MV	2.0 to 41 L/min
↘ MV	0.2 to 40 L/min
↗ Paw	10 to 100 mbar (10 to 100 cmH_2O)
↗ VT	0.06 to 4.0 L 0.03 to 4.0 L[1)]
↗ RR	10 to 120/min
↗ T_{apn}[2)]	15 to 60 s
↗ $T_{disconnect}$[3)]	0 to 60 s
↗ $etCO_2$	0.1 to 13.1 Vol%
	1 to 98 mmHg
	0.1 to 13.3 kPa
↘ $etCO_2$	0 to 13.0 Vol%
	0 to 97 mmHg
	0 to 13.2 kPa
↗ FiO_2[4)]	19 to 99 Vol%
↘ FiO_2[4)]	18 to 98 Vol% 18 to 99 Vol%[5)]

1) Only if option ***Pediatric Plus*** is enabled
2) In the ***VC-SIMV***, ***SPN-CPAP*** and ***PC-BIPAP*** ventilation modes
3) In the application mode ***NIV***
4) In LPO mode
5) Only if ↗ FiO_2 is deactivated

The lower alarm limit for the airway pressure ***Paw*** is automatically linked to the set value for ***PEEP***.

In HPO mode, the alarm limits for the O_2 concentration ***FiO_2*** are automatically linked to the ***FiO_2*** set value:

Set value		Alarm limit
FiO_2 <60 Vol%	–>	FiO_2 ±4 Vol%
FiO_2 ≥60 Vol%	–>	FiO_2 ±6 Vol%

Setting an alarm limit

Prerequisite: The ***Alarms*** dialog window is opened.

1 Touch the corresponding button for the alarm limit.

2 Set the value by turning the rotary knob and confirm.

Deactivating alarm limits

WARNING

Risk of patient injury

If alarm limits are switched off, Savina 300 cannot monitor the patient.

Only deactivate alarm limits if the safety of the patient is not jeopardized by the absence of an alarm.

The following alarm limits can be deactivated:

Alarm limit	Mode
MV	Only in ***NIV*** application mode
VT	
Tapn	
FiO2	Only in LPO mode

How to deactivate an alarm limit

1 Touch the corresponding button for the alarm limit.

2 Turn the rotary knob until the set limit is reached.

3 Press the rotary knob to exceed the set limit. Then keep turning the rotary knob.

The following symbol is displayed instead of the value:

4 Confirm with the rotary knob.

The alarm limit is deactivated. When the alarm limits ***MV***, ***VT***, or ***Tapn*** are deactivated, the following symbol is displayed in the header bar:

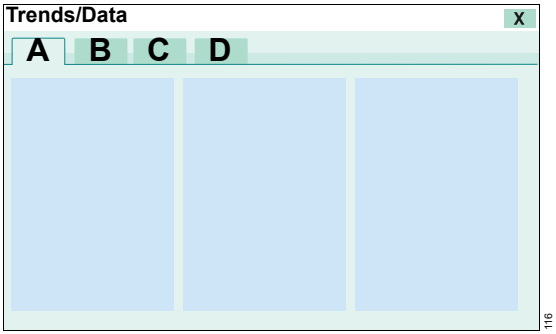
Response to power supply failure

Alarm limits are also retained in the event of a power supply failure, e.g., caused by a faulty internal battery.

Trends and data

Opening the dialog window

- Touch the ***Trends/Data...*** button in the main menu bar.



In the ***Trends/Data*** dialog window, the following is displayed:

A Measured values

B Set values

C Trends

D Logbook

Displaying measured values and set values

Prerequisite: The ***Trends/Data*** dialog window is opened.

Displaying measured values

- Touch the ***Measurements*** tab.

The measured values are displayed on a blue background.

Displaying set values

- Touch the ***Settings*** tab.

The set values are displayed on a green background.

Displaying trends

Trends are recorded for up to 10 days. The recorded data are displayed in a table with the corresponding recording times:
– Measured values in blue
– Set values in green

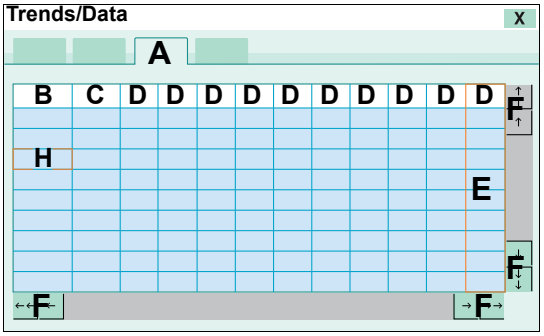
When Savina 300 is switched off, the saved trends are deleted.

For displaying trends, the time interval can be selected and the table can be configured.

Displaying a trend table

Prerequisite: The ***Trends/Data*** dialog window is opened.

1 Touch the ***Trends*** tab (A).



B Parameter column

C Column with the units for the parameters

D Time columns with the respective trend values

E Cursor for marking a time column

F Buttons for displaying further areas of the table

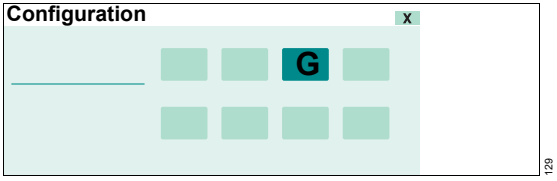
Displaying trend values for a particular point in time

- Select the time by turning the rotary knob or touching the time.

Selecting a time interval

1 Touch the header bar of the time columns (D).

Savina 300 opens the dialog window for selecting the time intervals.



2 Touch the corresponding time interval, e.g., (G).

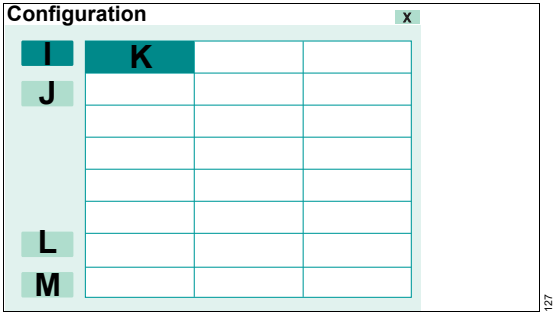
Savina 300 displays the trend table with the selected time interval.

Configuring a trend table

Selecting a parameter

1 In the parameter column (B), touch the relevant field, e.g., (H).

The selected field is marked. Savina 300 opens the ***Configuration*** dialog window.



2 Touch the ***Measurements*** (I) or ***Settings*** (J) button.

3 Touch the corresponding parameter, e.g., (K).

Savina 300 displays the trend table with the selected parameter.

Using an empty trend table

To rearrange the order of the parameters, the contents of the current trend table can be deleted.

- Touch the ***Clear all*** button (L).

Savina 300 displays an empty trend table.

Using factory settings

The order of the parameters in the dialog window ***Configuration*** can be adopted for the trend table.

- Touch the ***Dräger default*** button (M).

Displaying the logbook

The logbook records changed settings, events and alarms in chronological order. Events include, for instance, using the medication nebulizer. For current alarms, the priority is highlighted in color. Switching the device off and on is not recorded.

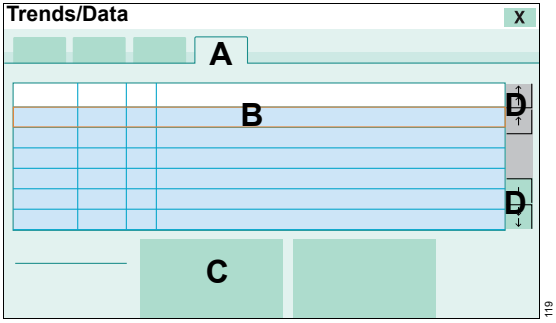
Starting at approx. 500 logbook entries, the oldest entries are overwritten.

The entries in the logbook are also retained after the device has been switched off and on again, or following a power supply failure.

Opening the logbook

Prerequisite: The ***Trends/Data*** dialog window is opened.

- Touch the ***Logbook*** tab (A).



B Cursor for marking a row in the logbook

C For the marked row, the device displays all the settings of the ventilation mode effective at this time.

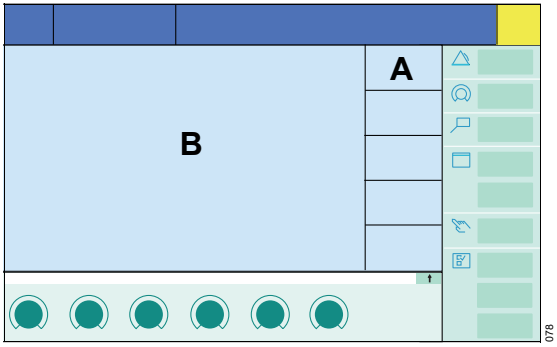
D Buttons for displaying further areas of the table

Displaying settings for a particular time

- Select the time by turning the rotary knob or touching the time.

Displaying waveforms and measured values on the main screen

Configuring a waveform field and parameter fields



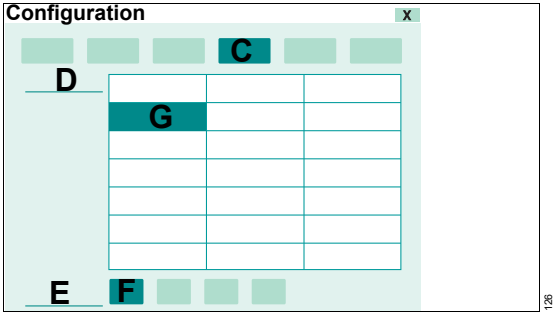
The parameters can be displayed in parameter fields (A) and in the waveform field (B).

In the waveform field (B), the following can be configured:
– Waveform
– Small loops
– Large loop
– Trend (measurem.)
– Trend (settings)
– Multi Trend

Configuring waveform fields

1 Touch the corresponding waveform field.

The waveform field is marked. Savina 300 opens the ***Configuration*** dialog window.



2 Touch button, e.g., ***Trend (measurem.)*** (C).

Savina 300 displays the list of parameters (D) and, for trends, also the time scale (E).

3 For trends, touch the respective button for the time scale, e.g., (F).

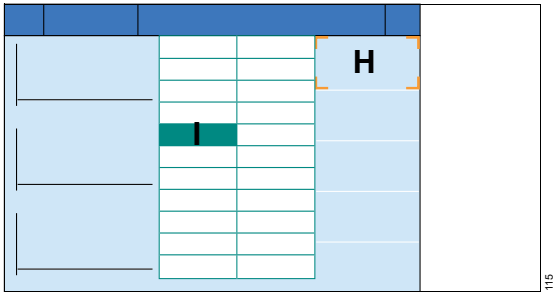
4 Touch the corresponding parameter, e.g., (G).

Savina 300 displays the main screen with the selected settings.

Selecting a parameter

1 Touch the corresponding parameter field.

The parameter field is marked, e.g., (H).
Savina 300 opens the parameter selection list.

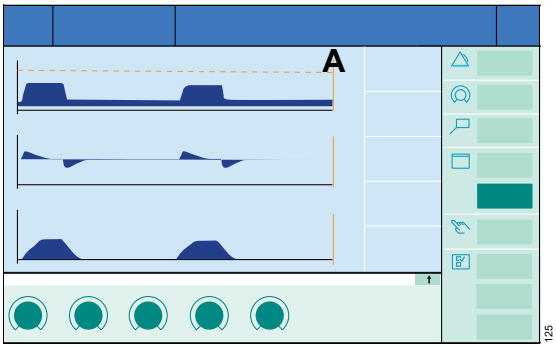


2 Touch the corresponding parameter, e.g., (I).

Savina 300 displays the main screen with the selected parameter.

Freezing waveforms

- Touch the ***Freeze waveforms*** button in the main menu bar.



The current waveforms are immediately frozen. The cursor (A) displays the time of "freezing" and the value at the cursor position.

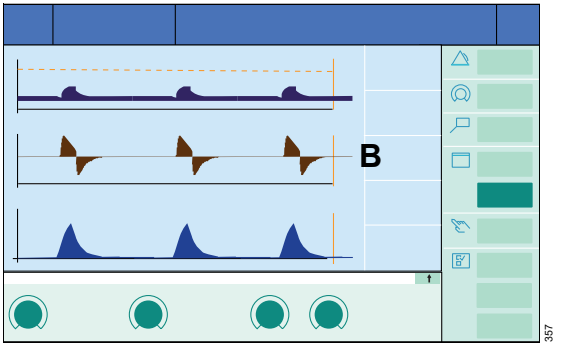
Displaying a measured value for a particular point in time

- Select the time by turning the rotary knob.

The measured value or the measured value pair is displayed above the waveform.

The frozen waveform remains displayed until the ***Freeze waveforms*** button (A) is touched again or another area of the screen is touched.

Evaluating spontaneous breaths

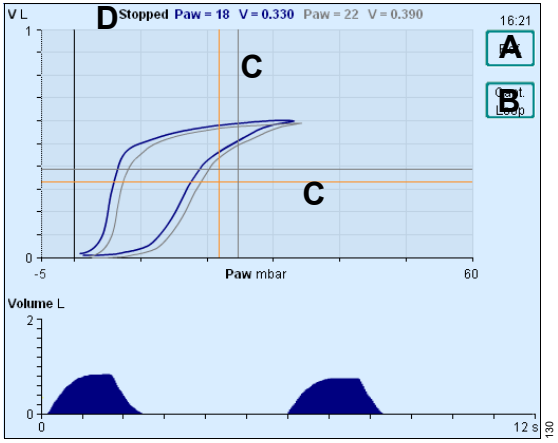


The flow waveform displays spontaneous breathing and mandatory ventilation in different colors:

– Spontaneous breaths (B) are displayed in light brown.
– Mandatory breaths are displayed in dark blue.

Evaluating Loops

Prerequisite: Loop display has been selected.



Displaying the reference loop

- Touch the ***Ref.*** button (A).

A loop is recorded and displayed as a reference loop. The time of the recording appears above the button (A). The reference loop is displayed in black and remains displayed until the ***Ref.*** button (A) is touched again.

Freezing and displaying the current loop

- Touch the ***Capt.*** button (B).

The current loop is frozen.

For large loops, a cursor (C) is displayed for the frozen loop and the reference loop, which can be moved using the rotary knob. The respective values are displayed (D).

The frozen loop remains displayed until the ***Capt.*** button (B) is touched again.

Monitoring

Information on monitoring

Monitoring is activated at the factory. Each monitoring function can be deactivated separately.

Calibrating the sensors

Savina 300 uses the following sensors for measurement and monitoring purposes:

Sensors	Intervals for calibration/check
Pressure sensors	Automatic calibration
Flow sensor	For calibration intervals, see page 122
O_2 sensors	For calibration intervals, see page 124
CO_2 sensor	For information on checking, see page 127

Saving calibration values

The last-determined calibration values of the sensors remain stored until the next calibration, even if the device is switched off.

Flow monitoring

Calibration intervals of the flow sensor

Savina 300 automatically calibrates the flow sensor:
- After the device has been switched on
- After the start of ventilation
- Every 24 hours during operation
- After replacing the flow sensor
- After and during medication nebulization
- After the oxygenation program for endotracheal suction
- After changing the O_2 concentration

In certain cases, it may be necessary to calibrate the flow sensor manually, e.g., when automatic calibration has failed.

Calibrating the flow sensor

Prerequisite: Savina 300 is switched on.

1 Remove the flow sensor.

2 Re-insert the flow sensor.

Savina 300 uses one full inspiratory phase for calibration. Short inspiratory times are prolonged to approx. 1 second.

Information on calibration is displayed in the message field.

If calibration was not successful

If calibration was not successful, the message ***Flow calibration failed.*** is displayed. The expiratory portion of the flow waveform and the measured values ***VTe***, ***MV***, and ***PEEP*** are not displayed.

- Replace flow sensor.

Savina 300 automatically calibrates the new flow sensor.

Deactivating or activating flow monitoring

Flow monitoring can be deactivated, e.g.:
– If the flow sensor has failed and cannot currently be replaced.
– To permit ventilation in the event of major tube leakage.

Savina 300 cannot determine the following measured values when flow monitoring is deactivated:
– MV
– MV_{spon}
– MV_{leak}
– VT_e
– VT_{spon}
– R
– C
– RSB
– PEEP

Instead of the measured value, the following is displayed in the parameter field and on page ***Trends/Data*** > ***Measurements***: ***Off***

Expiratory flow monitoring cannot be fully substituted via replacement monitoring. Set the minute volume alarm limits of the replacement monitoring accordingly.

WARNING
Risk of patient injury

If flow monitoring is deactivated, Savina 300 cannot monitor the patient completely.

Ensure that appropriate replacement monitoring is available immediately.

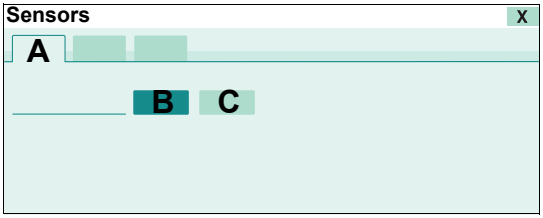
WARNING
Risk of patient injury

No apnea monitoring takes place when flow monitoring is deactivated.

Use independent apnea monitoring.

Deactivating flow monitoring

1 Touch the ***Sensors...*** button in the main menu bar. The ***Flow*** (A) page appears by default.



2 Touch the ***Off*** button (C) and confirm with the rotary knob.

The measured values are no longer displayed. The alarm function is deactivated. The following information is displayed in the header bar: ***Use external flow monitoring.***

Activating flow monitoring

Reactivate flow monitoring after replacing the flow sensor or as soon as possible.

- Touch the ***On*** button (B) and confirm with the rotary knob.

FiO_2 monitoring

Information on the O_2 sensors

The O_2 sensors are used in the following manner:
– O_2 sensor 1 for O_2 regulation in HPO mode and for displaying the measured value ***FiO_2***
– O_2 sensor 2 for FiO_2 monitoring

Calibration intervals of the O_2 sensors

O_2 sensors in HPO mode

Savina 300 automatically calibrates the O_2 sensor 1:
– Every 8 hours during operation
– After replacing the O_2 sensors
– After a change in atmospheric pressure by more than 200 hPa
– After a change in temperature of more than 10 °C

O_2 sensor 2 must be calibrated manually. Perform calibration:
– Every 4 weeks
– When the following alarm message is displayed: ***FiO_2 measurement failed***

O_2 sensors in LPO mode

In LPO mode, no automatic calibration is performed. Both O_2 sensors must be calibrated manually every 4 weeks in HPO mode for ±3 Vol% accuracy.

NOTE

If the O_2 sensors are not calibrated manually every 4 weeks in HPO mode, the accuracy of ±3 Vol% may not be guaranteed and may decrease to ±8 Vol% (maximum possible basic measuring error in O_2 measurement with a nominal concentration of 100 Vol% O_2 and assuming the worst-case ambient conditions in the hospital).

Calibrating the O_2 sensors

Prerequisites for calibration in HPO mode

CAUTION

Incorrect calibration

If the quality of the oxygen from the central gas supply system is insufficient, calibration may be incorrect.

Calibrate the O_2 sensor with calibration gas (100 Vol% O_2).

Prerequisites for calibration in LPO mode

– After switching on Savina 300, wait for the ten-minute warm-up phase to complete.
– If Savina 300 has been subjected to a significant change in temperature, wait for up to one hour. Example: after transport from a cold room to a heated room or when extreme ventilation settings were used.

FiO_2 measurement is possible during this period, provided no alarm message saying otherwise is displayed.

NOTE

In LPO mode, calibration of the O_2 sensors is performed with ambient air. The accuracy of the FiO_2 measurement is therefore reduced.

If a very accurate FiO_2 measurement is required, the O_2 sensors must be calibrated in HPO mode.

For information on the accuracy of the FiO_2 measurement, see chapter Technical data, "Displayed measured values" on page 203.

Information on calibrating

During calibration, the alarms that would be triggered due to patient disconnection and the altered O_2 concentration are deactivated.

Automatic cancelation of calibration

If reconnection has not taken place 30 seconds after being requested to do so by Savina 300, the set ventilation mode and the alarms are reactivated.

If calibration was not successful

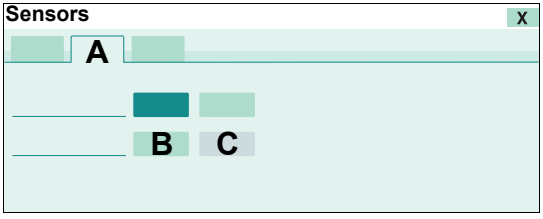
If the ***FiO_2 measurement failed*** alarm message is displayed after calibration, replace the O_2 sensors, see page 192.

Starting calibration of the O_2 sensors

1 Touch the ***Sensors...*** button in the main menu bar.

Savina 300 opens the ***Sensors*** dialog window.

2 Touch the ***O_2*** tab (A).



3 Touch the ***Start*** button (B) and confirm with the rotary knob.

4 In LPO mode: Disconnect the O_2 concentrator when prompted to do so by Savina 300. Confirm with the rotary knob.

The following information is displayed in the header bar: ***Disconnect patient.***

5 Disconnect the patient from the device within 30 seconds and continue ventilation using an independent ventilation device if necessary.

Savina 300 calibrates the O_2 sensors. After approx. 60 seconds, the following information is displayed: ***Reconnect patient.***

6 Reconnect the patient immediately.

7 In LPO mode: Reconnect the O_2 concentrator when prompted to do so by Savina 300.

Canceling calibration of the O_2 sensors

1 Touch the ***Cancel*** button (C) and confirm with the rotary knob.

2 Reconnect the patient immediately.

3 In LPO mode: Reconnect the O_2 concentrator.

Deactivating or activating FiO_2 monitoring

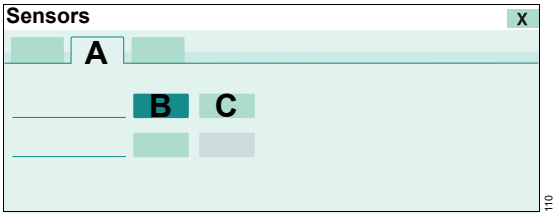
FiO_2 monitoring can be substituted by appropriate replacement monitoring. Set the FiO_2 alarm limits of the replacement monitoring according to the set value FiO_2:

Set value		Alarm limit
FiO_2 <60 Vol%	–>	FiO_2 ±4 Vol%
FiO_2 ≥60 Vol%	–>	FiO_2 ±6 Vol%

Switching off FiO_2 monitoring

1 Touch the ***Sensors...*** button in the main menu bar.

2 Touch the ***O_2*** tab (A).



3 Touch the ***Off*** button (C) and confirm with the rotary knob.

The measured values are no longer displayed. The alarm function is deactivated. The following information is displayed in the header bar: ***Use external FiO2 monitoring.***

Switching on FiO2 monitoring

Reactivate FiO2 monitoring as soon as possible.

- Touch the ***On*** button (B) and confirm with the rotary knob.

CO2 monitoring

Display of etCO2 measured values

The measured value for ***etCO2*** can be displayed in ***Vol%***, ***kPa***, or ***mmHg***. The display can be configured, see "Configuring units" on page 142.

Selecting the cuvette type

The following cuvettes can be used:
– Reusable cuvettes
– Disposable cuvettes

When the cuvette has to be replaced, the selected cuvette type must be observed:
– When using reusable cuvettes, insert a clean reusable cuvette.
– When using disposable cuvettes, insert a new disposable cuvette.

CAUTION

CO2 measurement inaccurate

The cuvette windows of the reusable cuvette have different optical properties to the cuvette windows of the disposable cuvette. The zero point is shifted by up to 8 mmHg CO2.

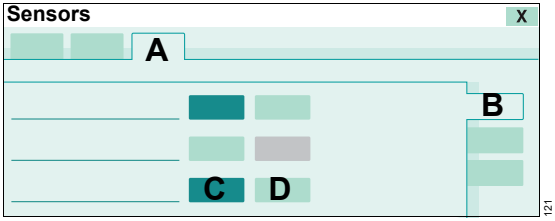
The cuvette type used must therefore be selected on the ***Zero calib. on/off*** page.

Selecting cuvette type being used

1 Touch the ***Sensors...*** button in the main menu bar.

2 Touch the ***CO2*** tab (A).

The ***Zero calib. on/off*** (B) page appears by default.



3 Touch the ***Reusable*** (C) or ***Disposable*** (D) button and confirm with the rotary knob.

Information on checking the CO_2 sensor

The CO_2 sensor is factory calibrated and can be used on any Savina 300 ventilator.

Information on checking the CO_2 zero indication and on CO_2 zero calibration

When checking the zero indication or performing zero calibration, do not breathe onto or into the cuvette or the cuvette shaft. Such breathing causes an undesirable increase of the CO_2 concentration in the cuvette.

The following checks are required for the CO_2 sensor:

Check	Required when?
Check CO_2 zero indication in ambient air	Required before measurement and when changing the CO_2 sensor to another ventilator.
Perform CO_2 zero calibration	When the CO_2 zero indication in ambient air is not between 0 and 1 mmHg (or 0 and 0.1 Vol% or 0 and 0.1 kPa).
Check calibration of the CO_2 sensor with test filter	Required in intervals of one month.
Check calibration of the CO_2 sensor with test gas	When the test values are not adhered to during the calibration check with test filter.
Perform calibration of the CO_2 sensor	When the test values are not adhered to during the calibration check with test gas.

CO_2 zero calibration in ambient air, calibration check with test filter or test gas, and calibration of the CO_2 sensor can be performed during ventilation.

Information on the alarm messages issued during CO_2 monitoring

The following information refers to alarm messages generated due to a soiled cuvette or CO_2 sensor.

Alarm message *Clean CO_2 cuvette*

If the ***Clean CO_2 cuvette*** alarm message is displayed, the following panes may be soiled:
– Reusable cuvette or disposable cuvette
– CO_2 sensor

- Clean cuvette. Or use a clean or new cuvette of the same cuvette type.
- Clean the CO_2 sensor.

Alarm message *CO_2 zero calibration required*

If the ***CO_2 zero calibration required*** alarm message is displayed or if incorrect measured values are suspected, proceed as follows:

1 Check whether the cuvette windows are soiled.

2 Clean soiled windows. Or use a clean or new cuvette of the same cuvette type.

If the cuvette windows are extremely soiled, e.g., by deposits due to medication nebulization, this may result in a zero shift. The CO_2 measured values may be inaccurate even before insufficient measuring light causes the ***Clean CO_2 cuvette*** alarm message to be displayed.

If the ***CO_2 zero calibration required*** alarm message does not disappear or if the CO_2 measured values remain suspect, CO_2 zero calibration must be performed.

Checking the CO_2 zero indication

Prerequisites:
– A clean CO_2 sensor is placed on the cuvette that is used for measurement. Or a clean or new cuvette of the same cuvette type is used.
– The three-minute warm-up phase for the CO_2 sensor has at least elapsed.

Checking the CO_2 zero indication

1 Select the cuvette type, see page 126.

2 Display the CO_2 measured value as a waveform, see "Configuring waveform fields" on page 118.

3 Remove the CO_2 sensor with cuvette from the breathing circuit and hold in ambient air. Do not breathe onto or into the cuvette.

4 Observe the CO_2 measured value. If 0 to 1 mmHg (or 0 to 0.1 Vol% or 0 to 0.1 kPa) is not displayed when the cuvette is being exposed to ambient air, perform CO_2 zero calibration.

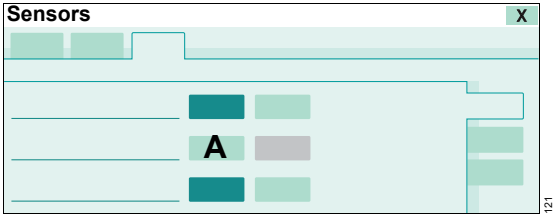
Performing CO_2 zero calibration

Prerequisites:
– A clean CO_2 sensor is placed on the cuvette that is used for measurement. Or a clean or new cuvette of the same cuvette type is used.
– The three-minute warm-up phase for the CO_2 sensor has at least elapsed.

Starting CO_2 zero calibration

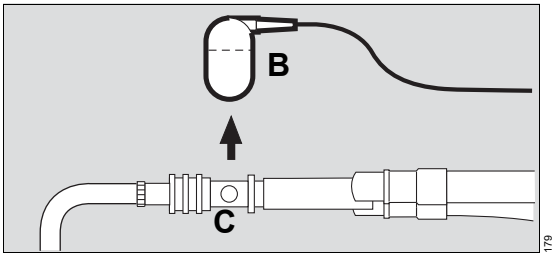
1 Touch the ***Sensors...*** button in the main menu bar.

2 Open the ***CO_2*** > ***Zero calib. on/off*** page.



3 Touch the ***Start*** button (A).

When requested by Savina 300:



4 Remove the CO_2 sensor (B) from the cuvette (C).

5 Confirm with the rotary knob.

Savina 300 performs CO_2 zero calibration.

If CO_2 zero calibration was successful

After approx. 5 seconds, Savina 300 displays the following information: ***CO_2 zero calibration successful.***

- Fit the CO_2 sensor (B) back on the cuvette (C).

If CO_2 zero calibration was not successful

Savina 300 displays the following information: ***CO_2 zero calibration failed.***

- Repeat CO_2 zero calibration.

If CO_2 zero calibration is still not successful

1 Check if the CO_2 sensor is soiled and clean it if necessary. If the CO_2 sensor is faulty, replace the CO_2 sensor.

2 Repeat CO_2 zero calibration.

Checking the calibration of the CO_2 sensor with test filter

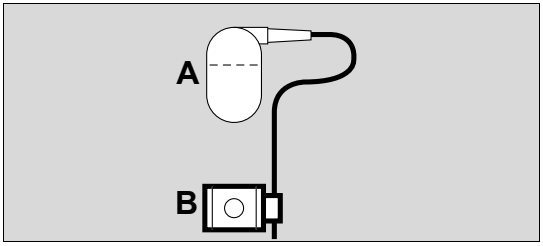
Perform a calibration check of the CO_2 sensor with test filter in intervals of one month.

Prerequisite: The three-minute warm-up phase for the CO_2 sensor has at least elapsed.

Before the check

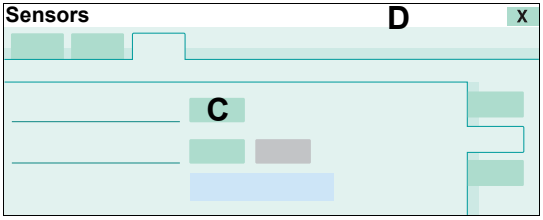
- Perform CO_2 zero calibration in ambient air.

Starting the check



1 Remove the CO_2 sensor (A) from the cuvette and connect it to the test filter (B) on the sensor cable.

2 Open the ***CO_2*** > ***Check sensor*** page.



3 Touch the ***Filter check*** button (C) and confirm with the rotary knob.

Savina 300 starts the check and displays information in the message field (D).

If the check was successful

Savina 300 displays the following information: ***Filter check of CO_2 sensor successful.*** The test value is within the permissible tolerance.

- Fit the CO_2 sensor back on the cuvette.

If the check was not successful

Savina 300 displays the following information: ***Filter check of CO_2 sensor failed.*** The test value is outside the permissible tolerance.

- Check the CO_2 calibration with test gas.

Checking the calibration of the CO_2 sensor with test gas

Perform the check when the test values are not within the permitted tolerance during the calibration check of the CO_2 sensor with test filter.

CAUTION

CO_2 measurement inaccurate

If an incorrect test gas is used for the check and calibration, display deviations of ±0.5 Vol% CO_2 are possible.

Use test gas composed of CO_2 and N_2.

Prerequisite: The three-minute warm-up phase for the CO_2 sensor has at least elapsed.

Before the check

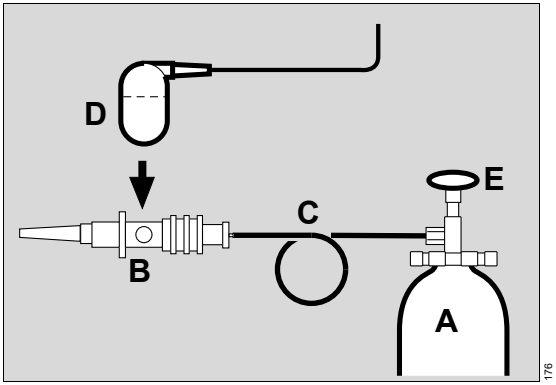
- Perform CO_2 zero calibration in ambient air.

Connecting the test gas supply

The permitted test gas must only be composed of CO_2 and N_2!

1 Use the reusable cuvette from the calibration set!

At the start of the check with test gas, Savina 300 automatically sets the cuvette type to ***Reusable***.



2 Connect the test gas cylinder (A) and the cuvette (B) of the calibration set to the hose (C).

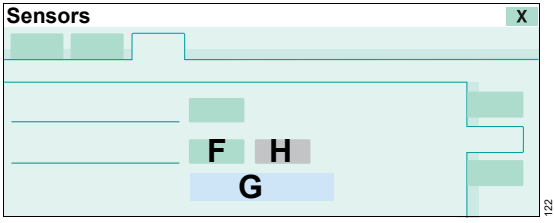
3 Fit the CO_2 sensor (D) onto the cuvette (B) of the calibration set.

4 Read the CO_2 concentration of the test gas from the test gas cylinder (A).

5 Open the test gas cylinder (E) and set a low test gas flow (approx. 0.1 L/min).

Starting the check

1 Open the ***CO_2*** > ***Check sensor*** page.



2 Touch the ***Gas check*** button (F) and confirm with the rotary knob.

Savina 300 displays the measured CO_2 concentration (G). Within 60 seconds after setting the test gas flow, the measured CO_2 value must match the CO_2 concentration of the test gas read from the test gas cylinder with a tolerance of ±0.2 Vol%.

3 Close the test gas cylinder again.

4 Touch the ***Stop/Cancel*** button (H) and confirm with the rotary knob.

If the test value is outside the permitted tolerance, the CO_2 sensor must be recalibrated with test gas.

After the check

The cuvette type is automatically reset to the previously set cuvette type.

- Fit the CO_2 sensor back on the cuvette in the breathing circuit.

Performing calibration of the CO_2 sensor

The CO_2 sensor must be calibrated if the test values are not within the permitted tolerance during the calibration check with test gas.

CAUTION

CO_2 measurement inaccurate

If an incorrect test gas is used for the check and calibration, display deviations of ±0.5 Vol% CO_2 are possible.

Use test gas composed of CO_2 and N_2.

Prerequisite: The three-minute warm-up phase for the CO_2 sensor has at least elapsed.

Before calibration

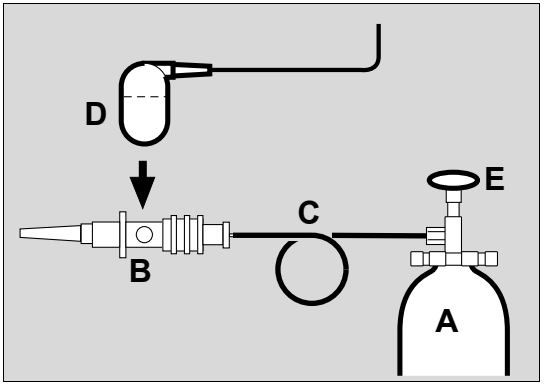
- Perform CO_2 zero calibration in ambient air.

Connecting the test gas supply

The permitted test gas must only be composed of CO_2 and N_2!

1 Use the reusable cuvette from the calibration set!

At the start of calibration, Savina 300 automatically sets the cuvette type to ***Reusable***.



2 Connect the test gas cylinder (A) and the cuvette (B) of the calibration set to the hose (C).

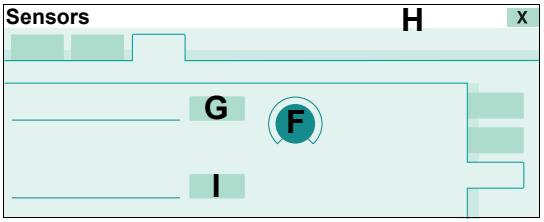
3 Fit the CO_2 sensor (D) onto the cuvette (B) of the calibration set.

4 Read the CO_2 concentration of the test gas from the test gas cylinder (A).

5 Open the test gas cylinder (E) and set a low test gas flow (approx. 0.1 L/min).

Starting calibration

1 Open the ***CO_2*** > ***Calibration*** page.



2 Touch the ***CO_2*** (F) therapy control. Enter the value for the CO_2 test gas concentration with the rotary knob and confirm.

3 Approx. 1 minute after setting the test gas flow, touch the ***Start*** button (G) and confirm with the rotary knob.

Savina 300 starts calibration and displays information in the message field (H).

4 Close the test gas cylinder again.

If calibration was successful

Savina 300 displays the following information: ***CO_2 zero calibration successful.***

The cuvette type is automatically reset to the previously set cuvette type.

- Fit the CO_2 sensor back on the cuvette in the breathing circuit.

If calibration was not successful

Savina 300 displays the following information: ***CO_2 zero calibration failed.***

If calibration failed, the following causes are possible:

Cause	Remedy
The entered CO_2 concentration does not match the value on the test gas cylinder.	Check the entered CO_2 concentration and repeat calibration of the CO_2 sensor.
The test gas cylinder is empty.	Use a new test gas cylinder and repeat calibration of the CO_2 sensor.
The CO_2 sensor is soiled.	Clean the CO_2 sensor and repeat calibration of the CO_2 sensor.
The CO_2 sensor is faulty.	Replace the CO_2 sensor and check the CO_2 zero indication.

Resetting the calibration of the CO_2 sensor

If problems occurred during calibration, the CO_2 sensor can be reset to the delivery default values.

1 Open the ***CO_2*** > ***Calibration*** page.

2 Touch the ***Reset calibration*** button (I) and confirm with the rotary knob.

After approx. 5 seconds, the factory-set calibration is effective again and must be checked with the test filter.

3 Check the calibration of the CO_2 sensor with test filter, see page 129.

Deactivating or activating CO_2 monitoring

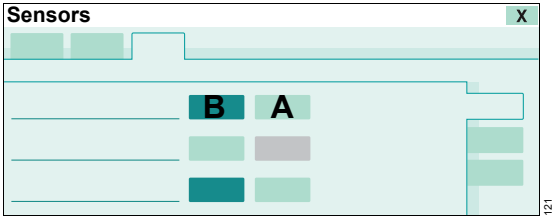
If CO_2 monitoring is deactivated, the measured values are no longer displayed. The alarm function is deactivated.

Switch off CO_2 monitoring if:
– A defective CO_2 sensor cannot be replaced.
– No CO_2 sensor is connected.
– The CO_2 measured values are not needed.

Switching off CO_2 monitoring

1 Touch the ***Sensors...*** button in the main menu bar.

2 Open the ***CO_2*** > ***Zero calib. on/off*** page.



3 Touch the ***Off*** button (A) and confirm with the rotary knob.

Switching on CO_2 monitoring

- Touch the ***On*** button (B) and confirm with the rotary knob.

Configuration

Information on configuration

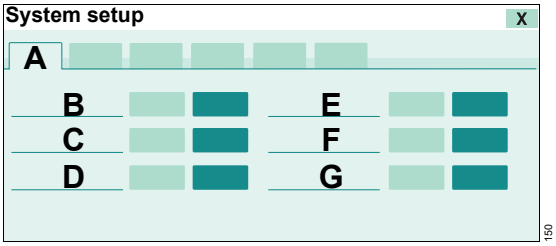
The following settings can be configured:
– Ventilation functions
– Start settings for ventilation
– Device settings
– Country-specific settings
– Interfaces
– Options

Opening the dialog window

- Touch the ***System setup...*** button in the main menu bar.

Configuring the ventilation functions

Prerequisite: The ***System setup*** > ***Ventilation*** (A) page is opened.



The following ventilation functions can be activated or deactivated:

B ***Pressure limitation***

C Inspiratory pause time ***Plateau***

D Low Pressure Oxygen ***LPO***

E ***Insp. termination***

F ***Leakage compensation ("Tube")***

G ***Timax ("Tube")***

Information on leakage compensation

In ***Tube*** application mode, leakage compensation can be activated or deactivated. In ***NIV*** application mode, leakage compensation is always activated.

Information on the ventilation function *Pressure limitation*

Prerequisites:
– ***Pressure limitation*** is switched on.
– ***AutoFlow*** is switched off.

In the ***VC-CMV***, ***VC-AC***, ***VC-SIMV*** and ***VC-MMV*** ventilation modes, the pressure is limited with the ***Pmax*** therapy control.

Information on the inspiratory pause time *Plateau*

Prerequisite: ***Plateau*** is switched on

In the ***VC-CMV***, ***VC-AC***, ***VC-SIMV*** and ***VC-MMV*** ventilation modes, the inspiratory time is set with the ***Ti*** therapy control.

Switching ventilation functions on or off

1 Touch the ***On*** or ***Off*** button.

2 Confirm with the rotary knob.

Additional information

For a description of the ventilation modes, see page 224.

Low Pressure Oxygen (LPO), see page 100.

Configuring the start settings

The configuration of the start settings is protected by a user password.

Information on the user password

The following pages are protected by a user password to prevent unauthorized adjustments:

- ***Settings 1***
- ***Settings 2***
- ***Settings 3***
- ***ATC settings***
- ***Alarm settings***
- ***Password***

For more information, see: "Information on the user password" on page 271.

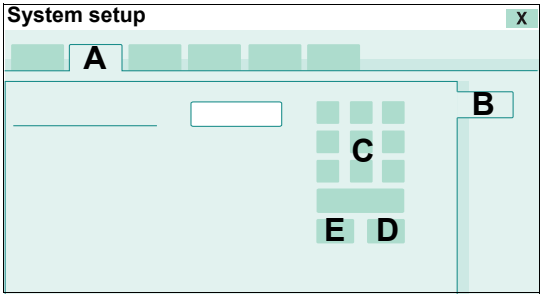
The user password can be changed (see "Changing the user password" on page 140).

Entering the user password

It is only required to enter the user password once as long as the ***System setup*** dialog window is open.

If the user password is not available, contact specialized service personnel.

Prerequisite: The ***System setup*** > ***Startup settings*** (A) > ***Password*** (B) page is opened.



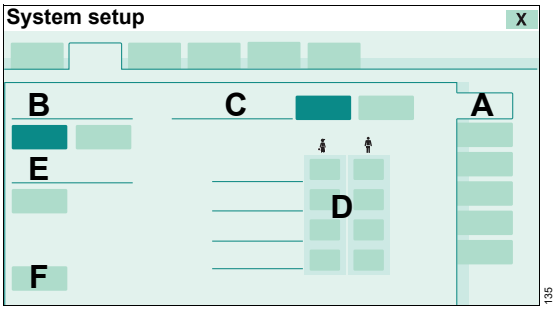
1. Enter the user password by touching the buttons (C).
2. Touch the ***OK*** button (D).

The ***Settings 1*** page is displayed.

If the password is not correct, it can be deleted with the ***Clear*** button (E).

Defining start settings for a new patient

Prerequisite: The ***System setup*** > ***Startup settings*** > ***Settings 1*** (A) page is opened.



The following settings can be configured:

B ***Startup configuration***

C ***Based on:***
- ***Patient category***
- ***Patient weight***

D Start values for ***VT***, ***RR***, ***FlowAcc***, ***Trigger***

E ***Startup mode***

F ***Dräger default***

Switching the startup configuration on or off

1. Touch the corresponding button below row (B).
2. Confirm with the rotary knob.

Setting the start values based on the patient category

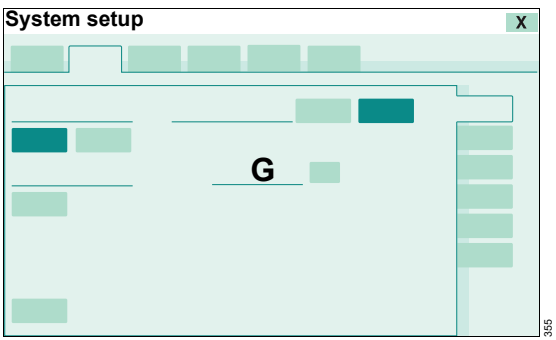
If the patient category is selected as the basis for calculating the start values, the start values for ***VT***, ***RR***, ***FlowAcc***, and ***Trigger*** can be set.

1. Touch the ***Patient category*** button in row (C).
2. Confirm with the rotary knob.
3. Touch the appropriate button (D).
4. Set the value by turning the rotary knob and confirm.

Setting the start values based on the body weight

If the body weight is selected as the basis for calculating the start values, the ***VT / IBW [mL/kg]*** parameter can be set. For more information, see "Calculating the start values" on page 137.

1. Touch the ***Patient weight*** button in row (C).
2. Confirm with the rotary knob.



3. Touch the button in row ***VT / IBW [mL/kg]*** (G).
4. Set the value by turning the rotary knob and confirm.

Selecting the start mode

1. Touch the button below row (E).
2. Select the ventilation mode with the rotary knob and confirm.

Selecting factory settings

1 Touch the ***Dräger default*** button (F).

2 Confirm with the rotary knob.

The user password is not reset to the factory setting.

Calculating the start values

The tidal volume is calculated using the following formula:
VT = ***IBW*** x factor (VT per kg of body weight)

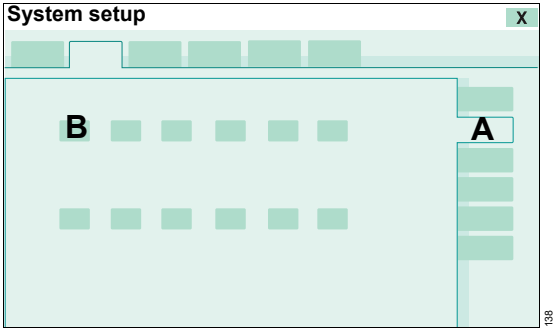
The following table lists the other start values for a body weight of 5, 15, and 75 kg. Values in between are interpolated linearly.

Body weight (kg)	***RR*** (/min)	***FlowAcc***[1)] (mbar/s (or hPa/s or cmH2O/s))	***FlowAcc***[2),3)] (mbar/s (or hPa/s or cmH2O/s))	***Trigger*** (L/min)
5	32	60	150	2
15	26	50	100	2
75	12	30	75	5

1) If a volume-controlled ventilation mode (VC) is selected as the start mode and the additional setting ***AutoFlow*** is switched off.
2) If a pressure-controlled ventilation mode (PC) or the ***SPN-CPAP*** ventilation mode is selected as the start mode.
3) If a volume-controlled ventilation mode (VC) is selected as the start mode and the additional setting ***AutoFlow*** is switched on.

Defining the start settings for the ventilation parameters

Prerequisite: The ***System setup*** > ***Startup settings*** > ***Settings 2*** (A) page is opened.



The start settings for the ventilation parameters are displayed.

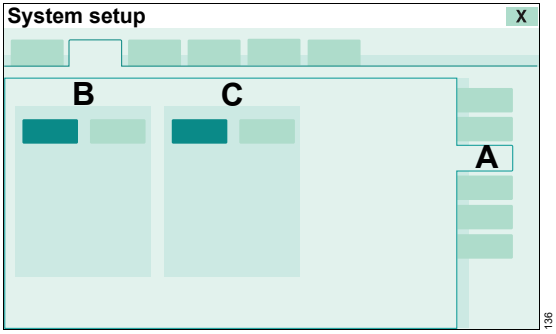
Setting the ventilation parameters

1 Touch the appropriate button, e.g., (B).

2 Set the value by turning the rotary knob and confirm.

Defining the start settings for the additional settings

Prerequisite: The ***System setup*** > ***Startup settings*** > ***Settings 3*** (A) page is opened.



The following settings can be activated or deactivated:

B ***Apnea ventilation***

C ***AutoFlow***

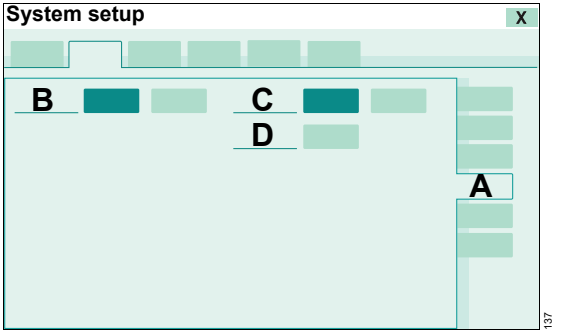
Switching apnea ventilation and AutoFlow on or off

1 Touch the ***On*** or ***Off*** button.

2 Confirm with the rotary knob.

Defining the start setting for tube compensation (ATC)

Prerequisite: The ***System setup*** > ***Startup settings*** > ***ATC settings*** (A) page is opened.



The following settings can be configured:

B ***ATC***

C ***Tube type***

D ***Tube Ø***

Switching tube compensation on or off

1 In the ***ATC*** (B) line, touch the ***On*** or ***Off*** button.

2 Confirm with the rotary knob.

Selecting the tube type

1 In the ***Tube type*** (C) line, touch the ***ET*** or ***Trach.*** button.

2 Confirm with the rotary knob.

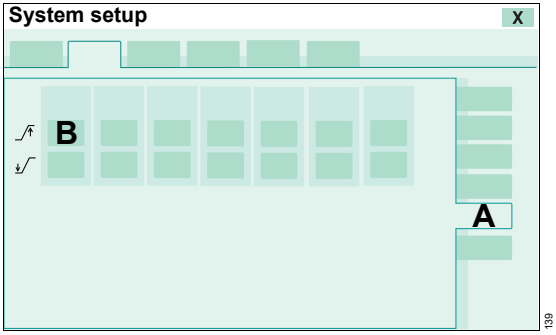
Entering the inner diameter of the selected tube

1 Touch the button in the ***Tube Ø*** (D) line.

2 Set the value by turning the rotary knob and confirm.

Defining the start setting for the alarm limits

Prerequisite: The ***System setup*** > ***Startup settings*** > ***Alarm settings*** (A) page is opened.



The start settings for the alarm limits are displayed.

Setting the alarm limit

1 Touch the appropriate button, e.g., (B).

2 Set the value by turning the rotary knob and confirm.

Factory settings

The following table lists the alarm limits with the factory settings and the factory settings used for a new patient:

Alarm limit	Factory setting on delivery of the device	Factory setting for a new patient
MV	9 L/min	(VT x RR) +50 %
MV	4 L/min	(VT x RR) –20 %
Paw	40 mbar (or hPa or cmH_2O)	40 mbar (or hPa or cmH_2O)
VT	0.75 L	VT +99 %
RR	35/min	RR +20 %
T_{apn}	15 s	15 s
$T_{disconnect}$	0 to 60 s	0 to 60 s
$etCO_2$	8.0 Vol%	8.0 Vol%
	60 mmHg	60 mmHg
	8.0 kPa	8.0 kPa

Alarm limit	Factory setting on delivery of the device	Factory setting for a new patient
↓ etCO2	4.0 Vol%	4.0 Vol%
	30 mmHg	30 mmHg
	4.0 kPa	4.0 kPa
↑ FiO2	24 Vol%	24 Vol%
↓ FiO2	18 Vol%	18 Vol%

Use the factory setting for a new patient:

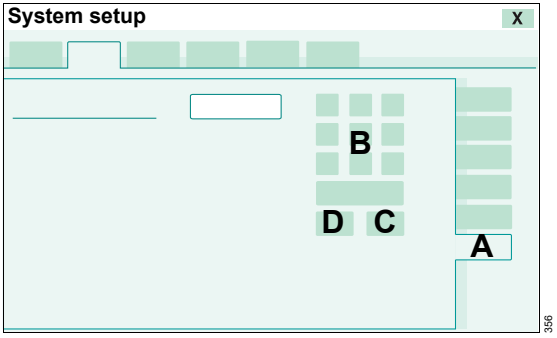
1 Open page ***System setup*** > ***Startup settings*** > ***Settings 1***.

2 Touch the ***Dräger default*** button.

3 Confirm with the rotary knob.

Changing the user password

Prerequisite: The ***System setup*** > ***Startup settings*** > ***Password*** (A) page is opened.



1 Enter a new user password consisting of 4 to 8 digits by touching the buttons (B).

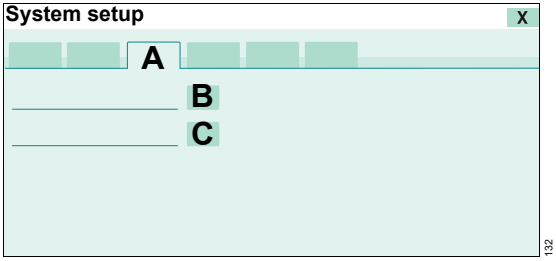
2 Save the new user password by touching the ***OK*** button (C).

If the password is not correct, it can be deleted with the ***Clear*** button (D).

Configuring the device settings

The following settings can be configured on the ***Device settings*** page:
– Alarm volume [%]
– Brightness [%]

Prerequisite: The ***System setup*** > ***Device settings*** (A) page is opened.



Setting the alarm volume

WARNING
Risk of not hearing alarm signals

If the alarm volume is too low, alarm signals may not be heard.
– Set the alarm volume loud enough so that the alarm signals can be heard in the environment where the device is located.
– The user must remain within hearing distance of the alarm signals.

Factory setting of the alarm volume: 100 %

The minimum alarm volume can be configured in service mode. Contact DrägerService.

Setting the alarm volume

1 Touch the button for alarm volume (B).

2 Set the value by turning the rotary knob and confirm.

Adjusting screen brightness

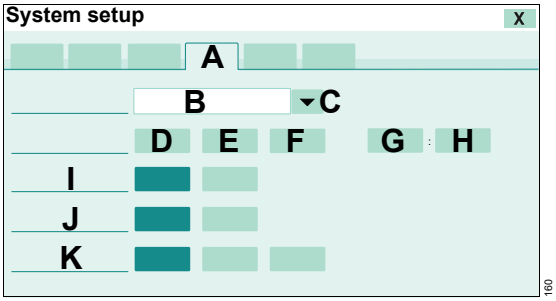
The brightness of the screen can be set.

1 Touch the button for brightness (C).

2 Set the value by turning the rotary knob and confirm.

Configuring country-specific settings

Prerequisite: The ***System setup*** > ***Country*** (A) page is opened.



Selecting the screen text language

Savina 300 is factory-set to the customer's own language. The current language is displayed in the field (B).

Selecting a different language

1 Touch the ▼ (C) button.

Savina 300 opens the selection list containing the available languages.

2 Select the language with the rotary knob and push to confirm.

Setting date and time

Savina 300 does not change over automatically between daylight saving time and standard time. The user must change the time manually. Otherwise, the on-screen time indications will be incorrect.

1 Touch the appropriate button:

- **D** Year
- **E** Month
- **F** Day
- **G** Hours
- **H** Minutes

2 Set the value by turning the rotary knob and confirm.

Configuring units

The following units can be selected:

I	Pressure unit	mbar
		cmH_2O
J	Height unit	cm
		in
K	CO_2 unit	mmHg
		kPa
		Vol%

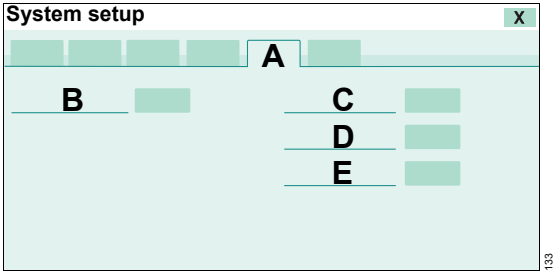
Selecting the unit

- Touch the corresponding button in the respective row.

Configuring the data interface

Data exchange with MEDIBUS-capable display devices, e.g., patient monitors or the patient data management system, takes place using the serial interface.

Prerequisite: The ***System setup*** > ***Interface*** (A) page is opened.



The following interface parameters can be configured:

B ***Protocol***

C ***Baud rate***

D ***Parity***

E ***Stopbit***

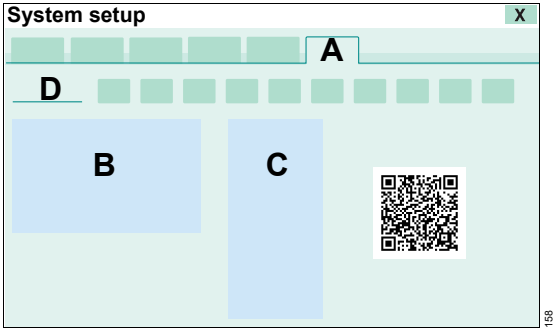
Configuring interface parameters

1. Touch the appropriate button.
2. Select the setting with the rotary knob and push to confirm.

Enabling software options

Savina 300 can be supplemented with additional Dräger options. The options are enabled by means of a numerical code.

Prerequisite: The ***System setup*** > ***Options*** (A) page is opened.



B Device-specific information

C Options available

D ***Release code***

Enabling options

1. Touch the relevant button in the ***Release code*** line (D).
2. Select the number with the rotary knob and confirm.
3. After entering all the numbers, restart Savina 300.

The option is enabled.

Scanning the QR code

The QR code can be scanned.

Prerequisite: Savina 300 is in standby mode

General product information from the Dräger web page is shown when a normal scan program is used.

If the code is scanned using the Dräger ServiceConnect app, detailed information on this product is shown.

Prerequisite: The ***System setup*** > ***Options*** page is opened.

- Scan the QR code using an appropriate device.

Troubleshooting

Failure of the power supply

If the power supply fails, Savina 300 generates a power supply failure alarm. The ventilation settings and the alarm limits remain saved even in the event of a power supply failure.

- Restore the power supply immediately, see page 60.

Or:

- Disconnect patient from the device and continue ventilation without delay using another independent ventilator.

Power supply of the O_2 sensors

The O_2 sensors are also supplied from the internal battery of Savina 300 when the device is switched off. This allows Savina 300 to immediately provide valid FiO_2 measured values when the device is switched on. If the internal battery is discharged, Savina 300 does not display any FiO_2 measured values for the first 20 minutes after it is switched on. The accuracy of the O_2 delivery is reduced during this period.

Failure of the gas supply

If the O_2 supply fails, Savina 300 substitutes the missing O_2 portion with ambient air and generates an alarm. The minute volume remains constant. The inspiratory O_2 concentration falls to 21 Vol%.

If the patient requires a higher O_2 concentration:

- Restore the O_2 supply immediately.

If the turbine fails, Savina 300 can no longer continue with ventilation.

- Disconnect patient from the device and continue ventilation without delay using another independent ventilator.

High ambient temperature

To prevent the breathing gas from becoming too hot, Savina 300 reduces the maximum speed of the turbine as the ambient temperature rises. If high inspiratory pressures are set at the same time, e.g., higher than 80 mbar (or hPa or cmH_2O), high flows, e.g., of 180 L/min, can no longer be achieved.

Even at slower speeds, the breathing gas delivered by the turbine is warmed. To ensure that the breathing gas temperature at the Y-piece remains under 41 °C (105.8 °F), the inspiratory hose length must be at least 1.2 m (3.9 ft) to allow the gas to cool down.

If the inspiratory breathing gas temperature is too high, Savina 300 generates the following high-priority alarm message: ***Breathing gas temperature high***

Savina 300 continues ventilating the patient.

- Lower the ambient temperature.

Alarm – Cause – Remedy

Alarm messages are displayed in hierarchical order in the alarm message field of the header bar. See "Display of alarms" on page 108.

Within an alarm category, alarm messages are assigned internal priorities. In the following table, internal priorities are indicated as numbers behind the exclamation marks. The alarm message with the highest priority receives number 1000. The lower the priority, the lower the number.

In the following table, the alarm messages are listed in alphabetical order. Alarm messages that start with quotation marks are at the beginning of the table. The table shows possible causes for an alarm and corresponding remedies. Causes and remedies must be worked through in the order listed until the alarm has been resolved.

Priority		Alarm	Cause	Remedy
!!	211	"Alarm reset" key failed	The key is stuck, faulty, or it was pressed for a longer period of time.	Ventilation functions are not affected. Release the key. If the error persists, contact specialized service personnel.
!!	210	"Alarm reset" key overused	The key is either faulty or has been pressed very frequently.	The function of this key is not available as long as the fault exists. If the fault cannot be eliminated, contact specialized service personnel.
!	050	"Apnea" alarm off	Only in NIV application mode: The apnea alarm time was switched off.	Switch on apnea alarm time again if necessary.
!!	221	"Audio paused" key failed	The key is stuck, faulty, or it was pressed for a longer period of time.	Ventilation functions are not affected. Release the key. If the error persists, contact specialized service personnel.
!!	220	"Audio paused" key overused	The key is either faulty or has been pressed very frequently.	Acknowledge message by pressing "Alarm reset" key. The function of this key is not available as long as the fault exists. If the fault cannot be eliminated, contact specialized service personnel.

Priority		Alarm	Cause	Remedy
!!	241	"Inspiration hold" key failed	The key is stuck, faulty, or it was pressed for a longer period of time.	Ventilation functions are not affected. Release the key. If the error persists, contact specialized service personnel.
!!	240	"Inspiration hold" key overused	The key is either faulty or has been pressed very frequently.	Acknowledge message by pressing "Alarm reset" key.
				The function of this key is not available as long as the fault exists. If the fault cannot be eliminated, contact specialized service personnel.
!	046	"MV low" alarm off	Only in NIV application mode: The lower alarm limit for minute volume was switched off.	Switch on alarm limit again if necessary.
!!	231	"O_2 Suction" key failed	The key is stuck, faulty, or it was pressed for a longer period of time.	Ventilation functions are not affected. Release the key. If the error persists, contact specialized service personnel.
!!	230	"O_2 Suction" key overused	The key is either faulty or has been pressed very frequently.	Acknowledge message by pressing "Alarm reset" key.
				The function of this key is not available as long as the fault exists. If the fault cannot be eliminated, contact specialized service personnel.
!	042	"VT high" alarm off	Only in NIV application mode: The upper alarm limit for inspiratory tidal volume was switched off.	Switch on alarm limit again if necessary.
!!!	250	Airway pressure high	Breathing hose kinked.	Check breathing circuit.
				Check tube or mask.
			The upper alarm limit for the airway pressure has been exceeded. The patient is breathing against the ventilator or coughing.	Check patient condition.
				Check ventilation settings.
				Adjust alarm limit if necessary.

Priority		Alarm	Cause	Remedy
!!!	240	Airway pressure low	Leakage or disconnection.	Check breathing circuit for tight connections.
				Make sure that the expiratory valve is properly engaged.
				Make sure that the tube or mask is connected correctly.
!	210	Ambient pressure high	The device is being used at a too high air pressure.	Use the device within the specified air pressure range.
			One of the pressure sensors is faulty.	Check patient condition.
				Since there are no current measured values for ambient pressure, the device calculates the values for tidal volume and minute volume on the basis of 1013 mbar (14.7 psi).
!	200	Ambient pressure low	The device is being used at a too low air pressure.	Use the device within the specified air pressure range.
			One of the pressure sensors is faulty.	Check patient condition.
				Since there are no current measured values for ambient pressure, the device calculates the values for tidal volume and minute volume on the basis of 1013 mbar (14.7 psi).
!!!	340	Ambient pressure sensor failed	Internal ambient pressure sensor failed.	Accuracy of measured values depending on the atmospheric pressure could be impaired (e.g., MV, O_2 concentration). Contact specialized service personnel.
!	260	Ambient temperature high	Due to high ambient temperatures (35 to 40 °C / 95 to 104 °F), the device achieves peak pressure, but not peak flow.	Reduce ambient temperature.

Priority		Alarm	Cause	Remedy
!!!	220	Apnea	The patient has stopped breathing.	Check patient condition.
				Apply controlled ventilation if necessary.
			Obstruction	Check patient condition.
				Check breathing circuit.
				Check tube or mask.
			Flow sensor is not calibrated or faulty.	Calibrate flow sensor and replace it if necessary.
			Apnea alarm time is set shorter than the time required for a respiratory cycle.	Increase apnea alarm time.
!!	350	Apnea ventilation	Due to detected apnea, the ventilator has automatically switched to Apnea Ventilation.	Check ventilation settings and patient condition. To return to the original ventilation mode, press the "Alarm reset" key.
!!!	820	Battery is not charging	Due to high ambient temperatures, the batteries do not charge.	Reduce ambient temperature.
				When mains power supply is available, ventilation with this device can be continued.
				Downgrade alarm priority: Press "Alarm reset" key.
			Due to overvoltage of the mains power supply, the batteries do not charge.	Use mains power supply with the correct voltage or connect a battery with 24 V.
				When mains power supply or power supply via a charged external battery is established, ventilation with this device can be continued.
				Downgrade alarm priority: Press "Alarm reset" key.
				Contact specialized service personnel.

Priority		Alarm	Cause	Remedy
!	247	Battery is not charging	Due to high ambient temperatures, the batteries do not charge.	Reduce ambient temperature.
				When mains power supply is available, ventilation with this device can be continued.
			Due to overvoltage of the mains power supply or an external battery with too high voltage, the batteries do not charge.	Use mains power supply with the correct voltage or connect a battery with 24 V.
				When mains power supply or power supply via a charged external battery is established, ventilation with this device can be continued.
				Contact specialized service personnel.
!!!	100	Breathing gas temperature high	Breathing gas temperature at the inspiratory port is too high.	Reduce ambient temperature.
!!	300	Check settings	Loss of stored data was detected.	Check all settings and adjust if necessary.
				Acknowledge message by pressing "Alarm reset" key.
!!	290	Check settings	Loss of stored data was detected.	Check all settings and adjust if necessary.
				Acknowledge message by pressing "Alarm reset" key.
!	294	Check tube diameter	Before activating ATC, check whether the correct tube diameter is set.	If necessary, adjust the setting and confirm with the rotary knob.
!!	087	CO_2 cuvette fitted?	The selected type of CO_2 cuvette is not correct.	Select the correct type of CO_2 cuvette.
			CO_2 cuvette or sensor soiled.	Clean the CO_2 cuvette or sensor.
			CO_2 sensor drift.	Perform CO_2 zero calibration.
			Inspiratory CO_2 concentration high.	Check ventilation settings. Check patient condition.

Priority		Alarm	Cause	Remedy
!!	089	CO_2 measurement failed	CO_2 sensor faulty.	Replace faulty CO_2 sensor.
			CO_2 measurement incorrect.	Use external CO_2 monitoring and deactivate integrated CO_2 monitoring.
				Contact specialized service personnel.
!!	088	CO_2 sensor soiled?	Cuvette or sensor window is soiled, e.g., with deposits due to nebulization.	Use clean cuvette and/or clean CO_2 sensor.
!!	090	CO_2 signal not detected	Plug of CO_2 sensor was removed during operation.	Reinsert plug.
			CO_2 sensor not positioned on cuvette.	Place CO_2 sensor on cuvette.
			CO_2 sensor faulty.	Replace faulty CO_2 sensor.
!!	085	CO_2 zero calibration required	Zero point of the CO_2 sensor is outside of the tolerance range.	Perform CO_2 zero calibration.
!!!	120	Cooling fan failure	Cooling fan failed.	Disconnect patient from the device and continue ventilation without delay using another independent ventilator.
!!	079	Device check canceled	Device check canceled or interrupted.	Repeat device check.
!!	080	Device check failed	Test of acoustic alarm, auxiliary acoustic alarm, expiratory valve, or safety valve failed.	See chapter "Performing device check", section "Failed test steps and remedy".
			Test of breathing circuit failed.	Connect breathing circuit and repeat device check.
			Test of humidifier failed.	Connect humidifier and repeat device check.
			Test of expiratory flow sensor failed.	Check if sensor is connected correctly. Repeat device check.
				Replace flow sensor.
!!!	710	Device failure	The device failed.	Disconnect patient from the device and continue ventilation without delay using another independent ventilator.

Priority		Alarm	Cause	Remedy
!!!	700	Device failure	The device failed.	Disconnect patient from the device and continue ventilation without delay using another independent ventilator.
!!	310	Device temperature high	The internal device temperature is too high.	Check dust filter for soiling and replace if necessary.
!	291	ΔintPEEP not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	ΔP_{supp} not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!!	083	$etCO_2$ high	Upper alarm limit for end-expiratory CO_2 concentration has been exceeded.	Check patient condition.
				Check ventilation settings.
				Adjust alarm limit if necessary.
				Perform CO_2 zero calibration if necessary.
				Check whether the cuvette windows are soiled.
!!	082	$etCO_2$ low	Lower alarm limit for end-expiratory CO_2 concentration has been exceeded.	Check patient condition.
				Check ventilation settings.
				Adjust alarm limit if necessary.
				Perform CO_2 zero calibration if necessary.
				Check whether the cuvette windows are soiled.
!	060	Expiration hold interrupted	The "Exp. hold" button was pressed too long.	Release "Exp. hold" button.

Priority		Alarm	Cause	Remedy
!!!	280	Expiratory valve inoperable	Expiratory valve incorrectly connected to the port.	Insert expiratory valve correctly.
			Expiratory valve is faulty.	Replace expiratory valve.
			Flow sensor faulty.	Replace flow sensor.
!	110	External DC supply active	Due to missing mains power supply, the device is supplied from the external battery. The device can only be supplied for up to 4 hours if the battery in the trolley is fully charged.	Reestablish mains power supply.
!!	375	External DC supply failed	External battery is not sufficiently charged, faulty, or its voltage is too high.	Acknowledge message by pressing "Alarm reset" key.
				Disconnect external battery from the device and connect a new external battery with correct voltage.
!	215	External DC supply failed	External battery is missing, faulty, or not connected or fuse is faulty.	Acknowledge message by pressing "Alarm reset" key.
				Disconnect external battery from the device and connect a new external battery with correct voltage.
!!!	130	FiO_2 high	HPO mode: Mixer function faulty.	To continue ventilation with this device, use external O_2 monitoring and deactivate integrated O_2 monitoring.
			HPO mode: Due to a low minute volume, the mixer is not yet fully operational.	When the mixer is fully operational, the message is no longer displayed.
!!!	130	FiO_2 high	LPO mode: The upper alarm limit for the O_2 concentration was exceeded.	Check patient condition.
				Check LPO flow and ventilation settings.
				Adjust alarm limit if necessary.

Priority		Alarm	Cause	Remedy
!!!	140	FiO_2 low	HPO mode: Mixer function faulty.	To continue ventilation with this device, use external O_2 monitoring and deactivate integrated O_2 monitoring.
			HPO mode: Due to a low minute volume, the mixer is not yet fully operational.	When the mixer is fully operational, the message is no longer displayed.
				Check patient condition.
			HPO mode: O_2 supply pressure too high. If FiO_2 = 21 Vol%, O_2 supply is not required.	Make sure that the supply pressure is lower than 6 bar (87 psi).
!!!	140	FiO_2 low	LPO mode: The lower alarm limit for the O_2 concentration was exceeded.	Check LPO flow and ventilation settings.
				Adjust alarm limit if necessary.
!!	401	FiO_2 measurement failed	O_2 measurement provides invalid values.	Calibrate O_2 sensor.
			O_2 sensor is faulty or not installed.	Install and calibrate a new O_2 sensor.
			O_2 measurement faulty.	To continue ventilation with this device, use external O_2 monitoring and deactivate integrated O_2 monitoring.
!!	400	FiO_2 measurement failed	O_2 measurement provides invalid values.	Calibrate O_2 sensor.
			O_2 sensor is faulty or not installed.	Install and calibrate a new O_2 sensor.
			O_2 measurement faulty.	To continue ventilation with this device, use external O_2 monitoring and deactivate integrated O_2 monitoring.
!	291	FiO_2 not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.

Priority		Alarm	Cause	Remedy
!	265	Flow low	The set flow value is not reached.	Check if the set flow exceeds the specified flow range for the mask or tube.
				Check if the mask or tube is blocked.
!!!	300	Flow measurement inaccurate	Water in flow sensor.	Drain water trap of breathing circuit. Dry flow sensor.
			Diaphragm inserted incorrectly in expiratory valve.	Insert diaphragm in expiratory valve correctly.
			Flow measurement is not reliable. Expiratory minute volume exceeds the minute volume delivered by the ventilator by 20 %.	Calibrate flow sensor. In order to continue ventilation with this device, use external flow monitoring and deactivate integrated flow monitoring. This can impair ventilation quality.
!	291	Flow not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!!!	305	Flow sensor inoperable	Flow sensor is not calibrated or faulty.	Calibrate flow sensor and replace it if necessary.
!!!	290	Flow sensor not fitted correctly	Flow sensor seated incorrectly in flow sensor sleeve of expiratory valve.	Insert flow sensor correctly.
!	048	Flow sensor off	Flow monitoring is deactivated.	Reactivate flow monitoring or use external flow monitoring.
!	291	Flow trigger not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.

Priority		Alarm	Cause	Remedy
!	291	FlowAcc not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!!!	094	High-priority test alarm	Alarm signals are being tested.	Complete or cancel device check.
!	291	Insp. term. not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!!!	210	Insp./Exp. cycle failure	Device does not deliver any gas.	Set respiratory rate to at least 4/min.
			Apnea alarm time is set shorter than the time required for a respiratory cycle.	Increase apnea alarm time.
			Disconnection.	Connect patient.
!	290	Inspiration hold interrupted	The "Inspiration hold" key was pressed for more than 15 seconds.	Release "Inspiration hold" key.
!!	380	Internal battery activated	Due to missing mains power supply and missing or discharged external battery, the device is supplied from the internal battery. Maximum operating time is 45 minutes.	Reestablish mains power supply or power supply from a charged external battery within 45 minutes.
				Acknowledge message by pressing "Alarm reset" key.
!	220	Internal battery activated	Due to missing mains power supply and missing or discharged external battery, the device is supplied from the internal battery. Maximum operating time is 45 minutes.	Reestablish mains power supply or power supply from a charged external battery within 45 minutes.

Priority		Alarm	Cause	Remedy
!!!	800	Internal battery discharged	Operating time with power supply from the internal battery has almost elapsed. Sudden failure of the device is possible.	Immediately connect the device to the mains power supply or a charged external battery. Charge internal battery.
!	240	Internal battery discharged	Internal battery is almost fully discharged. Mains power supply or external battery is available.	Device cannot be supplied from the internal battery. Charge internal battery.
!!!	810	Internal battery failed	Internal battery faulty. If mains power supply fails, no internal battery is available.	When mains power supply or power supply via a charged external battery is established, ventilation with this device can be continued.
!	245	Internal battery failure	Internal battery faulty. If mains power supply fails, no internal battery is available.	When mains power supply or power supply via a charged external battery is established, ventilation with this device can be continued.
!!!	831	Internal battery is missing	Internal battery exhaustively discharged.	When mains power supply or power supply via a charged external battery is established, ventilation with this device can be continued.
				Charge internal battery.
			Internal battery is missing, faulty, or not connected or the fuse is faulty.	When mains power supply or power supply via a charged external battery is established, ventilation with this device can be continued.
				Contact specialized service personnel.

Priority		Alarm	Cause	Remedy
!!!	830	Internal battery is missing	Internal battery exhaustively discharged.	When mains power supply or power supply via a charged external battery is established, ventilation with this device can be continued. Charge internal battery.
			Internal battery is missing, faulty, or not connected or the fuse is faulty.	When mains power supply or power supply via a charged external battery is established, ventilation with this device can be continued.
!	250	Internal battery is missing	Internal battery exhaustively discharged.	When mains power supply or power supply via a charged external battery is established, ventilation with this device can be continued. Charge internal battery.
			Internal battery is missing, faulty, or not connected or the fuse is faulty.	When mains power supply or power supply via a charged external battery is established, ventilation with this device can be continued.
!!	390	Internal battery low	Operating time with power supply from the internal battery will soon elapse.	Connect the device to the mains power supply or a charged external battery.
!	230	Internal battery low	With power supply from the internal battery: Operating time with power supply from the internal battery will soon elapse.	Connect the device to the mains power supply or a charged external battery.
			With mains power supply or power supply from the external battery: Internal battery is not yet sufficiently charged.	Allow the internal battery to charge.

Priority		Alarm	Cause	Remedy
!!	200	Key overused	The key is either faulty or has been pressed very frequently.	Acknowledge message by pressing "Alarm reset" key.
				The function of this key is not available as long as the fault exists. If the fault cannot be eliminated, contact specialized service personnel.
!	100	Leakage	Only monitored on intubated patients! Leakage in breathing circuit. The calculated leakage minute volume is larger than the measured expiratory minute volume.	Check for leakages in breathing circuit.
				Make sure that the tube is connected correctly.
!	293	Low-priority test alarm	Alarm signals are being tested.	Complete or cancel device check.
!	291	Lower limit for $etCO_2$ not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	Lower limit for FiO_2 not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	Lower limit for MV not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!!!	995	Main switch off	The main switch at the rear of the device has been actuated during ventilation.	To switch the device off, press the rotary knob to confirm the message.
				To continue ventilation, switch the main switch to "On" again.

Priority		Alarm	Cause	Remedy
!	120	MEDIBUS communication failed	MEDIBUS communication failed.	Ventilation functions are not affected. Check MEDIBUS connection. Check MEDIBUS settings.
!!	391	Medium-priority test alarm	Alarm signals are being tested.	Complete or cancel device check.
!!	110	Microfilter blocked	Microfilter is extremely soiled.	Replace microfilter.
!!!	320	Microfilter is missing	Microfilter missing or incorrectly inserted.	Insert microfilter.
!!!	180	MV high	The minute volume exceeds the upper alarm limit.	Check patient condition.
				Check ventilation settings.
				Adjust alarm limit if necessary.
			Water in flow sensor.	Drain water trap of breathing circuit. Dry flow sensor.
!!!	190	MV low	The minute volume has fallen below the lower alarm limit.	Check patient condition.
				Check ventilation settings.
				Adjust alarm limit if necessary.
			Obstruction	Check patient condition.
				Check breathing circuit.
				Check tube or mask.
			Leakage or disconnection.	Check breathing circuit for tight connections.
				Make sure that the expiratory valve is properly engaged.
				Make sure that the tube or mask is connected correctly.
			Device failure	Disconnect patient from the device and continue ventilation without delay using another independent ventilator. Contact specialized service personnel.

Priority		Alarm	Cause	Remedy
!	255	Nebulization not possible	Inspiratory flow is too low, so that no nebulizer flow can be applied.	If necessary, increase ventilation parameters for flow acceleration or pressure limitation, so that a higher inspiratory flow is applied.
!	139	Nebulizer on	Medication nebulization is activated.	Wait until nebulization is finished, or terminate nebulization prematurely.
!!	330	O_2 sensor off	O_2 monitoring is deactivated.	Reactivate O_2 monitoring or use external O_2 monitoring. Downgrade alarm priority: press "Alarm reset" key.
!	044	O_2 sensor off	O_2 monitoring is deactivated.	Reactivate O_2 monitoring or use external O_2 monitoring.
!!	100	O_2 supply pressure high	O_2 supply pressure too high.	Make sure that the supply pressure is lower than 6 bar (87 psi).
!	150	O_2 supply pressure high	O_2 supply pressure too high. If FiO_2 = 21 Vol%, O_2 supply is not required.	Make sure that the supply pressure is lower than 6 bar (87 psi).
!!!	310	O_2 supply pressure low	O_2 supply pressure too low.	Make sure that the supply pressure is greater than 2.7 bar (39.2 psi).
!	090	O_2 supply pressure low	O_2 supply pressure too low. If FiO_2 = 21 Vol%, O_2 supply is not required.	Make sure that the supply pressure is greater than 2.7 bar (39.2 psi).
!	292	PC-AC not confirmed	The ventilation mode was changed, but the change was not confirmed.	Check the ventilation mode.
				If necessary, change the ventilation mode and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	292	PC-APRV not confirmed	The ventilation mode was changed, but the change was not confirmed.	Check the ventilation mode.
				If necessary, change the ventilation mode and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.

Priority		Alarm	Cause	Remedy
!	292	PC-BIPAP not confirmed	The ventilation mode was changed, but the change was not confirmed.	Check the ventilation mode.
				If necessary, change the ventilation mode and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!!!	260	PEEP high	Expiratory valve or breathing circuit obstructed.	Check breathing circuit and expiratory valve. Check for condensate.
			Expiratory resistance increased.	Check bacterial filter. Replace if necessary.
!!!	230	PEEP inoperable	Measured PEEP is 5 mbar (5 cmH_2O) above or below set PEEP.	Check breathing circuit for tight connections.
				Make sure that the expiratory valve is properly engaged.
				Contact specialized service personnel.
!	291	PEEP not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!!	078	Perform device & br. circuit check	Device check was not performed, not completed, or not successful.	Perform device check.
			Selection of breathing circuit or humidifier changed.	Perform breathing circuit check.
!	291	P_{high} not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	P_{insp} not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.

Priority		Alarm	Cause	Remedy
!	291	P_{low} not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	P_{max} not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!!!	270	Pressure measurement inaccurate	Fluid in expiratory valve.	Replace expiratory valve. Clean and dry the used valve.
			Pressure measurement failure.	Disconnect patient from the device and continue ventilation without delay using another independent ventilator.
!!!	160	PS breath > 4 s	Pressure support was terminated three times by the termination criterion.	Check breathing circuit for tight connections.
!	180	PS breath > 4 s	Pressure support was terminated by the termination criterion.	Check breathing circuit for tight connections.
!!	373	Replace external battery	Due to aging or wear the expected duration of operation of the external battery has been reduced.	Contact specialized service personnel.
!!	374	Replace internal battery	Due to aging or wear the expected duration of operation of the internal battery has been reduced.	Contact specialized service personnel.

Priority		Alarm	Cause	Remedy
!!	251	Rotary knob failed	The rotary knob is either faulty or was pressed for a long time.	If the rotary knob is still being pressed, release the rotary knob. Otherwise, press the rotary knob again and turn it.
				If the alarm condition persists, the settings can no longer be adapted. Disconnect patient from the device and continue ventilation without delay using another independent ventilator.
!!	250	Rotary knob overused	The rotary knob is either faulty or was pressed too often.	Acknowledge message by pressing "Alarm reset" key.
				Press the rotary knob again and turn it.
				If the alarm condition persists, the settings can no longer be adapted. Disconnect patient from the device and continue ventilation without delay using another independent ventilator.
!!!	170	RR high	The patient is breathing at a high respiratory rate.	Check patient condition.
				Check ventilation settings or spontaneous respiratory rate.
				Adjust alarm limit if necessary.
			Auto-triggering caused by water in the breathing circuit.	Drain water trap of breathing circuit. Dry flow sensor.
				Check breathing circuit.
!	291	RR not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.

Priority		Alarm	Cause	Remedy
!	291	RR_{apn} not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!!!	900	Service Mode activated	Device has been switched to external service mode.	Acknowledge external service mode by pressing the "Alarm reset" key. If ventilation is to be continued with this device, remove cable from the serial interface. Then switch the device off and switch it on again.
!	292	SPN-CPAP not confirmed	The ventilation mode was changed, but the change was not confirmed.	Check the ventilation mode.
				If necessary, change the ventilation mode and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!!!	1000	Standby mode activated	Device has been switched to standby mode.	Acknowledge standby mode by pressing "Alarm reset" key.
!	291	T_{apn} not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	$T_{disconnect}$ not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!!!	115	Temp. sensor (Y-piece) failed	Temperature sensor faulty.	Insert a new temperature sensor.

Priority		Alarm	Cause	Remedy
!!!	110	Temp. sensor (Y) disconn./faulty	The connector of the temperature sensor was unplugged during operation.	Plug in the connector of the temperature sensor.
			Temperature sensor cable broken.	Insert a new temperature sensor.
!!!	095	Temperature high (Y-piece)	Breathing gas temperature higher than 40 °C (104 °F).	Reduce the temperature of the breathing gas humidifier. Use longer inspiratory hoses.
!	291	T_{high} not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	T_i not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	T_{imax} not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	T_{low} not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	Tube diameter not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.

Priority		Alarm	Cause	Remedy
!	291	Upper limit for $etCO_2$ not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	Upper limit for FiO_2 not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	Upper limit for MV not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	Upper limit for Paw not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	Upper limit for RR not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	Upper limit for VT not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.

Priority		Alarm	Cause	Remedy
!	292	VC-CMV/VC-AC not confirmed	The ventilation mode was changed, but the change was not confirmed.	Check the ventilation mode.
				If necessary, change the ventilation mode and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	292	VC-MMV not confirmed	The ventilation mode was changed, but the change was not confirmed.	Check the ventilation mode.
				If necessary, change the ventilation mode and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	292	VC-SIMV not confirmed	The ventilation mode was changed, but the change was not confirmed.	Check the ventilation mode.
				If necessary, change the ventilation mode and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!!!	200	VT high	The upper alarm limit of the applied inspiratory tidal volume has been exceeded.	Check patient condition.
				Check ventilation settings.
				Adjust alarm limit if necessary. Confirm message by pressing "Alarm reset" key.
!	280	VT high	The upper alarm limit of the applied inspiratory tidal volume has been exceeded.	Check patient condition.
				Check ventilation settings.
				Adjust alarm limit if necessary.
!!	354	VT low	The lower alarm limit of the applied inspiratory tidal volume has been exceeded.	Check patient condition.
				Check ventilation settings. Increase inspiratory time or flow acceleration.
				Adjust alarm limit if necessary.
!	274	VT low	The lower alarm limit of the applied inspiratory tidal volume has been exceeded.	Check patient condition.
				Check ventilation settings. Increase inspiratory time or flow acceleration.
				Adjust alarm limit if necessary.

Priority		Alarm	Cause	Remedy
!	291	VT not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.
!	291	VT_{apn} not confirmed	The setting was changed, but the change was not confirmed.	Check the setting.
				If necessary, adjust the setting and confirm with the rotary knob.
				Acknowledge message by pressing "Alarm reset" key.

Reprocessing

Safety information

WARNING

Risk due to inappropriately reprocessed products

Reusable products must be reprocessed, otherwise there is an increased risk of infection.

- **Follow the infection prevention policies and reprocessing regulations of the health-care facility.**
- **Follow the national infection prevention policies and reprocessing regulations.**
- **Use validated procedures for reprocessing.**
- **Reprocess reusable products after every use.**
- **Follow the manufacturer's instructions for cleaning agents, disinfectants, and reprocessing devices.**

CAUTION

Risk due to faulty products

Signs of wear, e.g., cracks, deformation, discoloration, or peeling, may occur with reprocessed products.

Check the products for signs of wear and replace them if necessary.

Safety information on the expiratory valve

CAUTION

High leakage due to damaged expiratory valve

Not all damage can be detected in the device check.

Replace the expiratory valve if the following damage occurs:

- Cracking of the plastic parts
- Torn diaphragm
- Deformation or hardening of the rubber parts

Discolorations of the metal insert do not impair its function.

Safety information on the flow sensors

WARNING

Risk of fire

Residual vapors of highly flammable disinfectants (e.g., alcohols) and deposits that were not removed during reprocessing may ignite when the flow sensor is in use.

- **Ensure particle-free cleaning and disinfection.**
- **After disinfection, allow the flow sensor to air for at least 30 minutes.**
- **Before inserting the flow sensor check for visible damage and soiling, such as residual mucus, medication aerosols, and particles.**
- **Replace flow sensors when damaged, soiled, or not particle-free.**

CAUTION

Risk of failure of flow measurement

Improper reprocessing and soiling, such as deposits or particles, may damage the flow sensor:
- No machine cleaning or disinfection
- No plasma sterilization or radiation sterilization
- No water jets, compressed air, brushes or the like
- No ultrasonic bath
- No steam sterilization for the Spirolog flow sensor
- Clean and disinfect the flow sensor in accordance with the corresponding instructions for use.
- For disinfecting the flow sensor use only clean disinfectant solutions.

Information on reprocessing

Follow the national infection prevention policies and reprocessing regulations.

Follow the infection prevention policies and reprocessing regulations of the health-care facility (e.g., concerning the reprocessing cycles).

Reusable components through which contaminated gas flows during normal operation and in the event of a fault must be reprocessed. During normal operation, contaminated gas flows through the expiratory valve and other accessories in the expiratory path. In the event of a fault, accessories in the inspiratory path may become contaminated.

Classifications for reprocessing

Classification of medical devices

The classification depends on the intended use of the medical device. The risk of infection transmission through the application of the product to the patient without proper reprocessing is the basis of the Spaulding classification.

Classification	Explanation
Non-critical	Components that come into contact only with skin that is intact
Semi-critical	Components that carry breathing gas or come into contact with mucous membranes or pathologically altered skin
Critical	Components that penetrate skin or mucous membranes or come into contact with blood

Classification of device-specific components

The following classification is a recommendation from Dräger.

Non-critical

– Device surface including screen
– Trolley and holders
– Removable parts of the main device

Semi-critical

– Expiratory valve

Before reprocessing

Observe before disassembly

1 Switch off the device and all devices connected to it.

2 Disconnect all power plugs.

3 Drain the water traps and the breathing hoses.

4 Drain the water reservoir of the breathing gas humidifier.

Patient-specific accessories and consumables

The patient-specific accessories and consumables must be removed from the device and, if necessary, disassembled.

Reusable products:

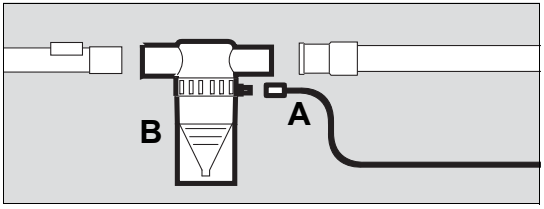
- If the reusable product has its own instructions for use, perform reprocessing in accordance with the separate instructions for use.
- If no separate instructions for use are available for the reusable product, perform reprocessing in accordance with these instructions for use.

Disposable products:

- Dispose of the disposable products.

Removing the pneumatic medication nebulizer

When using a breathing circuit for adults:

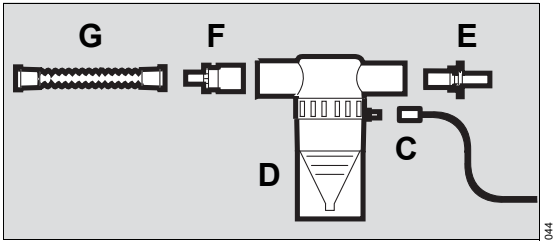


1 Remove the nebulizer hose (A) from the medication nebulizer (B) and from the nebulizer port on the device.

2 Remove the medication nebulizer (B) from the breathing circuit.

3 Disassemble the medication nebulizer in accordance with the corresponding instructions for use.

When using a breathing circuit for pediatric patients:



1 Remove the nebulizer hose (C) from the medication nebulizer (D) and from the nebulizer port on the device.

2 Remove the medication nebulizer (D) from the breathing circuit.

3 Pull the catheter connector (E) out of the inlet port.

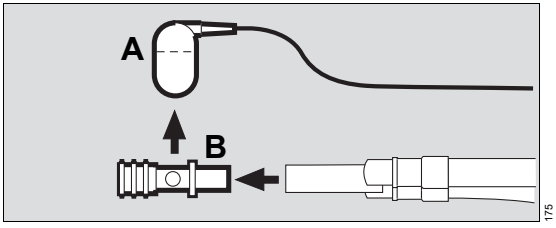
4 Pull the adapter (F) out of the outlet port.

5 Remove the corrugated hose (G) from the adapter (F).

6 Disassemble the medication nebulizer in accordance with the corresponding instructions for use.

Removing the CO_2 sensor

Prerequisites:
– The sensor plug at the rear of the device has been removed.



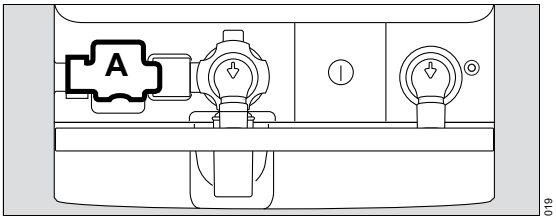
1 Remove the CO_2 sensor (A) from the cuvette.

2 Remove the cuvette (B) from the patient port of the Y-piece.

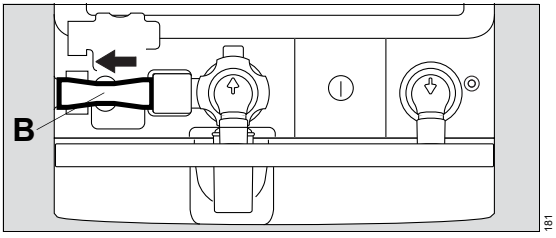
Removing the breathing circuit

- Remove the breathing hoses from the inspiratory port and expiratory port.

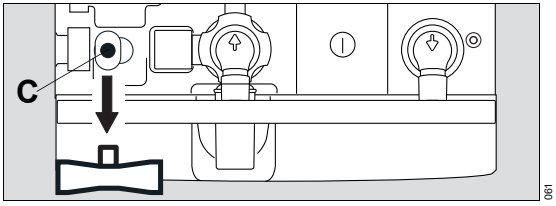
Removing the expiratory flow sensor



1 Lift the flap (A) by the lower edge and pivot it upwards.



2 Push the flow sensor (B) to the left end position.

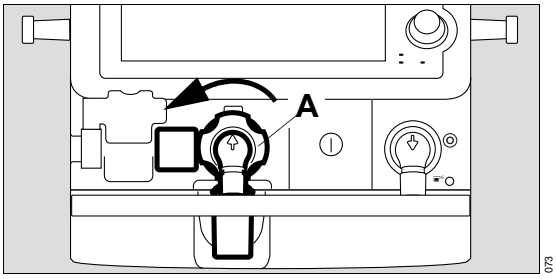


3 Remove the flow sensor from the socket (C).

Device-specific components

The device-specific components must be removed from the device and, if necessary, disassembled.

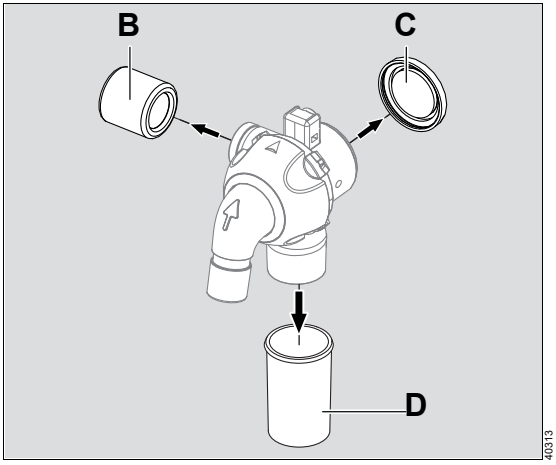
Removing the expiratory valve



1 Turn the locking ring (A) to the left end position.

2 Remove the expiratory valve from the fitting.

Disassembling the expiratory valve



1 Remove the flow sensor sleeve (B) from the expiratory valve.

2 Remove the diaphragm (C) and do not disassemble further.

3 Remove the water trap container (D).

4 Drain the water trap container.

Validated reprocessing procedures

Overview of the reprocessing procedures for the device and the device-specific components

Device and components	Surface disinfection with cleaning	Machine cleaning with thermal disinfection
Device surface, trolley, and other non-critical components	Yes (see "Surface disinfection with cleaning" on page 178)	No
Expiratory valve	No	Yes (see "Machine cleaning with thermal disinfection" on page 179)

Surface disinfection with cleaning

Surface disinfectant	Manufacturer	Concentration	Contact time
Dismozon pur/plus	BODE Chemie	1.6 %	15 min
Oxycide	Ecolab USA	2.3 %	5 min

Prerequisites:

– The surface disinfectant has been prepared in accordance with the manufacturer's instructions.
– The manufacturer's instructions, e.g., regarding shelf life or application conditions, are observed.
– An uncontaminated, lint-free cloth soaked in surface disinfectant is used for the cleaning surface disinfection.

WARNING

Risk due to penetrating liquid

Penetrating liquid may cause the following:

– Damage to the device
– Electric shock
– Device malfunctions

Ensure that no liquid penetrates the device.

Cleaning

1 Wipe off obvious soiling with a disposable cloth soaked in surface disinfectant. Dispose of the cloth.

2 Wipe all surfaces. After that, there must no longer be any soiling visible.

Surface disinfection

3 Wipe cleaned surfaces again to visibly wet all surfaces to be disinfected with surface disinfectant.

4 Wait for the surface disinfectant contact time.

5 At the end of the contact time, moisten a new, uncontaminated and lint-free cloth with water (at least drinking water quality).

6 Wipe all surfaces until no remains of the surface disinfectant, such as foam residues or streaks, are visible.

7 Wait until the surfaces are dry.

8 Check the surfaces for visible damage and, if necessary, replace the product.

Machine cleaning with thermal disinfection

Use a washer-disinfector that meets the requirements of the standard ISO 15883. Dräger recommends the use of a load carrier for anesthesia accessories and ventilation accessories. Follow the manufacturer's instructions for the washer-disinfector.

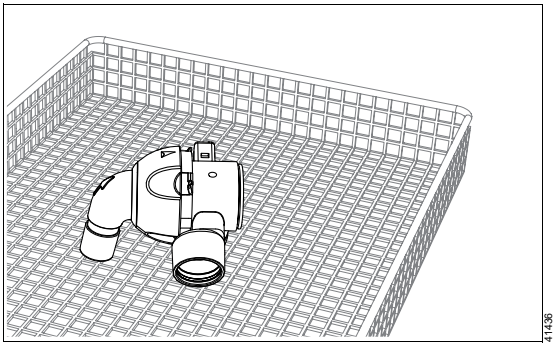
Components:
– Expiratory valve

Step	Agent	Manufacturer	Concentration	Temperature	Contact time
Preliminary cleaning	Tap water	–	–	Tap water temperature	Min. 2 min
Cleaning	neodisher Medi-Clean forte	Dr. Weigert	Min. 0.3 %	Min. 55 °C (131 °F)	Min. 5 min
Neutralizing	neodisher Z	Dr. Weigert	Min. 0.1 %	Tap water temperature	Min. 1 min
Flushing	Demineralized water	–	–	Tap water temperature	Min. 1 min
Disinfecting	–	–	–	Min. 90 °C (194 °F)	Min. 5 min
Drying	–	–	–	–	Drying time depends on the load

Prerequisites:
– The washer-disinfector has been prepared in accordance with the manufacturer's instructions.

Positioning the components in the load carrier

1 Position the expiratory valve as shown.



2 Position the components (flow sensor sleeve, diaphragm, water trap container) to be stable.

3 Ensure the following:
- All surfaces and interiors can be completely rinsed.
- The water can drain off freely.

Performing reprocessing

1 Select a cycle.

2 When the cycle has ended, check the components for visible soiling and repeat the cycle if necessary.

3 Check the components for visible damage and replace if necessary.

Storage and transport

After reprocessing, there are no special requirements for storage and transport of the product. However, the following must be observed:
- Store dry and free of dust
- Avoid recontamination and damage during transport

All further information on storage and transport included in the accompanying documents must be observed.

Other agents and reprocessing procedures

Disinfectants

Use nationally approved disinfectants suitable for the respective reprocessing process and the intended application.

Surface disinfectants

The manufacturers of the surface disinfectants have verified at least the following spectra of activity:
– Bactericidal
– Yeasticidal
– Virucidal or virucidal against enveloped viruses

Follow the manufacturer's instructions for surface disinfectants.

The following surface disinfectants were compatible with the material at the time of testing:

Class of active ingredient	Surface disinfectant	Manufacturer	Listing
Chlorine-releasing agents	BruTab 6S	Brulin	EPA[1)]
	Clorox Professional Disinfecting Bleach Cleaner	Clorox	EPA
	Dispatch Hospital Cleaner Disinfectant Towels with Bleach		
	Klorsept 17	Medentech	EPA
	Actichlor plus	Ecolab USA	EPA
Oxygen-releasing agents	Descogen Liquid	Antiseptica	CE
	Descogen Liquid r.f.u.		
	Oxygenon Liquid r.f.u.		
	Dismozon plus	BODE Chemie	CE
	Oxycide	Ecolab USA	EPA
	Perform	Schülke & Mayr	CE
	SteriMax Wipes	Aseptix	CE
	Incidin OxyWipes	Ecolab USA	CE

Class of active ingredient	**Surface disinfectant**	**Manufacturer**	**Listing**
Quaternary ammonium compounds	acryl-des[2)]	Schülke & Mayr	CE
	Mikrozid alcohol free liquid[2)]		
	Mikrozid alcohol free wipes[2)]		
	Mikrozid sensitive liquid[2)]		
	Mikrozid sensitive wipes[2)]		
	Cleanisept Wipes Maxi	Dr. Schumacher	CE
	Surfa'Safe Premium	ANIOS Laboratories	CE
	Wip'Anios Excel		
	Tuffie 5	Vernacare	ARTG[3)]

1) United States Environmental Protection Agency
2) Virucidal against enveloped viruses
3) Australian Register of Therapeutic Goods

Dräger states that oxygen-releasing agents and chlorine-releasing agents may cause color change in some materials. Color change does not indicate that the product is not functioning correctly.

Other surface disinfectants are used at one's own risk.

Reprocessing procedures

Manual cleaning followed by disinfection by immersion

The following components are suitable for manual cleaning followed by disinfection by immersion:
– Expiratory valve

The following disinfectants were compatible with the material at the time of testing:

	Manufacturer
Cleaning agent:	
neodisher LM2	Dr. Weigert
Disinfectants	
Korsolex Extra	BODE Chemie

Steam sterilization

The following components can be steam sterilized:
– Expiratory valve

NOTE
Sterilize the components of the expiratory valve (valve housing, flow sensor sleeve, diaphragm, water trap container) only after disassembly.

Prerequisites:
– The components have been cleaned, disinfected, and are dry.
– Use a steam sterilizer that meets the requirements of the standard ISO 17665. Dräger recommends steam sterilization with fractionated vacuum.

Procedure:

1 Sterilize the components (maximum 134 °C (273.2 °F), 5 min).

2 Check the components for visible damage and replace if necessary.

After reprocessing

Assembling and fitting device-specific components

Prerequisites:
– All components have been reprocessed and dried.

Procedure:

- See section "Preparing the ventilator" on page 52.

Preparation before next use of device

Assembling and fitting patient-specific accessories and consumables

- See section "Preparing the ventilator" on page 52.

Checking the operational readiness

Prerequisites:
– The device has been assembled and prepared so that it is ready for operation.

Procedure:

- Check the operational readiness, see chapter "Getting started" on page 69.

Service

Safety information

WARNING

Risk if service is not performed regularly

Wear and material fatigue of the components may lead to device failure and malfunctions.

Perform service at the specified intervals.

WARNING

Risk if service is not performed properly

Personal injury and property damage may occur if service is not performed properly.

Service must be performed by those user groups that are assigned to the particular measure.

WARNING

Risk when the housing is being opened

Under the housing, there are live electrical components, which may cause an electric shock.

The housing may only be opened by those user groups that are assigned to that particular measure.

CAUTION

Risk if the battery is not replaced properly

If the battery is not replaced properly, short circuits and high temperatures leading to explosion or fire may occur.

The battery must be replaced by the assigned user groups.

CAUTION

Risk due to inappropriately reprocessed products

The product may be contaminated with infectious agents.

Before service is performed and before the product is sent back for repair, reprocess the product in accordance with the chapter "Reprocessing".

CAUTION

Risk of medical device failure

If the safety-relevant tests are not performed on a regular basis, the proper functioning of the medical device can be compromised.

The electrical safety test and the functional tests described in the technical documentation IPM must be carried out within the specified intervals.

NOTE

If Savina 300 is used under the following conditions, the specified intervals, e.g., for checking the batteries, must be reduced:

– Environments of use with extreme conditions
– Frequent intrahospital patient transports

Reduce the intervals after consulting DrägerService.

Definition of service terminology

Concept	Definition
Service	All measures (inspection, maintenance, repair) intended to maintain or restore the functional integrity of a product
Inspection	Measures intended to determine and assess the current state of a product
Maintenance	Regular specified measures intended to maintain the functional integrity of a product
Repair	Measures intended to restore the functional integrity of a product after a failure

Inspection

Measure	Interval	User group
Inspection	Must be carried out for the first time after 2 years or at the latest after 12000 operating hours, whichever occurs first. Thereafter annually or after 6000 operating hours, whichever occurs first.	Service personnel
Safety check	Every 12 months	Service personnel

Safety checks

Safety checks are not a substitute for maintenance, which includes the preventive replacement of wearing parts as specified by the manufacturer.

Performing the safety checks

1 Check that the respective instructions for use are present.

2 Perform a functional test of the following functions in accordance with the instructions for use:
- All functions described in the test steps of the device check and breathing circuit check.
- Internal and if applicable external batteries

3 Check that the product is in good condition:
- All labels are complete and legible
- There is no visible damage
- Fuses that are accessible from the outside are in compliance with the specified values.

4 Observe the instructions for use and check that all components and accessories needed to use the product are present.

5 Check electrical safety in accordance with the IEC 62353 standard.
Any breathing gas humidifiers or power socket strips present (e.g., on the trolley) must be subjected to the same above-mentioned check. The test must be carried out on individual devices and together in the system.
- Contact resistance of protective ground conductor ≤0.2 Ω
- Equivalent leakage current (device) ≤1 mA
- Equivalent leakage current (patient) ≤5 mA

6 Check the safety equipment:
- Correct functioning of the pneumatic safety valve:
  Pressure 100 to 110 mbar (or hPa or cmH_2O)
- Correct functioning of the emergency expiratory valve:
  Pressure 5 to 10 mbar (or hPa or cmH_2O)
- Correct functioning of the non-return valve in the expiratory valve
- Correct functioning of the emergency breathing valve
- Correct functioning of the power supply failure alarm

Maintenance

Component	Interval	Measure	User group
O_2 sensors	If the ***FiO_2 measurement failed*** alarm message is displayed or if calibration is no longer possible	Replace, see page 192.	Users
Microfilter	Every 12 months	Replace, see page 190.	Users
Dust filter set	Every 4 weeks	Clean, see page 191.	Users
	Every 12 months	Replace, see page 191.	Users
Diaphragm of the reusable expiratory valve	Every 12 months	Replace, see page 192.	Users
Internal battery	Every 12 months	Check capacity, replace battery if necessary	Service personnel
	Every 2 years	Replace battery	
External battery	Every 12 months	Check capacity, replace battery if necessary	Service personnel[1)]
Filter in LPO gas inlet (for LPO option only)	Every 2 years	Replace	Specialized service personnel
O_2 filter (in the O_2 gas inlet)	Every 6 years	Replace	Service personnel
Real-time clock	Every 6 years	Replace	Specialized service personnel
Wiring harness for Spirolog flow sensor	Every 6 years	Replace	Specialized service personnel
Turbine	Every 8 years	Replace	Specialized service personnel

1) The capacity test for the external battery is not part of the service provided by DrägerService and is therefore the responsibility of the user.

Repair

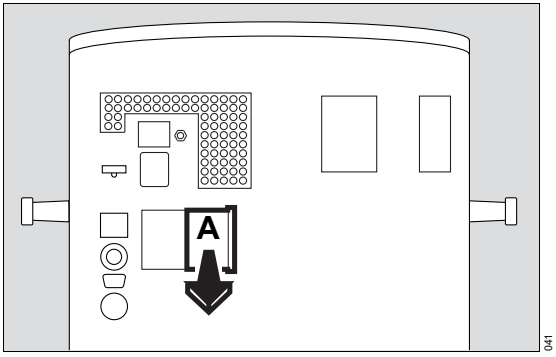
Repairs may be performed only by specialized service personnel.

It is recommended that only original parts from Dräger are used and that the parts are replaced by Dräger.

Replacing the microfilter

Replace the microfilter after 1 year.

1 Remove the filter cover, see page 67.



2 Remove the soiled microfilter (A) from the holder and dispose of it with domestic waste.

3 Push new microfilter (A) into the holder as far as it will go.

4 Fit the filter cover, see page 67.

Replacing the dust filter set

CAUTION

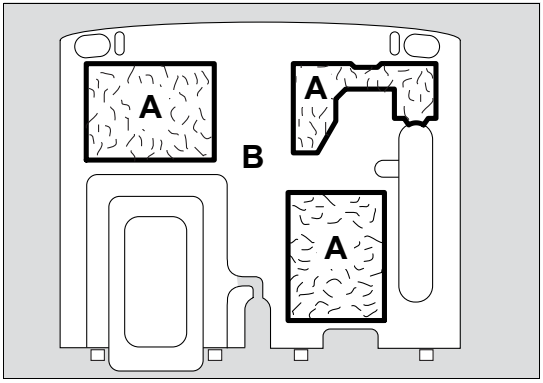
Risk of malfunction

Soiled dust filters may impair the proper functioning of the device.

Replace the dust filter set at regular intervals.

Visually check the dust filter set for soiling after 4 weeks and clean or replace as necessary. Replace after 1 year at the latest.

1 Remove the filter cover, see page 67.



2 Remove the soiled dust filter set (A) from the filter cover (B) and dispose of with domestic waste.

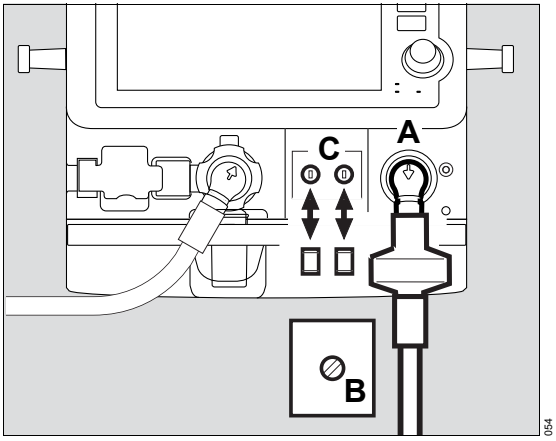
3 Insert the new dust filter set (A).

4 Fit the filter cover, see page 67.

Replacing the O_2 sensors

Replace the O_2 sensors if:
– Calibration is no longer possible.
– The alarm message ***FiO_2 measurement failed*** is displayed.

Prerequisite: Savina 300 is switched off.



1 Swivel the inspiratory port (A) downwards.

2 Release the screw using a coin and remove the cover plate (B).

3 Remove the old O_2 sensors from the holder (C).

4 Insert the new O_2 sensors into the respective holder (C) and turn them, applying slight pressure, until the O_2 sensors slide further into the holder.

5 Fit the cover plate (B) again and tighten the screw using a coin.

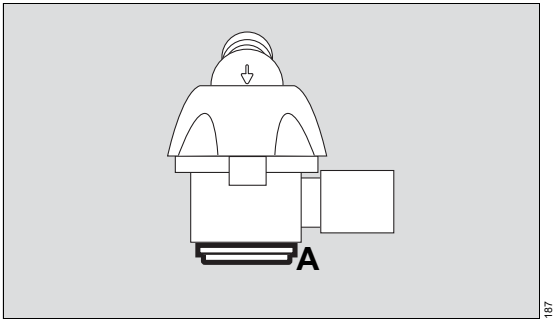
6 Switch on Savina 300 and wait for the O_2 sensors to complete their warm-up phase (10 to 20 minutes).

7 Calibrate the O_2 sensors, see page 124.

8 Dispose of the old O_2 sensors, see page 195.

Replacing the diaphragm of the reusable expiratory valve

Prerequisite: The expiratory valve has been removed, see "Removing the expiratory valve" on page 177.



1 Remove the diaphragm (A).

2 Fit the new diaphragm onto the edge of the expiratory valve housing. Make sure that the diaphragm is fitted properly.

3 Dispose of used diaphragm with domestic waste.

4 Fit the expiratory valve, see "Fitting the expiratory valve" on page 53.

Disposal

Safety information

CAUTION

Risk due to inappropriately reprocessed products

The product may be contaminated with infectious agents.

Before disposal, reprocess the product in accordance with the chapter "Reprocessing".

Disposing of the packaging material

Dispose of the packaging material of the device and the accessories listed in the list of accessories in accordance with the applicable laws and regulations.

Disposing of the batteries

The medical device contains batteries with toxic substances.
In the Federal Republic of Germany: The user is obliged by the law on the return and disposal of used batteries to return batteries which contain toxic substances either to the manufacturer/sales outlet or to a collection center operated by public waste disposal corporations. The battery installed in the device must therefore be removed by service personnel before disposal of the device. Observe the applicable laws and regulations for battery disposal.

Disposing of the O_2 sensors

O_2 sensors can be returned to Dräger.

Disposing of the device

The disposal of electrical and electronic devices is subject to special guidelines. This device must be disposed of in accordance with national regulations. In countries of the European Union, Dräger will organize the return of the device. Additional information is available at www.draeger.com (search term: WEEE).

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Technical data

Ambient conditions

During operation	
Temperature	
Battery operation	5 to 40 °C (41 to 104 °F)
Mains operation, battery fully charged	5 to 35 °C (41 to 95 °F)
Mains operation, battery charging	5 to 30 °C (41 to 86 °F)
Atmospheric pressure	700 to 1060 hPa
Relative humidity	5 to 95 %, without condensation
During storage and transport	
Temperature	–15 to 40 °C (5 to 104 °F)
Atmospheric pressure	600 to 1200 hPa
Relative humidity	10 to 95 %, without condensation

Ambient conditions may be restricted depending on the accessories used. Observe corresponding instructions for use.

If not explicitly specified, the tolerance specifications in the technical data do not include the measurement uncertainty of external test equipment.

Set values

Ventilation modes	VC-CMV / VC-AC, VC-SIMV, VC-MMV, PC-BIPAP, PC-AC, PC-APRV, SPN-CPAP
Respiratory rate ***RR***	2/min to 80/min
Accuracy	±1/min
Respiratory rate during apnea ventilation ***RR$_{apn}$***	2/min to 80/min (0 = apnea ventilation off)
Accuracy	±1/min
Inspiratory time ***Ti***	0.2 to 10 s
Accuracy	0.1 s
Resolution	0.05 s in the range up to 1 s, 0.1 s in the range above 1 s

Set values (cont.)

Maximum inspiratory time for supported breaths ***Timax***	0.2 to 4 s
Accuracy	0.1 s
Resolution	0.05 s in the range up to 1 s, 0.1 s in the range above 1 s
Tidal volume ***VT***	50 to 2000 mL, BTPS If the ***Pediatric Plus*** option is enabled: 20 to 2000 mL, BTPS
Tidal volume during apnea ventilation ***VTapn***	50 to 2000 mL, BTPS If the ***Pediatric Plus*** option is enabled: 20 to 2000 mL, BTPS
Resolution	1 mL in the range up to 300 mL, 10 mL in the range above 300 mL
Accuracy Valid for 25 °C (77 °F) ambient temperature and 50 % relative humidity, no leakage, VT measured value valid, no pressure- or flow-related alarms. At higher humidity levels, the flow-dependent measured values are up to 8.3 % lower than the values displayed.	VT ≥50 mL: ±10 % of the set value or ±12.5 mL, whichever is greater VT <50 mL: ±25 % of the set value
O_2 concentration	21 to 100 Vol%
Accuracy Valid for 25 °C (77 °F) ambient temperature and 50 % relative humidity. At higher humidity levels, the O_2 concentration of the dry gas is up to 2.5 Vol% higher than the measured value.	±3 Vol% The accuracy of the inspiratory O_2 concentration is considerably reduced when operating the device without O_2 sensors.
$T_{0...90}$ (VT = 500 mL, maximum values for the combination of accessories in accordance with ISO 80601-2-12)	<60 s
$T_{0...90}$ (VT = 150 mL, breathing circuit for pediatric patients, maximum values for the combination of accessories in accordance with ISO 80601-2-12)	<100 s
$T_{0...90}$ (VT = 30 mL (only possible if the ***Pediatric Plus*** option is enabled), maximum values for the combination of accessories in accordance with ISO 80601-2-12)	<140 s

Set values (cont.)

Pressure	
Inspiratory pressure ***Pinsp***	1 to 99 mbar (or hPa or cmH2O) [1 mbar = 100 Pa]
Positive end-expiratory pressure PEEP or intermittent PEEP	0 to 50 mbar (or hPa or cmH2O)
Pressure support ***ΔPsupp*** above PEEP	0 to 50 mbar (or hPa or cmH2O) (relative to PEEP)
Inspiratory pressure limit ***Pmax***	1 to 99 mbar (or hPa or cmH2O) [1 mbar = 100 Pa]
Sigh pressure ***ΔintPEEP***	0 to 20 mbar (or hPa or cmH2O)
Accuracy	±2 mbar (or hPa or cmH2O)
Trigger sensitivity Can be switched off in VC-CMV / VC-AC ventilation mode Trigger switched off = VC-CMV Trigger switched on = VC-AC	1 to 15 L/min
Accuracy	±8 % of the set value or ±0.5 L/min, whichever is greater
Termination criterion (peak inspiratory flow) ***Insp. term.***	5 to 75 % PIF
Accuracy	Dependent on the accuracy of flow measurement
Flow acceleration ***FlowAcc***	5 to 200 mbar/s (or hPa/s or cmH2O/s)
Accuracy	±20 % of the set value
Airway Pressure Release Ventilation	APRV
Thigh	0.2 to 22.0 s
Tlow	0.1 to 22.0 s
Accuracy	0.1 s
Resolution	0.05 s in the range up to 1 s, 0.1 s in the range above 1 s
Phigh	1 to 95 mbar (or hPa or cmH2O)
Plow	0 to 50 mbar (or hPa or cmH2O)
Accuracy	±2 mbar (or hPa or cmH2O)
Automatic tube compensation	***ATC***
Tube type	Endotracheal tube ***ET*** or tracheostomy tube ***Trach.***
Inner diameter of the tube	3.5 to 12.0 mm in increments of 0.5 mm

Set values (cont.)

O_2 therapy	
Constant flow ***Flow*** (BTPS)	2 to 100 L/min in increments of 1 L/min
Accuracy	±10 % of the set value or ±1 L/min, whichever is greater
O_2 concentration ***FiO_2***	21 to 100 Vol% in increments of 1 Vol%
Accuracy	±3 Vol% O_2

Performance characteristics

Control principle	Time-cycled, volume-constant, pressure-controlled
Supply system for spontaneous breathing and pressure support	Turbine with quick-action pressure control valve
Maximum inspiratory flow	250 L/min, BTPS
Intermittent PEEP duration	2 cycles every 3 min
Medication nebulization (with high-pressure O_2 supply only)	For up to 30 min, in the inspiratory flow phase, 2 bar (or 200 kPa or 29 psi), max. 10 L/min, Savina 300 takes the nebulizer flow into consideration and keeps the minute volume constant
Oxygenation for endotracheal suction (with high-pressure O_2 supply only)	
Disconnection detection	Automatic
Reconnection detection	Automatic
Preoxygenation	Max. 180 s at 100 Vol% O_2
Active suction phase	Max. 120 s
Postoxygenation	Max. 120 s at 100 Vol% O_2
Device compliance (with bacterial filter, 2.3 to 2.8 m (7.5 to 9.2 ft) breathing circuit for adults, breathing hoses heated or unheated, water traps and breathing gas humidifier)	
Fisher & Paykel breathing gas humidifier MR 850 with empty F&P humidifier chamber MR 370	≤2 mL/mbar ≤2 mL/hPa ≤2 mL/cmH_2O

Performance characteristics (cont.)

Device compliance (with bacterial filter, 2.7 to 2.8 m (8.9 to 9.2 ft) breathing circuit for pediatric patients, Fisher & Paykel breathing gas humidifier MR 850 with empty F&P humidifier chamber MR 340, breathing hoses heated or unheated and water traps)	≤1 mL/mbar ≤1 mL/hPa ≤1 mL/cmH_2O
Maximum values for the combination of accessories in accordance with ISO 80601-2-12 (including inspiratory bacterial filter)	
Breathing circuit for adults	
Compliance	≤3,2 mL/mbar ≤3,2 mL/hPa ≤3,2 mL/cmH_2O
Inspiratory resistance	≤16 mbar/L/s at 60 L/min ≤16 hPa/L/s at 60 L/min ≤16 cmH_2O/L/s at 60 L/min ≤12 mbar/L/s at 30 L/min ≤12 hPa/L/s at 30 L/min ≤12 cmH_2O/L/s at 30 L/min
Expiratory resistance	≤10 mbar/L/s at 60 L/min ≤10 hPa/L/s at 60 L/min ≤10 cmH_2O/L/s at 60 L/min ≤10 mbar/L/s at 30 L/min ≤10 hPa/L/s at 30 L/min ≤10 cmH_2O/L/s at 30 L/min
Breathing circuit for pediatric patients	
Compliance	≤1 mL/mbar ≤1 mL/hPa ≤1 mL/cmH_2O
Inspiratory resistance	≤50 mbar/L/s at 30 L/min ≤50 hPa/L/s at 30 L/min ≤50 cmH_2O/L/s at 30 L/min ≤40 mbar/L/s at 15 L/min ≤40 hPa/L/s at 15 L/min ≤40 cmH_2O/L/s at 15 L/min ≤10 mbar/L/s at 2.5 L/min ≤10 hPa/L/s at 2.5 L/min ≤10 cmH_2O/L/s at 2.5 L/min

Performance characteristics (cont.)

Expiratory resistance	≤44 mbar/L/s at 30 L/min ≤44 hPa/L/s at 30 L/min ≤44 cmH_2O/L/s at 30 L/min ≤40 mbar/L/s at 15 L/min ≤40 hPa/L/s at 15 L/min ≤40 cmH_2O/L/s at 15 L/min ≤10 mbar/L/s at 2.5 L/min ≤10 hPa/L/s at 2.5 L/min ≤10 cmH_2O/L/s at 2.5 L/min
Device resistance in case of device failure in accordance with ISO 80601-2-12	
Breathing circuit for adults	
Inspiratory resistance	≤6.0 mbar at 30 L/min ≤6.0 hPa at 30 L/min ≤6.0 cmH_2O at 30 L/min
Expiratory resistance	≤6.0 mbar at 30 L/min ≤6.0 hPa at 30 L/min ≤6.0 cmH_2O at 30 L/min
Breathing circuit for pediatric patients	
Inspiratory resistance	≤6.0 mbar at 15 L/min ≤6.0 hPa at 15 L/min ≤6.0 cmH_2O at 15 L/min
Expiratory resistance	≤6.0 mbar at 15 L/min ≤6.0 hPa at 15 L/min ≤6.0 cmH_2O at 15 L/min
Additional functions	
Inspiratory relief valve	Opens breathing system in case of failure
Safety valve	Opens the breathing system at max.120 mbar (or hPa or cmH_2O)

Displayed measured values

Airway pressure measurement (resistive relative pressure sensor)	
Peak inspiratory pressure	***PIP***
Plateau pressure	$\boldsymbol{P_{plat}}$
Positive end-expiratory pressure	***PEEP***

Displayed measured values (cont.)

Mean airway pressure	***P_{mean}***
Range	0 to 99 mbar (or hPa or cmH_2O)
Resolution	1 mbar (or hPa or cmH_2O)
Accuracy	±2 mbar (or hPa or cmH_2O)
Intrinsic PEEP	***PEEPi***
Externally applied PEEP	***incl. PEEP***
Range	0 to 100 mbar (or hPa or cmH_2O)
Resolution	0.1 mbar (or hPa or cmH_2O)
Accuracy	±2 mbar (or hPa or cmH_2O)
Inspiratory O_2 measurement (maintenance-free electrochemical sensor, ambient pressure-compensated)	
Inspiratory O_2 concentration	***FiO_2***
Range	18 to 100 Vol%
Resolution	1 Vol% O_2
Accuracy in HPO mode and LPO mode	±3 Vol% O_2
Drift of measurement accuracy	±1 Vol%/day
Warm-up time	10 to 20 min
Maximum response time from 21 Vol% to 60 Vol%	$T_{0...90}$ <20 s
Flow measurement	
Constant flow (O_2 therapy)	***Flow***
Inspiratory peak flow	***$Flow_{ipeak}$***
Range	0 to 196 L/min BTPS
Resolution	1 L/min
Accuracy	±10 % of the measured value or ±1 L/min, whichever is greater
Minute volume measurement	
Minute volume	***MV***
Spontaneous minute volume	***MV_{spon}***
Range	0 to 99 L/min BTPS
Resolution	0.01 L/min in the range up to 10 L/min 0.1 L/min in the range above 10 L/min
Accuracy	±12 % of the measured value or ±0.6 L/min, whichever is greater
$T_{10...90}$	Approx. 35 s

Displayed measured values (cont.)

Leckage minute volume in relation to the inspiratory minute volume	***MV*$_{leak}$**
Range	0 to 100 %
Resolution	1 % Leakages <10 % cannot be indicated with sufficient resolution. 0 % is displayed.
Accuracy	±18 percentage points
Expiratory tidal volume	***VT*$_e$**
Range	0 to 4000 mL, BTPS
Resolution	1 mL
Accuracy	For values ≥50 mL: ±10 % of the measured value or ±11 mL, whichever is greater For values <50 mL: ±13 mL
Tidal volume	***VT***
Tidal volume of spontaneous breaths	***VT*$_{spon}$**
Range	0 to 4000 mL, BTPS
Resolution	1 mL
Accuracy	Application mode ***NIV***: ±18 % of the measured value or ±20 mL, whichever is greater Application mode ***Tube*** (without leakage): ±10 % of the measured value or ±10 mL, whichever is greater
Volume trapped in the lung by intrinsic PEEP and not exhaled during subsequent expiration	***V*$_{trap}$**
Range	0 to 2000 mL, BTPS
Resolution	1 mL
Accuracy	±10 % of the measured value or ±11 mL, whichever is greater
Respiratory rate measurement	
Spontaneous respiratory rate	***RR*$_{spon}$**
Total respiratory rate	***RR***
Range	0 to 150/min
Resolution	1/min
Accuracy	±1/min
$T_{10...90}$	Approx. 35 s

Displayed measured values (cont.)

Ratio of inspiratory time to expiratory time	***I:E***
Range	1:150 to 150:1
Resolution	0.1 for values <100 1 for values ≥100
Accuracy	±6 % of the measured value
Inspiratory time	T_i
Range	0 to 25 s
Resolution	0.1 s
Accuracy	0.1 s
Plateau time	T_{plat}
Range	0 to 25 s
Resolution	0.1 s
Accuracy	0.1 s
Resistance	***R***
Range	3 to 300 mbar/L/s (or hPa/L/s or cmH_2O/L/s)
Resolution	1 mbar/L/s (or hPa/L/s or cmH_2O/L/s)
Accuracy (only without leakage and without spontaneous breathing, ***C*** ≥10 mL/mbar or (mL/hPa or mL/cmH_2O)	±5 mbar/L/s (or hPa/L/s or cmH_2O/L/s) or ±40 %, whichever is the greater
Compliance	***C***
Range	0.5 to 200 mL/mbar (or mL/hPa or mL/cmH_2O)
Resolution	0.1 mL/mbar (or mL/hPa or mL/cmH_2O) for values <10 1 mL/mbar (or mL/hPa or mL/cmH_2O) for values ≥10
Accuracy (only without leakage)	±2 mL/mbar (or mL/hPa or mL/cmH_2O) or ±35 %, whichever is greater
Tidal volume per kg of body weight	***VT / IBW***
Range	0 to 99.9 mL/kg
Resolution	0.1 mL/kg
Rapid shallow breathing index	***RSB***
Range	0 to 9999 (1/min/L)
Resolution	1/min/L
Accuracy	See measurement of VT_{spon} and RR_{spon}

Displayed measured values (cont.)

CO_2 measurement in the main stream	
End-tidal CO_2 concentration (infrared absorption spectroscopy, "Raemer" algorithm, ambient pressure-compensated)	***etCO2***
Range measurable by the CO_2 sensor	0 to 100 mmHg (or 0 to 13.2 Vol% or 0 to 13.3 kPa)
Range displayed by Savina 300	0 to 98 mmHg (or 0 to 13.1 Vol% or 0 to 13.3 kPa)
Resolution	1 mmHg or 0.1 Vol% or 0.1 kPa
The accuracy can be reduced by up to 8 % if there is no valid internal O_2 measured value.	
Total system response time	≤2.2 s
Warm-up time, typical	3 min
For further details, refer to the instructions for use for the CO_2 sensor.	
Performing the breathing circuit check	
Leakage	
Range	0 to 9999 mL/min
Resolution	1 mL/min
Accuracy	±20 % of the measured value or ±0.5 L/min, whichever is greater
Compliance	
Range	0.0 to 9.9 mL/mbar (or mL/hPa or mL/cmH_2O)
Resolution	0.1 mL/mbar (or mL/hPa or mL/cmH_2O)
Accuracy	±20 % of the measured value
Inspiratory resistance	
Range displayed	0.0 to 150.0 mbar/L/s (or hPa/L/s or cmH_2O/L/s)
Range with guaranteed accuracy	0.0 to 100.0 mbar/L/s (or hPa/L/s or cmH_2O/L/s)
Resolution	0.1 mbar/L/s (or hPa/L/s or cmH_2O/L/s)
Accuracy	±35 % of the measured value
Expiratory resistance	
Range displayed	0.0 to 400.0 mbar/L/s (or hPa/L/s or cmH_2O/L/s)
Range with guaranteed accuracy	0.0 to 100.0 mbar/L/s (or hPa/L/s or cmH_2O/L/s)
Resolution	0.1 mbar/L/s (or hPa/L/s or cmH_2O/L/s)
Accuracy	±35 % of the measured value

Displayed measured values (cont.)

Waveform displays	
Airway pressure Paw (t)	–5 to 100 mbar (or hPa or cmH_2O)
Tracheal pressure P_{trach} (t)	–5 to 100 mbar (or hPa or cmH_2O)
Flow (t)	–200 to 200 L/min
Tidal volume VT (t)	0 to 5000 mL
CO_2 (t)	0 to 100 mmHg (or 0 to 14 Vol% or 0 to 14 kPa)
$T_{0...90}$	<500 ms

Monitoring

Sound pressure level L_{PA} of the alarm signals, measured according to IEC 60601-1-8 and A1:2012: Operator's position: at the front of the device at a distance of 1 m (39 in) and a height of 1.5 m (59 in)	
Range for high-priority alarms according to volume setting	63 dB (A) to 75 dB (A)
Range for medium-priority alarms according to volume setting	62 dB (A) to 74 dB (A)
Range for low-priority alarms according to volume setting	60 dB (A) to 70 dB (A)
Range for power supply failure alarm and auxiliary alarm	55 dB (A) to 62 dB (A)
Expiratory minute volume	***MV***
Upper alarm limit alarm	If the upper alarm limit has been exceeded
Range	2 to 41 L/min in increments of 0.1 L/min

Monitoring (cont.)

Lower alarm limit alarm	If the value has fallen below the lower alarm limit
Range	0.2 to 40 L/min in increments of 0.1 L/min
Alarm suppression	– For the first 2 min after the device is switched on – In standby mode and for 2 min after starting ventilation – When flow monitoring is deactivated and for 2 min after activation – During detected disconnection and for 2 min after reconnection
Airway pressure	***Paw***
Upper alarm limit alarm	If the upper alarm limit has been exceeded
Range	10 to 100 mbar (or hPa or cmH_2O)
Lower alarm limit alarm	When the value "PEEP + 5 mbar (or hPa or cmH_2O)" (coupled with the set value for PEEP) is not exceeded for at least 0.1 s in two successive mandatory breaths at PEEP+Pinsp ≥5 mbar
Delay time ***$T_{disconnect}$*** for alarm message ***Airway pressure low*** (only in ***NIV*** application mode)	0 to 60 s
Inspiratory O_2 concentration (HPO mode)	***FiO_2***
Upper alarm limit alarm	If the upper alarm limit has been exceeded for at least 20 s
Lower alarm limit alarm	If the lower alarm limit has been exceeded for at least 20 s
Setting range	Both alarm limits are automatically allocated to the set value: <60 Vol% at ±4 Vol% ≥60 Vol% at ±6 Vol%
Inspiratory O_2 concentration (LPO mode)	***FiO_2***
Alarm limits	Manual adjustment
Range of upper alarm limit	19 to 99 Vol%, , in increments of 1 Vol%
Range of lower alarm limit	18 to 98 Vol%, in increments of 1 Vol% (18 to 99 Vol% if the upper alarm limit is switched off)

Monitoring (cont.)

End-expiratory CO_2 concentration	***etCO2***
Upper alarm limit alarm	If the upper alarm limit has been exceeded
Range	1 to 98 mmHg (or 0.1 to 13.1 Vol% or 0.1 to 13.3 kPa)
Lower alarm limit alarm	If the value has fallen below the lower alarm limit
Range	0 to 97 mmHg (or 0 to 13.0 Vol% or 0 to 13.2 kPa)
Respiratory rate	***RR***
Alarm	If the respiratory rate (mandatory and spontaneous breaths) has been exceeded
Setting range	10 to 120/min
Apnea alarm time	***Tapn***
Alarm	If no breathing activity is detected
Range	15 to 60 s adjustable in increments of 1 s
Tidal volume	***VT***
Alarm	If the delivered tidal volume VT exceeds the alarm limit
Range	60 to 4000 mL If the ***Pediatric Plus*** option is enabled: 30 to 4000 mL
Alarm suppression	– For the first 15 s after the device is switched on – In standby mode and for 15 s after starting ventilation – During detected disconnection and for 15 s after reconnection

Operating data

Mains power supply	
Mains power connection	100 V~ to 240 V~ 50 Hz to 60 Hz
Current consumption	
at 240 V~	Max. 1.3 A
at 100 V~	Max. 3.4 A
Inrush current	Max. 15 A

Operating data (cont.)

Device fuse	
Range 100 to 240 V~	F 5 H 250 V IEC 60127-2 5x20 (2x)
Degree of protection	
Ventilator	Class I
Expiratory valve and breathing hoses	Type BF 
CO_2 sensor (sensor fitted)	Type BF 
Degree of protection against ingress of liquids and particulate matter	IP21 Protected against finger access and solid foreign bodies with a diameter from 12.5 mm (0.47 in) Protected against vertically falling water drops
Battery supply	
Internal battery	
Type	Lead-gel batteries, maintenance-free, sealed
DC fuse	Blade fuse F15A32V ISO 8820-3 type C
Operating time if mains power supply is not available and no external battery is available (new and fully-charged internal battery)	Typically 45 min
External battery	
Type	Lead-gel batteries, maintenance-free, sealed
DC fuse	Blade fuse F25A80V UL 248, type C, standard size, arc-quenching
Supply voltage	24 V
Minimum capacity	17 Ah
Input current (DC)	Typically 5 A, max. 15 A
Charging current	2 A
The external battery is mounted to the Dräger Savina 300 trolley or Dräger Savina 300 compact trolley.	
Operating time if mains power supply is not available, with a fully-charged external battery at 17 Ah and typical ventilation (Typical ventilation, see page 215)	Approx. 4 hours (e.g., with 2 lead-gel batteries 12 V / 17 Ah)

Operating data (cont.)

Battery charging	
The batteries are charged until the end-of-charge voltage is reached. The charging system then switches to trickle charging.	
Trickle charging is effected by short current pulses.	
Charging times	
The charging times indicated refer to immediate charging of the internal or external battery after discharge.	
If the batteries are only partially discharged several times in a row without being completely charged in this time, the specified charging times are increased.	
Internal battery	Max. 6 hours (max. 3 hours for 75 % charge)
External battery	Max. 24 hours (max. 18 hours for 75 % charge)
Gas supply (HPO)	
O_2 operating pressure	2.7 bar to 6 bar 270 kPa to 600 kPa 39 psi to 87 psi
O_2 input flow	Up to 180 L/min
Constant O_2 input flow in O_2 therapy	Up to 60 L/min at an inlet pressure of 2.8 bar (or 280 kPa or 40 psi)
O_2 port	NIST
Dew point	5 °C below ambient temperature
Oil concentration	<0.1 mg/m³
Particle size	Dust-free air (filtered with pore size <1 µm)
Gas supply (LPO)	
Connecting hose	Max. ø 7 mm
Return valve	Resistance approx. 50 mbar (or hPa or cmH_2O) at a flow of 10 L/min
O_2 operating pressure	100 mbar to max. 2 bar 100 hPa to max. 200 kPa 1.45 psi to max. 29 psi
O_2 flow	0.5 L/min to max. 10 L/min
O_2 humidity	Without condensation
Output for pneumatic medication nebulizer	O_2, max. 2 bar (or 200 kPa or 29 psi), max. 16 L/min

Operating data (cont.)

Sound pressure level of device during typical ventilation (mean sound pressure level Leq (A))	≤48 dB (A) for typical ventilation With quiet "Low Noise" turbine: ≤45 dB (A) for typical ventilation (Typical ventilation, see page 215)
(Average over 4 sides in an open area in accordance with ISO 3744 at a distance of 1 m (39 in) and at a height of 1.5 m (59 in))	
Noise emission according to ISO 80601-2-12:2011 with consideration of ISO 4871:2009 and ISO 3744:2010	
A-evaluated averaged measuring surface sound pressure level (LpA) at a radius of 2 m (79 in)	38 dB
Uncertainty (k)	3.5 dB
A-evaluated sound power level (LWA)	52 dB
Uncertainty (k)	3.5 dB
Dimensions (W x H x D)	
Basic device	460 x 383 x 364 ±2 mm (18.11 x 15.08 x 14.33 ±0.08 in)
Device with Dräger Savina 300 trolley	577 x 1295 x 677 ±5 mm (22.72 x 50.98 x 26.65 ±0.20 in)
Device with Dräger Savina 300 compact trolley	577 x 1295 x 677 ±5 mm (22.72 x 50.98 x 26.65 ±0.20 in)
Device with LPO	460 x 383 x 364 ±2 mm (18.11 x 15.08 x 14.33 ±0.08 in)
Weight	
Basic device	26 kg (57.3 lb) without trolley
Device outputs	
Digital output	Output and reception via an RS 232 C interface for MEDIBUS protocol
Maximum load	
Load for Dräger Savina 300 trolley	100 kg (220.5 lb)
Load for Dräger Savina 300 compact trolley	54 kg (119.0 lb)
Including:	
Maximum load for universal holder with standard rail	10 kg (22.0 lb)
Maximum load for standard rail	5 kg (11.0 lb)
Maximum load for humidifier holder	5 kg (11.0 lb)
Maximum load for hinged arm	1 kg (2.2 lb)

Operating data (cont.)

Electromagnetic compatibility EMC according to European Directive 89/336/EEC	Tested in accordance with IEC 60601-1-2
Classification Medical Device Europe	Class IIb
UMDNS code Universal Medical Device Nomenclature System - Nomenclature for medical devices	17-429
Materials used	
Part	Material
Breathing hose	Silicone rubber (milky, transparent)
Water trap	Polysulphone (gray, transparent)
Y-piece	Polysulphone (yellow, transparent)
Expiratory valve (housing, closure)	Polyamide (white, blue)
Inspiratory valve	Polyamide (white, blue)
Diaphragm	Silicone rubber and nickel (whitish and gray)
For nurse call (optional)	
Connection	With 1846248 plug only
Potential-free DC contact	
Input voltage	Max. 40 V =
Input current	Max. 500 mA
Switching power	Max. 15 W
Alarm delay	≤2.5 s
MEDIBUS	
Alarm delay (on request)	≤3 s

Declaration of hazardous substances in accordance with Regulation CLP 1272/2008 Annex VI Part 3

Certain materials of this product contain the following substances in a proportion exceeding 0.1 % by mass:
– Lead (CAS No. 7439-92-1)

This product is safe to use for patients who are sensitive to the indicated substances.

Dräger is aware of the following residual risks:
– None

Typical ventilation	
Ventilation mode	VC-CMV without AutoFlow and ATC
VT	0.45 L
FiO_2	21 Vol%
FlowAcc	30 mbar/s (or hPa/s or cmH_2O/s)
T_i	2 s
RR	12/min
PEEP	5 mbar (or hPa or cmH_2O)
Test lung compliance	50 mL/mbar (50 mL/cmH_2O)
Test lung resistance	5.0 mbar/L/s (5.0 $cmH_2O/L/s$)

Alarm system of Savina 300

The alarm system of Savina 300 meets the requirements of the IEC 60601-1-8 standard.

The optical and acoustic alarm signals include:
– flashing LEDs
– on-screen display of alarm messages
– main acoustic alarm and auxiliary acoustic alarm (also used as power supply failure alarm).

The alarm system is designed so that the user can recognize alarm messages from a distance of 1 m (39 in). The volume of the alarm tone specified applies to a distance of 1 m (39 in) in front of the device and a height of 1.5 m (59 in). For the volumes of the main acoustic alarm with regard to the individual alarm priorities, see "Monitoring" on page 208.

The alarm system has configurable alarm presets or default alarm presets. For "factory settings", see page 139.

Savina 300 has two interfaces (MEDIBUS or MEDIBUS.X, nurse call) that can be used for a distributed alarm system. According to IEC 60601-1-8, this distributed alarm system is not suitable for the safe transmission of alarms. Data transfer via MEDIBUS or MEDIBUS.X or the nurse call do not replace regular checks of the monitoring on the device screen. Each device in the alarm system connected to these interfaces must be labeled with a warning that the connected device cannot guarantee the safe receipt of alarm signals.

The alarms are output acoustically and optically immediately upon detection of an alarm, without an additional delay.

NOTE

Certain alarm conditions are based on time-dependent parameters and are not detected immediately. For additional information, see chapter "Monitoring" on page 208.

According to IEC 60601-1-8, when there are multiple simultaneously active alarms with the same priority, the intelligent Savina 300 alarm system always displays the one with the highest urgency on the screen.

For a list of alarm conditions, their priorities and, where applicable for individual alarm messages, their escalation or de-escalation, refer to chapter "Alarm – Cause – Remedy" on page 147.

All the alarm limits which can be set by the user are displayed in the ***Alarms*** dialog window. For a description of alarm system operation, see chapter "Alarms" on page 107.

All the automatically set alarm limits are listed in the chapter "Automatic alarm limits" on page 217.

The acoustic alarm signal can be suppressed for a maximum of 2 minutes by pressing the ***Audio paused 2 min.*** key, see chapter "Alarm silence" on page 110. A deactivated alarm signal is displayed in the screen header bar by means of a corresponding symbol from table C.1 of the standard.

If a higher-priority alarm occurs during this time, the acoustic alarm signal sounds once, informing the user of the alarm.

The alarm system is activated during the Savina 300 system start.

Following completion of the system start, Savina 300 starts the therapy with the last set alarm and ventilation parameters. The main screen for ventilation is displayed.

Read chapter "Getting started" on page 69 carefully before using Savina 300 on a patient.

During operation, all alarm limits and ventilation parameters are stored permanently and remain immediately available even after a lengthy device failure and following a restart.

Individual alarm conditions can be deactivated by the user subject to certain prerequisites, see chapter "Setting the alarm limits" on page 111.

Groups of alarm conditions can also be deactivated by the user, see chapter "Monitoring" on page 121.

Deactivated alarm conditions are displayed in the screen header bar by means of a corresponding symbol from table C.1 of the standard.

Operation is terminated by activating standby mode (see page 104) and then switching off Savina 300 (see page 105).

Automatic alarm limits

The following tables describe the alarm limits which cannot be set by the user.

Pressure monitoring

Alarm message	Description/Detection
PEEP high	A too high PEEP value during ventilation is monitored. The alarm limit is always 8 mbar (8 cmH_2O) above the set PEEP.
PEEP inoperable	Too low or too high a PEEP value during ventilation is monitored. The alarm limit depends on the set value of the PEEP level. The alarm limit is 5 mbar (5 cmH_2O) lower or higher than the set PEEP respectively.
Airway pressure low	A too low airway pressure is monitored by checking whether the mean value of the lower pressure level falls below the set PEEP value. The alarm is only generated if the set PEEP $\geq$3 mbar (3 cmH_2O). With NIV the alarm is delayed by the time ***$T_{disconnect}$***.

Volume monitoring

Alarm message	Description/Detection
VT low	Volume-controlled breaths are monitored to detect whether the set volume is reached. The alarm limit corresponds to the set value VT.

Monitoring of the breathing circuit and the patient connection

Alarm message	Description/Detection
Leakage	Leakages are monitored. The alarm limit is set at 55 % of relative leakage. Leakages during NIV are not monitored.

FiO_2 monitoring

Alarm message	Description/Detection
FiO_2 high	A too high O_2 concentration of the applied gas is monitored.
	The alarm limit is 4 Vol% above the set value if this set value is less than or equal to 60 Vol%.
	The alarm limit is 6 Vol% above the set value if this set value is greater than 60 Vol%.
FiO_2 low	A too low O_2 concentration of the applied gas is monitored.
	For an FiO_2 concentration of 21 Vol%, the alarm limit is 18 Vol%.
	The alarm limit is 4 Vol% below the set value if this set value is greater than 21 Vol% and less than or equal to 60 Vol%.
	The alarm limit is 6 Vol% below the set value if this set value is greater than 60 Vol%.

Device combinations

This device can be operated in combination with other Dräger devices or with devices from third-party manufacturers. Follow the accompanying documents of the individual devices.

If a device combination is not approved by Dräger, the safety and the functional integrity of the individual devices may be compromised. The operating organization must ensure that the device combination complies with the applicable editions of the relevant standards for medical devices.

Device combinations approved by Dräger meet the requirements of the following standards:
– IEC 60601-1 (electrical safety, mechanical safety, software)
– IEC 60601-1-2 (EMC)
– IEC 60601-1-8 (alarm systems)

EMC declaration

General information

This device was tested for electromagnetic compatibility using accessories from the list of accessories. Other accessories may only be used if they do not compromise the electromagnetic compatibility. The use of non-compliant accessories may result in increased electromagnetic emissions or decreased electromagnetic immunity of the device.

This device may be used in the direct vicinity of other devices only if Dräger has approved this device arrangement. If no approval has been given by Dräger, it must be ensured that this device functions correctly in the desired arrangement before use. The instructions for use for the other devices must be followed.

Electromagnetic environment

This device may only be used in environments specified in section "Environments of use" on page 18.

Emissions	Compliance
Radiated emissions	Class A, group 1 (30 MHz to 1 GHz)
Conducted emissions	Class A, group 1 (150 kHz to 30 MHz)

NOTE

The emissions characteristics of this equipment make it suitable for use in industrial areas and hospitals (CISPR 11 class A). If it is used in a residential environment (for which CISPR 11 class B is normally required), this equipment might not offer adequate protection to radio-frequency communication services. The user might need to take mitigation measures, such as relocating or re-orienting the equipment.

Immunity against	Test level and required electromagnetic environment
Electrostatic discharge (ESD) (IEC 61000-4-2)	Contact discharge: ±8 kV
	Air discharge: ±15 kV
Fast transient electrical disturbances (bursts) (IEC 61000-4-4)	Power cable: ±2 kV
	Longer signal input lines/output lines: ±1 kV

Immunity against	Test level and required electromagnetic environment
Impulse voltages (surges) (IEC 61000-4-5)	Voltage, external conductor – external conductor: ±1 kV
	Voltage, external conductor – protective ground conductor: ±2 kV
Magnetic fields at mains frequency (IEC 61000-4-8)	50 Hz: 30 A/m
Voltage dips and short interruptions in the supply voltage (IEC 61000-4-11)	Voltage dips of 30 % to 100 %, 8.3 ms to 5 s, different phase angles
Radiated high-frequency disturbances (IEC 61000-4-3)	80 MHz to 2.7 GHz: 20 V/m: Savina 300 without trolley 10 V/m: Savina 300 with trolley during hospital use 3 V/m: Savina 300 with CO_2 sensor
Conducted high-frequency disturbances (IEC 61000-4-6)	150 kHz to 80 MHz: 3 V, ISM bands: 6 V
Electromagnetic fields in the vicinity of wireless communication devices	Various frequencies from 385 MHz to 5785 MHz: 9 V/m to 28 V/m

Recommended separation distances from wireless communication devices

To ensure that the functional integrity of this device is maintained, there must be a separation distance of at least 1.0 m (3.3 ft) between this device and wireless communication devices.

Connections to IT networks

In an IT network, data can be exchanged by means of wired or wireless technologies. An IT network can be any data interface (e.g., RS232, LAN, USB, printer interface) that is described in standards and conventions.

During operation, this device can exchange information with other devices by means of IT networks and supports the following functions:

– Display of waveforms and parameter data
– Signaling of alarms
– Transfer of device settings
– Service mode, access to logbooks

Connecting this device to a network that incorporates other devices or making subsequent changes to that network can lead to new risks for patients, users, and third parties. Before the device is connected to the network or the network is changed, these risks must be identified, analyzed, and evaluated, and appropriate measures taken.

Example of subsequent changes to the network:

– Adding new devices to the network

Information about connecting to the network

Prerequisites

This device must only be connected to the network by service personnel. The IT representative of the hospital must be consulted in advance.

The following documents must be observed:

– Accompanying documents of this device
– Description of the network interface
– Description of the network-based alarm systems

Dräger recommends complying with IEC 80001-1 (Risk management for IT-networks incorporating medical devices).

Serial interfaces

The following interfaces are supported:

– RS232 interfaces conforming to EIA RS232 (CCITT V.24/V.28) for the following applications:
  – MEDIBUS, MEDIBUS.X
  – Connections to medical devices from other manufacturers

Consequences of using an unsuitable network

If the network does not meet the requirements, dangerous situations can result. The following situation can occur with this device:

– Data are sent incomplete, sent to the wrong device, or not sent at all.

Requirements for the electrical characteristics of connected devices and networks

The serial interfaces are only suitable for the connection of devices or networks that have a rated voltage of at most 24 V DC on the network side and that meet the requirements of one of the following standards:

– IEC 60950-1: Ungrounded SELV circuits
– IEC 60601-1 (as of 2nd edition): Touchable secondary circuits

Open-source software

Dräger devices that use software may use open-source software, depending on their setup. Open-source software may be subject to different terms of license. Additional information regarding the open-source software used in this device is available at the following web page:

www.draeger.com/opensource

Principles of operation

Ventilation modes

VC-CMV/VC-AC

VC-CMV

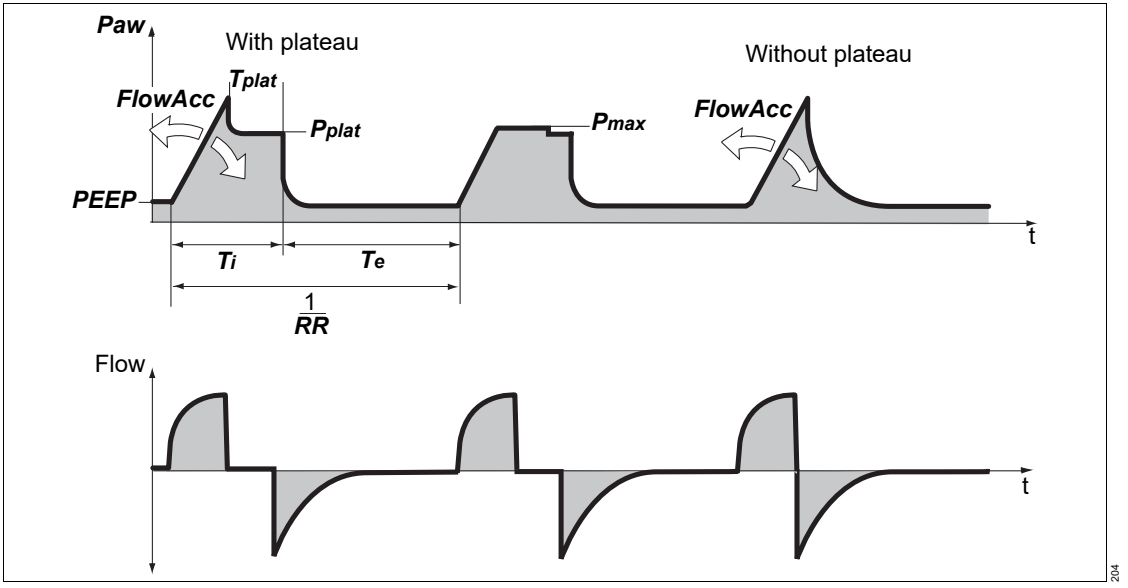
Volume Control-Continuous Mandatory Ventilation

Continuous volume-controlled ventilation

VC-AC

Volume Control-Assist Control

Assisted-controlled, volume-controlled ventilation
with backup respiratory rate



Volume-controlled ventilation

The tidal volume of the mandatory breaths is determined by the volume ***VT***. The pressure rise is determined by the flow acceleration ***FlowAcc***. The mandatory breaths are time-cycled and are not triggered by the patient. The number of mandatory breaths is determined by the respiratory rate ***RR***.

If the flow acceleration is so high that the set tidal volume is already reached before the set inspiratory time ***Ti*** has fully elapsed, an inspiratory pause occurs. The inspiratory pause can be identified as the plateau ***Pplat*** in the waveform Paw (t).

If the inspiratory pause time ***Plateau*** is deactivated, Savina 300 immediately switches to expiration as soon as the set tidal volume ***VT*** is applied.

When the ***Pressure limitation*** ventilation function is activated, the P_{max} therapy control is active. The set tidal volume ***VT*** is maintained and pressure peaks are avoided.

Assisted-controlled ventilation *VC-AC*

Every inspiratory effort of the patient on PEEP level triggers a synchronized mandatory breath. Thus, the time and number of mandatory breaths are determined by the patient. The trigger window covers the expiratory time minus a refractory period for the previous expiration. The expiratory time is determined by the respiratory rate ***RR*** and the inspiratory time T_i. A non-synchronized mandatory breath is triggered at the latest at the end of the expiratory time (backup respiratory rate). The minimal number of mandatory breaths is determined by the respiratory rate ***RR***.

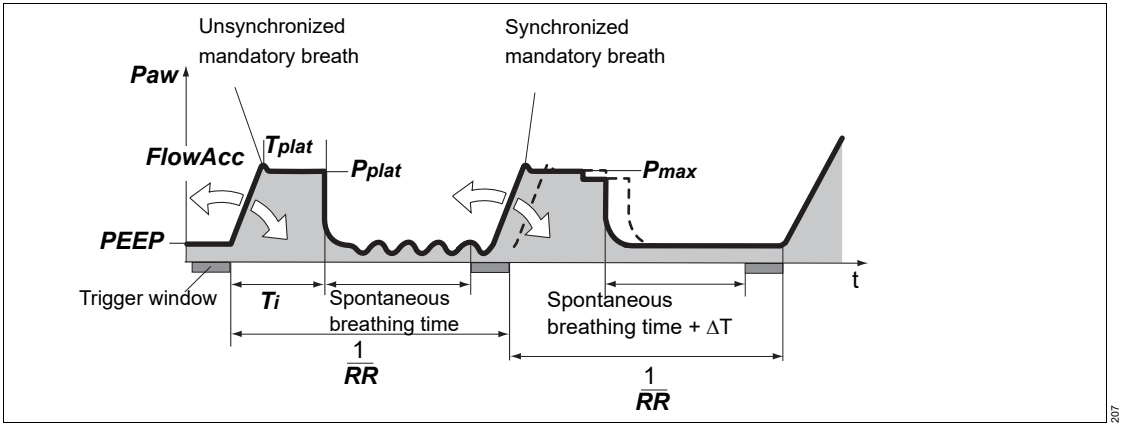
Additional information

A detailed description of the following ventilation functions can be found on page 234:
– Volume-controlled ventilation without plateau
– Flow acceleration
– Pressure limitation

VC-SIMV

Volume Control-Synchronized Intermittent Mandatory Ventilation

Intermittent, triggered, volume-controlled ventilation, allowing spontaneous breathing during the expiratory phase



Volume-controlled ventilation

The tidal volume of the mandatory breaths is determined by the volume ***VT***. The pressure rise is determined by the flow acceleration ***FlowAcc***. The number of mandatory breaths is determined by the respiratory rate ***RR***.

If the flow acceleration is so high that the set tidal volume is already reached before the set inspiratory time ***Ti*** has fully elapsed, an inspiratory pause occurs. The inspiratory pause can be identified as the plateau ***Pplat*** in the waveform Paw (t).

If the inspiratory pause time ***Plateau*** is deactivated, Savina 300 immediately switches to expiration as soon as the set tidal volume ***VT*** is applied.

When the ***Pressure limitation*** ventilation function is activated, the ***Pmax*** therapy control is active. The set tidal volume ***VT*** is maintained and pressure peaks are avoided.

During spontaneous breathing on PEEP level, the patient can be supported with ***PS***.

Synchronization

The mandatory breaths can be triggered by the patient's inspiratory effort on PEEP level.

A mandatory breath can only be triggered within a "trigger window" by the flow trigger in synchrony with the patient's inspiration. This prevents the breath being applied during expiration.

The trigger window has a maximum duration of 5 seconds. For expiratory times shorter than 5 seconds, the trigger window covers the entire expiratory time minus a refractory period of 500 ms for the previous expiration.

Synchronization of the mandatory breath reduces the expiratory time. Savina 300 prolongs the subsequent expiratory time or spontaneous breathing time by the missing time ΔT. This prevents an increase of the mandatory respiratory rate.

The number of mandatory breaths is determined by the respiratory rate ***RR***.

If the patient breathes in at the beginning of the trigger window and has already inspired a significant volume, Savina 300 takes this volume into account. During the subsequent mandatory breath, the ventilator reduces the inspiratory flow phase and the inspiratory time. The tidal volume remains constant and overinflation of the lungs is prevented.

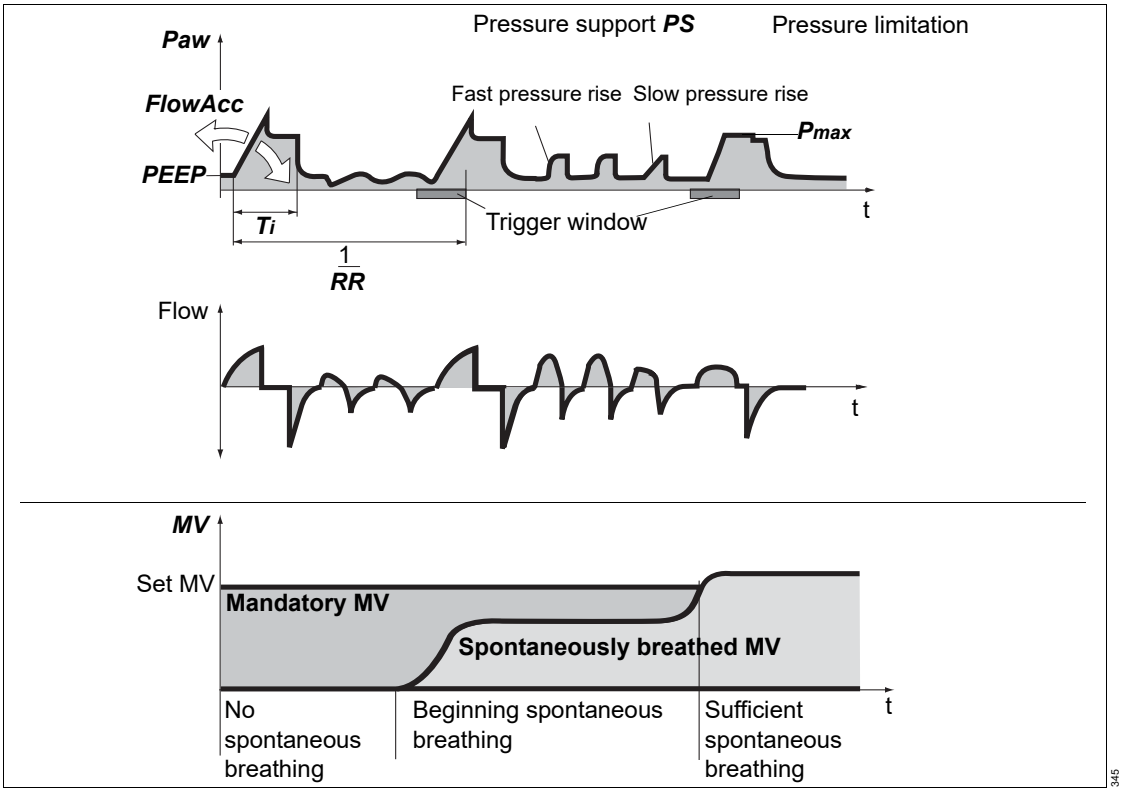
Additional information

A detailed description of the following ventilation functions can be found on page 234:
– Volume-controlled ventilation without plateau
– Flow acceleration
– Pressure limitation
– Pressure support

VC-MMV

Volume Control-Mandatory Minute Volume Ventilation

Volume-controlled ventilation to ensure a mandatory minute volume



Volume-controlled ventilation

The tidal volume of the mandatory breaths is determined by the volume ***VT***. The duration of the mandatory breaths is determined by ***Ti***. The pressure rise is determined by the flow acceleration ***FlowAcc***. If the inspiratory flow is so high that the set tidal volume is already reached before the set inspiratory time ***Ti*** has fully elapsed, an inspiratory pause occurs.

MMV works similar to SIMV, however, the breaths are only provided if spontaneous breathing is not sufficient and below the prescribed minimum ventilation. When spontaneous breathing increases, fewer breaths will be provided. The minimum ventilation is determined by the settings of the tidal volume ***VT*** and the respiratory rate ***RR***.

The maximum number of breaths is determined by the respiratory rate ***RR***. However, this number is only provided when insufficient spontaneous breathing is present.

When the ***Pressure limitation*** ventilation function is activated, the ***Pmax*** therapy control is active. The set tidal volume ***VT*** is maintained and pressure peaks are avoided.

During spontaneous breathing on PEEP level, the patient can be supported with ***PS***.

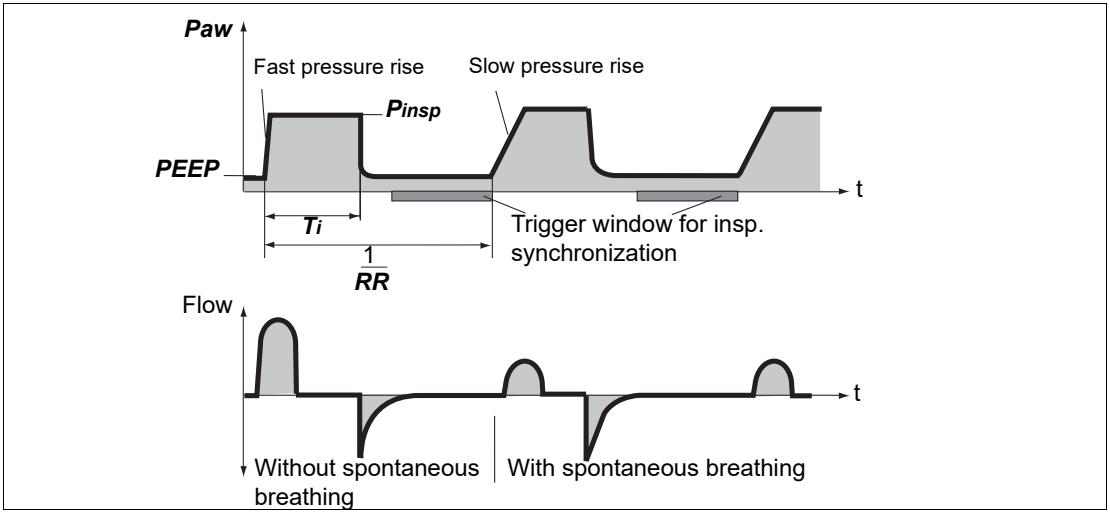
Additional information

A detailed description of the following ventilation functions can be found on page 234:
- Volume-controlled ventilation without plateau
- Flow acceleration
- Pressure limitation
- Pressure support

PC-AC

Pressure Control-Assist Control

Assisted-controlled, pressure-controlled ventilation allowing spontaneous breathing during the entire respiratory cycle and back-up respiratory rate



Pressure-controlled ventilation

The upper pressure level is determined by ***Pinsp***. The duration of the mandatory breaths is determined by ***Ti***. As in all pressure-controlled ventilation modes, the tidal volume delivered depends on the difference in pressure "***Pinsp*** – ***PEEP***", the lung mechanics (resistance and compliance), and the patient's respiratory drive. The pressure rise is determined by the flow acceleration ***FlowAcc***.

Assisted-controlled ventilation

Every inspiratory effort of the patient on PEEP level triggers a synchronized mandatory breath. Thus, the time and number of mandatory breaths are determined by the patient. The trigger window covers the expiratory time minus a refractory period for the previous expiration. The expiratory time is determined by the respiratory rate ***RR*** and the

inspiratory time ***Ti***. A non-synchronized mandatory breath is triggered at the latest at the end of the expiratory time (backup respiratory rate).

The minimal number of mandatory breaths is determined by the respiratory rate ***RR***.

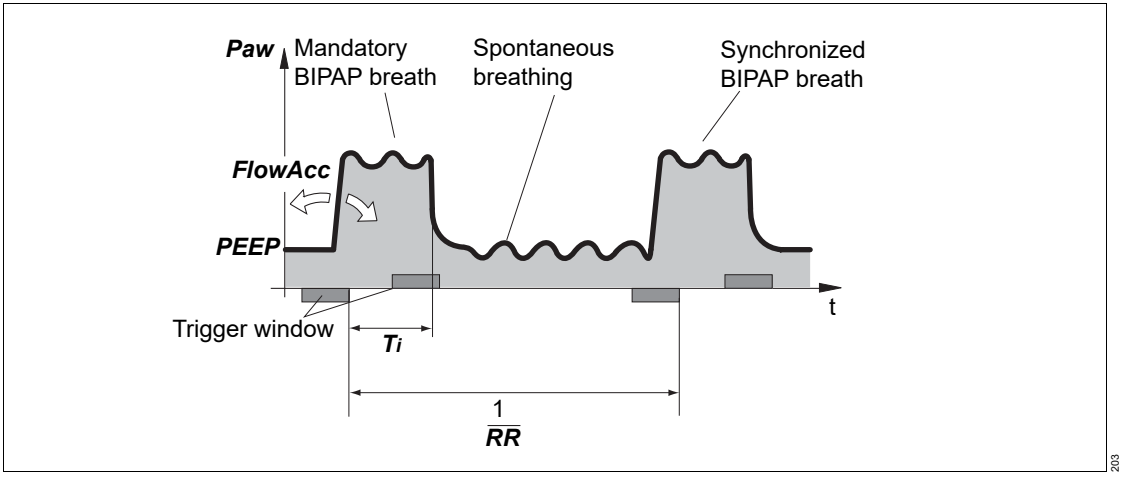
Additional information

For information on flow acceleration, see page 234.

PC-BIPAP

Pressure Control-Biphasic Positive Airway Pressure

Intermittent, synchronized, pressure-controlled ventilation allowing spontaneous breathing (open system) during the entire respiratory cycle and expiratory synchronization



Pressure-controlled ventilation

The upper pressure level is determined by ***Pinsp***. The duration of the mandatory breaths is determined by ***Ti***. As in all pressure-controlled ventilation modes, the tidal volume delivered depends on the difference in pressure "P_{insp} – PEEP", the lung mechanics (resistance and compliance), and the patient's respiratory drive. The pressure rise is determined by the flow acceleration ***FlowAcc***.

The change-over from the inspiratory to the expiratory pressure level is synchronized with the patient's spontaneous breathing. Synchronization of the mandatory breath reduces the duration of the

mandatory breath. Savina 300 prolongs the subsequent breath by the missing time. This prevents an increase in respiratory rate.

During spontaneous breathing on PEEP level, the patient can be supported with ***PS***.

Synchronization

The mandatory breaths can be triggered by the patient's inspiratory effort on PEEP level.

A mandatory breath can only be triggered within a "trigger window" by the flow trigger in synchrony with the patient's inspiration. This prevents the breath being applied during expiration.

The trigger window has a duration of 5 seconds. For expiratory times shorter than 5 seconds, the trigger window covers the entire expiratory time minus a refractory period of 500 ms for the previous expiration.

Synchronization of the mandatory breath reduces the expiratory time. Savina 300 prolongs the subsequent expiratory time or spontaneous breathing time by the missing time. This prevents an increase in the mandatory respiratory rate.

The number of mandatory breaths is determined by the respiratory rate ***RR***.

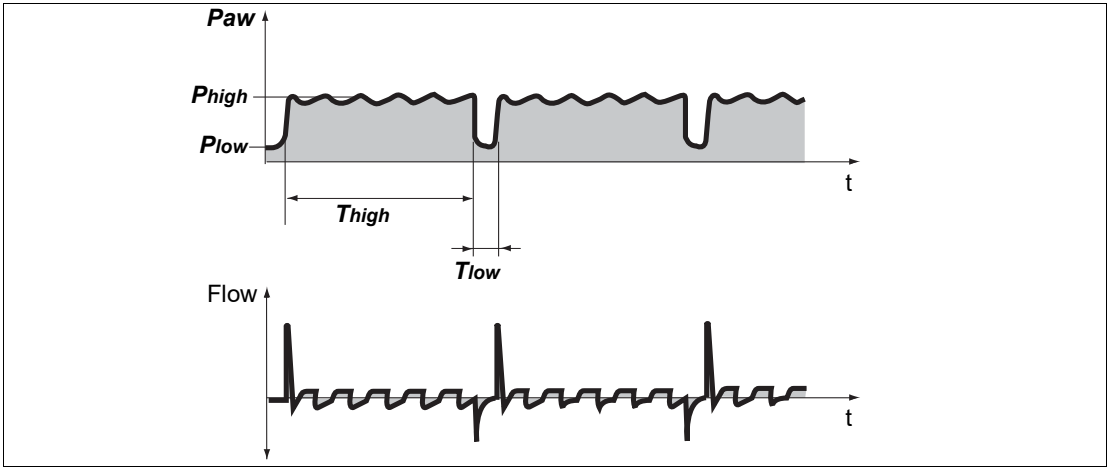
Additional information

A detailed description of the following ventilation functions can be found on page 234:
– Flow acceleration
– Pressure support

PC-APRV

Pressure Control-Airway Pressure Release Ventilation

Spontaneous breathing under continuous positive airway pressure with brief pressure releases



The patient breathes spontaneously at a high pressure level ***Phigh*** for an adjustable length of time ***Thigh***. For very short expiratory times ***Tlow*** Savina 300 switches to a low pressure level ***Plow***. The normal lung areas are emptied, but the "slow" lung areas only change volume to a lesser extent*.

The number of pressure releases is determined by the ***Thigh*** and ***Tlow*** settings. The releases are time-cycled and are not triggered by the patient. The duration is determined by ***Tlow***. The tidal volume exchanged during the release phases depends on the difference in pressure ***Phigh*** – ***Plow***, the lung mechanics (resistance and compliance), and the length of pressure release ***Tlow***. The pressure rise from the lower pressure level ***Plow*** to the upper pressure level ***Phigh*** is determined by the ***FlowAcc*** flow acceleration.

Additional information

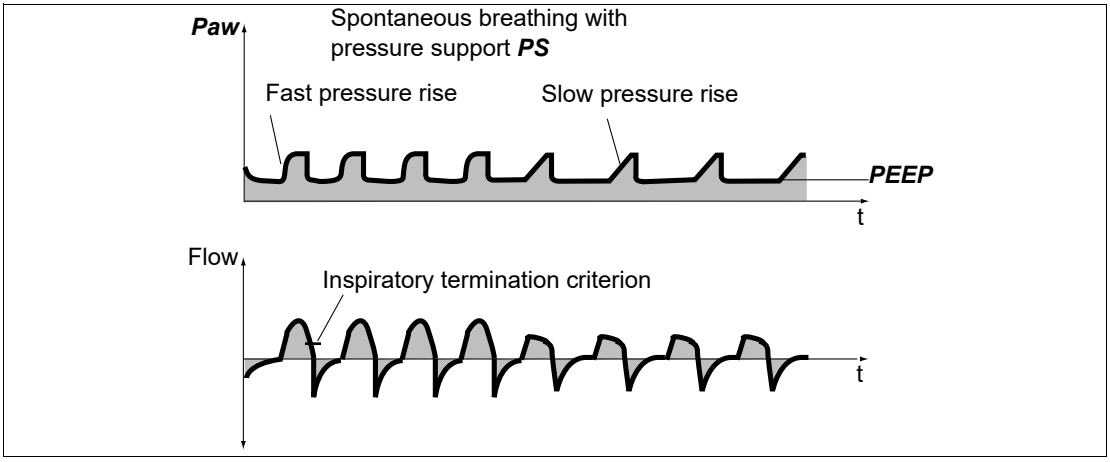
For information on flow acceleration, see page 234.

* References [2], [4], [5], [6], see page 258.

SPN-CPAP

Spontaneous-Continuous Positive Airway Pressure

Spontaneous breathing with continuous positive pressure level



When the pressure support is not switched on, the patient's spontaneous breathing is merely supported by an increased PEEP.

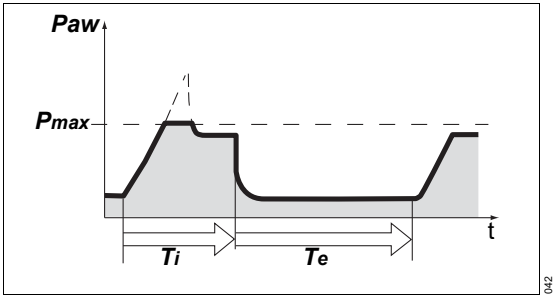
For information on pressure support, see page 234.

General ventilation functions

Flow acceleration

With the ***FlowAcc*** parameter, the pressure rise and flow increase can be modified at the start of inspiration. A greater flow acceleration results in a steeper pressure rise and flow increase. With the help of flow acceleration, the pressure waveform and the flow waveform can be adapted to the patient's needs.

Pressure limitation



When the ***Pressure limitation*** ventilation function is activated, the ***Pmax*** therapy control is active. The set tidal volume ***VT*** is maintained and pressure peaks are avoided.

The inspiratory pressure is maintained at the level of ***Pmax*** until Savina 300 has applied the set tidal volume ***VT*** or until the inspiratory time has fully elapsed.

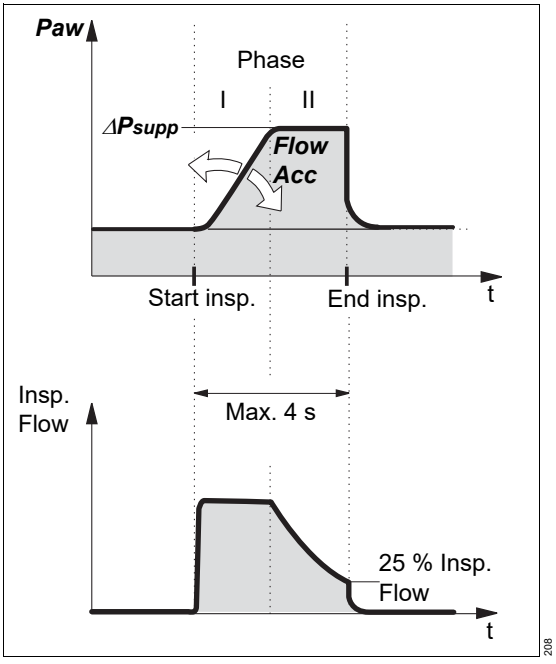
If the set tidal volume ***VT*** cannot be fully applied, an alarm message ***VT low*** is generated.

Volume-controlled ventilation without plateau

If the inspiratory pause time ***Plateau*** is deactivated, Savina 300 immediately switches to expiration as soon as the set tidal volume ***VT*** is applied. The inspiratory time ***Ti*** cannot be set, but is derived from the resistance and compliance of the patient's lungs in conjunction with the set tidal volume ***VT*** and the flow acceleration ***FlowAcc***. Savina 300 ensures a minimum expiratory time of 500 ms and limits the resulting I:E ratio to a maximum of 4:1.

Pressure support

During spontaneous breathing on PEEP level, the patient can be supported with ***PS***. Every inspiratory effort of the patient on PEEP level that meets the trigger criteria triggers a pressure-supported breath. By setting the trigger level, the patient's inspiratory efforts are synchronized. The time, number, and duration of pressure-supported breaths is determined by the patient's spontaneous breathing.



Pressure support is initiated when the flow trigger is triggered.

As in all pressure-controlled ventilation modes, the tidal volume supplied depends on the difference in pressure "P_{supp} – PEEP", the lung mechanics (resistance and compliance), and the patient's respiratory drive. The pressure rise from the lower pressure level ***PEEP*** to the upper pressure level ***Psupp*** is determined by the ***ΔPsupp*** setting.

The inspiratory flow can be adapted to the needs of the patient with the aid of the flow acceleration ***FlowAcc***.

Pressure support is terminated:

– When the inspiratory flow returns to 0 during phase I, i.e., when the patient exhales or breathes against the ventilator

  Or

– When the inspiratory flow falls below 25 % of the last delivered inspiratory flow in phase II (so that ΔP_{supp} above ***PEEP*** is reached)

  Or

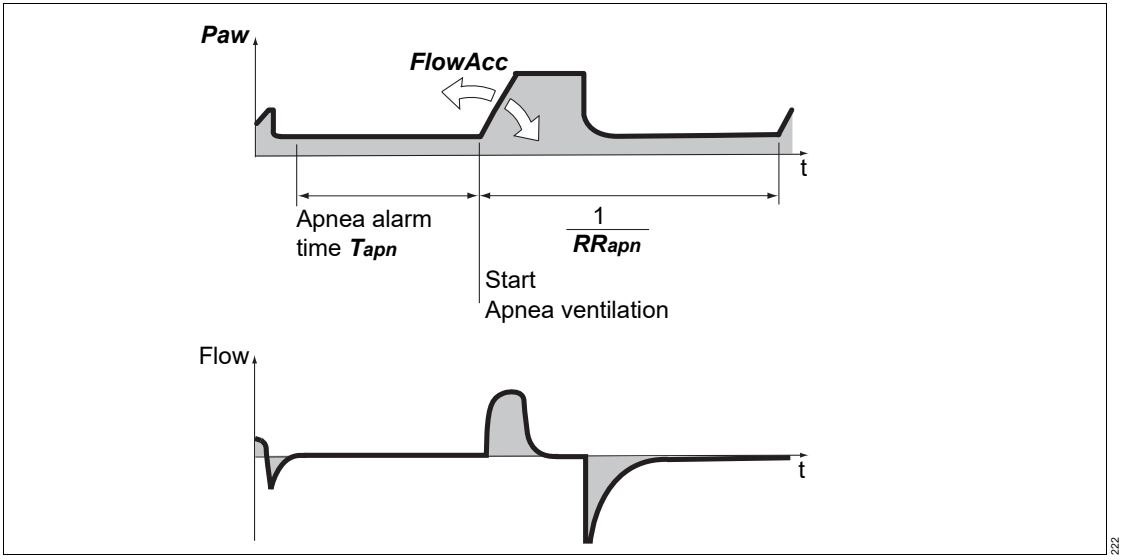
– At the latest after 4 seconds, if the two other criteria did not become effective. In this case, Savina 300 displays the low-priority alarm message ***PS breath > 4 s***. If the time is exceeded three times in succession, Savina 300 generates the low-priority alarm message ***PS breath > 4 s***.

In the ***NIV*** application mode, the maximum duration of pressure support is set using the T_i therapy control.

Additional settings

Apnea ventilation

For switching over automatically to volume-controlled mandatory ventilation in case of apnea



Apnea ventilation corresponds to the VC-SIMV ventilation mode with AutoFlow.

For Savina 300 to be able to detect apnea, flow measurement must function and flow monitoring must be activated.

Savina 300 detects apnea when no expiratory flow is measured or insufficient inspiratory gas is delivered during the set ***Tapn*** apnea alarm time. When apnea ventilation is activated, volume-controlled ventilation starts with the ***RRapn*** and ***VTapn*** ventilation parameters. The inspiratory time for apnea ventilation is determined from the set apnea respiratory rate ***RRapn*** and a fixed I:E ratio of 1:2.

The patient can breathe spontaneously and the mandatory breaths are synchronized with the patient's spontaneous breathing. The apnea respiratory rate ***RRapn*** remains constant. Savina 300 provides synchronized intermittent mandatory ventilation.

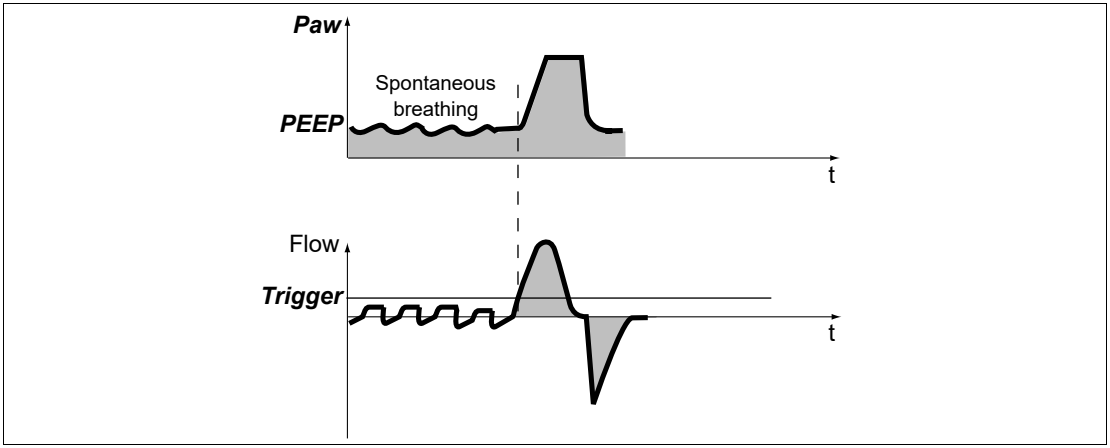
Apnea ventilation is terminated by pressing the ***Alarm reset*** key. Savina 300 continues ventilating in the previous ventilation mode. Changing the ventilation mode also terminates apnea ventilation.

If an apnea situation generating an alarm occurs again during apnea ventilation, this indicates that the apnea respiratory rate ***RRapn*** has been set too low in relation to the apnea alarm time ***Tapn***.

Flow trigger

The flow trigger is used to synchronize mandatory breaths with spontaneous breathing. The flow trigger is also used to trigger pressure support ***PS***.

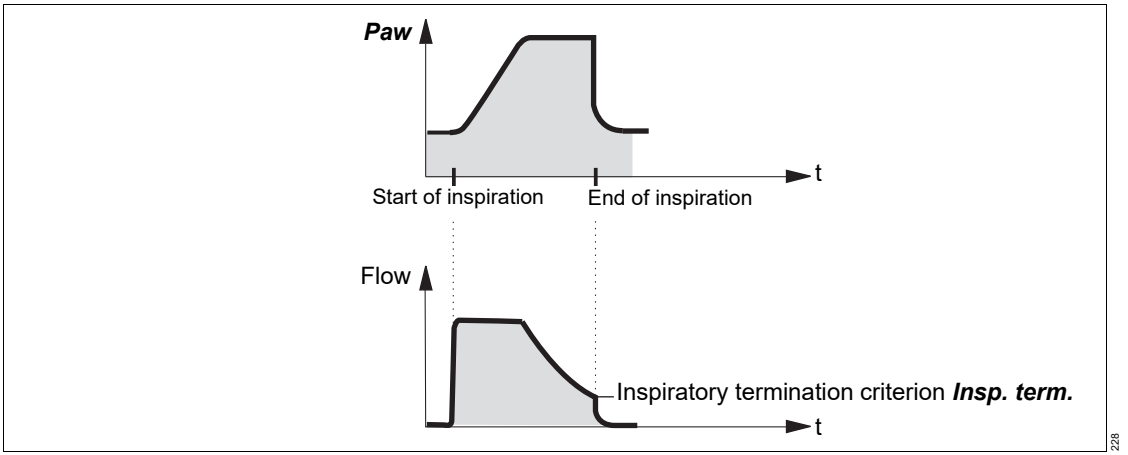
The flow trigger is triggered when the spontaneous inspiratory flow reaches the set value of the trigger threshold ***Trigger*** or when the spontaneously inspired volume exceeds 25 mL.



With the trigger threshold ***Trigger***, the mandatory breaths and pressure support ***PS*** are synchronized with the inspiratory efforts.

Spontaneous breathing activity by the patient is indicated on the screen by the brief appearance of the symbol.

Inspiratory termination



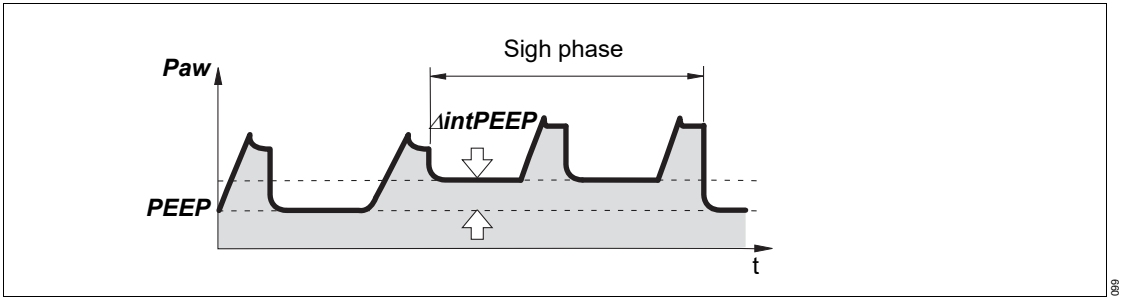
For supported spontaneous breaths, the length of inspiration is determined by the inspiratory termination criterion. Inspiratory termination specifies at which percentage of the peak inspiratory flow ***Insp. term.*** expiration is to start.

The standard setting is 25 %.

The termination criterion can be configured on the ***System setup*** > ***Ventilation*** page.

When configured, the inspiratory termination can be set with the ***Insp. term.*** therapy control in order to achieve better adaptation to the patient's lung properties and breathing pattern.

Sigh

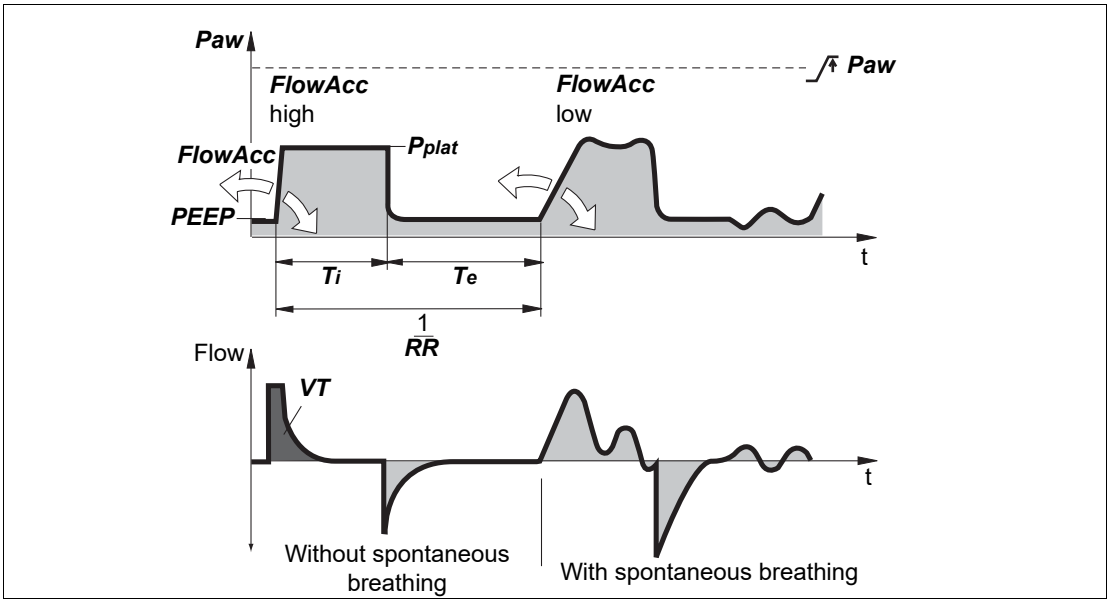


Atelectasis can be prevented by activating the sigh function and setting the sigh in the form of an intermittent PEEP. The purpose of expiratory sigh is to open collapsed areas of the lungs or to keep open slow areas of the lungs.

The sigh function can be activated in the VC-CMV/VC-AC and VC-MMV ventilation modes. When the sigh function is activated, the end-expiratory pressure PEEP increases by the set value of the intermittent pressure ***ΔintPEEP*** for 2 breaths every 3 minutes.

The average airway pressure is higher, and a usually longer filling time is available.

AutoFlow



Savina 300 provides ventilation with AutoFlow with a decelerating flow in order to avoid pressure peaks. Savina 300 determines the pressure required for the set tidal volume, taking into account the condition in the lungs (compliance, resistance) and the patient's spontaneous breathing demand.

When the patient breathes in, Savina 300 delivers an additional inspiratory flow limited by the ***VT*** alarm limit. The patient can also breathe out during the inspiratory plateau phase. Set the ***VT*** alarm limit with care in order to prevent, e.g., overinflation of the lungs following rapid changes in compliance.

The inspiratory pressure is limited by the alarm limit ***Paw***. With AutoFlow, the maximum pressure applied is limited to 5 mbar (5 cmH_2O) below the upper alarm limit ***Paw***. Always set this alarm limit in order to generate an alarm in the event of an increase in airway pressure due to reduced compliance.

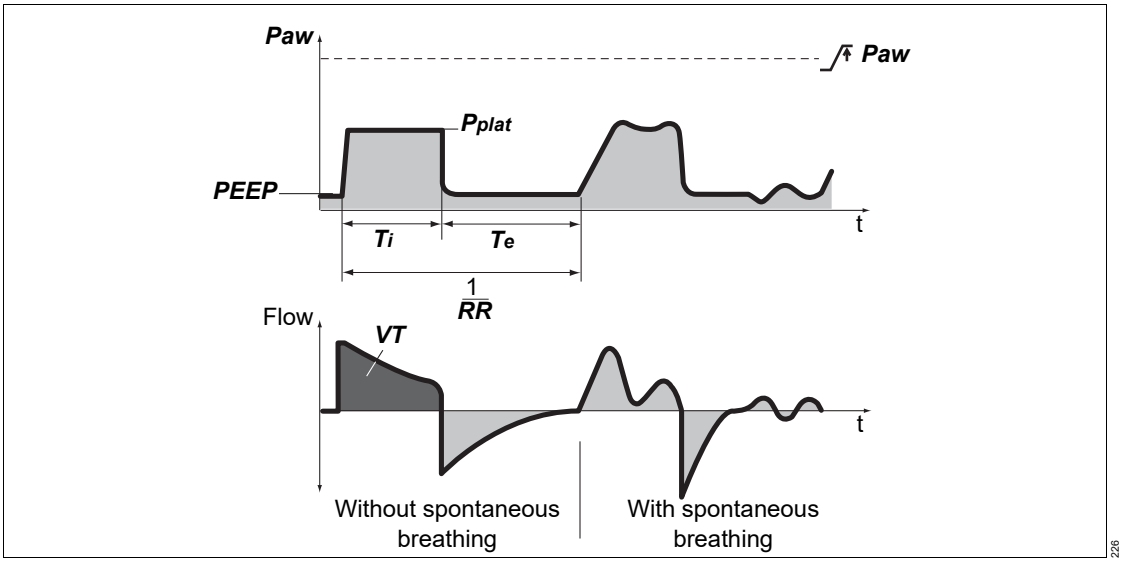
The minimum inspiratory pressure for mandatory non-triggered breaths is 5 mbar (5 cmH_2O) above PEEP, for triggered mandatory and spontaneous breaths it is 0.1 mbar (0.1 cmH_2O) above PEEP.

Typically, the selected inspiratory time ***Ti*** is much longer than the lung filling time. The inspiratory pressure ***Pinsp*** corresponds to the minimum value calculated from the tidal volume ***VT*** and compliance ***C*** of the lungs. The inspiratory flow is automatically controlled so that there is no pressure peak caused by the resistances of the tube and the airways. With AutoFlow, these fluctuations occur in increments with a maximum of 3 mbar (3 cmH_2O) between breaths.

If the tidal volume ***VT*** is reached (inspiratory flow = 0) before the inspiratory time ***Ti*** has fully elapsed, the control system for the inspiratory valve and expiratory valve ensures that the patient can breathe in and out during the remaining inspiratory time, even when the plateau pressure ***Pplat*** is constant. If the patient breathes in or out during mandatory inspiration, the plateau pressure is not changed for the duration of this breath. Only the inspiratory and expiratory flows are adapted to the patient's demand. The applied tidal volume ***VT*** may deviate from the set tidal volume ***VT*** in individual breaths. However, as an average over time, a constant tidal volume ***VT*** is supplied.

Exceeding the tidal volume ***VT*** can be limited by the ***VT*** alarm limit. If the set alarm limit is exceeded once, Savina 300 generates a low-priority alarm message (!). If it is exceeded three times in succession, Savina 300 generates a high-priority alarm message (!!!). Tidal volume is actively limited to the value of the alarm limit ***VT*** by switching to PEEP level.

Set the ***MV*** and ***MV*** alarm limits appropriately in order to avoid insufficient or excessive ventilation caused by rapid changes in compliance. When using AutoFlow, activate flow monitoring!



A set inspiratory time ***Ti*** shorter than the lung filling time can be recognized from the flow waveform. The flow at the end of the inspiratory time has not returned to baseline. In this case, it must be decided whether the current condition of the patient permits prolongation of the inspiratory time ***Ti*** or an increase in flow acceleration ***FlowAcc*** in order to reduce peak pressure even further. This effect can also be caused during ventilation, e.g., due to a build-up of secretions. In this situation, the pressure is limited by Savina 300 as described. If the set tidal volume ***VT*** can no longer be fully applied as a result, the low-priority alarm message ***VT low*** is generated.

The pressure rise from the PEEP level to the inspiratory level can be even more closely adapted to the needs of the patient in the VC-CMV, VC-SIMV, PC-BIPAP and SPN-CPAP ventilation modes via the ventilation parameter ***FlowAcc***.

Start-up procedure with AutoFlow

When ***AutoFlow*** is switched on, Savina 300 applies the set tidal volume ***VT*** by means of a volume-controlled breath. The plateau pressure ***Pplat*** calculated for this breath serves as the start value for inspiratory pressure for the ***AutoFlow*** function.

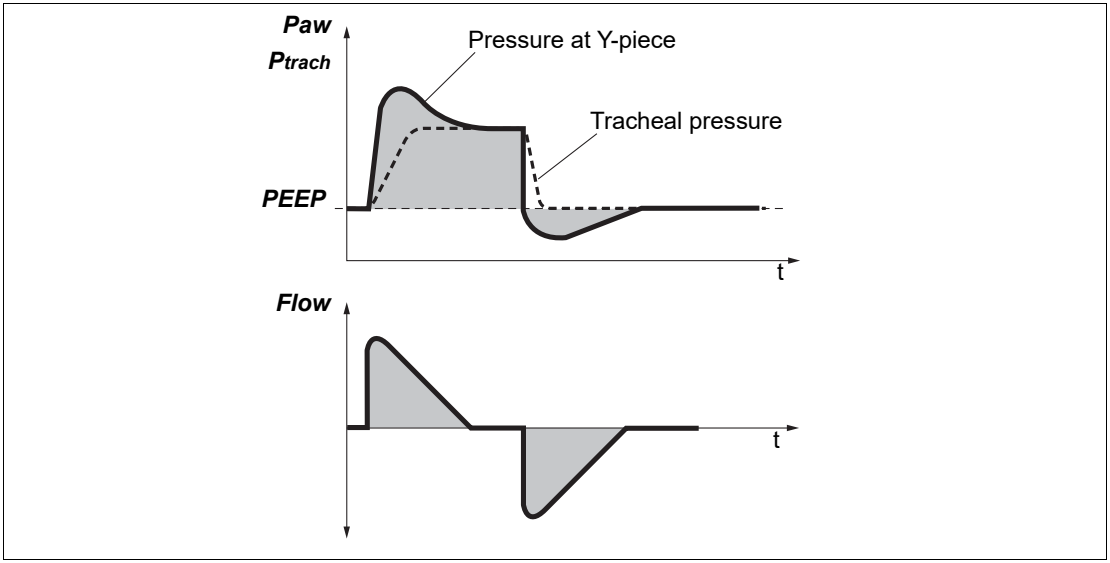
The start of mandatory inspiration can be synchronized with the patient's inspiratory efforts by means of the variable flow trigger.

The flow trigger can only be deactivated in the ***VC-CMV*** ventilation mode.

Tube compensation (ATC)

Automatic Tube Compensation

Automatic tube compensation



Automatic tube compensation regulates the airway pressure to the tracheal level. This function calculates and displays the tracheal pressure on the basis of a mathematical tube model, the set tube type and the inner diameter of the tube.

When tube compensation is activated, the tracheal pressure is displayed in the pressure waveform together with the pressure at the Y-piece as a line. The header bar displays the text ***ATC*** and the inner diameter. For loops, the tracheal pressure can be selected as a parameter.

Calculating the tracheal pressure

Savina 300 calculates the tracheal pressure on the basis of a square function of tube resistance and patient flow.

$P_{Trachea} = Paw - K_{Tube} \times Flow \times |Flow|$

$P_{Trachea}$	Pressure in the trachea
Paw	Pressure at the Y-piece of the breathing circuit
K_{Tube}	Tube coefficient (see the table on page 243)
Flow	Patient flow Inspiration: Flow >0 Expiration: Flow <0
|Flow|	Amount of flow

The selected tube type and the inner diameter of the tube must correspond with the real tube for the tracheal pressure to be calculated and displayed correctly. This is required for correct tube compensation.

When tube compensation is activated, the ventilation pressure in the breathing circuit is increased during inspiration or decreased during expiration.

Tube compensation is inactive during volume-controlled inspiratory phases without AutoFlow.

When tube compensation is activated, Savina 300 controls the ventilation pressure so that the resistive work of breathing on the tube is compensated.

Depending on the direction of the patient flow, the airway pressure is increased during inspiration or decreased during expiration.

The airway pressure can be reduced to a minimum of 0 mbar (0 cmH_2O).

When the ***Pressure limitation*** ventilation function is disabled, the maximum pressure is limited to 5 mbar (5 cmH_2O) below the ***Paw*** alarm limit. The message for the pressure limit appears when the maximum permitted values are reached.

If the value selected for ***Paw*** or ***Pmax*** is too low, it may impair the effectiveness of tube compensation. If the value selected for ***Paw*** or ***Pmax*** is too high, it may result in unwanted high airway pressures.

When setting ***Pmax***, be aware that this value may actually be reached in contrast to the value for ***Paw***.

Calculating the support

The applied support ΔPaw is calculated on the basis of a square function of tube resistance and patient flow.

$$\Delta Paw = K_{Tube} \times Flow \times |Flow|$$

K_{Tube}	Tube coefficient (see the table on page 243)
Flow	Patient flow
|Flow|	Amount of flow

Tube coefficient

The tube coefficient K_{Tube} is largely determined on the basis of the measurement results obtained by Guttmann et al*.

The values for the tube coefficients are shown in the following tables.

* Reference [7], see page 258

Table for endotracheal tube:

Inner diameter of the tube (mm)	**Tube coefficient K_{Tube} (mbar/L^2/s^2)**
3.50	170.00
4.00	100.00
4.50	50.00
5.00	30.96
5.50	23.70
6.00	17.21
6.50	13.05
7.00	10.56
7.50	8.41
8.00	6.57
8.50	5.17
9.00	4.29
9.50	3.80
10.00	3.50
10.50	3.00
11.00	2.50
11.50	2.00
12.00	1.50

Table for tracheostomy tube:

Inner diameter of the tube (mm)	**Tube coefficient K_{Tube} (mbar/L^2/s^2)**
3.50	170.00
4.00	100.00
4.50	50.00
5.00	30.96
5.50	15.40
6.00	10.00
6.50	7.90
7.00	6.38
7.50	5.20
8.00	4.50
8.50	3.70
9.00	2.95
9.50	2.65
10.00	2.50
10.50	2.05
11.00	1.65
11.50	1.35
12.00	1.10

Therapy types and application modes

O_2 therapy

O_2 therapy can be used for patients with independent breathing. The continuous flow is applied via an oxygen mask, a hood or nasal cannula. The O_2 concentration and the flow can be adjusted.

Non-invasive ventilation (NIV)

Non-invasive ventilation by mask for patients with spontaneous breathing

Leakages are greater with non-invasive ventilation than with invasive ventilation. Savina 300 takes into account the leakages in the ***NIV*** application mode accordingly. The inspiratory trigger is automatically adapted to the measured leakage. This prevents auto-triggering due to a flow trigger which has been set too low and prolonged inspirations.

The inspiratory tidal volume is typically far higher than the patient's tidal volume. The expiratory tidal volume is slightly lower than the patient's tidal volume. The measured values for tidal volume are leakage-corrected and indicate the patient's actual tidal volume. In ventilation modes with AutoFlow, the corrected measured values are set. During volume-controlled ventilation, the inspiratory volume escaping through the leakage is additionally supplied.

Monitoring during NIV

In order to prevent artifacts in the case of very high leakages, the following alarm limits may be deactivated:

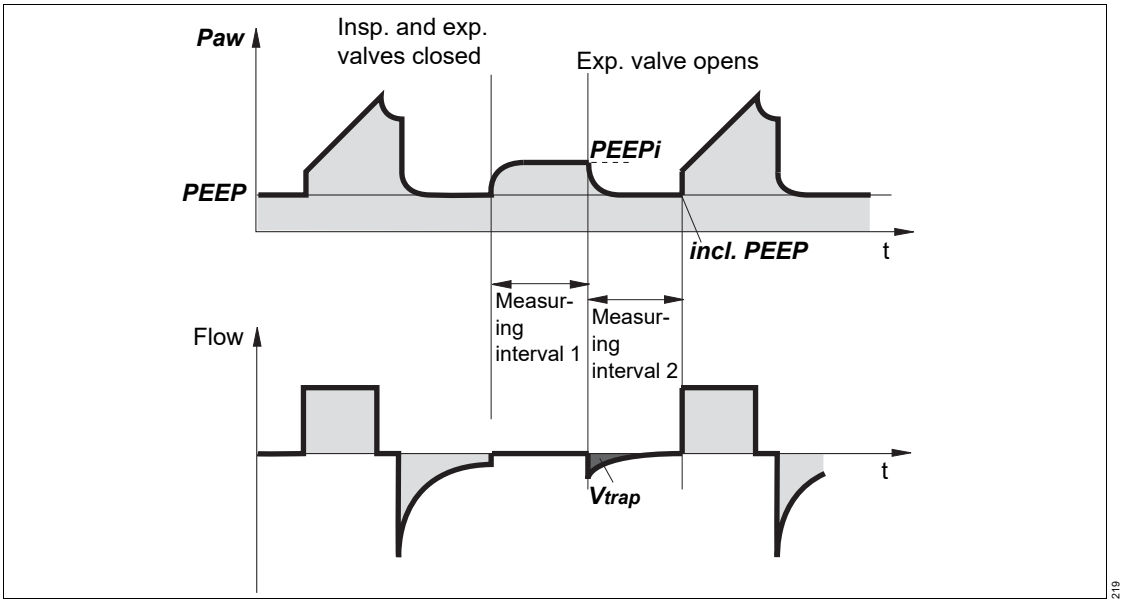
– ***$\downarrow\sqrt{}$ MV***
– ***VT***
– ***T_{apn}***

To delay the high-priority alarm message ***Airway pressure low***, the delay time ***$T_{disconnect}$*** can be set between 0 and 60 seconds for the lower alarm limit of the airway pressure.

The leakage minute volume ***MV_{leak}*** is displayed as a percentage of the measured minute volume in the ***Trends/Data*** dialog window. The tidal volume ***VT*** indicates the volume actually reaching the patient. ***VT*** is the delivered tidal volume minus the volume lost through leakage during inspiration.

Special maneuvers

Intrinsic PEEP – PEEPi



Intrinsic PEEP is the actual end-expiratory pressure in the lungs. Owing to dynamic influences of the lung mechanics (resistance, compliance, closing volume) and the ventilation setting parameters, Intrinsic PEEP may deviate from PEEP in the upper airways.

This measurement maneuver also measures the "trapped" volume ***Vtrap*** in the lungs, which does not participate in gas exchange.

Intrinsic PEEP is measured in two phases. Savina 300 keeps the inspiratory and expiratory valves closed during measuring interval 1. This ensures that it is impossible for gas to flow into the breathing circuit or escape from it. During this measuring interval, pressure is equalized between the lungs and the breathing circuit. Savina 300 measures this pressure progression.

Measuring interval 1 is terminated:
- when no pressure changes are detected any longer, but at the earliest after 0.5 seconds.
- depending on the selected breathing circuit at the latest after:
  - 3 seconds for ***22 mm Adult***
  - 1.5 seconds for ***15 mm Pediatric***

The start value corresponds to PEEP and the value at the end of the measuring interval is the Intrinsic PEEP. At the end of measuring interval 1, Savina 300 opens the expiratory valve and, in measuring interval 2, measures the expiratory flow generated by Intrinsic PEEP. During this period, lung pressure is allowed to decrease to PEEP level. At the end of measuring interval 2, the PEEP is measured and displayed as measured value ***incl. PEEP***.

Measuring interval 2 is terminated:
– when the expiratory flow has returned to 0, but after 0.5 seconds at the earliest.
– depending on the selected breathing circuit at the latest after:
  – 7 seconds for ***22 mm Adult***
  – 3.5 seconds for ***15 mm Pediatric***

The integrated flow corresponds to the volume trapped in the lungs ***V_{trap}*** by Intrinsic PEEP.

Low Pressure Oxygen (LPO)

LPO mode provides the option of supplying Savina 300 from external low-pressure oxygen sources, such as an O_2 concentrator. Savina 300 can thus be supplied with oxygen independently from a central gas supply system. The required oxygen is supplied by the O_2 concentrator.

The O_2 flow from the O_2 concentrator is fed directly into the mixing chamber via the LPO inlet valve on the rear of Savina 300. In the mixing chamber, a mixture of oxygen and air is formed, which is then delivered to the patient.

FiO_2 monitoring in LPO mode

The gas mixture is drawn from the mixing chamber in synchrony with the ventilator-delivered breaths. The oxygen from the O_2 concentrator, however, is fed at a constant flow. This leads to a varying O_2 concentration in the mixing chamber, which depends on the following factors:
– Ventilation settings
– Lung parameters
– Flow from O_2 concentrator (LPO flow)

The resulting range of variation is indicated as an additional tolerance (±) in the parameter field for ***FiO_2***. With small tidal volumes, the tolerance is small and with larger tidal volumes, it is correspondingly greater.

O_2 calibration in LPO mode

Calibration of the O_2 sensors is carried out in LPO mode in ambient air at approx. 21 Vol% O_2. This O_2 concentration depends on the humidity and temperature of the air. As Savina 300 does not measure the humidity of the ambient air, calibration is carried out under the following assumptions:
– Temperature = 25 °C (77 °F)
– Relative humidity = 50 %

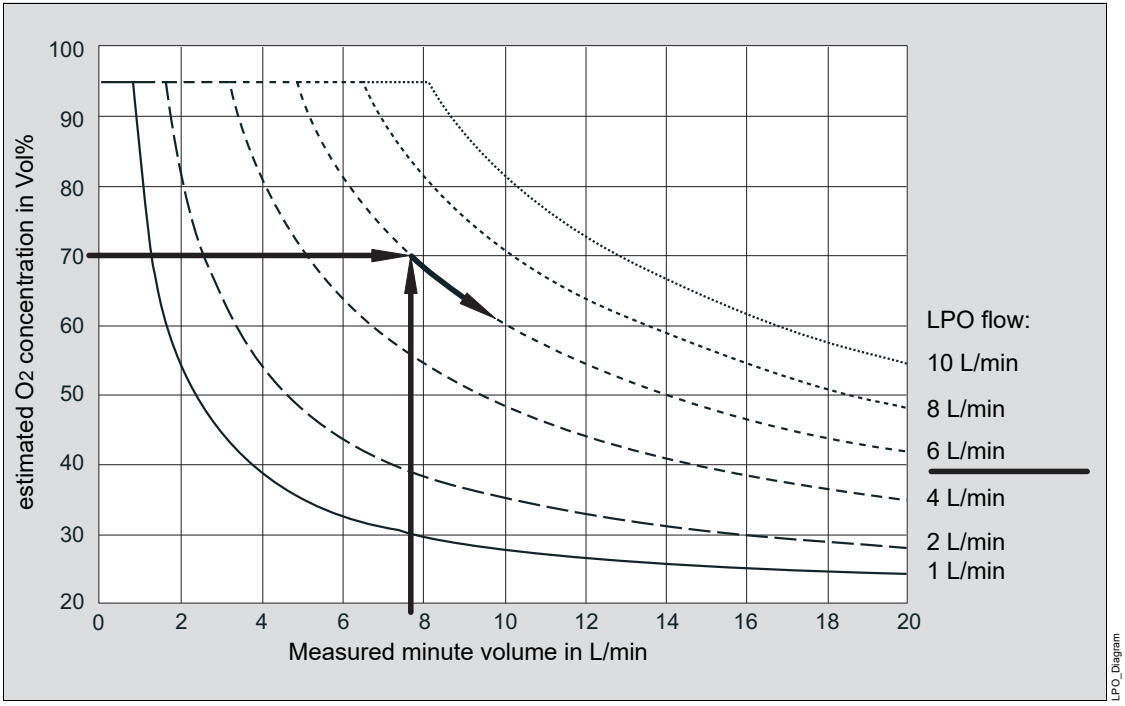
If the ambient conditions at the time of calibration differ from these figures, a calibration error occurs. This calibration error is taken into account in the FiO_2 measured value tolerance displayed.

In the case of extreme ambient conditions at the time of calibration, the calibration error may be unacceptable. Calibration must be carried out in HPO mode with 100 Vol% O_2 from the central gas supply system or a compressed O_2 cylinder.

LPO flow setting diagram

The O_2 concentration for the patient depends on the flow of the O_2 concentrator (LPO flow) and the applied minute volume (MV). The following diagram provides a rough estimate.

For the actual O_2 concentration for the patient, refer to the measured values displayed on the device.



Example:

What flow has to be set on the O_2 concentrator in order to attain the desired O_2 concentration FiO_2 of 70 Vol% at a minute volume MV of 7.8 L/min?

Read off from the diagram:

Intersection of MV = 7.8 L/min and FiO_2 = 70 Vol%

Result: LPO-Flow = 6 L/min

Setting recommendation:

For adult patients, start with an LPO flow of approx. 4 L/min. For pediatric patients, start with an LPO flow between approximately 1 L/min and 2 L/min.

Observe the measured FiO_2 values for approx. 30 to 60 seconds and adapt the LPO flow if necessary:

– If the FiO_2 value is too low, set a higher value for the LPO flow.
– If the FiO_2 value is too high, set a lower value for the LPO flow.

Automatic leakage compensation

The automatic leakage compensation feature of Savina 300 ensures that ventilation is adapted to the new conditions after a few breaths in the case of leakage changes.

In ***Tube*** application mode, leakage compensation can be activated or deactivated. In ***NIV*** application mode, leakage compensation is always activated.

Mode of operation

Savina 300 determines the difference between the delivered inspiratory flow and the measured expiratory flow. This difference provides a measure of the amount of leakage and is displayed by Savina 300 as the leakage minute volume ***MV$_{leak}$*** in percent.

Performance characteristics of leakage compensation

- Correction of the flow trigger and the termination criterion
- Compensation of volume losses during delivery of the tidal volume ***VT***
- Maintenance of the inspiratory and expiratory airway pressure during pressure-controlled ventilation and volume-controlled ventilation with AutoFlow
- Correction of the measured ***VT*** value and the waveforms for flow and volume

Flow trigger and termination criterion

The inspiratory trigger threshold and the termination criterion are continuously corrected by the determined leakage flow value. Auto-triggering is prevented and manual adjustment of the trigger threshold minimized.

Tidal volume *VT*

During volume-controlled ventilation, Savina 300 supplies additional volume in order to compensate the leakage. Unlimited volume compensation would however be inappropriate. Savina 300 compensates for losses of up to 100 % of the set tidal volume ***VT***.

Airway pressure

For pressure-controlled breaths, e.g., in PC-BIPAP, SPN-CPAP and AutoFlow, the flow is corrected so that the set pressure levels are maintained. Leakages are compensated up to the maximum flow the turbine can deliver.

Patient monitoring

The following measured values are displayed after correction for leakage:
- VT, VT$_{spon}$, Flow$_{ipeak}$
- Flow and volume waveforms

The following purely expiratory measured values are displayed without correcting for leakage:
- VT$_{e}$, MV, MV$_{spon}$

Leakage compensation with and without AutoFlow

The tidal volume ***VT*** is leakage-compensated, regardless of whether AutoFlow is activated or deactivated. When AutoFlow is deactivated, volume loss due to leakage occurs during the inspiratory pause and the plateau pressure ***P$_{plat}$*** falls as a result. When AutoFlow is activated, the plateau pressure and the delivered tidal volume ***VT*** are maintained.

Specification of compensation ranges according to ventilation mode

The following table shows the leakage compensation ranges for the individual ventilation modes.

Application mode	**NIV**	**Tube[1)]**	**NIV**	**Tube[1)]**	**Tube[2)]**
Ventilation mode	**PC-AC, PC-BIPAP, PC-APRV, SPN-CPAP**		**VC-CMV, VC-AC, VC-SIMV, VC-MMV**		**All**
Flow trigger and termination criterion	Unlimited		Up to 25 L/min		Up to 10 L/min
Delivered tidal volume	-		Up to 100 % of the set VT		None
Airway pressures: – PEEP, P_{insp}, P_{high}, P_{low}, ΔP_{supp} – P_{insp}/P_{plat} (when AutoFlow is activated)	Unlimited		Unlimited		Unlimited
Measured flow and volume values: – VT, VT_{spon}, $Flow_{ipeak}$ – Flow and volume waveforms	Unlimited		Up to 25 L/min		None
Expiratory measured values: – VT_e – MV – MV_{spon}	None		None		None

1) Leakage compensation is activated.
2) Leakage compensation is deactivated.

Monitoring of leakages

If Savina 300 detects a significant leakage in the ***Tube*** application mode, the low-priority alarm message ***Leakage*** is displayed. In this case, the breathing circuit and the tube must be checked for leakages.

Measurements

Flow measurement

Adaptation to ambient conditions

The volume of a gas depends on the ambient conditions with regard to temperature, pressure, and humidity. In lung physiology, reference is made to the conditions inside the lung for the values of minute volume and tidal volume: 37 °C (99 °F) body temperature, pressure inside the lungs, 100 % rel. humidity.

Measured values for flow and volume under these conditions are characterized as BTPS. Medical gases from cylinders or from a central gas supply system are dry (approx. 0 % rel. humidity) and are supplied by the ventilator at 20 °C (68 °F) and 1013 mbar (1013 cmH_2O). Measured values for flow and volume under these conditions are characterized as NTPD.

The difference between values measured as NTPD and BTPS is approx. 12 % at a pressure of 1013 mbar (1013 cmH_2O).

Example: 500 mL tidal volume NTPD become 564 mL BTPS when warmed to 37 °C (99 °F) and humidified to 100 % rel. humidity.

Savina 300 controls tidal volume in such a way that the set tidal volume value is applied under BTPS conditions in the lungs.

The expiratory measurement is performed on the basis of saturated gases at 30 °C (86 °F).

CO_2 measurement

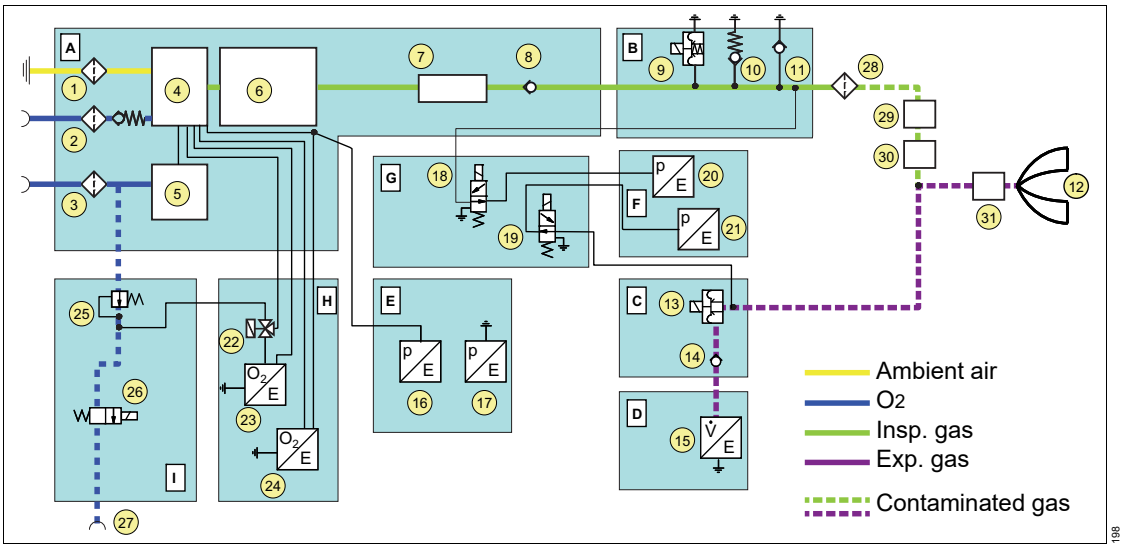
CO_2 measurement is performed using mainstream sampling with a sampling rate of 20 ms and is based on an absorption measurement.

A light source generates a spectrum. Two light detectors record the characteristic absorption spectrum and supply electrical signals that depend on the CO_2 concentration.

These signals are then evaluated and displayed. Heating the CO_2 measurement unit prevents condensation.

Pneumatic functional description

Pneumatic diagram of Savina 300



1 Gas inlet for ambient air with microfilter

2 Gas inlet LPO with filter and return valve

3 Gas inlet HPO with filter

4 Mixing chamber

5 O_2 metering unit

6 Turbine with flow metering

7 Flow measurement

8 Return valve

9 Safety valve

10 Pressure-limiting valve

11 Emergency breathing valve

12 Patient's lung

13 Expiratory valve

14 Return valve

15 Expiratory flow sensor

16 Barometric pressure sensor 1

17 Barometric pressure sensor 2

18 Calibration valve for inspiratory pressure sensor

19 Calibration valve for expiratory pressure sensor

20 Inspiratory pressure sensor

21 Expiratory pressure sensor

22 Calibration valve O_2 sensor 1

23 O_2 sensor 1

24 O_2 sensor 2

25 Pressure regulator O_2

26 Nebulizer switching valve

27 Nebulizer outlet

28 Bacterial filter

29 Breathing gas humidifier

30 Medication nebulizer

31 CO_2 measurement

A Gas mixing and gas delivery assembly

B Inspiratory unit assembly

C Expiratory valve assembly

D Expiratory flow sensor

E Barometric pressure measurement assembly

F Airway pressure measurement assembly

G Calibration assembly

H O_2 measurement assembly

I Medication nebulization assembly

Description of pneumatic functions

Savina 300 consists of 9 pneumatic assemblies.

The **gas mixing and gas delivery** assembly (A) delivers a gas mixture flow that varies over time with adjustable portions of ambient air and high pressure O_2 (HPO). Oxygen from the (central) gas supply enters the device through the gas inlet connection for HPO and the subsequent filter (3) and is delivered by the O_2 delivery unit (5) in accordance with the selected concentration. Ambient air is drawn in through the microfilter (1). If a low-pressure O_2 source (LPO, e.g., an O_2 concentrator) is used, the low-pressure oxygen flow is directed into the device through the filter (2) and a return valve.

The gases mix in the mixing chamber (4). The turbine assembly with integrated flow metering (6) draws the gas mixture out of the mixing chamber and directs it through a flow measurement (7) with a downstream return valve (8) into the inspiratory unit (B).

The **inspiratory unit** assembly (B) consists of the safety valve (9) and two return valves, the pressure limiting valve (10) and emergency breathing valve (11). The safety valve is closed during normal operation, so that the inspiratory flow moves from the gas mixing and gas delivery assembly (A) to the patient (12). In other modes, the emergency breathing valve (11) permits spontaneous inspiration. The pressure limiting valve (10) limits the maximum airway pressure under any conditions to a maximum of 120 mbar. The safety valve (9) is opened when a detected stenosis prevents a pressure relief in the expiratory limb. In that case, the required (external) bacterial filter (28) on the inspiratory port prevents contamination of the inspiratory unit (B).

The **expiratory valve** assembly (C) consists of the expiratory valve (13) and a return valve (14). The expiratory valve is a proportional valve used to adjust the pressure in the breathing system. The return valve (14) works with the spring-loaded valve in the pressure limiting valve (10) to prevent pendulum breathing during spontaneous breathing. The **expiratory flow sensor** (D) (15) measures the expiratory flow using the metrological principle of hot wire anemometry. The measured flow is thus a mass flow (NTPD). The expiratory valve assembly and the expiratory flow sensor can be removed from Savina 300 for cleaning.

To convert the mass flow into a volume flow (BTPS), it is necessary to know the ambient pressure. The ambient pressure is measured in the **barometric pressure measurement** assembly (E). This measurement is carried out by the independent sensors (16) and (17), with sensor (16) measuring the barometric pressure in the mixing chamber.

The pressure in the breathing system is also measured with two independent pressure sensors (20) and (21). Together, these constitute the **pressure measurement** assembly (F). The pressure sensors are zero calibrated periodically. To do this, the pressure sensors are vented to the ambient air through the two calibration valves (18) and (19). Together, they constitute the **calibration** assembly (G).

The **O_2 measurement** assembly (H) measures the inspiratory O_2 concentration using two redundant sensors (23) and (24) based on a side stream measurement principle. O_2 sensor 1 (23) with upstream calibration valve (22) permits automatic calibration to 100 Vol% O_2 during operation. The calibration of O_2 sensor 2 (24) to 100 Vol% O_2 must be done by manually switching to an inspiratory O_2 concentration of 100 Vol%.

For medication nebulization a pneumatic medication nebulizer (30) can be connected to the nebulizer gas outlet (27). Savina 300 provides a flow from the HPO supply to drive the medication nebulizer. The upstream pressure regulator (25) throttles the variable oxygen supply pressure to a constant value for delivery. The nebulizer switch valve (26) closes the nebulizer gas outlet when the nebulizer function is not activated. The pressure regulator and nebulizer switch valve constitute the **medication nebulization** assembly (I).

Overview of the menu structure

The following tables list the grouped buttons of the main menu bar with the resulting dialog windows of the same name and the tabs. For information on operation, see "Operating concept" on page 35.

Group ⚠

Button in main menu bar	Horizontal tab	Vertical tab	Functions
Alarms...			Alarms

Group ◎

Button in main menu bar	Horizontal tab	Vertical tab	Functions
Ventilation settings...	VC-CMV/VC-AC	General settings	
		More settings	Sigh
			Flow trigger
			AutoFlow
		ATC settings	ATC
	VC-SIMV	General settings	
		More settings	Apnea ventilation
			Flow trigger
			AutoFlow
		ATC settings	ATC
	VC-MMV	General settings	
		More settings	Sigh
			Flow trigger
			AutoFlow
		ATC settings	ATC
	PC-AC	General settings	
		More settings	Sigh
			Flow trigger
		ATC settings	ATC

Button in main menu bar	Horizontal tab	Vertical tab	Functions
	PC-BIPAP	General settings	
		More settings	Apnea ventilation
			Flow trigger
		ATC settings	ATC
	PC-APRV	General settings	
		More settings	Apnea ventilation
		ATC settings	ATC
	SPN-CPAP	General settings	
		More settings	Apnea ventilation
			Flow trigger
		ATC settings	ATC

Group

Button in main menu bar	Horizontal tab	Vertical tab	Functions
Trends/Data...	Measurements		
	Settings		
	Trends		
	Logbook		

Group

Button in main menu bar	Horizontal tab	Vertical tab	Functions
Day/Night			
Freeze waveforms			

Group

Button in main menu bar	Horizontal tab	Vertical tab	Functions
Special maneuvers...			Expiration hold
			Intrinsic PEEP

Group

Button in main menu bar	Horizontal tab	Vertical tab	Functions
Sensors...	Flow		Flow sensor
	O_2		O_2 sensor
			O_2 calibration
	CO_2	Zero calib. on/off	CO_2 sensor
			CO_2 zero calibration
			Type of CO_2 cuvette
		Check sensor	Check with test filter
			Check with test gas
		Calibration	Calibration
			Reset calibration
System setup...	Ventilation		Pressure limitation
			Plateau
			LPO
			Insp. termination
			Leakage compensation ("Tube")
			T_{imax} ("Tube")
	Startup settings		Password
		Settings 1	Startup configuration
			Start values for VT, RR, FlowAcc, Trigger
			Startup mode
			Dräger default
		Settings 2	FiO_2, I:E, T_{imax}, P_{insp}, P_{max}, PEEP, ΔP_{supp}, P_{high}, P_{low}, T_{high}, T_{low}
		Settings 3	Apnea ventilation
			AutoFlow
		ATC settings	ATC
			Tube type
			Tube Ø
		Alarm settings	MV, Paw, VT, RR, T_{apn}, $etCO_2$, FiO_2
		Password	

Button in main menu bar	Horizontal tab	Vertical tab	Functions
	Device settings		Alarm volume [%]
			Brightness [%]
	Country		Language
			Date/Time
			Pressure unit
			Height unit
			CO_2 unit
	Interface		Protocol
			Baud rate
			Parity
			Stopbit
	Options		Release code
			QR code
Key lock			

Key ⏻

Key	Horizontal tab	Vertical tab	Functions
Start/Standby	Start/Standby		Therapy type
			Patient admission
			Body height and ideal body weight
			Check settings
			Start: Start ventilation or Start O_2 therapy or Standby
	Device check		Device check
	Breathing circ. check		Breathing circuit
			Breathing circuit check
	Check results		Breathing circuit check

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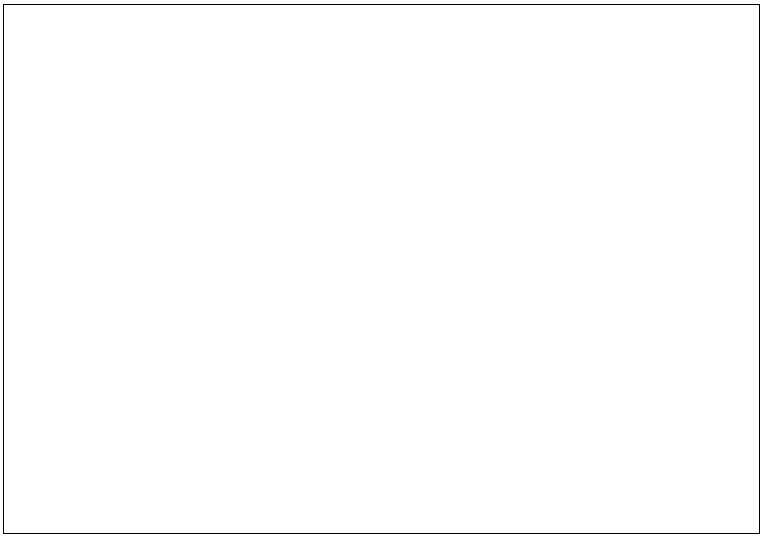
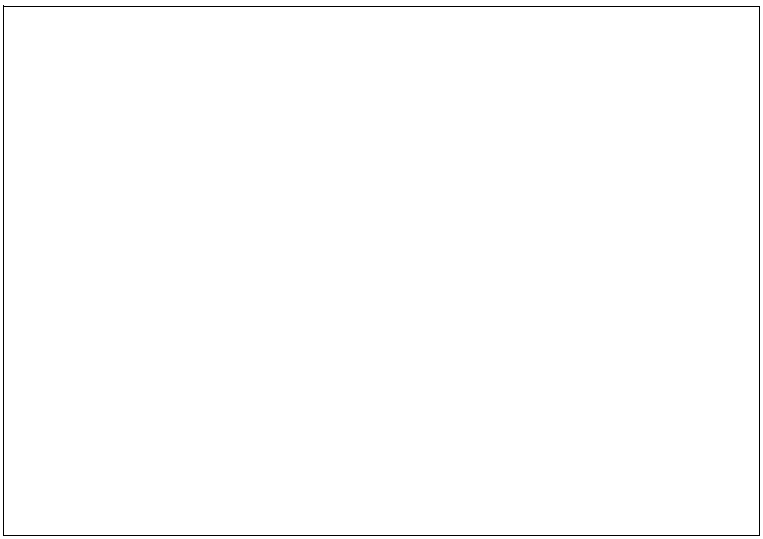
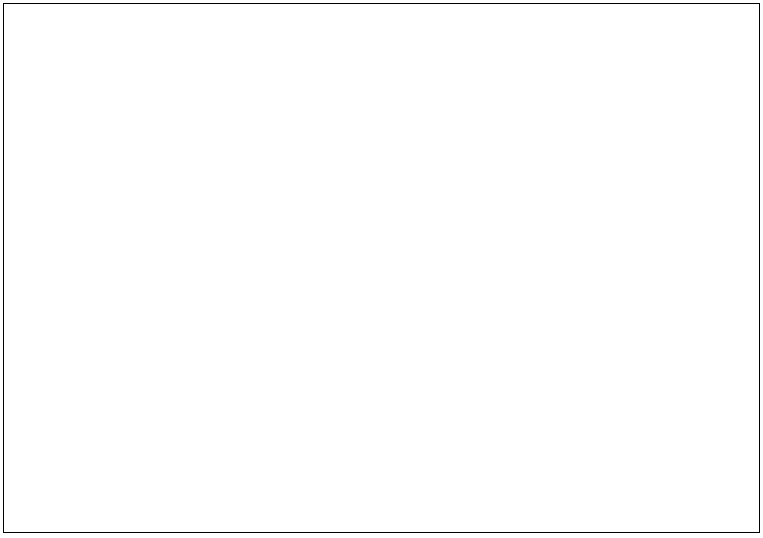
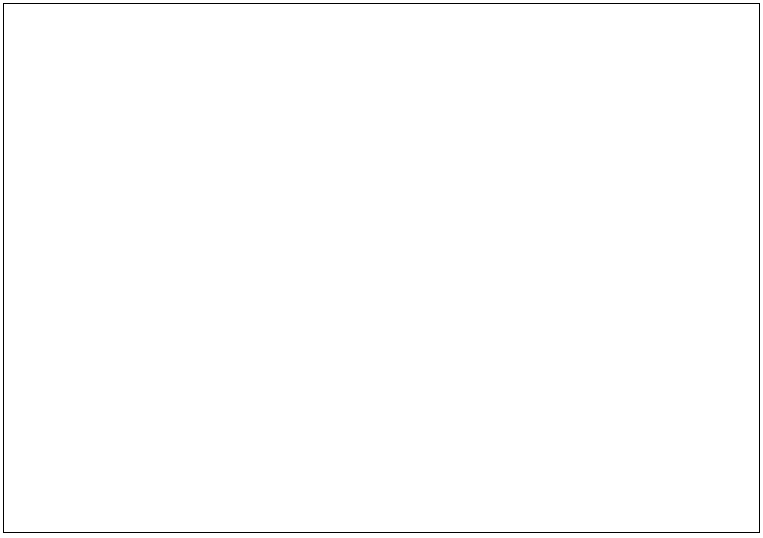
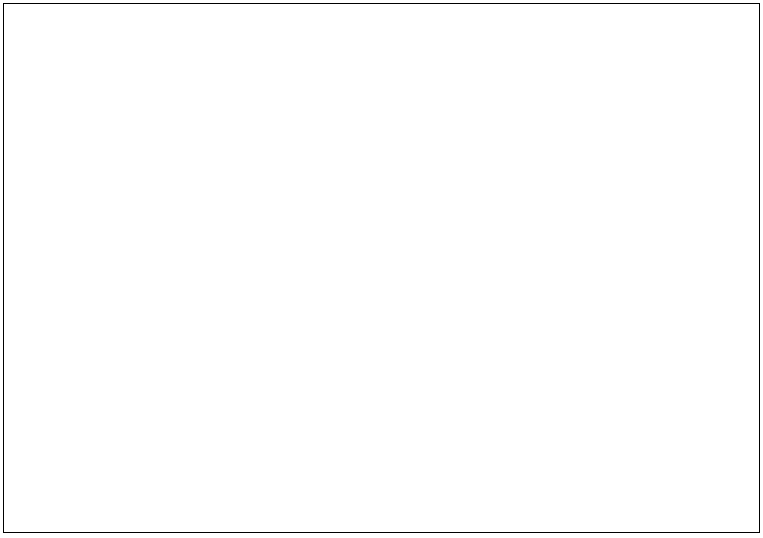
Labels for options

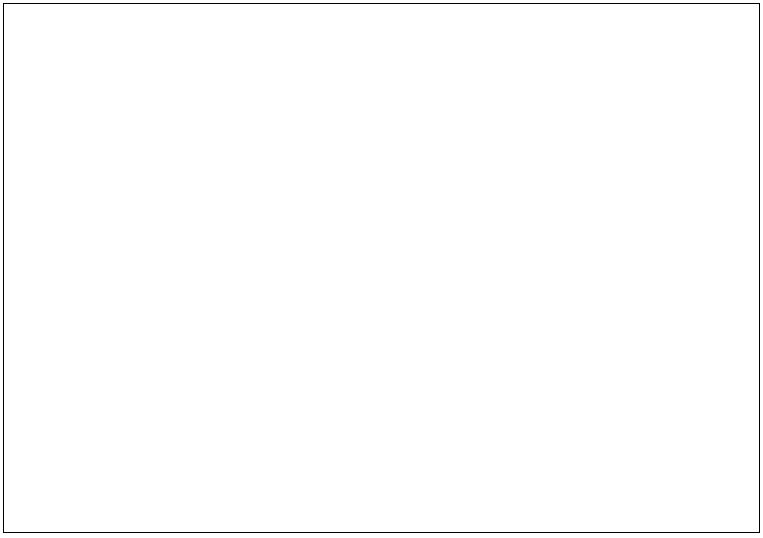


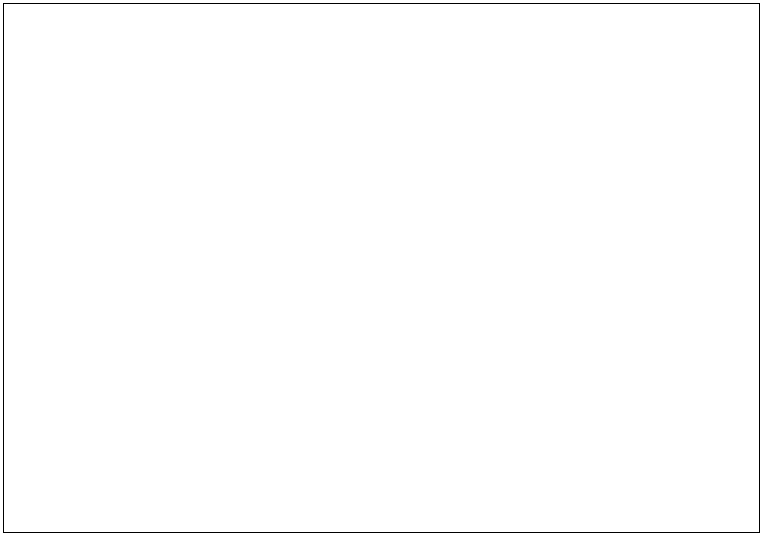


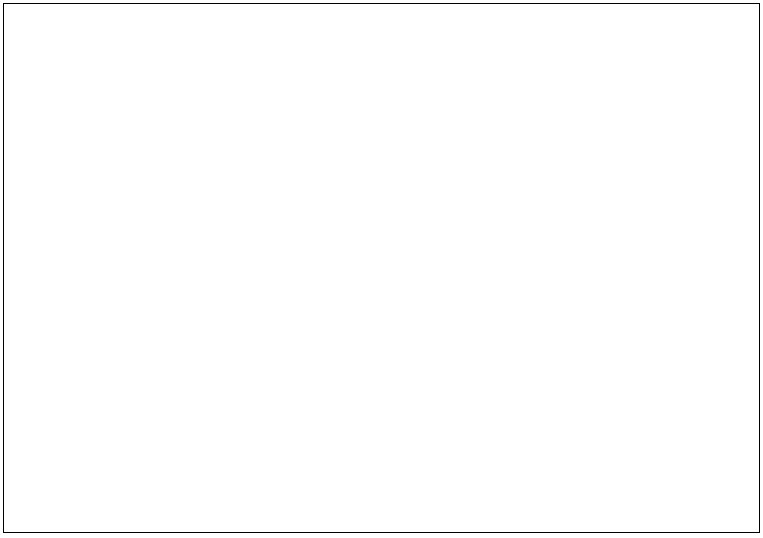












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User password for Savina 300 SW 5.n

Cut out from the instructions for use of Savina 300 SW 5.n

To prevent unauthorized adjustments, the start settings (***System setup*** > ***Startup settings***) are protected by the following default user password:

4155

Information on the user password

To prevent unauthorized adjustments, the start settings (***System setup*** > ***Startup settings***) are protected by a user password. For more information, see: "Information on the user password" on page 135.

The default user password can be found on this page of the instructions for use.

- Cut out the area containing the user password and keep it in a safe place protected against access by unauthorized persons.

The user password can only be reset by specialized service personnel.

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These instructions for use only apply to
Savina 300 SW 5.n
with the Serial No.:
If no Serial No. has been filled in by Dräger, these instructions for use are provided for general information only and are not intended for use with any specific medical device.
These instructions for use are provided for customer information only and are only updated or exchanged upon customer request.

CE 0123

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