INSPIRE - 100

An Emergency Ventilator Device

Troubleshooting Guide

TekMedika

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Important

Please read through and understand the accompanying Operating Manual before using this document. Many terms used in this document are explained in detail in the Operating Manual.

General Safety Guidelines

Operator Training

- Ensure proper training for staff and operator(s).
- The operator(s) must undergo proper training, understand the operational mechanism, and develop a clear understanding of crucial operations through careful reading of the operating manual.
- Familiarize operator(s) with Alarm situations.

Servicing & Testing

- Never ignore Service alerts.
- Never ignore BVM replacement alerts.
- Never bypass the built-in Pre-use checks.

Power Source

- Always plug into a UPS after checking UPS battery.
- Ensure that the AC supply is grounded.
- Use correct plug receptacle.
- Secure the power cord.

Gas Supply

- If using cylinders, ensure that the cylinder is full.
- Always Have a spare cylinder handy.
- If using an Oxygen Concentrator, ensure that it has been recently serviced.
- Never place the ventilator in a combustible environment.

Alarms

- Never ignore an alarm.
- Never mute the alarm on regular basis.
- If the reason for the alarm(s) cannot be immediately identified, begin manual ventilation until alarm(s) can be corrected.

Checking for leakages

All the components of the breathing circuit are off-the-shelf with standard industry dimensions and should fit together snugly and without any leakages. The one exception that is not off-the-shelf is the proprietary pressure connector, which also adheres to standard industry dimensions.

The operator is guided step-by-step through a leakage checking procedure at system initialization time. In addition, the system continuously monitors leakages during every delivered breath. The operator does not have to do anything special to invoke leakage checking, except to check the system if errors are detected.

During specific troubleshooting, the following possible leakage points may have to be checked carefully. Whenever possible, error messages point to specific connection points for checking.

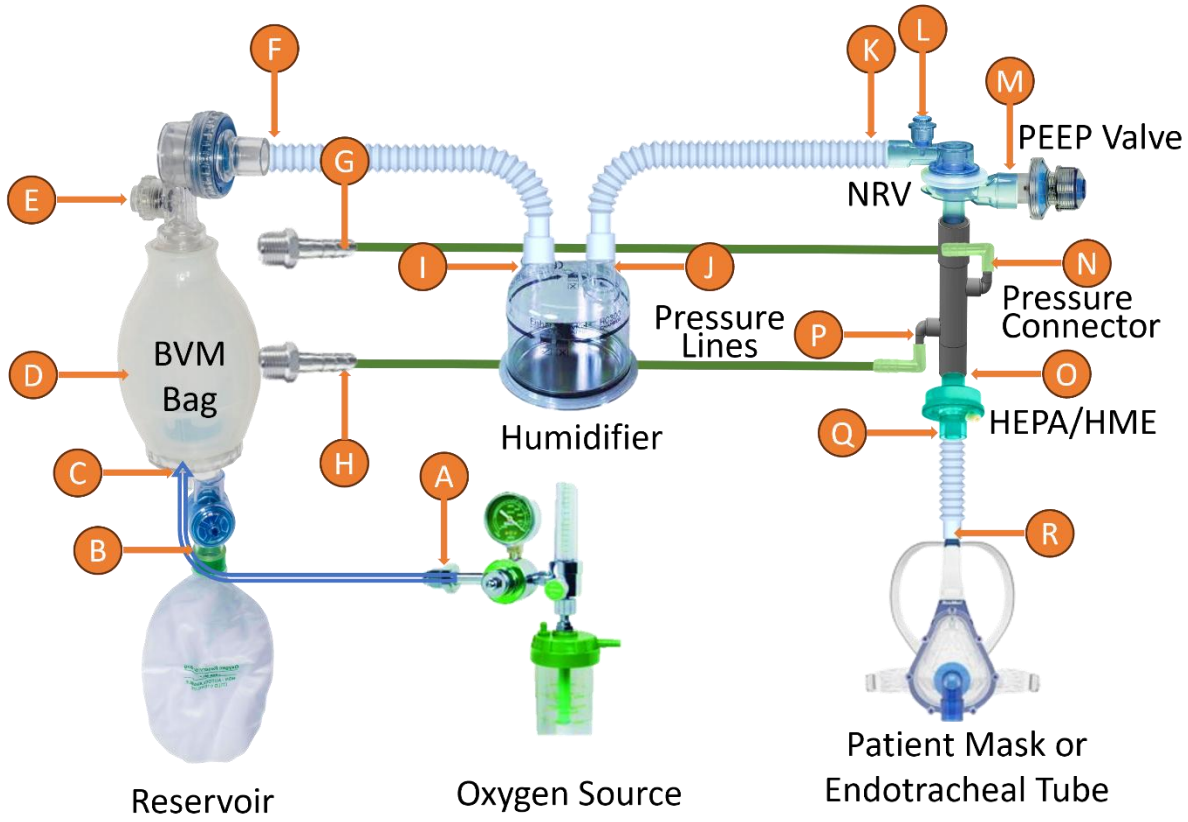
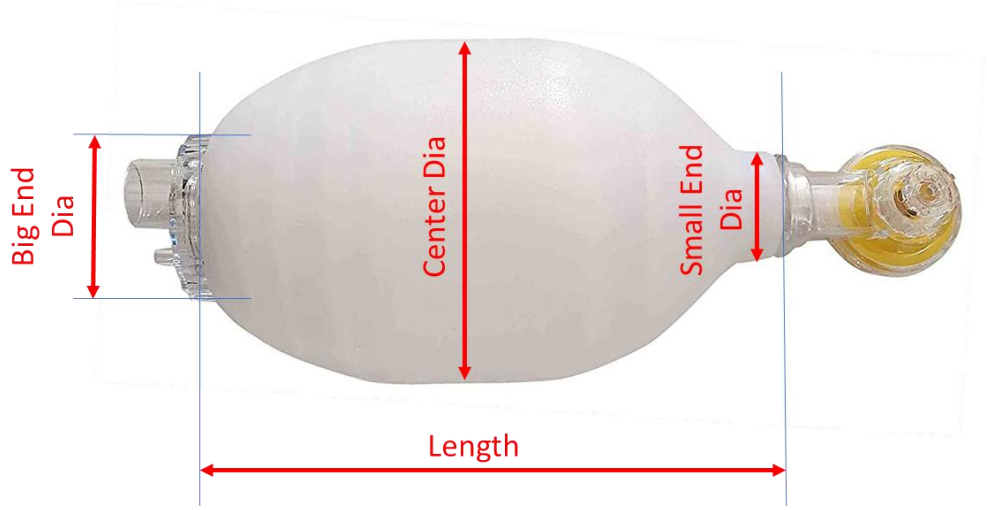


Figure 1: Possible Leakage Points

BVM (AMBU) Bag Specifications



	Units	Min	Max
Length	mm	210	215
Center Diameter	mm	115	125
Big End Diameter	mm	60	65
Small End Diameter	mm	25	30
Connector Diameter	mm	22	22
Volume	ml	1600	1800

Figure 2: BVM Bag Specifications

The INSPIRE-100 system has been tested with the BVM bag from the following manufacturer.

Adult Ambu Bag

https://surginatal.com/brands/surginatal/ambu-bag-adult?srsltid=AfmBOor4oOKlO92iFtuuhtsrghDnprUfBjnYOR0tJcpAozq-U5OqHJGZ

- Brand: SURGINATAL
- Ambu bag for fast ventilation of oxygen.
- Made of medical-grade silicone, it ensures comfort.
- Allows for manual inflation without the need for external sources.
- Comes with a connector 15mm/22mm size.
- Consists of a self-inflating bag, a one-way valve, and a mask.
- Easy to use manual oxygen reservoir bag.

Glossary of Acronyms

The table below summarizes all the abbreviations used in this document.

Symbol	Variable	Description
VT	Tidal Volume	Volume of air delivered each inspiration phase (ml)
RR	Respiratory Rate	Breaths per minute
E/I	Expiration/Inspiration ratio	Ratio of expiration vs inspiration time in a breath cycle
PMAX	Max Inspiration Pressure	MAX inspiration pressure never to be exceeded (cm H_2O)
PEAK	Peak Inspiration Pressure	Max pressure during Inspiration phase of breath delivery (cm H_2O)
PLAT	Plateau Pressure	Plateau pressure during breath delivery (cm H_2O)
PEEP	Peak End Expiration Pressure	Pressure in the lungs that exists at the end of expiration (cm H_2O)
PS	Pressure Support	Level of support pressure to assist patient-initiated (spontaneous) breaths (cm H_2O)
TPS	PS Inspiration duration	Termination of the inspiration phase for which the pressure support is to be delivered. It can be Flow controlled (%age of Peak Flow) or Time controlled (secs).
FiO_2	Fraction of Inspired Oxygen	Concentration of oxygen in the inspired air. This is guided by the system but controlled outside the system in the Oxygen source. (%age)

Troubleshooting Tips

The table starting from the next page is a list of error and warning messages issued by the system with an explanation of possible causes and possible solutions.

These messages are organized by the system state i.e. INITIAL, STANDBY, ACTIVE or ERROR.

Please consult the index at the end of this document to search for topic of interest.

Figures 1and 2 above are referred to by some messages. Please study them carefully.

During System RESET		
	Symptom	**Watchdog RESET**
	Message	<< RESTART REASON >> Watchdog RESET Report the problem Continue (YES) ?
	Possible Causes	System reset itself because of an unexpected error This is only a fail-safe scenario and should NEVER occur
	Possible Solutions	Call the Service Technician Report the problem In the meantime the system is usable starting from RESET Press YES to start initialization

During System Initialization		
	Symptom	**Supply Voltage too low**
	Message	Low Board Voltage 4.723 Volts Min 4.900 Volts Call Service Tech
	Possible Causes	Defective Power Supply - minimum required is 4.9 volts Loose Spiral Cable connection
	Possible Solutions	Call the Company Service Technician

During System Initialization		
	Symptom	**Clock Battery needs replacing**
	Message	Clock Battery needs replacing Call Service Tech Noted (YES) ?
	Possible Causes	Clock Battery too weak Not able to keep time when power is switched off
	Possible Solutions	Call the Company Service Technician Press YES to continue normal operation. It will lead to setting the current date and time.

During System Initialization		
	Symptom	**Portal does not open automatically for Patient, Location Wi-Fi networks when trying to enter Localtion, Patient or Wi-Fi information**
	Message	Connect Laptop / Phone To Wi-Fi Network INSPIRE-100 Patient .. 1 ..
	Possible Causes	Wi-Fi Access device (laptop/smartphone) not configured correctly
	Possible Solutions	Try once again Get an IT technician to configure the access device correctly Use a different access device After logging into the Patient/Location WiFi network, use a Browser and navigate to URL 192.168.1.4

During System Initialization		
	Symptom	**Unable to log into WiFi Network**
	Message	Wi-Fi Login Failed Re-enter W-Fi Credentials (YES or NO) ?
	Possible Causes	Wi-Fi Network inaccessible Incorrect WiFi password WiFi Router malfunction Broadband connection is down
	Possible Solutions	Retry the Login process - press NO Enter new WiFi credentials - press YES Reboot the WiFi router - press NO

During System Initialization		
	Symptom	**Failed to calibrate Pressure Sensors**
	Message	Pressure Sensor ZERO Calibration FAILED
	Possible Causes	The breathing tube was not open during test Pressure Sensors are defective
	Possible Solutions	Try once again starting from RESET keeping breathing tube open If the failure repeats, call the Company Service Technician

During System Initialization	Symptom	Residual Pressure Failure
	Message	FAILED because of Residual Pressure in Breathing Circuit Noted (YES)
	Possible Causes	The breathing tube was not open during test
	Possible Solutions	Try once again starting from RESET keeping breathing tube open If the failure repeats, call the Company Service Technician Pressing YES will lead to an option to retry The system will refuse to go further till this error is resolved

During System Initialization	Symptom	No Pressure during Auto-touch
	Message	FAILED - No pressure Check Pressure tubes Call Service Tech Noted (YES)
	Possible Causes	Major Leakage in the Breathing system Possible disconnect in the Breathing System Remote possibilities include motor failure or a broken belt
	Possible Solutions	Check BVM bag for wear and tear Check points E-P for leakage as shown in Figure 1 above Pressing YES will lead to an option to retry The system will refuse to go further till this error is resolved

During Pre-use Checks	Symptom	Fast Compression Failure
	Message	FAST Compression While BLOCKED FAILED Noted (YES) ?
	Possible Causes	The Breathing tube was not blocked properly Leakage in the Breathing system Defective BVM Bag – may need to be replaced
	Possible Solutions	Try again after blocking Breathing tube firmly Check points E-P for leakage as shown in Figure 1 above Pressing YES will lead to an option to retry The system will refuse to go further till this error is resolved

During Pre-use Checks	Symptom	Downstream Pressure Line Leakage
	Message	Check for Leakage(s) Downstream Pressure BVM, Breathing tubes Noted (YES) ?
	Possible Causes	The downstream pressure line has leakage BVM Bag or the breathing tube has leakage
	Possible Solutions	Check points P and H for leakage as shown in Figure 1 above Check BVM bag for wear and tear Pressing YES will lead to an option to retry The system will refuse to go further till this error is resolved

During Pre-use Checks	Symptom	Upstream Pressure Line Leakage
	Message	Check for Leakage(s) Upstream Pressure BVM, Breathing tubes Noted (YES) ?
	Possible Causes	The upstream pressure line has leakage BVM Bag or the breathing tube has leakage
	Possible Solutions	Check points N and G for leakage as shown in Figure 1 above Check BVM bag for wear and tear Pressing YES will lead to an option to retry The system will refuse to go further till this error is resolved

During Pre-use Checks	Symptom	Pressure lines interchanged
	Message	Upstream / Downstream Pressure lines Leakage or Swapped Noted (YES) ?
	Possible Causes	The upstream/downstream pressure lines connected incorrectly BVM Bag or the breathing tube has leakage
	Possible Solutions	Check points N is connected to G as shown in Figure 1 above Check points P is connected to H as shown in Figure 1 above Check BVM bag for wear and tear Pressing YES will lead to an option to retry The system will refuse to go further till this error is resolved

During Pre-use Checks	Symptom	Incorrect BVM Bag size
	Message	Incorrect BVM Size Measured Dia=110mm Range [115,125]mm Noted (YES) ?
	Possible Causes	System detected that the BVM bag size is too small Could also be due to leakage in the Breathing system Could also be that a HEPA/HME filter is not installed
	Possible Solutions	Check if BVM Bag is deformed Check Figure 2 for system BVM Bag Specifications Check for leakages using Figure 1 as a guide Pressing YES will lead to an option to retry The system will refuse to go further till this error is resolved

During STANDBY state	Symptom	Patient not connected
	Message	Patient Disconnected from the Breathing Circuit Reconnect when ready
	Possible Causes	The Breathing tube is not connected to the patient
	Possible Solutions	Connect patient to the Breathing tube before starting breath delivery

During STANDBY state	Symptom	Conflicting Parameter settings - PS and PEEP
	Message	PARAMETER Conflict PS less than PEEP Change PARAMETERS YES -> Commit
	Possible Causes	PS can never be set to be less than PEEP
	Possible Solutions	Change parameters and press YES

During STANDBY state	Symptom	PS Parameter too low
	Message	PS setting too close to PEEP Confirm to accept (YES or NO) ?
	Possible Causes	Support pressure PS parameter too low
	Possible Solutions	Reconfirm to accept - press YES Change parameters - press NO

During STANDBY state	Symptom	Conflicting Parameter settings - PMAX and PEEP
	Message	PARAMETER Conflict PMAX less than PEEP Change PARAMETERS YES -> Commit
	Possible Causes	PMAX can never be set to be less than PEEP
	Possible Solutions	Change parameters and press YES

During STANDBY state	Symptom	Conflicting Parameter settings - PMAX and PS
	Message	PARAMETER Conflict PMAX less than PS Change PARAMETERS YES -> Commit
	Possible Causes	PMAX can never be set to be less than PS
	Possible Solutions	Change parameters and press YES

During STANDBY state	Symptom	Conflicting Parameter settings - TPS and RR
	Message	PARAMETER Conflict TPS more than (RR/2) Change PARAMETERS YES -> Commit
	Possible Causes	TPS cannot be set to more than half of RR time
	Possible Solutions	Change parameters and press YES

During STANDBY state	Symptom	Extreme Volume Control settings
	Message	VT,RR,EI combination may be too extreme Confirm to accept (YES or NO) ?
	Possible Causes	The VT, RR, EI parameter settings may cause too much breath volume in too short a time.
	Possible Solutions	Reconfirm to accept - press YES Change parameters - press NO

During STANDBY state	Symptom	Extreme Pressure Support settings
	Message	PS, TPS combination may be too extreme Confirm to accept (YES or NO) ?
	Possible Causes	The PS, TPS parameter settings may cause result in high support pressure
	Possible Solutions	Reconfirm to accept - press YES Change parameters - press NO

During STANDBY state	Symptom	Extreme PEEP setting
	Message	PEEP Parameter may be too high Confirm to accept (YES or NO) ?
	Possible Causes	PEEP parameter set too high
	Possible Solutions	Reconfirm to accept - press YES Change parameters - press NO

During STANDBY state	Symptom	Extreme PMAX setting
	Message	PMAX Parameter may be too high Confirm to accept (YES or NO) ?
	Possible Causes	PMAX parameter set too high
	Possible Solutions	Reconfirm to accept - press YES Change parameters - press NO

During STANDBY state	Symptom	Pop-off valve warning
	Message	Pressure > 40 cm H2O needs Pop-Off valve to be locked Done (YES or NO) ?
	Possible Causes	PMAX parameter set greater than 40 cm H2O Pop-off valves must be locked to enable this
	Possible Solutions	Lock the Pop-off valves Reduce PMAX parameter setting

During STANDBY state	Symptom	Cannot start Breath delivery if patient disconnected
	Message	Cannot START Breath Delivery Connect Patient and Press START again
	Possible Causes	The Breathing tube is not connected to the patient
	Possible Solutions	Connect patient to the Breathing tube and press START again

During ACTIVE state	Symptom	PEEP valve needs adjustment
	Message	PEEP delta Observed +1.5 cmH2O Adjust PEEP valve or PEEP setting
	Possible Causes	Measured PEEP different from the desired PEEP setting It could be higher or lower
	Possible Solutions	Adjust the PEEP valve while checking the measured PEEP on display There is no need to pause the breath delivery

During ACTIVE state	Symptom	Abnormal Breath Pressure waveform
	Message	Abnormal Breath Patient might be coughing hiccupping Check immediately
	Possible Causes	The breath waveform shows too many peaks and troughs The patient may be distressed
	Possible Solutions	Check with the Doctor immediately May need to disconnect patient and give manual resuscitation till the problem is identified and resolved

During ACTIVE state	**Symptom**	**No Patient initiated breath for a long time**
	Message	Delivered Mandatory Breath in PSV mode Missing Spontaneous Breath for a while
	Possible Causes	While in PSV ventilation mode, all breaths are expected to be initiated by the Patient instead of by the ventilator system The system was forced to deliver a mandatory breath because of too long interval(s) between Patient-initiated breaths
	Possible Solutions	Check with the Doctor

During ACTIVE state	**Symptom**	**Pressure Leak detected during Breath delivery**
	Message	Some Pressure Leak Check BVM Bag Check Patient Mask Check Pressure Lines
	Possible Causes	Some connection in the Breathing circuit has become loose
	Possible Solutions	Check points E-R as shown in Figure 1 for leakage

During ACTIVE state	**Symptom**	**Total loss of Pressure**
	Message	Airway Blockage Check Breathing tube Aspirate Patient Call Service Tech
	Possible Causes	A sudden rise detected in measured lung pressure
	Possible Solutions	Patient may need to be aspirated There may be a sudden decline in patient's lung compliance Consult the Doctor immediately

During ACTIVE state	Symptom	Airway blockage detected during Breath delivery
	Message	TOTAL Pressure Loss Check Patient Mask Check Breathing tube Call Service Tech
	Possible Causes	Patient disconnected suddenly Some component of Breathing system disconnected
	Possible Solutions	Check all possible leakage points as shown in Figure 1

During ACTIVE state	Symptom	Pressure exceeded PMAX limit
	Message	Pressure beyond PMAX Temporarily changed Breath Settings Check DISPLAY
	Possible Causes	Peak pressure exceeded the set PMAX limit Patient may be in distress Patient's lung compliance may have changed
	Possible Solutions	System temporarily reduces VT to continue breath delivery Consult the Doctor Change PMAX parameter setting Change other parameter settings

During ACTIVE state	Symptom	Patient Initiated breaths while system in CMV Ventilation mode
	Message	123 Patient Initiated breaths Detected but Ignored While in CMV mode
	Possible Causes	While in CMV mode, the system ignores all patient-initiated breaths and only delivers mandatory breaths according to set parameters
	Possible Solutions	It is an informational message - not an alarm If the number is too high, it may be time to change ventilation mode Consult the Doctor

During ACTIVE state	Symptom	System unable to provide set level of Pressure support
	Message	Unable to deliver set Pressure Support Change setting for Pressure Support
	Possible Causes	The PS parameter setting may be too high for the patient
	Possible Solutions	Consult the Doctor Change PS parameter setting

During ACTIVE state	Symptom	System unable to provide set Volume Controlled breaths
	Message	Unable to deliver set Tidal Volume BVM Bag too small Change Settings
	Possible Causes	VT, RR, EI parameter settings are too high for the patient's lungs
	Possible Solutions	Consult the Doctor Change VT, RR and EI parameter settings

During ACTIVE state	Symptom	Minute volume discrepancy between expect and actual in PSV ventilation mode
	Message	Low Minute Volume Minute Vol=4200 ml Expected > 5000 ml Backup SIMV active
	Possible Causes	Patient-initiated breaths not ready for expected Minute volume Either the frequency of patient initiated is too small or the patient not drawing enough during each breath
	Possible Solutions	Consult the Doctor Change MV parameter settings Change the ventilation mode System has switched to SIMV mode automatically

During ACTIVE state	Symptom	Change Oxygen Inflow rate
	Message	Minute Volume Change Set O2 Flow (l/min) -> 4.8 (l/min)
	Possible Causes	Required Oxygen inflow rate is dependent on Minute Volume
	Possible Solutions	Change the Oxygen inflow rate to that specified in the message to achieve required FiO2

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