FLIGHT MEDICAL INNOVATIONS LTD.

FLIGHT 50 Ventilator

Service Manual

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Legal Notice

Disclaimer

FLIGHT MEDICAL INNOVATIONS Ltd. (FLIGHT MEDICAL) provides this Service Manual in its commitment to help reduce patient risk and injury. However, this manual is not intended to in any way replace or substitute duty of care to a patient, professional responsibility, or professional judgment, nor is it intended to provide any warranty, promise, guarantee, assumption of risk or duty, release, or indemnity. Physicians shall at all times maintain responsibility for patient treatment and outcomes, and FLIGHT MEDICAL further assumes no liability for patient treatment or outcome or for physician's negligence, breach of duty of care, or malpractice.

The FLIGHT 50 Ventilator operator is solely responsible for selecting the appropriate level and method of patient monitoring.

Product modification or misuse can be dangerous. FLIGHT MEDICAL disclaims all liability for the consequences of product alterations or modifications, as well as for the consequences which might result from the combination of this ventilator with other products, whether supplied by FLIGHT MEDICAL or by other manufacturers, unless such a combination has been specifically endorsed by FLIGHT MEDICAL.

The design of FLIGHT 50 Ventilator, the Operator's and Service Manuals, and the labeling on the ventilator, take into consideration that the purchase and use of the equipment is restricted to trained professionals, and that certain inherent characteristics of the ventilator are known to the operator. Instructions, warnings, and caution statements are therefore limited to the specifics of the FLIGHT 50 Ventilator.

Federal law (US) restricts this device to sale by or on the order of a physician.

This Operator's Manual excludes references to various hazards which are obvious to medical professionals and operators of this equipment, to the consequences of product misuse, and to potential adverse effects in patients with abnormal conditions.

When the FLIGHT 50 Ventilator is used in homecare and sub acute environments, only properly trained personnel should operate the ventilator. The FLIGHT 50 Ventilator is a restricted medical device designed for use by respiratory therapists or other properly trained and qualified personnel under the direction of a physician and in accordance with applicable state laws and regulations.

Transport of patients with the FLIGHT 50 Ventilator requires that medical staff have a good working knowledge of the ventilator's use and problem resolution. Proper emergency backup equipment must be immediately available during transport.

FLIGHT 50 Ventilator operators must recognize their responsibility for implementing safety monitoring mechanisms which supply appropriate

information on equipment performance and patient condition. Patient safety may be achieved through a wide variety of means, such as electronic surveillance of equipment performance and patient condition. However, equipment surveillance should not replace direct observation of clinical signs.

The liability of FLIGHT MEDICAL is subject to and limited to the exclusive terms and conditions as set forth herein. Said liability is limited whether arising out of, or related to, the manufacture and sale of goods, their installation, demonstration, sales representation, use, performance, or otherwise. Any liability based upon product warranty is limited regardless of any fault attributable to FLIGHT MEDICAL and the nature of the action (including breach of warranty, negligence, and strict liability).

The written warranties are in lieu of all other warranties, expressed or implied, including, without limitation, warranties of merchantability, fitness for any purpose, or non-infringement.

FLIGHT MEDICAL shall not be liable for any special incidental or consequential damages incurred by the buyer to a third party. The buyer shall not be entitled to make liability recoveries from FLIGHT MEDICAL due to such situations.

Warranty

The FLIGHT 50 Ventilator warranty does not apply for/ in case of:

- Defects caused by misuse, mishandling, tampering, or by modifications not authorized by FLIGHT MEDICAL or its representatives.
- Rubber and plastic components and materials, which are guaranteed to be free of defects at time of delivery.

Any product which proves during the warranty period to be defective in workmanship or material, will be replaced, credited, or repaired. FLIGHT MEDICAL retains the discretion to select the most suitable of these options. FLIGHT MEDICAL is not responsible for deterioration, wear, or abuse. In all cases, FLIGHT MEDICAL will not be liable beyond the original selling price.

Application of this warranty is subject to the following conditions:

- FLIGHT MEDICAL or its authorized representatives must be promptly notified upon detection of the defective material or equipment.
- Defective material or equipment must be returned to FLIGHT MEDICAL or its authorized representative.
- Examination by FLIGHT MEDICAL or its authorized representatives must confirm that the defect is covered by the terms of this warranty.

To ensure complete protection under this warranty, the Warranty Registration Card must be returned to a FLIGHT MEDICAL authorized representative within ten (10) days of equipment receipt.

The above is the sole warranty provided by FLIGHT MEDICAL. No other warranty, expressed or implied, is intended. Representatives of FLIGHT MEDICAL are not authorized to modify the terms of this warranty.

In no way does this or any of FLIGHT MEDICAL policies, training materials, guidelines, or instructions create an obligation for FLIGHT MEDICAL to perform any services.

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1 Safety Instructions

At all times, strictly follow this manual. The safe use of the FLIGHT 50 Ventilator requires full understanding of its operation, and adherence to the manual's instructions. The equipment is only to be used for the purpose specified in section 2. Observe all of the WARNINGS and CAUTIONS posted in this manual, and on buttons found on the FLIGHT 50 Ventilator and associated accessories.

1.1 General Warnings

External power connection: To maintain grounding integrity when using AC power, only connect to hospital grade receptacles. Always disconnect the external power supply prior to servicing. There is a risk of explosion if used in the presence of flammable anesthetics.

All settings and adjustments in the different ventilation modes must be made in accordance with a physician's prescribed therapy.

Do not use electrically conductive patient circuits.

Always use a clean, disinfected patient circuit.

Always use an outlet filter or equivalent at the Airway Pressure Connector, to protect the internal transducers from moisture and other contaminants.

The ventilator is ready for operation only when:

- It is completely assembled.
- The OVP has been successfully completed.

Failure to identify and correct alarm violations may result in patient injury.

Ensure that the oxygen source is not empty before and during the use of the optional Air/Oxygen Entrainment Mixer or Oxygen Blending Bag Kit.

As Li-Ion batteries are charged and discharged over time, their ability to hold a charge is decreased with use. This can shorten the amount of time the ventilator can function while on battery power.

The batteries should be replaced when the batteries no longer meet the needs of the user. This depends on a number of factors including settings and usage patterns.

Charge the batteries for a minimum of three hours before powering the ventilator from the batteries. This provides fully charged batteries.

During storage, charge the batteries for a minimum of three hours every 30 days. This provides charged batteries.

Always ensure that the green Ext. Power LED is illuminated after connecting the FLIGHT 50 Ventilator to an external AC or DC power source. If the LED is not illuminated, check all power connections and resolve any problems.

Always plug the FLIGHT 50 Ventilator into an AC power supply source when not in use, to ensure best battery performance.

The flow resistance of the air inlet filter, located on the right side of the ventilator, is likely to increase with repeated use. Ensure that the filter is changed regularly.

Only a FLIGHT MEDICAL approved patient circuit can be used with the FLIGHT 50 Ventilator.

Only a FLIGHT MEDICAL approved exhalation valve can be used with the FLIGHT 50 Ventilator.

Perform an exhalation valve calibration each time a clean circuit/exhalation valve is installed.

The FLIGHT 50 Ventilator has been tested and found to comply with EMC limits according to the EN60601-1-1-2 standard class B. These limits are designed to provide reasonable protection against harmful interference in a typical medical installation. The equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with these instructions, may cause harmful interference to other devices in the vicinity. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference with other devices, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving device.
- Increase the distance between the equipment.
- Connect the equipment into an outlet on a circuit different from that to which the device (s) is connected.
- Consult the manufacturer for help.

1.2 Cautions

Only use medical grade oxygen with the Air/Oxygen Entrainment Mixer or Oxygen Blending Bag Kit.

Do not place liquid containers in the immediate vicinity or on top of the FLIGHT 50 Ventilator. Liquids that get into the ventilator can cause equipment malfunction and damage.

After the FLIGHT 50 Ventilator is serviced, it must completely pass an Operational Verification Procedure (OVP) before being returned to patient use.

An authorized FLIGHT MEDICAL factory-trained technician must do all service or repairs performed on the FLIGHT 50Ventilator.

Do not open the ventilator or perform service on an open unit while connected to external power.

Use standard antistatic techniques while working inside the ventilator or handling any electronic parts.

Clean all external accessories of the ventilator prior to servicing.

Water in the oxygen supply can cause equipment malfunction and damage.

Batteries contain Li-Ion. Do not discard them in an incinerator or force them open. Batteries should not be disposed of with normal waste.

Use the tools and equipment specified in this manual to perform specific procedures.

2 Introduction

The FLIGHT 50 Ventilator provides continuous or intermittent mechanical ventilator support for the care of those who require mechanical ventilation. The ventilator is a restricted medical device. Only qualified, trained personnel under the direction of a physician should use the FLIGHT 50. Explicitly, the FLIGHT 50 Ventilator can be used to support adult and pediatric (infants, children and adolescent) patients weighing 10 kg or 22 lbs (or more), who require the following general types of ventilatory support, as prescribed by an attending physician:

- Positive pressure ventilation with assist/control
- SIMV ventilation
- SPONT ventilation

The FLIGHT 50 Ventilator is suitable for use in hospital, emergency room, sub-acute, home care environments as well as for transport and emergency response uses.

The FLIGHT 50 Ventilator features front panel controls which enable trained operators to select between a number of operational modes, pressure support and volume or pressure control. The system includes a comprehensive range of built-in alarms that alert the user to violations of safety limits that have been configured by the operator. When new and fully charged, the internal battery system provides up to 10 hours of power. With its patented, self-contained gas supply source, the FLIGHT 50 Ventilator requires no external air compressor.

2.1 Symbols

Main Power On

Alarm Setting

Main Power Standby

Audible Alarm Silence/Reset

Equipotentiality

High Alarm

Set High Alarm

Refer to Operating Manual

Low Alarm

Set Low Alarm

Applied Parts Type BF

Table 1

Controls/Alarms/Monitors	Range/Selection
MODE (Pressure or Volume Control)	A/CMV SIMV SPONT
Volume Control (Tidal Volume)	100 to 2,200 mL, ATPS, ± 10%
Pressure Control (Target Pressure)	PEEP +5 to 60 cmH2O / mbar
$\dot{V}$ **(Flow)**	6 to 100 L/min
t_I **(Inspiratory Time)**	0.1 to 3.0 sec
f **(Frequency)**	1 to 99 b/min
Ptrig (Sensitivity)	–9.9 to 0 cmH2O / mbar, pressure triggering (Patient Effort Indicator LED blinks once each time the airway pressure reaches the Ptrig setting.)
P support (Pressure Support)	0 to 60 cmH2O / mbar above baseline pressure, limited to PEEP + Psupport ≤ 60 cmH2O / mbar
I:E Ratio	1:99 to 3:1
Maximum Limited Airway Pressure (Safety Valve)	100 cmH2O (98 mbar)
Manual Inflation	3 sec maximum (While button is pushed, the ventilator closes the exhalation valve and delivers an operator controlled breath to the patient.)
Humidifier (Optional)	19ºC to 39ºC
Airway Pressure Meter	-10 to 100 cmH2O/-10 to 98 mbar
Alarm Silence/Reset Button & Indicator	Pressing the button silences an audible alarm violation for 60 seconds and resets a latched alarm indicator. LED lights to indicate that Silence is active.

ALARMS Indicators	Indicators for violated alarms blink red. When the alarm is no longer violated, the indicator latches (stays lit). Cancel a latched indicator by pressing the Silence/Reset button.
Int. Battery Button and Indicator	Pressing the button displays the internal battery charge level in the airway pressure meter (Paw) window. Use only when operating on the internal battery system for accurate reading. LED lights to indicate internal battery system operation and alarms.
F_IO_2 (with optional accessories)	0.21 to 1.00
On / Standby Button	Press once to put in Setting condition. (On-Setting/LED off) Press again to begin ventilating (On-Ventilating/LED on). When the FLIGHT 50 Ventilator is ventilating, press two times to put ventilator into Standby/Off condition (LED off).
Push To Unlock Buttons & Indicator	Pressing the button unlocks the front panel buttons, if they were locked by automatic panel lock feature. Auto lock is enabled/ disabled in User Set Up. LED lights to indicate panel is locked.
Alarms	
▲Paw (High Pressure)	4 to 99 cmH_2O / 4 to 99 mbar, must be 1< Low Paw
▼Paw (Low Pressure)	3 to 98 cmH_2O / 3 to 98 mbar, limited by ≥ PEEP + 3 and High Paw -1
Low Baseline Pressure	Paw $\leq$ PEEP - 3 cmH_2O/mbar for 3 sec during exhalation
High Baseline Pressure	Paw $\geq$ PEEP + 8 cmH_2O/mbar at onset of a breath or 3 sec after the start of exhalation
Occlusion	Paw $\geq$ PEEP + 15 cmH_2O/mbar at onset of a breath or 3 sec after start of expiration
Apnea	30 sec ± 3 sec
PCV Not Reached	Paw P < 50% of PCV setting
▲ $\dot{V}_I$ Insp. Min. Volume	1.1 to 50.0 L/min
▼ $\dot{V}_I$ Insp. Min. Volume	0.1 to 49.0 L/min
Check Prox Line	Prox Paw does not match machine Paw during inspiration
Humidifier (5 messages)	Humidifier malfunction/disconnection
Power Switchover	External power to internal battery switchover alert
Battery Low	Minimum of 30 minutes battery time remains until shutdown
Battery Empty	Minimum of 15 minutes battery time remains until shutdown

The time between the Battery Low Alarm violation and the Battery Empty Alarm violation will vary depending on the ventilator load. At high volumes and pressures, the Battery Empty Alarm will occur much sooner after the

	Battery Low Alarm, than it will at lower volumes and pressures. In all cases, the stated minimum times for each alarm will be met, even if the two alarms occur almost simultaneously.
Device Alert (5 messages)	Ventilator malfunction: FAULT BAT SYS, OCCLUSION, 10V SHUTDOWN, SYSTEM ERROR or MOTOR FAULT
Shut Down Alert	On to Standby/Off Shut Down Alert
Message Display Window	
Up to 16 characters, LED alpha numeric display. Displayed monitored parameters:	V_T (Actual delivered tidal volume) V_I (Inspiratory minute volume) f (Total breath frequency) Paw P (Peak airway pressure) Paw M (Mean airway pressure) Paw B (Baseline airway pressure) H (Hours of operation) S (Software version) L (or Q) (Buzzer volume (Loud or Quiet) for audible alarm) Power Save (On / Off)
Other displayed parameters (In USER SET UP):	Airway Pressure Units (cmH_2O / mbar) Set Up (User / Default) Auto Panel Lock (Enabled / Disabled) Tech. Setup (Technical set up, refer to Service Manual)
Front Panel Indicators	
Modes:	
A/CMV	Green LED indicates that A/CMV mode is active.
SIMV	Green LED indicates that SIMV mode is active.
SPONT	Green LED indicates that SPONT mode is active.
Controls:	
Volume Control	Green LED indicates Volume Control ventilation.
Pressure Control	Green LED indicates Pressure Control ventilation.
Alarms:	
▲Paw (High Pressure)	Red LED indicates high peak airway pressure, high baseline pressure, or occlusion alarm violation.
▼Paw (Low Pressure) / Apnea	Red LED indicates low peak airway pressure, low baseline pressure, apnea, or PCV (50% of PCV setting not achieved) alarm violation.
Device Alert	Red LED indicates ventilator malfunction alert.
▲ $\dot{V}_I$ (High Insp. Min. Volume)	Red LED indicates high inspiratory minute volume alarm limit is violated.
▼ $\dot{V}_I$ (Low Insp. Min. Volume) (Back-Up Vent)	Red LED indicates low inspiratory minute volume alarm limit is violated.

Miscellaneous Indicators	
Silence / Reset	Yellow LED indicates that the audible alarm is silenced for 60 seconds.
Auto Lock On	Green LED indicates that the panel is currently locked.
On / Standby	Green LED indicates that the FLIGHT 50 is ventilating.
Ptrig	Green LED blinks on to indicate patient breathing effort.
$\dot{V}$ (Flow)	Green LED indicates that Flow is displayed in the $\dot{V}$/ I:E Ratio numeric window display.
I:E	Green LED indicates that the I:E Ratio is displayed in the $\dot{V}$/ I:E Ratio numeric window display. Blinking LED indicates a breath with an inverse I:E Ratio.
Ext. Power / Charging Int. Battery	Green LED indicates external power is on and the internal battery is being charged. Red LED indicates power switchover to internal battery.
Int. Battery (Push to Test)	Yellow LED indicates internal battery is in use. LED blinks yellow to indicate Battery Low alarm condition or blinks red to indicate Battery Empty alarm condition.
Humidifier On	Green LED indicates humidifier is active. LED blinks yellow to indicate humidifier alarm condition.

Hardware	Requirements
Electrical	Applied parts type BF
External A.C. /D.C. (Battery Input)	100-240 VAC, max. 2 A 50 / 60 / 400 Hz 12-30 VDC, max. 12 A
Battery	Primary battery: lead acid, 12 VDC, 5 AH Secondary back up battery: nickel metal hydride,12 VDC, 2.1 AH When new and fully charged, internal battery supplies power for up to 10 hours of operation at these settings: A/CMV mode, f=15, Volume Control=500 mL, t_I =1.0 sec, PEEP=Ø, max. airway pressure 30 cmH_2O/mbar, Power Save mode ON.
RS-232C Interface /Remote Alarm Output	8 pin SEMCONN connector. Operates at 19,200 baud. Allows put for interfacing with central alarms systems
Pneumatics	Gas delivery system requires no external air compressor.

The battery charges whenever the FLIGHT 50 Ventilator is connected to an external power source. Battery charge level is best maintained by keeping the FLIGHT 50 Ventilator continuously connected to external power.

The primary internal battery capacity diminishes with age. As the battery ages the Battery Low alarm will occur sooner. If this begins to infringe on the needed battery time, prior to scheduled replacement, the primary internal battery should be replaced.

Miscellaneous	Description
Operating Temperature	–18ºC to 50ºC

For proper operation at low range temperatures (-18°C), the FLIGHT 50 Ventilator must be started in a normal room temperature environment and allowed to run for 30 minutes prior to transfer to colder environment.

At temperatures over 40ºC the charging circuit is disabled and the internal battery does not charge.

Operating Humidity	15 to 95% non-condensing

Operating Altitude	Sea level to 15,000 ft (0 to 4,572 m) There is no altitude limitation when FLIGHT 50 Ventilator is operated in a pressurized environment.
Operating Pressure	600 to 1,100 mbar
Regulatory and Agency Standards/Requirements	Complies with the following international standards and requirements: **IEC 60601-1:1988** (+A1:1991 +A2:1995; EN 60601-1:1990 +A1:1993 +A2:1995 +A3:1996) Medical Electrical Equipment – Part 1: General Requirements for Safety **CEI/IEC 60529:2001** Degrees of Protection Provided by Enclosures (IP Code) **MIL-STD-810E** Environmental Test Methods and Engineering Guidelines **IEC 601-2-12:1988** Particular Requirements for the Safety of Lung Ventilators for Medical Use **IEC 60601-1-2:2001** (+A1:2006) Medical Electrical Equipment, Collateral Standard: Electromagnetic Compatibility – Requirements and Tests IEC 68-2-6 Test Fc Environmental Tests: Vibration (sinusoidal) **IEC 68-2-29** Test Eb Environmental Tests: Bump **IEC 68-2-32** Test Ed Environmental Tests: Free Fall **IEC 68-2-36** Test Fdb Environmental Tests: Random Vibration **ISO 8185:1997** Humidifiers for Medical Use: General Requirements for Humidification Systems **ASTM F 1100-90:1990** Standard Specifications for Ventilators Intended for Critical Care Use **ASTM F 1246-91:1991** Standard Specifications for Electrically Powered Home Care Ventilators – Part 1: Positive-Pressure Ventilators and Ventilator Circuits **DO-160D** Environmental Conditions and Test Procedures for Airborne Equipment.
Storage Temperature	–40ºC to 65ºC
Storage Humidity	0 to 95% non-condensing
Height (includes handle)	10 inches (26 cm)
Width	11 inches (27 cm)
Depth	8 inches (20 cm)
Weight	16.7 lbs. (7.6 kg) without humidifier 18.0 lbs. (8.2 kg) with humidifier
Patient Range	Adult - Pediatric (i.e. infant, child & adolescent) with body weight ≥10 kg

Factory Default Parameters	
Patient Settings	
MODE	A/CMV
Volume Control	500 mL
t_I	1.0 sec
f	15 b/min
Ptrig	-1.0 cmH_2O
Paw Alarms	5 cmH_2O ▼ Paw 40 cmH_2O ▲ Paw
$\dot{V}_I$ Alarms	3 L/min ▼ $\dot{V}_I$ 20 L/min ▲ $\dot{V}_I$
PEEP/CPAP	0 cmH_2O
Psupport	0 cmH_2O
Humidifier	Off
Buzzer Volume	Loud
User Set Up	
Power Save	On
Pressure Units	cmH_2O
Auto Panel Lock	Disabled
Set Up	User
Patient Circuit	Reusable 22 mm I.D. adult/pediatric circuit with 3/16 inch (4.8 mm) I.D. proximal pressure sensing line, 1/8 inch (3.2 mm) I.D. exhalation valve control drive line, and exhalation valve.
Exhalation Valve	FLIGHT MEDICAL'S FLIGHT 50 exhalation valve (P/N HT600039) is manufactured and designed specifically for the FLIGHT 50 Ventilator. FLIGHT MEDICAL does not approve of the use of any type or brand of exhalation valve that has not been tested and approved by FLIGHT MEDICAL for use with the FLIGHT 50.
FLIGHT 50 HUMIDIFIER (operates on A.C. power only)	
Set Target Temperature Range	19ºC to 39ºC
Operating Water Volume	300 mL
Usable Volume of Water Bottle	265 mL
Compliance at Minimum Water Level (Refill Line)	0.5 mL/cmH_2O / mbar @ 23ºC
Compliance at Maximum Water Level (Full Line)	0.33 mL/cmH_2O / mbar @ 23ºC

Intended Use	Adult and pediatric patients whose supraglottic airway is or is not bypassed.
Warm-Up Time	30 minutes
Gas Leakage	2 mL/min at airway pressure of 80 cmH_2O / mbar
Humidifier Output	33.8 mg/L at a continuous flow of 10 L/min @ 39ºC
Maximum Operating Airway Pressure	100 cmH_2O / 98 mbar
Maximum Temperature at the Patient Wye That Triggers an Alarm	41ºC

Air / Oxygen Entrainment Mixer Specifications
(optional)

Pneumatic Requirements:	
Oxygen	35 to 90 psig (2.4 to 6.2 Bar) full operating range 40 to 70 psig (2.7 to 4.8 Bar) accuracy ± .08
Air	Atmospheric pressure
F_IO_2 Control	Adjusted continuously from 0.21 to 1.00

Continuous oxygen monitoring is required for patient safety. FLIGHT 50 does not have a built-in alarm system to notify user of a failure or disconnect of the oxygen source.

Oxygen Blending Bag Kit Specifications
(optional)

Pneumatic Requirements:	
Oxygen	0-10 L/min (calibrated)
Air	Atmospheric pressure
F_IO_2 Control:	F_IO_2, indirectly adjusted from 0.21 up to 1.00 via oxygen flow (L/min)

Continuous oxygen monitoring is required for patient safety. FLIGHT 50 does not have a built-in alarm system to notify user of a failure or disconnect of the oxygen source.

3 Functional Description

3.1 Front Panel Overview

The following is an overview of the FLIGHT 50 Ventilator front panel button functions. For an in depth description, please review Front Panel Controls and Indicators

3.1.1 Turning the FLIGHT 50 Ventilator On/Off

The On/Standby button toggles between the following conditions:

Standby -► Setting -► On -► -► Standby

➔ **To turn the FLIGHT 50 Ventilator On/Off:**

1. Press **On/Standby** button once to go from Standby to Setting
2. Press again to turn On.
3. Press twice to go from On to Standby.

- **Standby**: FLIGHT 50 Ventilator dormant.
- **Setting**: Enables setting of control parameters and exhalation valve calibration.
- **On**: Enables ventilation

There is approximately a two second delay in going from Standby to Setting condition. During this time, the FLIGHT 50 Ventilator performs a self-test and will light all displays on the front panel.

3.1.2 Changing the MODE Control

The MODE control buttons (A/CMV / SIMV / SPONT) function differently in Setting and On conditions.

3.1.2.1 Setting Condition

Press the **A/CMV**, SIMV or **SPONT** button.

The LED on the selected Mode will light green to confirm the selection.

3.1.2.2 On Condition

Press the **A/CMV**, **SIMV** or **SPONT** button.

The LED on the selected Mode will blink green and the Message Display Window will read "**PRESS AGAIN**." Press the button again within 5 seconds to confirm the mode change, or the previously selected mode will continue.

3.1.3 Changing between Pressure Control and Volume Control

The Pressure Control and Volume Control buttons function differently when in A/CMV or SIMV in On condition compared to when in SPONT mode in On condition or Settings condition.

3.1.3.1 On Condition: A/CMV or SIMV

1. Select—**Adjust (▲Up / ▼Down)—Accept**
2. Select the **Pressure Control** or **Volume Control** button.

The LED indicator and the target value blink.

3. Adjust the blinking target value for the selected control with the **▲Up / ▼Down** buttons.
4. Press the desired control button (Volume or Pressure) a second time to accept the new control and target value you must

3.1.3.2 On Condition: SPONT or Setting Condition: A/CMV, SIMV, or SPONT

1. Select—**Adjust (▲Up / ▼Down)—Accept**
2. Select the Pressure Control or Volume Control button.

The LED indicator and the target value blink.

3. Adjust the blinking target value for the selected control with the **▲Up / ▼Down** buttons.
4. To accept the new control and target value, either:
   - Press the selected button again
   - Press another button to select a new parameter for adjustment
   - Wait 5 seconds without making a change.

The transition to a new pressure or volume target may require several breaths.

3.1.4 Changing a Parameter (or Multiple Parameters)

1. Select—**Adjust (▲Up / ▼Down)—Accept**
2. Select the parameter by tapping the labeled button (i.e. ***ƒ***, **P trig**, etc).

The parameter's numeric display blinks.

3. Adjust the numeric value with the **▲Up / ▼Down** buttons.
4. To accept the value, either:
   - Press the selected button again
   - Press another button to select a new parameter for adjustment
   - Wait 5 seconds without making a change.

3.1.5 Enabling/Disabling Auto Panel Lock

Auto Panel Lock can be enabled or disabled via User Set Up (see 3-34). When the Auto Panel Lock is enabled, the Panel will lock 30 seconds after the last button is pushed and the LED lights green. All touch buttons (except Silence/Reset and Internal Battery Test) are locked, preventing accidental parameter changes.

Auto Panel Lock is factory preset to "**Disabled**" (off).

To temporarily unlock parameters when Auto Panel Lock is active, tap the **Push To Unlock** button for at least one second. The Panel will relock 30 seconds after the last button is pressed.

3.2 Front Panel Controls and Indicators

Figure 1 - FLIGHT 50 Ventilator Front Panel

Front panel controls that have corresponding LED indicators are included with the description of the control.

The FLIGHT 50 Ventilator front panel is shown in *Figure 1*.

3.2.1 On / Standby

Figure 2 - On/Standby Button

This button toggles between the following conditions:

- Standby: (if attached to external power, the battery is being charged) -*• Setting (allows setting of contr**o**l parameters) -►On (enables ventilation) -► -► Standby.
- Standby: The FLIGHT 50 Ventilator is dormant and ventilation is not enabled. If attached to external power, the Ext. Power/ Charging Int. Battery LED is lit green, indicating that the internal battery is being charged. The On/Standby indicator is not lit.
- Setting: Pressing the **On/Standby** button once changes the ventilator from Standby to Setting condition.

There is approximately a two second delay in going from Standby to Setting condition. During this time, the FLIGHT 50 Ventilator performs a self-test and will light all displays on the front panel.

During Setting condition, all adjustable LEDs are lit. This allows the operator to adjust and preset controls prior to ventilation. The On/Standby indicator is not lit. The Message Display Window shows "**Press ON to Vent**," and suggests to the operator that the **On/Standby** button needs to be pressed if you want the FLIGHT 50 Ventilator to start ventilation.

On:

- Pressing the **On/Standby** button once more changes the ventilator from Setting to On. In the On condition, the FLIGHT 50 Ventilator is ventilating and the On/Standby indicator is lit green.
- Pressing the **On/Standby** button twice while in On condition turns the ventilator from On to Standby.

3.2.2 MODE Control

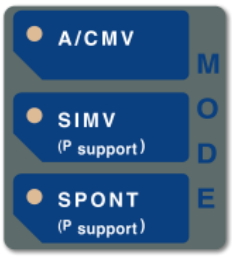


Figure 3 - Mode Control Button

The MODE control buttons enable the user to switch between the following operational modes:

- A/CMV
- SIMV
- SPONT

In A/CMV and SIMV, mandatory breaths can be pressure controlled or volume controlled. A green LED indicates which mode is active.

Changes are made to the FLIGHT 50 Ventilator as follows:

- Setting condition: Pressing the requested **MODE** button once.
- ON condition: Pressing the requested **MODE** button twice. After the first tap, the Message Display Window reads "**PRESS AGAIN**" and the requested MODE's indicator starts to blink.

If the requested MODE button is not pressed within 5 seconds, the change is cancelled.

3.2.3 A/CMV Mode (Assist / Control Mandatory Ventilation)

Figure 4 - A/CMV Mode Button

In A/CMV, the user may choose to volume or pressure control mandatory breaths. In either case, all breaths delivered to the patient, whether time (ventilator initiated) or patient activated, are the same.

The *f* (frequency) setting determines the minimum number of time activated (mandatory) breaths delivered each minute. The Ptrig setting determines the airway pressure threshold that patient effort must reach to trigger additional mandatory breaths. If patient effort doesn't cause airway pressure to drop enough to meet the Ptrig threshold, or if the patient doesn't breathe, the FLIGHT 50 Ventilator will deliver the set *f* (frequency) of mandatory breaths.

If the Ptrig setting is not adjusted to a level that allows the patient's inspiratory effort to be detected, A/CMV mode performs as CMV (control) mode.

3.2.4 SIMV Mode (Synchronized Intermittent Mandatory Ventilation)

Figure 5 - SIMV Mode Button

In SIMV, the user may choose to volume or pressure control mandatory breaths. In either case, all mandatory breaths delivered to the patient, whether time (ventilator initiated) or patient-activated, are the same. In addition, the user may choose to pressure support the spontaneous breaths in between mandatory breaths.

Unlike A/CMV, the *f* (frequency) setting in this mode determines the total rather than the minimum number of time (ventilator) or patient activated mandatory breaths delivered each minute.

The *ƒ* (frequency) setting also establishes a timing window which determines whether a patient activation results in a mandatory breath or a spontaneous breath.

The Ptrig setting determines the airway pressure threshold that patient effort must reach to activate mandatory breaths and also to activate spontaneous breaths in between mandatory breaths.

If patient effort doesn't cause airway pressure to drop enough to meet the Ptrig threshold or if the patient doesn't breathe, the FLIGHT 50 Ventilator will deliver the set *ƒ* (frequency) of mandatory breaths each minute.

3.2.5 SPONT Mode (Spontaneous Ventilation)

Figure 6 - Spont Mode

In this mode, all breaths are patient activated by spontaneous efforts. Psupport (Pressure Support Ventilation) may be used to support spontaneous efforts. When PEEP/CPAP is set above 0, the ventilator mode is CPAP (without PSV) or Bi-level Positive Airway Pressure (with PSV).

3.2.6 ▲ Up and ▼ Down Control

The **▲Up/▼Down** control buttons have multiple uses on the FLIGHT 50 Ventilator.

3.2.6.1 Parameter Adjustment

Use the **▲Up/▼Down** buttons to adjust ventilation control parameter values (including Pressure Control and Volume Control values), alarms, and humidifier setting (if available). Select the desired parameter by tapping its touch button once. The corresponding value (numerical display) will blink. Press the **▲Up** control to increase or the **▼Down** to decrease the affected parameter value. The value continuously changes when the **▲Up/▼Down** controls are pressed and held. The value adjustment is accepted if:

- The user presses the selected parameter button again
- The user selects a different parameter
- Five seconds elapse

Pressing a parameter button without pressing either the **▲Up** or **▼Down** control button within 5 seconds causes the parameter to preserve its current value.

If in the On condition and switching between Volume Control and Pressure Control, the value adjustment for the new breath type selected (Volume or Pressure) will be accepted as noted above, but the breath type (VC or PC) will only change if the user taps the new breath type control button again.

3.2.6.2 Monitored Information:

The ▲Up/▼Down controls are used to access and display monitoring messages in the Message Display Window. Monitored information includes volume, frequency, pressure values and operation information. See Front Panel Message Display Window for more information on the Message Display Window.

When the FLIGHT 50 Ventilator is ventilating, and there are no alarm messages displayed on the Message Display Window, press the **▲Up** control button to access the monitoring information. Pressing the **▲Up** button again allows you to scroll through the messages.

3.2.6.3 Changing Default Settings:

The ▲Up/▼Down controls are also used in User Set Up to change a set up value. See User Set Up on pg 3-34 for more details.

3.2.7 Frequency of Breaths (*f*)

Figure 7 - Frequency of Breaths Button

Range: 1 to 99 b/min

In the ACMV mode, the *f* (frequency) setting determines the minimum number of time-triggered mandatory breaths; in the SIMV mode, it determines the total number of mandatory breaths. The frequency or rate value is displayed in the window adjacent to the selector button.

The user is alerted to frequency settings which result in an inverse I:E Ratio by an audible beep and an "**Inverse I:E**" message in the Message Display Window. Attempts to continue increasing the value after this alert are permitted up to an I:E Ratio of 3:1.

3.2.8 t_I (Inspiratory Time)

Figure 8 - tI (Inspiratory Time) Button

Range: 0.1 to 3.0 sec

The t_I setting determines the inspiratory time for mandatory breaths (volume or pressure control). The selected time value is displayed in the window adjacent to the selector button. If the t_I settings results in an inverse I:E Ratio, the user is alerted by an audible beep and an **Inverse I:E** message in the Message Display Window. Attempts to continue increasing the value after this alert are permitted up to an I:E Ratio of 3:1.

If the inspiratory time setting causes the flow rate to reach the maximum or minimum level of the flow specification, adjustment of t_I ceases, a beep sounds, and a setting limitation message appears in the Message Display Window.

In SPONT mode, the t_I setting is not utilized but the value can be preset.

See pg 3-28 for a list of setting limitation messages.

3.2.9 Volume Control (Tidal Volume)

Figure 9 - Volume Control Button

Range: 100 to 2,200 mL, ATPS

When Volume Control is first initiated, or when a large change is made to the volume setting, it may take 5 or 6 breaths to reach the volume setting.

Pressing this control button, followed by pressing the **▲Up/▼Down** controls, allows the adjustment of the tidal volume setting. When the green Volume Control LED illuminates, the adjacent window displays the set tidal volume. If the Volume Control setting causes the flow rate to reach the maximum or minimum level of the flow specification, adjustment of Volume Control ceases, a beep sounds, and a setting limitation message appears in the Message Display Window.

See pg. 3-28 for a list of setting limitation messages.

In SPONT mode, the Volume Control is not utilized but the value can be preset.

3.2.10 Switching from Pressure Control to Volume Control:

Press the **Volume Control** button. The set tidal volume is displayed in the adjacent window if the FLIGHT 50 Ventilator is ventilating. A "**PRESS AGAIN**" message appears in the Message Display Window.

Adjust the tidal volume level by pressing the **▲Up/▼Down** controls while the LED and numerical display are blinking. If the FLIGHT 50 Ventilator is ventilating you will need to press the **Volume Control** button again within 5 seconds following adjustment.

3.2.11 Pressure Control (Target Pressure)

Figure 10 - Pressure Control Button

Range: 5 to 60 cmH_2O / mbar

> When Pressure Control is first initiated or the setting is changed, the first few breaths may cycle off early until slope/rise is optimized. If early cycling off continues, reassess the breathing circuit configuration and lengthen the tubing as necessary.

Pressing this control button, followed by pressing the **▲Up/▼Down** controls, allows the adjustment of the target airway pressure setting. Target pressure is referenced to ambient (atmospheric pressure). When the green Pressure Control LED illuminates, the adjacent window displays the set airway pressure.

> In SPONT mode, the Pressure Control is not utilized but the value can be preset.

3.2.11.1 Switching from Volume Control to Pressure Control

➔ **To switch from volume control to pressure control:**

1. Press **Pressure Control**.

   The set target airway pressure value is displayed in the adjacent window if the FLIGHT 50 Ventilator is ventilating.

   A "**PRESS AGAIN**" message appears in the Message Display Window.

2. Adjust the set target airway pressure by pressing the **▲Up/▼Down** controls while the LED and numerical display are blinking.
3. If the FLIGHT 50 Ventilator is ventilating you will need to press the **Pressure Control** button again within 5 seconds following adjustment.

> The minimum target airway pressure is 5 cmH_2O / mbar above set baseline pressure.

3.2.12 Ptrig (Sensitivity)

Figure 11 - *Ptrig* Button

Range: 0.0 to –9.9 cmH_2O/mbar

The Ptrig setting determines trigger sensitivity in terms of how far airway pressure must drop below the set baseline pressure for a patient's spontaneous efforts to be detected. The Ptrig LED indicator illuminates each time the airway pressure reaches the set Ptrig level, and turns off once the airway pressure has returned to baseline pressure. The blinking Ptrig LED is referred to as the Patient Effort Indicator. The Ptrig value is displayed in the adjacent window.

Set Ptrig as close to 0.0 cmH_2O as possible, without auto-triggering, to maximize triggering synchrony.

3.2.13 PEEP/CPAP

Figure 12 - PEEP/CPAP Button

Range: 0 to 30 cmH_2O/mbar

The PEEP/CPAP setting establishes airway pressure in the patient circuit during the exhalation phase. It is also referred to as base or baseline pressure. The set PEEP/CPAP value is displayed in the adjacent window.

In Pressure Control ventilation, PEEP/CPAP cannot be set higher than 5 cmH_2O/mbar below the set Pressure Control setting.

The value of PEEP/CPAP plus Psupport cannot exceed 60 cmH_2O/mbar.

3.2.14 PSupport

Figure 13 - PSupport *Button*

Range: 0 to 60 cmH_2O/mbar

The Psupport functions during patient activated spontaneous breaths in SIMV and SPONT modes only. During each spontaneous breath, the ventilator supports the patient by elevating the airway pressure to the PSV above peep + PEEP level.

Any time the active Psupport control is pressed, Psupport flow delivery slows to a lower level then it gradually increases to the appropriate level as pressure rise is re-assessed.

The value of PEEP/CPAP plus P support cannot exceed 60cmH_2O/mbar.

3.2.15 Manual Inflation

Figure 14 - Manual Inflation Button

Range: 0 to 3.0 sec

Pressing this button delivers an operator initiated Manual Inflation. Pressing the **Manual Inflation** button will not initiate an inflation if the patient is currently in the inspiratory phase of a breath or if airway pressure is > 5 cmH_2O (mbar) above the set PEEP/CPAP level. Manual Inflation delivers the set flow rate (in Volume Control) or the set target pressure (in Pressure Control), but inspiratory time is controlled by the user.

During Manual Inflation, the breath is terminated if:

- The Manual Inflation button is released
- The ▲Paw (High Pressure) alarm is violated
- Three seconds have elapsed.

Manual Inflation is only available in A/CMV and SIMV modes.

Manual Inflation may be prematurely cycled off in the first several breaths in Pressure Control when the initial flow has not yet been optimized.

3.2.16 Humidifier On Button

Figure 15 - Humidifier On Button

Range: 19ºC to 39ºC

This touch button activates the built-in humidifier. Pressing this button displays the set target temperature in the adjacent window. While the display is blinking, use the **▲Up/▼Down** controls to adjust the target temperature.

When temperature adjustment is complete and the following occurs:

- Five seconds have elapsed without touching the control
- The Humidifier On button is pressed again
- Another parameter is selected for adjustment

The display stops blinking and the measured temperature is displayed.

While the humidifier is On, the target temperature can be readjusted by pressing the **Humidifier On** button and using the **▲Up/▼Down** controls.

Preheating the humidifier for 30 minutes prior to beginning ventilation will improve the heating performance of the humidifier.

During ventilation (On condition) the displayed temperature is the measured temperature at the patient connector. In the Setting condition, the displayed temperature is the measured temperature at the humidifier bottle outlet.

To turn the humidifier Off, press and hold the **Humidifier On** button for three seconds. See Humidifier On Button pg 3-11 for more details.

The measured proximal temperature may be different from the set target temperature due to the patient temperature, environmental temperature, minute volume , etc.

The humidifier is operational only when the FLIGHT 50 Ventilator is powered by external A.C. power.

If the humidifier and/or the temperature probe is removed or malfunctions or if the humidifier bottle is removed prior to turning the humidifier off, the Humidifier On LED changes from green to blinking yellow, an audible alarm sounds and the heater shuts down automatically. To restart the humidifier, correct the alarm condition and press the **Humidifier On** button.

3.2.17 $\dot{V}$ (Mandatory Flow)

Figure 16 – $\dot{V}$ (Mandatory Flow) Button

Range: 6 to 100 L/min

$\dot{V}$ shares a numeric display window with I:E Ratio.

$\dot{V}$ LED is illuminated green when flow is displayed.

Displays the calculated flow delivered from the ventilator during volume controlled mandatory breaths. $\dot{V}$ display is not available during Pressure Controlled breaths or SPONT mode.

> Flow can be adjusted indirectly by changing the tidal volume (Volume Control) or t_I settings.

3.2.18 I:E Ratio (inspiratory time to expiratory time)

Figure 17 - I:E *Ratio* Button

Range: 1:99 to 3:1

I:E Ratio shares a numeric display window with V .

I:E LED is illuminated green when I:E Ratio is displayed.

I:E Ratio is determined by the / and t_I settings. If expiratory time is longer than inspiratory time, the display format is 1:X.X. If expiratory time is shorter than t_I, the display format is X.X:1. When the I:E Ratio is inverse, the I:E Ratio indicator illuminates once every breath. I:E Ratio does not function during SPONT mode.

3.2.19 Internal Battery Test Button and Indicator

Figure 18 - *Internal* battery Test Button

When the FLIGHT 50 Ventilator is powered by the battery, the LED on this button illuminates as follows:

- A yellow LED indicates the internal battery system is in use.
- A blinking yellow LED indicates low power.

A blinking red LED light indicates when the battery system is completely discharged. Pressing this button allows the Int. Battery Charge Level to be read in the lower half of the Paw meter window. The battery charge level should only be tested when the FLIGHT 50 Ventilator is operating on the battery. Testing while plugged into any external power source will give inaccurate readings.

Test the FLIGHT 50 Ventilator battery periodically to verify that the charge level is in the blue area. The numbers on the Paw meter do not reflect the percent of charge.

3.2.20 Internal Battery Charge Level Meter

Figure 19 - *Internal* Battery Charge Level Meter

The Internal Battery Charge Level meter is below the Paw meter. If the needle is in the red when the test button is pressed the battery charge is low. You should use an external power source. The blue area indicates medium to full battery charge. Each battery use time is different based on your conditions. The numbers on the Paw meter do not reflect the percent of charge.

The battery charge level is best maintained by keeping the FLIGHT 50 Ventilator continuously plugged into an external power source.

3.2.21 Push to Unlock Button and Auto Lock Indicator

Figure 20 - *Push* to Unlock Button and Auto Lock Indicator

Auto Panel Lock can be enabled or disabled via Enabling/Disabling Auto Panel Lock(see pg 3-33-34). When Auto Lock is set to "**Enabled**" in User Set Up and the ventilator is in **On** condition and thirty (30) seconds have elapsed without pressing any buttons, the Auto Lock function is automatically activated and the (Auto Lock On) LED illuminates green. When Auto Lock is active, all touch buttons (except Int. Battery Test and Silence/Reset) are locked, preventing accidental changes.

➔ **To unlock the panel and enable the activation of all touch buttons for adjustment:**

1. Press and hold **Push to Unlock** for at least one second.

   An audible beep sounds and the LED is extinguished.

2. After thirty (30) seconds have elapsed without pressing any buttons, the Auto Lock is automatically activated again.

Auto Panel Lock is factory preset to "**Disabled**" (off).

3.2.22 Silence / Reset

Figure 21- Silence Reset Button

The Silence/Reset button has three functions:

- Silencing alarms: press the **Silence/Reset** button to silence all alarms for 60 seconds. When the Silence/Reset indicator is illuminated, all alarms are silenced except Device Alert alarm. Press the **Silence/ Reset** button again to cancel the silence period.
- Clearing alarm messages: press the **Silence/Reset** button to clear all alarm messages in the Message Display Window and to release latched LED indicators when the cause for the alarm is no longer present.
- Toggle Buzzer Volume (alarm loudness) between Loud and Quiet: press and hold the **Silence/Reset** button when there are no alarm messages displayed to toggle the alarm audible volume between loud and quiet. The alarm will sound at the new setting.

The Battery Empty Alarm and the Device Alert Alarm cannot be silenced permanently. These alarms indicate that an alternate source of ventilation must be utilized. See pgs 3-24 and 3-25 for more details.

3.2.23 Paw Meter (airway pressure meter)

Figure 22 - Paw Meter

Range: –10 to 100 cmH2O / 98 mbar

The Paw meter displays airway pressure. It also indicates the internal battery charge level when the **Int. Battery** button is pressed.

3.3 Front Panel Alarms

The front panel alarm LED indicators blink when an alarm limit setting is violated. Once the violation is no longer in effect, the indicators latch (remain steadily lit) until they are reset by pressing the **Silence/Reset** button.

3.3.1 High ▲ Paw and Low ▼ Paw Alarm Control and Display (Airway Pressure)

Figure 23 - *High* ▲ Paw *and Low* ▼ *Paw* Alarm Control and Display

Range:

Paw –10 to 100 cmH_2O / 98 mbar

High ▲ Paw Alarm 4 to 99 cmH_2O / 97 mbar

Low ▼ Paw Alarm 3 to 98 cmH_2O / 96 mbar

The ▲ Paw button allows the selection of the high (peak) airway pressure alarm setting.

The ▼ Paw button allows the selection of the low peak airway pressure alarm setting.

➔ **To adjust either alarm:**

1. Press the desired button once.

   The value in the adjacent display window blinks.

2. Use the ▲**Up**/▼**Down** controls to adjust the displayed alarm setting value.

3. The new setting can be retained by:
   - Pressing the selected button again to accept the alarm setting
   - Selecting another parameter for adjustment
   - Allowing five seconds to elapse without adjustment

In SPONT mode the ▼ Paw alarm is inactive but the value can be preset.

The ▼ Paw alarm setting cannot be a value below PEEP/CPAP + 3. The ▲ Paw alarm setting must be a value at least 1 above the ▼ Paw alarm setting.

3.3.2 ▲ Paw (High Pressure) Alarm (user adjustable)

Figure 24 - ▲ Paw (High Pressure) Alarm

Audible Alarm: Intermittent beep

Visual Alarm: ▲ Paw indicator blinks red

Message Window: HIGH PRESSURE

The High ▲ Paw Alarm is activated when airway pressure (Paw) reaches the ▲ Paw alarm limit setting. Any breath in progress immediately cycles to exhalation.

The alarm violation is cancelled when Paw falls below the Paw alarm limit setting and at least one second has elapsed since the alarm was activated.

3.3.3 ▼ Paw (Low Pressure) Alarm (user adjustable)

Figure 25 - ▼ Paw (Low Pressure) Alarm

Audible Alarm: Intermittent beep

Visual Alarm: ▼Paw indicator blinks red

Message Window: LOW PRESSURE

The Low ▼ Paw Alarm is activated when airway pressure remains below the ▼Paw alarm limit setting for two consecutive mandatory breaths.

The alarm violation is cancelled when one mandatory breath is delivered without a ▼ Paw alarm violation.

> The Low ▼ Paw Alarm does not function in SPONT mode. The ▼ Paw alarm limit does not apply to spontaneous breaths in SIMV mode.

3.3.4 High ▲ $\dot{V}_I$ and Low ▼ $\dot{V}_I$ Alarm Control and Display (inspiratory minute volume)

Figure 26 - High ▲$\dot{V}_I$ and Low ▼$\dot{V}_I$ Alarm Control and Display

Range:

$\dot{V}_I$	0 to 99.0 L/min
High ▲ $\dot{V}_I$ Alarm	1.1 to 50.0 L/min
Low ▼ $\dot{V}_I$ Alarm	0.1 to 49.0 L/min

This window displays the inspiratory minute volume (in liters) and is automatically updated every 10 seconds. The V_I window always displays the delivered minute volume, except when the user is in the process of setting either the High or Low $V^{\bullet}_I$ alarm limit.

To adjust the High or Low $\dot{V}_I$ alarm limit:

1. Press ▲ or ▼ .

   The value in the adjacent display window blinks.

2. Use the **▲Up/▼Down** controls to adjust the displayed alarm limit value.
3. The new limit can be retained by:
   - Pressing the selected button again to accept the alarm setting.
   - Selecting another parameter for adjustment.
   - Allowing five seconds to elapse without adjustment

The high inspiratory minute volume alarm limit is limited to 1 > the low alarm limit setting. The low alarm limit is limited to 1 < the high alarm limit setting.

3.3.5 ▲ V_I (High Insp. Minute Volume) Alarm (user adjustable)

Figure 27 - ▲ $\dot{V}_I$ (High Insp. Minute Volume) Alarm

Audible Alarm: Intermittent beep

Visual Alarm: ▲ $\dot{V}_I$ indicator blinks red

Message Window: HIGH $\dot{V}_I$

The High Insp. Minute Volume Alarm is activated when the delivered inspiratory minute volume exceeds the High ▲$\dot{V}_I$ alarm setting. The alarm is cancelled after delivered inspiratory minute volume falls below the ▲$\dot{V}_I$ alarm setting.

The Insp. Minute Volume Alarms are based on the delivered volume from the ventilator. The actual minute volume in the patient lungs may be significantly different in cases such as circuit leak, pneumothorax, and disconnection.

To verify the exhaled minute volume, use a separate exhaled volume monitor.

3.3.6 ▼ $\dot{V}_I$ (Low Insp. Minute Volume) Alarm Back-up Ventilation (user adjustable)

Figure 28 - ▼ $\dot{V}_I$ (Low Insp. Minute Volume) Alarm Back-up Ventilation

Audible Alarm: Intermittent beep

Visual Alarm: ▼$\dot{V}_I$ indicator blinks red

Message Window: LOW $\dot{V}_I$

LOW $\dot{V}_I$ (BUV) (if back-up ventilation is active

The Low Insp. Minute Volume Alarm is activated when delivered inspiratory minute volume falls below the Low ▼$\dot{V}_I$ alarm limit setting.

The Insp. Minute Volume Alarms are based on the delivered volume from the ventilator. The actual minute volume in the patient lungs may be significantly different in cases such as circuit leak, disconnection, and pneumothorax.

To verify the exhaled minute volume, use a separate exhaled volume monitor.

3.3.6.1 Back-up Ventilation

Back-up Ventilation is an alarmed function that activates when the delivered inspiratory minute volume ($\dot{V}$) falls below the Low ▼$\dot{V}_I$ setting. During Back-up Ventilation, the Low ▼$\dot{V}_I$ (Back-up Vent) alarm indicator blinks, an audible alarm sounds, and "**LOW $\dot{V}_I$ (BUV)**" is displayed in the Message Display Window. The ventilation settings employed by Back-up Ventilation are then displayed on the front panel. Back-up Ventilation ceases when $\dot{V}_I$ = ▼$\dot{V}_I$ + 10%, at which time ventilation and front panel displays return to user-set values.

Back-up Ventilation is functional in all modes.

3.3.7 High Baseline Pressure Alarm (automatic)

Figure 29 - High Baseline Pressure Alarm

Audible Alarm: Intermittent beep

Visual Alarm: ▲Paw indicator blinks red

Message Window: HIGH Pbase

The High Baseline Pressure (High Pbase) alarm is activated when airway pressure is above the Low ▼ Paw alarm limit setting at the beginning of a time activated mandatory breath. The alarm resets when Paw drops to within 5 cmH_2O / mbar of the set PEEP/CPAP level.

3.3.8 Occlusion Alarm, Circuit (automatic)

Figure 30 - Occlusion Alarm, Circuit (automatic)

Audible Alarm: Intermittent beep

Visual Alarm: ▲Paw indicator blinks red at the high priority rate

Message Window: OCCLUSION

An Occlusion alarm is activated when airway pressure is above the set PEEP + 15 cmH_2O/mbar at 3 seconds after the beginning of expiration, or at the end of expiration, whichever comes first. When a breathing circuit occlusion occurs, the ventilator will be unable to release the pressure, therefore additional breaths will not be delivered until the condition is corrected. The alarm resets when airway pressure falls to within 15 cmH_2O/mbar of baseline, at which point breath delivery is resumed.

3.3.9 Occlusion Alarm, Device (automatic)

Audible Alarm: Intermittent beep

Visual Alarm: ▲Paw indicator blinks red at the high priority rate and Device Alert indicator blinks

Message Window: OCCLUSION

An Occlusion alarm is activated when airway pressure is above the set PEEP + 15 cmH_2O/mbar at 3 seconds after the beginning of expiration, or at the end of expiration, whichever comes first. When the Occlusion alarm is caused by a malfunction inside the ventilator, the FLIGHT 50 Ventilator will attempt to relieve circuit pressure through its redundant safety system. If successful, ventilation will continue, but in an alarmed state.

It is possible that the condition causing the alarm will self-correct, in which case the alarm is reset. Otherwise, the ventilator will continue to alarm until the necessary service is performed. If the FLIGHT 50 Ventilator is unsuccessful in relieving circuit pressure, additional breaths will not be delivered unless airway pressure falls to within 15 cmH_2O/mbar of baseline.

WARNING

Any time a Device Alert violation occurs along with the message "**OCCLUSION**" an alternate method of ventilation should be provided for the patient as soon as possible so that the cause of the violation can be adequately and safely investigated.

3.3.10 Low Baseline Pressure Alarm (automatic)

Figure 31 - Low Baseline Pressure Alarm (automatic)

Audible Alarm: Intermittent beep

Visual Alarm: ▼Paw/Apnea indicator blinks red

Message Window: LOW Pbase

The Low Baseline Pressure (Low Pbase) Alarm is activated by an unstable baseline (leak in the breathing circuit) or by a baseline decrease since the last PEEP/CPAP control change. A Low Pbase violation occurs in all modes when airway pressure remains ≥ 3 cmH_2O/mbar below baseline for 3 seconds. The same LED that blinks during Low ▼Paw violations blinks when this alarm is activated. The alarm resets when airway pressure is <3 cmH_2O/mbar below baseline.

3.3.11 Check Prox Line Alarm (automatic)

Figure 32 - Check Prox Line Alarm (automatic)

Audible Alarm: Intermittent beep

Visual Alarm: ▾Paw/Apnea indicator blinks red

Message Window: CHECK PROX LINE

The Check Prox Line Alarm is activated when, during inspiration, the pressure measurement of the proximal pressure sensing line is significantly different from the internal back up pressure sensing line located inside the ventilator.

This may be caused by a disconnected, kinked, water-filled proximal sensing line, or a blocked proximal line filter. Ventilation is continued during the alarm condition, using the pressure measurement of the internal sensing line.

3.3.12 Apnea Alarm (automatic)

Figure 33 - Apnea Alarm (automatic)

Audible Alarm: Intermittent beep

Visual Alarm: ▼Paw/Apnea indicator blinks red

Message Window: APNEA

The Apnea Alarm is activated when no mandatory breaths or detected spontaneous efforts occur for 30 seconds. The alarm is reset by a time or patient trigger.

The Apnea Alarm does not activate Back-up Ventilation.

3.3.13 PCV Not Reached Alarm (automatic)

Figure 34 - PCV Not Reached Alarm (automatic)

Audible Alarm: Intermittent beep

Visual Alarm: ▼Paw/Apnea indicator blinks red

Message Window: PCV NOT REACHED

The PCV Not Reached Alarm is activated in pressure control ventilation when the maximum inspiratory pressure (Paw P) is less than 50% of the target pressure for two consecutive mandatory breaths.

The alarm is reset when maximum inspiratory pressure (Paw P) is ≥ 50% of the target pressure.

3.3.14 Humidifier Alarm (automatic)

Figure 35 - Humidifier Alarm (automatic)

Audible Alarm: Intermittent 3-pulse caution beep

Visual Alarm: Humidifier indicator blinks yellow

The Humidifier Alarm is activated when any of the following conditions occur in the FLIGHT 50 Ventilator built-in humidifier. When an alarm condition is detected the humidifier heater shuts down.

There are five humidifier alarms:

Message Display Window	Cause of Alarm
Check Humidifier	Bottle removed or not clamped properly when trying to activate the humidifier. Temp Probe not connected or missing when trying to activate the humidifier.
Humidifier Fail	Bottle removed while humidifier is On. Failure of the primary humidifier control.
Check Temp Probe	Temp Probe damaged or missing while humidifier is On.
High Prox Temp	Proximal temperature exceeds set target temperature by 4°C when set at ≥ 34°C or 6°C when set at < 34°C.
High Temp Core	Excessive temperature in the humidifier heating element.

The Humidifier Alarm is automatically set when using the FLIGHT 50 Ventilator humidifier. Humidifier Alarms (and the built-in humidifier) do not function when the FLIGHT 50 Ventilator is powered on internal battery.

3.3.15 Battery Low Alarm

Figure 36 - Battery Low Alarm

Audible Alarm: Intermittent 3-pulse caution beeps

Visual Alarm: Int. Battery indicator blinks yellow

Message Window: Battery Low

Indicates that a minimum of 15 minutes of operating power remains in the battery. Pressing the **Silence/Reset** button will cancel the audible three-pulse caution beeps but the visual alarm will continue to blink and the alarm will beep once every three minutes as long as the alarm condition continues. The alarm is reset when A.C. or external D.C. power is connected to the FLIGHT 50 Ventilator.

The battery condition and ventilator settings used will affect remaining time, but it will be at least 30 minutes.

3.3.16 Battery Empty Alarm (automatic)

Figure 37 - Battery Empty Alarm (automatic)

Audible Alarm: Intermittent beep

Visual Alarm: Int. Battery indicator blinks red

Message Window: BATTERY EMPTY

Indicates that a minimum of 15 minutes of operating power remains in the battery. An alternate power source must be located immediately. This alarm can only be temporarily silenced as long as the alarm condition continues. The alarm is reset when A.C. or external D.C. power is connected to the FLIGHT 50 Ventilator.

The actual time remaining depends on the battery condition and the ventilator settings used.

Frequent deep discharge of the battery will decrease the amount of time the FLIGHT 50 Ventilator will operate on battery power from a full charge state. Replace the battery when battery operation time is insufficient for application.

WARNING

Immediately secure an external power source when the Battery Empty alarm is violated. Charge the battery for a minimum of 5 hours (~80% recharged) before powering the ventilator again from the internal battery. If the battery is completely depleted, it takes approximately 7 to 8 hours to fully recharge.

If the FLIGHT 50 Ventilator is to be powered from the battery for an extended period, ensure that the battery is fully charged prior to use.

3.3.17 Fault Battery System Alarm, Device Alert (automatic)

Audible Alarm: Intermittent beep

Visual Alarm: Device Alert indicator blinks red

Message Window: FAULT BAT SYS

The status of the internal battery system and the charging system is continuously monitored and any deficiency will result in a Battery Fault Alarm.

The FLIGHT 50 Ventilator will continue to operate properly from an external power source but it cannot be powered by the internal battery system.

If the "**Fault Bat Sys**" device alert alarm occurs, keep the FLIGHT 50 Ventilator plugged into an external power source. Contact FLIGHT MEDICAL Technical Service Dept.

3.3.18 Power Switchover Alarm (automatic)

Figure 38 - Power Switchover Alarm (automatic)

Audible Alarm: Intermittent 3-pulse caution beeps

Visual Alarm: Ext. Power indicator illuminates red Int. Battery indicator blinks yellow

Message Window: No ext power

The Power Switchover Alarm is activated by switching from external power to the battery due to disconnection from the power cord or a power interruption.

Press the **Silence/Reset** button to cancel:

- The audible alarm
- The "**No ext power**" message
- The Ext. Power LED
- The Int. Battery LED to change to non-blinking yellow indicator

If external power is connected within 60 seconds following internal battery operation, the FLIGHT 50 Ventilator will immediately switch back to external power.

If internal battery operation has lasted longer than 60 seconds, there will be a delay of up to an additional 60 seconds before the FLIGHT 50 Ventilator will switch back to external power. If "**No ext power**" message is still displayed following the re-connection to external power, press **Silence/Reset** button to cancel the message.

3.3.19 Device Alert Alarm (automatic)

Figure 39 - Device Alert Alarm (automatic)

Audible Alarm: Intermittent beep

Visual Alarm: Device Alert indicator blinks red

Message Window: OCCLUSION or 10V SHUTDOWN or FAULT BAT SYS or SYSTEM ERROR or MOTOR FAULT

The Device Alert Alarm is activated when the microprocessor detects a functional problem with the ventilator. With the exception of OCCLUSION & FAULT BAT SYS, all other Device Alert alarms are non-recoverable and will result in the FLIGHT 50 Ventilator discontinuing ventilation. When this occurs, the ventilator must be powered down by pressing the **On/Standby** button.

DO NOT use the ventilator until the cause of the alert has been determined and corrected.

See Pg.3-20, Occlusion Alarm, Device (automatic), and Pg. 3-24, Fault Battery System Alarm, Device Alert (automatic), for a detailed description of these recoverable Device Alert Alarms.

There are three possible messages that will be displayed when a non-recoverable Device Alert Alarm occurs:

- MOTOR FAULT
- 10V SHUTDOWN
- SYSTEM ERROR.

For MOTOR FAULT and 10V SHUTDOWN the full text message will be displayed for 5 seconds, followed by an abbreviated form of the message, e.g. MTR Fail, or 10V Fail. A timing message will also appear, documenting how long the condition has been present. The format for the time is "**H:MM:SS**." The SYSTEM ERROR message will always be displayed with full text.

If the cause of the SYSTEM ERROR does not allow the FLIGHT 50 Ventilator to display the alarm message and the Device Alert indicator to light, the ventilator will shut down and the Shut Down Alert Alarm will activate.

Upon the next power up of the unit, the SYSTEM ERROR message will be displayed. If the cause of the alarm has been corrected, the message can be cancelled by pressing the **Silence/Reset** button.

If a non-recoverable Device Alert alarm occurs, immediately disconnect the patient from the ventilator and provide an alternate method of ventilation.

A non-recoverable Device Alert Alarm cannot be silenced without first turning the ventilator Off (Standby).

3.3.20 Shut Down Alert Alarm (automatic)

Audible Alarm: Intermittent beeps

The Shut Down Alert Alarm occurs when the ventilator is powered Off. An intermittent audible alert indicates the ventilator is no longer operating. The intermittent beeps will continue for at least 10 minutes or until it is silenced by pressing the **Silence/Reset** button

3.4 Front Panel Message Display Window

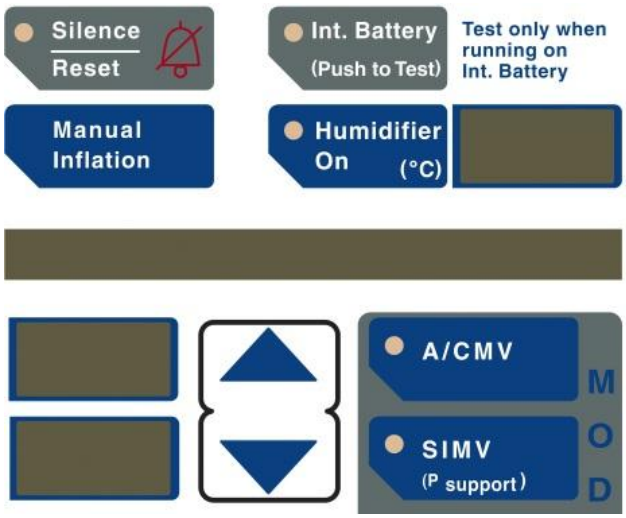


Figure 40 - *Front* Panel Message Display Window

All messages and alarms are displayed in a 16 character, alpha numeric window located above the MODE controls.

3.4.1 Message Monitoring

When the Message Display Window is blank, with no messages displayed, press the **▲Up** control to scroll through the available monitoring messages. Monitored information includes:

- Volume
- Frequency
- Pressure values
- Operation information

Tidal volume, baseline pressure, and peak pressure are updated breath by breath. Frequency and mean pressure are also updated breath by breath, using a 6 second rolling average for frequency and a 60 sec. rolling average for mean pressure. Minute volume is updated every ten (10) seconds using a sixty (60) second rolling average.

Monitoring Messages cannot be accessed during alarm violations.

There are 3 selections available:

- VT / $\dot{V}$i / f
- Paw / P / M / B
- H/S/L (or Q)

Press ▲ **Up** to scroll through the lines. Three seconds after selecting a line, the relevant operating parameters are displayed. The following table details the parameters for each line:

Line 1	"VT xxx $\dot{V}$i xx f xx" VT – Tidal volume (in mL) $\dot{V}_i$ – Insp. Minute Volume (in L/min) rounded to nearest whole number f – Total number of patient or time activated breaths detected for the last 60 seconds (in b/min)
Line 2:	"Paw Pxx Mxx Bxx" P – Peak airway pressure of last breath M – Mean airway pressure B – Baseline airway pressure at the end of expiration
Line 3	"H xxxxx Sxxxxx L (or Q)" H – Hour meter reading S – Software Version L/Q – Audible Level of Alarm (Loud or Quiet)

Table 2 – Message Monitoring Parameters

After 4 seconds this line will go blank. Access this information any time by pressing the ▲ **Up** button.

3.4.2 Alarm and Caution Messages

All alarms have corresponding messages in the Message Display Window. See pg 2-1 for list of alarms. If more than one alarm is violated, they are displayed in order of medical priority. Alarm messages override the display of monitored parameters.

3.4.3 Setting Limitation Messages

The following "**Setting Limitation**" messages are displayed to notify the user that adjustments have caused parameters to reach software defined limitations.

Reached Max $\dot{V}$	maximum $\dot{V}$ (flow) setting has been reached
Reached Min $\dot{V}$	minimum $\dot{V}$ (flow) setting has been reached
Inverse I:E	inverse I:E ratio has been reached
Reached Max I:E	inverse I:E ratio has reached 3:1
$\dot{V}$ Unavailable	$\dot{V}$ display is not available in Pressure Control
Peep + PS Too High	set PEEP + Psupport is higher than 60
PC - Peep Too Low	Pressure Control value minus PEEP is less than 5 cmH_2O/mbar
↑ - PEEP Too Low	High Pressure alarm limit minus PEEP is less than 5 cmH_2O/mbar

The following messages are provided as "prompts" or reminders.

Panel Locked:	Notifies user that the front panel buttons are now locked
PRESS AGAIN:	Notifies user that a second press on the same button is required in order to confirm change requested.

Table 3 - Setting Limitation Messages

3.5 Left Side Connectors

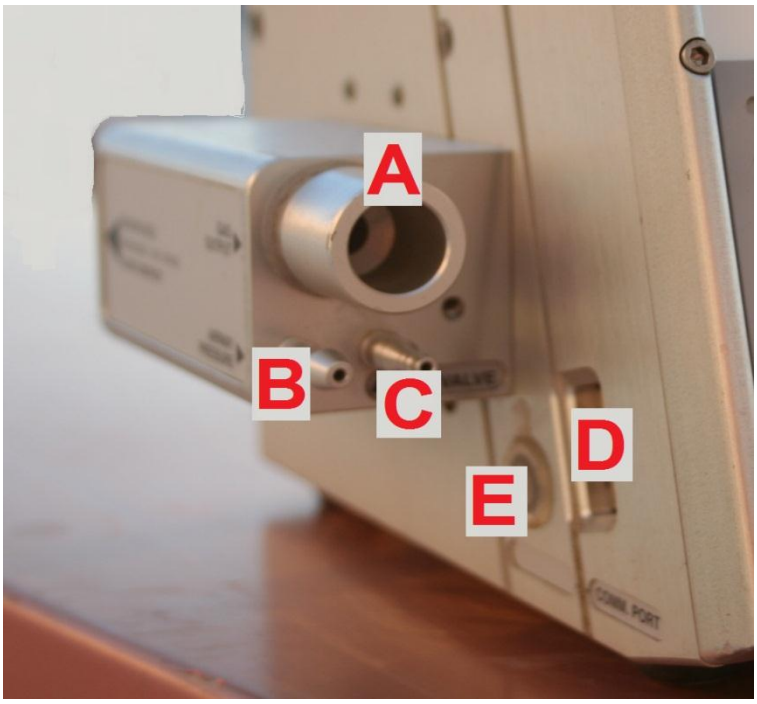


Figure 41- Left Side conectors

A	Gas Output Connector
B	Airway Pressure Connector
C	Exhalation Valve Connector
D	RS-232C Connector
E	Temperature Probe Connector (for humidifier)

WARNING

The round heater for the optional humidifier is located near the left side connectors. This heater becomes extremely hot when the humidifier is on. DO NOT TOUCH!

3.5.1 Airway Pressure Connector

Measures airway pressure. Connect the proximal pressure sensing line of the patient breathing circuit to this fitting.

WARNING

Always use an inline filter (p/n HT6004701 or equivalent) at the Airway Pressure Connector to protect the internal pressure transducers from moisture or other contaminants.

3.5.2 Gas Output Connector

Supplies gas flow to the patient. Connect the patient breathing circuit to this outlet.

3.5.3 Exhalation Valve Connector

Controls the exhalation valve. Connect the exhalation valve control drive line to this outlet.

3.5.4 RS-232C Connector

An 8 pin SEMCONN connector operating at 19,200 baud which allows the ventilator system to interface with central alarm systems and remote alarms.

3.5.5 Temperature Probe Connector

The electrical connector for dual-channel temperature probes which connectors are used to measure the temperature in the humidifier water bottle and the patient breathing circuit.

Contact your FLIGHT MEDICAL representative for more information regarding compatibility with specific remote monitoring systems.

3.5.6 Emergency Air Intake

This enables the patient to pull ambient air into the breathing circuit in the event of a complete system failure. Air intake opening pressure is approximately –3 cmH_2O (–3 mbar).

Do not obstruct the Emergency Air Intake! Any impediment could result in patient suffocation.

Should a complete failure of the ventilator occur, the Emergency Air Intake allows the patient to breath from room air through the intake valve. Blockage of the valve could result in suffocation. Check periodically to ensure that the valve functions correctly.

3.6 Right Side Connectors

3.6.1 Fresh Gas Intake and Filter Cover

Figure 42 - Fresh Gas Intake and Filter Cover

Environmental air enters through this 30 mm ID Fresh Gas Intake. The air inlet particle filter is placed behind the Filter Cover. This protects the patient as well as the ventilator's piston system from dirt and particles. The Fresh Gas Intake is the attachment socket for the optional FLIGHT 50 Ventilator Air/Oxygen Entrainment Mixer or an Oxygen Blending Bag.

WARNING

Do not block the Fresh Gas Intake.

3.6.2 External Power Connector

- 100-240 VAC, max. 2A
- 12-30 VDC, max. 12A
- 50/60/400 Hz

The FLIGHT 50 Ventilator uses a single inlet for both A.C. and D.C. power sources. The inlet power connector automatically recognizes A.C. voltage ranges from 100 to 240 and D.C. ranges from 12 to 30. A FLIGHT MEDICAL approved external battery can be attached to this connector.

WARNING

To ensure proper grounding and prevent possible shock hazards, this device should only be connected to "Hospital Grade" power receptacles.

WARNING

HOME CAREGIVERS: External power in the home environment must support min. 100 to max. 240 VAC and must have a grounded receptacle.

3.6.3 Equipotential Connector

Figure 43 - Equipotential Connector

Used for electric potential equalization.

3.6.4 Power Cord Ferrite

Figure 44 - Power Cord Ferrite

Use of the Power Cord Ferrite ensures that the FLIGHT 50 Ventilator meets EMC requirements. Anytime the FLIGHT 50 Ventilator is operating on A.C. power, the ferrite should be attached to the power cord. Operating from D.C. power does not require the use of the ferrite.

Always use the A.C. power cord supplied with the FLIGHT 50 Ventilator

3.7 Optional Accessories

3.7.1 Air/Oxygen Entrainment Mixer

Figure 45 - Air/Oxygen Entrainment Mixer

The Air/Oxygen Entrainment Mixer is used to blend atmospheric air with medical grade oxygen at a precise ratio. A control knob allows for incremental adjustment from 21% to 100% FIO2. The high pressure oxygen hose has a standard female DISS 1240 connection. The Mixer

attaches to the Fresh Gas Intake of the FLIGHT 50 Ventilator on the Filter Cover, located on the right side of the ventilator.

Pneumatic Requirements: Oxygen 35-90 psig (2.4 to 6.2 Bar)

3.7.2 Oxygen Blending Bag Kit

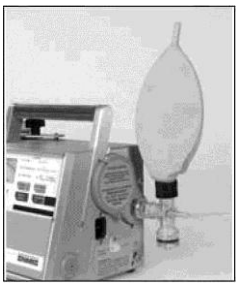


Figure 46 - Oxygen Blending Bag Kit

The Oxygen Blending Bag Kit is used to blend atmospheric air with a low flow (0 to 10 L/min) medical grade oxygen source. The Oxygen Blending Bag Kit attaches to the Fresh Gas Intake on the Filter Cover, located on the right side of the ventilator. This system allows the user to ventilate patients with oxygen enriched gas from 21% to 100% FiO2.

Pneumatic Requirements: Oxygen 0-10 L/min

3.7.3 Auto Lighter Cable

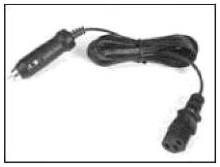


Figure 47 - Auto Lighter Cable

The Auto Lighter Cable allows the FLIGHT 50 Ventilator to be powered through the D.C. lighter plug in an automobile. The internal battery charges whenever the FLIGHT 50 Ventilator is connected to an external power source, equal to or greater than 12 VDC, including the D.C. lighter plug.

3.8 User Set Up

The User Set Up allows the operator to select a variety of functional parameters. User Set Up parameters must be established before the FLIGHT 50 Ventilator is used for ventilation.

HOME CAREGIVERS: The User Set Up parameters should be defined in conjunction with your physician or Homecare Dealer. Once established, these parameters are kept in memory and will be in affect each time the ventilator is powered on until the operator enters User Set Up and makes changes.

To enter User Set Up the FLIGHT 50 Ventilator must be in the Standby condition.

➔ **To access User Set Up, when connected to A.C. power:**

1. Press and hold the **Silence/Reset** button down.
2. When operating on internal battery, you must press the **On/Standby** button while pressing and holding the **Silence/Reset** button.
3. When the Message Display Window briefly displays the message **"USER SETUP",** release the button.

   The Message Display Window will next display the first parameter. See .
4. The user may scroll through the rest of the set up parameters by pressing the **Int. Battery** button. Use the **▲Up/▼Down** control buttons to change the parameter setting.

To exit User Set Up, press the **Silence/Reset** button once. The FLIGHT 50 Ventilator is now ready for use.

Only the ▲Up/▼Down, Silence/Reset, and Int. Battery buttons are active during User Set Up.

3.8.1 User Set Up Parameters

3.8.1.1 Power Save

Use the **▲Up/▼Down** controls to toggle the Power Save function On or Off. To conserve battery power consumption during internal battery operation, the Power Save function automatically blanks the FLIGHT 50 Ventilator's numeric displays if the ventilator has operated for 2 minutes with no buttons pressed or alarms violated. MODE, On/Standby, Int. Battery indicators and message display window remain active at all times.

If an alarm condition occurs, or any button is tapped, the Power Save function is suspended for 2 minutes. The Power Save feature can extend battery operating time by as much as 30%.

3.8.1.2 Pressure Units

Selects between cmH_2O and mbar as the unit used on the pressure meter and the various front panel controls. The FLIGHT 50 Ventilator is factory set to cmH_2O. Use the **▲Up/▼Down** controls to toggle to the mbar setting.

For consistency, particularly in medical record keeping, it is recommended that each institution standardize to either "cmH_2O" or "mbar" operation.

HOME CAREGIVERS: The unit of measure, along with other parameter settings, should be established by the patient's physician or Homecare Dealer.

3.8.1.3 Set Up

The Set Up parameter allows the operator to set the ventilator's start up settings. There are two selections, DEFAULT or USER. Use the **▲Up/▼Down** button to toggle between selections.

When USER is selected, all of the ventilation parameters in effect at shutdown will be saved. The saved parameters will appear next time the ventilator is powered on.

When DEFAULT is selected, factory set default parameters will appear next time the ventilator is powered on.

HOME CAREGIVERS: This parameter should always be set to USER for home use to ensure that when the FLIGHT 50 Ventilator is powered off and on the physician directed ventilation settings remain in place.

3.8.1.4 Auto Panel Lock

This setting allows the user to enable (turn on) or disable (turn off) the Auto Panel Lock feature. For a complete description of Auto Panel Lock see pg 3-36. The Auto Panel Lock feature is factory set at Disabled or off. Use the **▲Up/▼Down** buttons to toggle between Enabled and Disabled.

HOME CAREGIVERS: FLIGHT MEDICAL recommends that the Auto Panel Lock feature be enabled in homecare environments as an added safety feature to prevent accidental changes to panel controls.

3.8.1.5 Exiting User Set Up

Exit by pressing the **Silence/Reset** button at any time.

4 Removing and Reinstalling Modules

4.1 Introduction

The following assemblies are replaceable during service, if they are worn, damaged or suspected to be performing improperly.

- Internal battery assembly
- Manifold assembly
- Outlet assembly
- Humidifier assembly
- Front panel PCB assembly
- Main board assembly
- Power supply assembly

Hazardous voltages are present inside the ventilator. Disconnect electrical power and oxygen sources before attempting any disassembly. Failure to do so could result in injury to service personnel or equipment.

4.2 Required Equipment

- #10 screwdriver
- Phillips head screwdriver
- 7/64" Allen wrench
- Torque screwdriver (for #10 Torx & 7/16" Allen)

All Allen head and size #10 Torx screws are tightened to 12.

4.3 Internal Modules

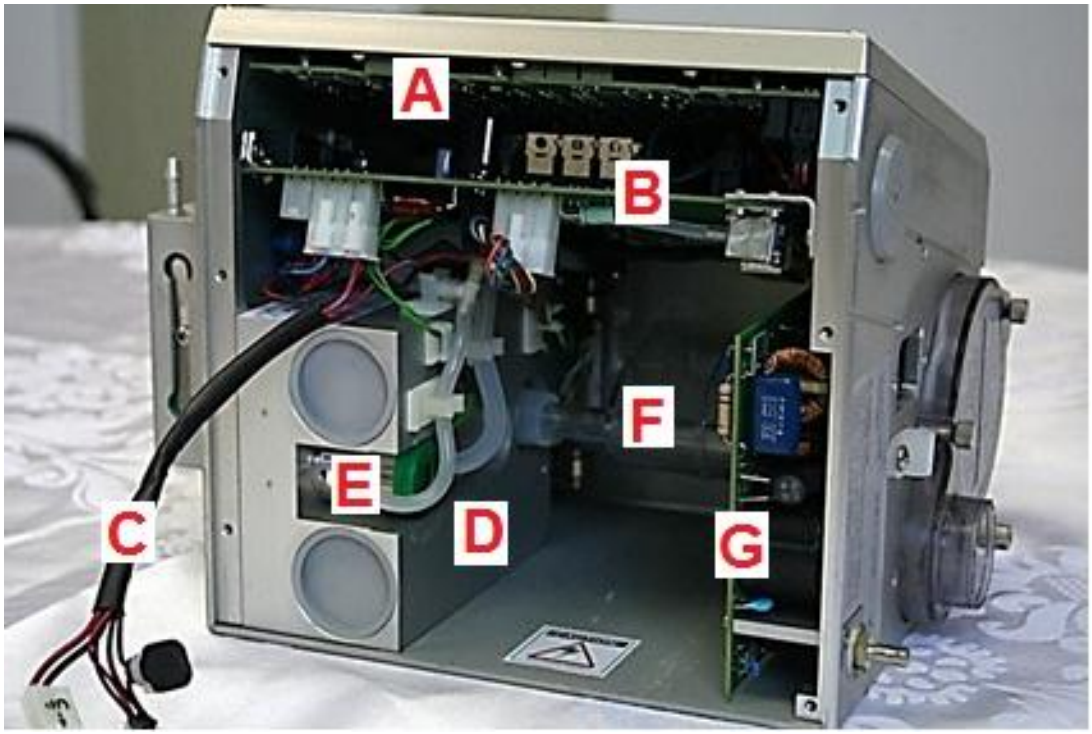


Figure 48 – Ventilator Modules

Module	P/N
A Panel Board (PB)	V11-71000-65
B Main Board (MB)	V09-60000-65
C Battery Cable	
D Manifold	V50-21000-60
E Solenoid	V11-21400-69
F Muffler	V11-33000-67
G Power Supply (PS)	V11-31001-65

Figure 49 - Internal Battery

4.4 Power Supply Discharge

Refer to pg 3-32, External Power Connector, for proper connection of an external DC power source.

1. Connect a DC power source to the external power connector on the FLIGHT 50 Ventilator, and leave for at least 10 seconds.
2. After 10 seconds has elapsed, remove the external power source. Only after the FLIGHT 50 Ventilator power supply has been discharged is it safe to remove components from the inside of the FLIGHT 50 VENTILATOR.

4.5 Lower Case Disassembly

1. Place the ventilator on the back side to access the lower case.
2. Remove the 6 Torx screws securing the lower case. DO NOT remove the four rubber supports (see Fig 50).
3. Carefully remove the cover avoiding tension on the battery cable.
4. Disconnect the battery cable from the battery.

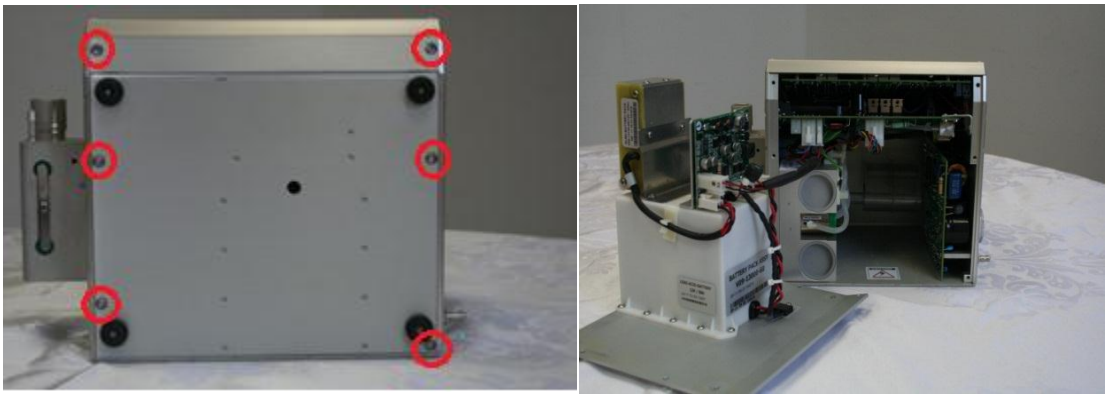


Figure 50 – Lower case disassembly

4.6 Lower Case Assembly

1. Connect the battery cable to the battery
2. Carefully insert the battery to the ventilator, verify all cables and wires are tucked so they are away from the battery.
3. Push the Lower Case all the way in, make sure the lower cover is flush, to ensure that wires don't get pinched between clamped surfaces.

4.7 Power Supply Replacement

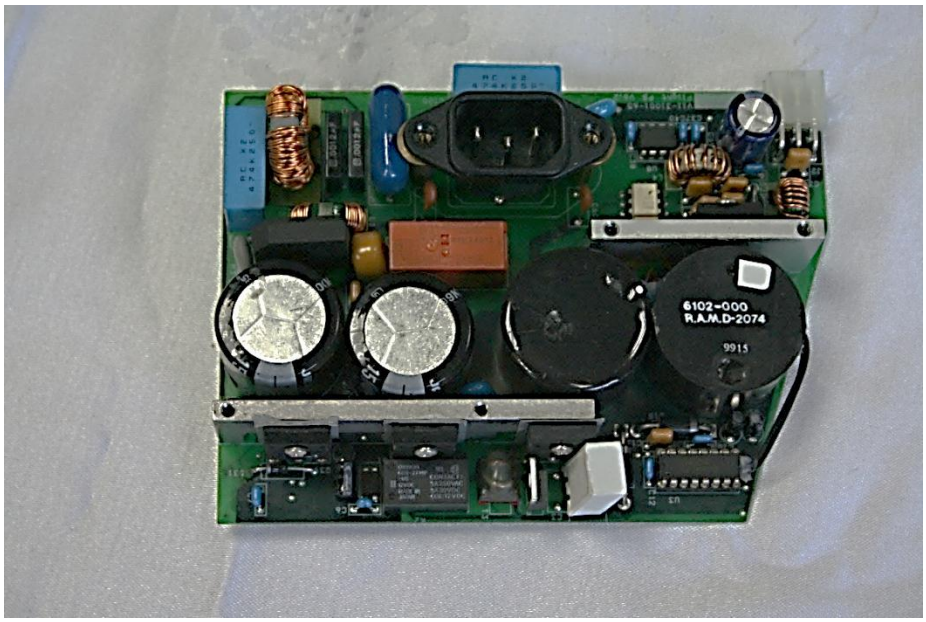


Figure 51 - Power Supply

1. Remove the Lower Case Assembly.
2. Remove the Filter Cover from the left side panel.

3. Remove the 6 Torx screws securing the Power Supply to the ventilator housing.

> The two screws that secure the power inlet (highlighted in Yellow below) are longer.

Figure 52 - Removing the power supply

4. Gently pull out the Power Supply from the ventilator case.

> There is a harness connected to the Power Supply, make sure it is free.

5. Disconnect the wiring harness from the Power Supply.

6. Reverse steps 1-5 to reassemble.

4.8 Internal Battery Replacement

Disassemble the Lower Case, refer to par. 4.5.

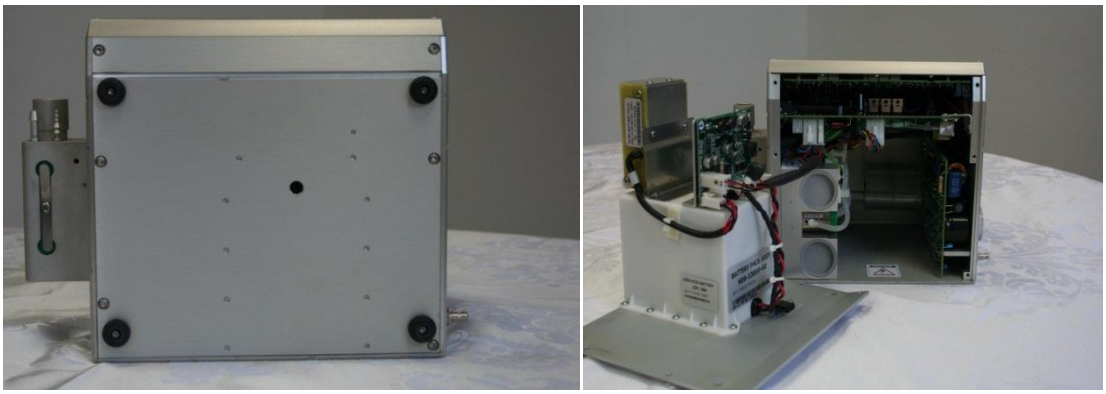


Figure 53 - Removing the battery

Disconnect the battery harness from the ventilator.

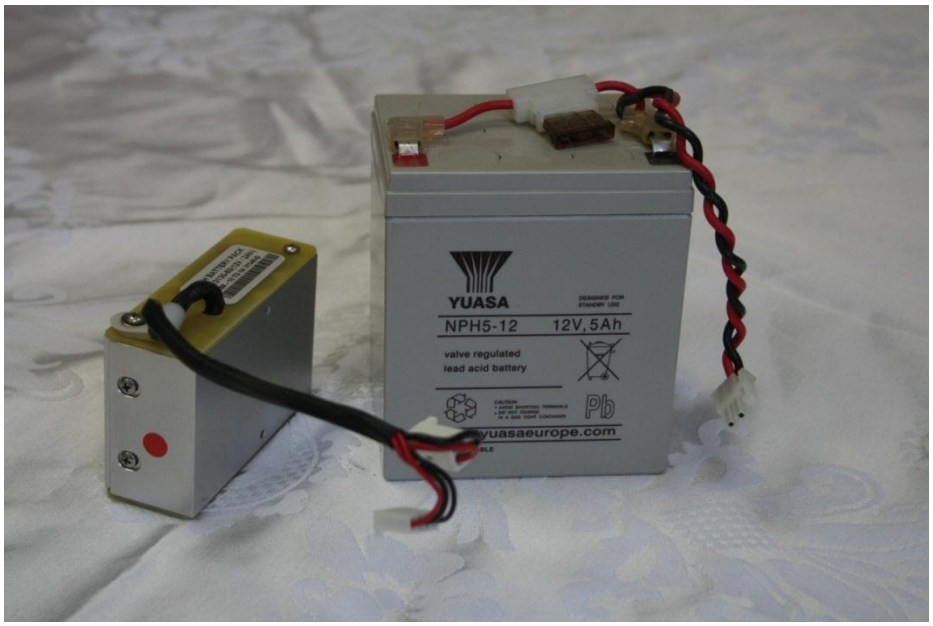


Figure 54 – NiMH(left) and Lead Acid(right) batteries

4.8.1 Replacing the NiMH Battery

Disconnect the cables from connectors J7; J8 (see Fig 55 below).

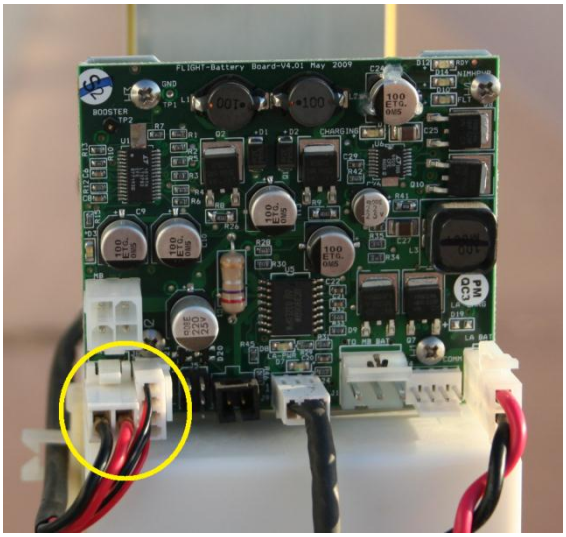


Figure 55 NiMH to battery board cables

Remove the 2 Philips screws securing the NiMH battery to its bracket.

4.8.2 Replacing the Lead Acid Battery

1. Disconnect the cables from connectors J6; J9 (see Fig 56 below).
2. Remove the 10 Torx screws securing the battery case to the lower case cover. Loosen the strain relief securing the battery wiring harness to the battery case.
3. Remove the battery case.

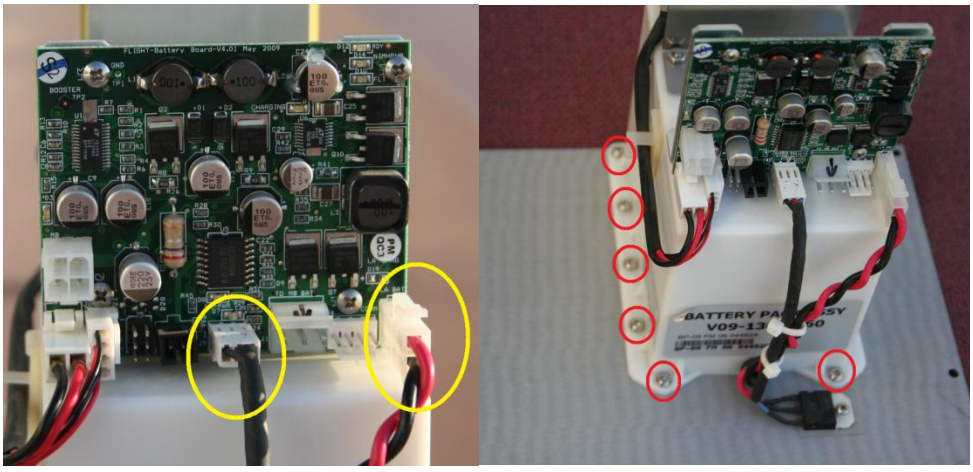


Figure 56– Battery Connectors and case

3. Remove the battery wiring harness from the old battery and attach it onto the new battery ensuring the red wire terminal connector with the in-line fuse is attached to the positive (+) terminal and the black wire terminal connector is attached to the negative (-) terminal on the battery.
4. Write the installation date and hours of the FLIGHT 50 Ventilator on the side of the new battery.
5. Lie the battery down on the side with the negative terminal closest to the lower case, tighten the strain relief securing the battery wiring harness to the battery case, then secure the battery cover over the battery using the 10 Torx screws removed in step 4.
6. Connect the cables to the battery circuit board (see Figure 56).
7. Assemble the Lower Case Assembly, refer to Par 4.6.

4.9 Manifold Assembly Replacement

1. Disassemble the Lower case, refer to Par 4.5
2. Disconnect the solenoid two-pin wiring harnesses from the Main harness by pressing the release tab on each connector.
3. Slide the Muffler Assembly from the pump inlet by pushing and twisting it back and forth until it disengages from the silicone cuff on the pump. After disconnecting the Muffler Assembly from the pump inlet, rotate it toward the rear panel of the ventilator housing so that it creates minimal interference with the removal of the pump.
4. Remove the 4 Torx screws securing the pump to the ventilator housing. See Figure 57.

Figure 57 - Manifold screws

5. Remove the 6 pin power supply wiring harness connector from the Main PCB JP8 by pressing the release tab on the connector.

6. Remove the 2 silicone tubes from the Solenoid. Note the position of the tubes as they must be connected to the new solenoid in the same order.
7. Gently slide the Pump Assembly out of the ventilator housing.

Before installing the new Pump Assembly, make certain the diaphragm in the new pump is clean and is properly seated in the pump housing counterbore.

8. Before installing the new Pump Assembly, make certain to attach each tube to the correct connector on the new solenoid.
9. Install replacement Pump Assembly by reversing steps 2 through 7.

When sliding the Muffler Assembly back into place, open the air intake filter cover and make certain that the end of the muffler is flush with the ventilator housing. This will minimize the possibility of a leak around either Muffler connection.

10. Remove Front Panel Assembly. Refer to Par 4.11.
11. Verify the silicone tube covers the Muffler Assembly and the air intake connector on the side pane
12. Reinstall the Front Panel Assembly.
13. Re-assemble the Lower Case Assembly

Setting "Next Service Due Meter"

After replacing the pump assembly, it is necessary to properly set the next service due meter. Follow these steps:

1. Record the current hours meter reading.
2. Connect the HT50 to the computer with the PCS download program via the communication cable P/N V23-00001-29.
3. Connect the HT50 to an AC power source.
4. Start the PCS download program.
5. Select the project (current version is 1.072)
6. The tables in the PCS download program will fill up with information from the HT50 Ventilator.
7. Locate the label "NextService".
8. Press the download button in the upper right corner of the PCS download program.

9. A window will show the progress of the download. While the software is being downloaded, select and highlight the "NextService" label. Change the number according to the hour meter reading and press the enter key.

The "NextService" number comes from the factory set to 15. This indicates the "Service Needed" message will appear when the Flight 50 hour meter reading equals 15,000 hours. If the manifold was replaced at 15,000 hours, the "NextService" number should be changed to 30. If the manifold was replaced at 7,500 hours, the "NextService" number should be changed to 22.5.

10. Do not remove the communication cable or close the PCS download program until the following END of download criteria have been met:
    - The program has completed the download.
    - The green LED for external power is illuminated.
    - The bottom of the PCS download program displays the message "Done Downloading Data"

4.10 Outlet Assembly Replacement

The outlet assemblies are different between the FLIGHT 50-H and FLIGHT 50-H1 models.

The Outlet Assembly should be replaced if:

- Any damage to any of the 3 connectors is visible.
- The Emergency Intake Valve is leaking (rear of outlet block).
- The Pressure Relief Valve is leaking at low pressure (bottom of outlet block).

To replace the Outlet Assembley:

1. Follow steps 1 through 7 of the Manifold Assembly Replacement , Par 4.9
2. Remove the 4 silicone tubes attached to the Outlet Assembly Caution: Mark the tubes to avoid incorrect reattachment.
3. Remove the two 2 Torx screws which secure the Outlet Assembly to the ventilator housing
4. Install the new Outlet Assembly, ensuring the O-ring seal and the humidifier's heater wires (FLIGHT 50-H only) are within the counterbore of the Outlet Assembly so that they aren't pinched by the Outlet Assembly when securing it to the ventilator housing.
5. Reverse steps 1 through 3 to reassemble.

4.11 Front Panel Board Replacement

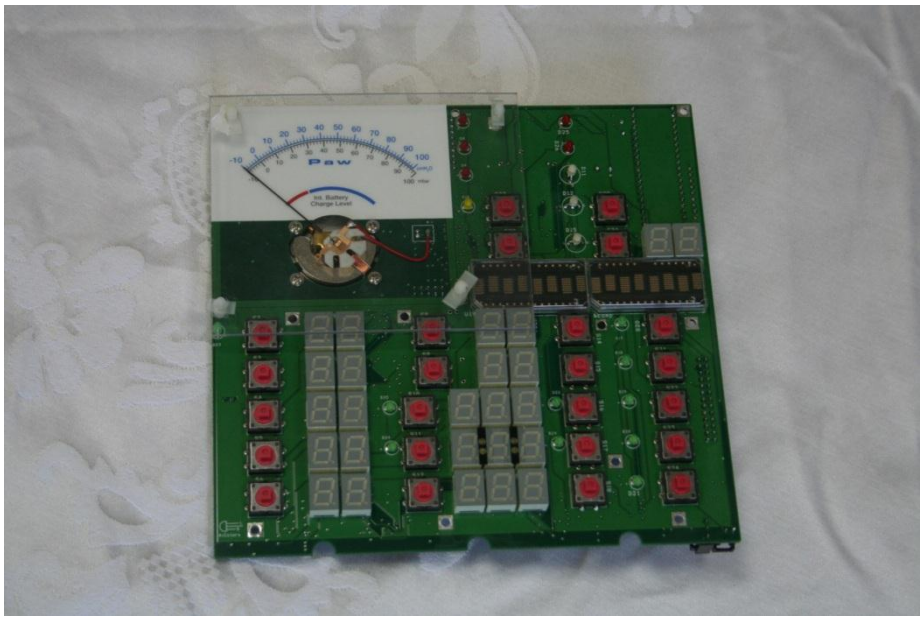


Figure 58 - Front panel

The Front Panel PCB should be replaced if:

- Any of the front panel buttons, displays, or alarms are malfunctioning.
- The analog meter is malfunctioning.

To replace the front panel board:

1. Remove the 6 Allen screws from the Front Panel bezel.
2. Carefully separate the bezel from the main ventilator housing.
3. Disconnect 2 connectors (JP1 & JP2) from the Front Panel PCB.
4. Place the Front Panel Assembly face down on a flat surface.
5. Remove the 10 Philips head screws securing the Front Panel PCB to the front panel plate.

> Some older FLIGHT 50 Ventilator units have 9 Phillips screws, instead of 10, securing the Front Panel PCB to the front panel plate.

6. Remove Front Panel PCB and place it inside an anti-static bag.
7. Remove the protective plastic cover from the analog meter.
8. Install the new Front Panel PCB, by reversing steps 1 through 3.

4.12 Front Panel Bezel Replacement

Refer to drawing Figure 9-2, Final Assembly Front View. The Front Panel Bezel should be replaced if the bezel is cracked or dented.

➔ **To replace the front panel bezel:**

1. Follow steps 1 through 4 in the FRONT PANEL BOARD REPLACEMENT section.
2. Remove the 6 Torx screws that secure the front panel plate to the bezel. Carefully separate the plate from the bezel.
3. To install the new Front Panel Bezel, reverse steps 1 and 2.

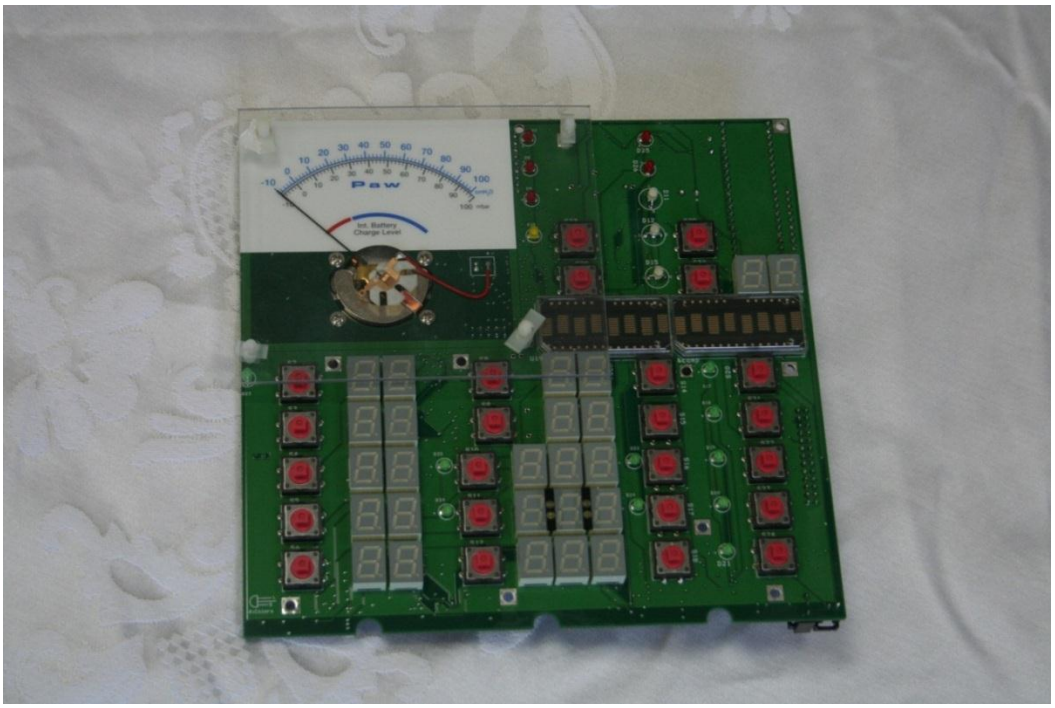


Figure 59 - Front panel bezel

4.13 Main Board Assembly Replacement

Figure 60 – Main Board

Any electronic malfunction that is not resolved with the replacement of the Front Panel PCB is usually resolved by replacing the Main PCB Assembly.

To replace the main board assembley:

1. Follow the steps in the DISASSEMBLY (Lower Case) section.
2. Remove the 6 Allen screws from the Front Panel bezel. Carefully separate the bezel from the main ventilator housing.
3. Disconnect 2 connectors (JP1 & JP2) from the Front Panel PCB.
4. Disconnect all electrical connectors from the Main PCB.
5. Remove the 4 Philips head screws that secure the RS232 connector P1 and the two transistors Q1 & Q9 to the left hand side of the ventilator housing.
6. Remove the 3 Torx screws that secure the Main PCB's mounting hardware to the ventilator housing.
7. Disconnect the 2 silicone tubes from the transducers mounted to the Main PCB.

Mark the tubes to avoid incorrect reattachment.

8. Remove defective Main PCB and transfer the mounting hardware as necessary to the new PCB.
9. Reverse steps 1 through 8 to install the new Main PCB and reassemble.

The small white insulator should be inserted into the transistor hole. Carefully tighten the screws making sure not to pinch the insulator.

Ensure that the insulator and the insulating bushing are properly placed.

5 Operation Verification Procedure (OVP)

5.1 Introduction

This procedure is intended to assist a FLIGHT MEDICAL approved service technician to establish a routine verification program to verify proper operation of the FLIGHT 50 Ventilator (p/n FLIGHT 50-H1, FLIGHT 50-H1-B, FLIGHT 50-H). An OVP must be executed each time the ventilator is serviced or a minimum of once a year.

Do not use the ventilator if it does not pass the Operational Verification Procedure.

5.2 Required Equipment

- 20 cc syringe with Luer lock
- FLIGHT 50 Ventilator adult reusable breathing circuit with exhalation valve
- 500 cc Test Lung that will function at 90 cmH_2O/mbar
- Parabolic resistor Rp50
- Calibrated manometer or pressure gauge (range: 0 to 100 cmH_2O/mbar)
- Vacuum gauge (0-120 mmHg minimum)
- T-connector
- Humidifier bottle and probe (for FLIGHT 50-H with humidifier)
- Stop watch or equivalent

The accuracy of any test equipment should be annually certified by a testing laboratory before use, taking calibration data into account.

Make a copy of the Test Record at the end of this section and check off each test as it is performed. Enter the software version number and hours on the test record.

Audible alarms will activate periodically while performing some tests. You may silence the alarm by pushing the **Silence/Reset** button.

After every setup parameter change, wait a few breaths to allow the ventilator to stabilize before recording values.

5.3 Pre-Test Inspection

There are 3 pre-test inspections that should be carried out:

- General Inspection
- Air Inlet Filter
- Connecting Breathing Circuit, Exhalation Valve, and Test Lung

Refer to Figure 9-1.

5.3.1 General Inspection

1. Inspect the patient breathing circuit, exhalation valve, and 500 cc test lung for any deterioration which may cause leaks in the system. If any defective parts are located, these should be replaced prior to performing the OVP.
2. Inspect the A.C. power cord for any deterioration, and if necessary, replace.
3. Inspect the proximal filter. If filter housing indicates the presence of dirt or moisture, replacement of the filter is necessary.

NEVER reverse filters. This practice will allow contaminates to enter the breathing circuit or ventilator. Dirty or contaminated filters must always be replaced with new filters.

5.3.2 Air Inlet Filter

1. To inspect the Air Inlet Filter:

1. Remove the Air Inlet Filter Cover.
2. Inspect the inlet filter. If the filter material indicates the presence of dirt or is discolored, replacement of the filter is necessary.
3. Before reinstalling the Inlet Filter Cover, ensure that the filter is lying flat within the counterbore of the cover.
4. Reinstall the Inlet Filter Cover, ensuring that the filter material remains securely in place. Verify that the O-ring is in its proper place.

5.3.3 Connecting Breathing Circuit, Exhalation Valve, and Test Lung

➔ **To connect the breathing circuit, exhalation valve, and test lung**

1. Attach one end of the patient tubing to the main flow outlet labeled "**GAS OUTPUT**" (bypassing any humidifier) and the other end to the exhalation valve.

2. Attach one end of the exhalation drive line tubing to the connector labeled "**EXH. VALVE**" and the other end to the white connector on the exhalation valve.
3. Attach one end of the proximal pressure tubing to the connector labeled "**AIRWAY PRESSURE**" (via the proximal inline filter) and the other end to the blue connector on the exhalation valve.
4. Connect the 500 cc test lung to the exhalation valve.

The proximal filter must remain inline for all calibrations and tests.

5.4 Front Panel Test/Alarm Check

➔ **To test the front panel and check alarms:**

1. Connect the ventilator to A.C. power.
2. Press the On/Standby button once. The ventilator performs a self-test and then switches to the Settings condition.
3. While carrying out this test, verify operation of the audible alarm and all LED indicators, numeric and alphanumeric displays. Verify that:
   - All single color and dual color indicator LEDs are functional and are at the same strength.
   - All 7-segment LEDs are functional.
4. Press all the buttons and verify that they are functional and can be operated with the same force.

Before continuing to the next step, verify that the ventilator has been in Settings or On mode for at least 5 minutes.

5. Disconnect the ventilator from the A.C. power.
6. Place the ventilator in the Standby condition by tapping the On/Standby button twice.
7. Allow the shutdown alarm to continue for at least two minutes before silencing it by pressing the alarm Silence/Reset button.
8. If the alarm does not continue strongly for at least two minutes, contact FLIGHT MEDICAL technical support.
9. Connect the ventilator to A.C. power.

5.5 System Leak Test

➔ **To test for a system leak:**

1. Set the FLIGHT 50 Ventilator to Standard Test Settings.

2. Ensure the 3 thumbscrews of the inlet filter cover are secure in order to ensure no leakage around the cover.
3. Connect the vacuum (negative pressure) gauge to the gas inlet.
4. Start ventilation.

The required pressure reading must be 120 mmHg or greater.

A failed test is characterized as:

- failing to achieve 120 mmHg negative pressure
- A rapid drop in the vacuum during exhalation.

During exhalation phase, a decrease in negative pressure on the negative pressure gauge is normal.

If system leak test fails and the leak exists in the pneumatic system between the manifold and patient circuit, calibration must be performed again after the leak is fixed.

5.6 Pressure Transducers Calibration

➔ **To calibrate the pressure transducers:**

1. Connect the T-connector between the patient fitting on the exhalation valve and a test lung.
2. Attach the small bore tubing from the T-connector to the calibrated pressure gauge.
3. While in the Standby condition, enter USER SETUP by pressing and holding the **Silence/Reset** button until the Message Display Window shows "**USER SETUP**," then release the button.
4. Use the **Int. Battery** button to scroll to the "Tech. Setup" message.
5. Use the **▲Up** control button to select this parameter.

   The Message Display Window displays "**Enter Code…,**"
6. Press the ***ƒ*** button then the **A/CMV** button within 5 seconds.

   The Message Display Window displays "**Pressure Cal.**"
7. Press the **▲Up** control button.

   The Message Display Window displays "**Apply Zero Pressure.**"

Ensure that the calibrated pressure gauge shows zero pressure. If pressure > 0, remove breathing circuit to relieve pressure.

The system starts the motor and inflates the test lung.

The Message Display Window will show "**Pressure = 60.0**" (60 is the default value).

8. Press the **Int. Battery** button.
9. Adjust the displayed value in the Message Display Window on the ventilator using the **▲Up/▼Down** control buttons so that it shows the same value as the calibrated pressure gauge. The value should be between 40 and 90.
10. Press the **Int. Battery** button again.

    After a couple of seconds, the two pressure values display: P1 = X and P2 = X (X is the pressure value)., and then, after a few more seconds the Message Display Window shows the message "**Pressure Cal.**"

    You are now ready to repeat the calibration.
11. Repeat steps 7 through 10, this time making note of the P1 and P2 values. These two numerical values should be within 1.5 of each other. If the difference is within an acceptable range, you are ready for the next calibration. If they are not, repeat calibration until the values are within this range.
12. Remove the T-connector and 500 cc test lung.

5.7 Pressure Meter Calibration

➔ **To calibrate the pressure meter:**

1. Use the Int. Battery button to scroll to "**Meter Cal.**"
2. Press the **▲Up** control button to select "**Meter Cal.**"

   The Message Display Window displays "Adjust to 0."
3. Use the **▲Up/▼Down** control buttons to adjust the Paw needle to 0.
4. Press the **Int. Battery** button.

   The Message Display Window displays "**Adjust to 60.**"
5. Use the **▲Up/▼Down** control buttons to adjust the Paw needle to 60.
6. Press the **Int. Battery** button.

   The Message Display Window displays "**Verification**" and then cycles the Paw meter needle to 0, 30, 60 and 90.

The needle should be within 4 at each setting. If it is not, complete step 7 then repeat steps 1-6.

7. Press the **Int. Battery** button to exit "**Verification.**"

   The routine exits after reaching 90, and the display returns to "**Meter Cal.**"

5.8 Volume Factor Calibration

➔ **To calibrate the volume factor:**

1. Use the Int. Battery button to scroll to "**Set Vol Factor.**"
2. Press the ▲**Up** control button.

   The Message Display Window displays "**Connect Rp50.**"
3. Connect an Rp50 parabolic resistor to the patient end of the exhalation valve and leave the other side of the resistor open to air.

ENSURE THERE IS NO BLOCKAGE IN ANY WAY.

4. Press the **Int. Battery** button.

   The system will start the motor. When the motor stops the Message Display Window will display "**Vol Factor=XXX.**" Valid numbers are between 80-120.
5. Record the value on the test sheet.
6. Press the **Int. Battery** button.
7. Press the ▲**Up** control button.
8. Repeat step 4. If the Volume Factor is not within ± 5 of the previous value and within the range of 80-120, repeat steps 2-6 until two consecutive calibration procedures produce Vol Factor + 5 of each other and both are between 80 and 120.
9. Press the **Int. Battery** button to exit the Volume Factor Calibration.

5.9 Pressure Relief Valve Calibration

➔ **To calibrate the pressure relief valve:**

1. Use the Int. Battery button to scroll to "**Adjust Rel Valve.**"
2. Block the Mainflow outlet and press the ▲**Up** control button.

   The motor starts causing the pressure in the system to begin to rise.
3. Verify there is no air leaking from the exhalation valve. All air leakage must be from the pressure relief valve.

If no leakage is noted, proceed to step 4.

If a leak is noted, you will need to pressurize the exhalation valve from an external source. While the motor continues to run, perform the following procedure:

4. Disconnect the exhalation valve tubing from the EXH.VALVE connector on the ventilator.
5. Connect this same tubing to the Luer connector on the 20 cc syringe.
6. Pressurize the exhalation valve diaphragm by pushing on the syringe plunger until the leakage from the exhalation valve ceases. The Message Display will indicate the circuit pressure.
7. Verify that the displayed pressure is 110 ±10.
8. If the pressure is outside this limit, use a Phillips screwdriver to adjust the pressure by slowly turning the pressure relief screw located on the underside of the Mainflow Outlet Assembly.
9. After verifying that the Message Display Window is showing 110 ±10, unblock the outlet of the Rp50, and press the **Int. Battery** button.

If the 20 cc syringe was used, remove it now and reconnect the exhalation valve tubing to the exhalation valve connector.

10. To exit Tech. Setup and USER SETUP, tap the **Silence/Reset** button twice.

If the pressure relief valve is adjusted, perform Pressure Transducers Calibration and Volume Factor Calibration again.

5.10 Exhalation Valve Calibration

Each time an exhalation valve is replaced it must be calibrated.

➔ **To calibrate the exhalation valve:**

1. Connect the FLIGHT 50 Ventilator patient breathing circuit to the ventilator
2. Connect an adult test lung with restrictor or use test lung or occlude the patient side of the exhalation valve.
3. Press the **On/Standby** button once to enter Settings condition.
4. Press the **Manual Inflation** button once, then again within three seconds.

   The FLIGHT 50 Ventilator starts the exhalation valve calibration and the ventilator automatically tests the exhalation valve. If it passes the test, the messages "**Cal Completed**", then "**Press ON to Vent**" will be displayed.
5. If it passes the test, the messages "**Cal Completed**", then "Press ON to Vent" will be displayed.

6. If the test fails, the message "**Cal Failed**" will be displayed.
7. Press the **Silence/Reset** button.
8. Check the integrity of the circuit, connections and test lung, then press the **Manual Inflation** button twice to initiate calibration again.

5.11 Operational Set-Up (Standard Test Setting)

➔ **To carry out the operational set-up:**

1. Connect the 500 cc test lung to the patient connection on the exhalation valve.
2. If testing model FLIGHT 50-H (w/ humidifier), the humidifier should no longer be bypassed. The patient circuit should be connected to the output of the humidifier chamber and the humidifier tubing should be connected between the input to the humidifier chamber and the connector on the ventilator labeled "**GAS OUTPUT.**"
3. With the ventilator in the Standby condition, press the **On/Standby** button once to enter Setting condition.
4. Adjust controls to the following Standard Test Settings:

Table 4 – Standard Test Settings

MODE	**A/CMV**
Volume Control	500 mL
t	1.0 sec
f	15 b/min
P trig	1 cmH_2O/mbar
Paw alarm	cmH O/mbar ▼Paw / 99 cmH O/mbar ▲Paw
$\dot{V}$ alarm	1 L/min min ▼ / 50 L/min max ▲
PEEP/CPAP	0 cmH_2O/mbar
P support	0 cmH2O/mbar
Humidifier	Off

5.12 Pressure Verification

➔ **To verify the pressure:**

1. Connect the T-connector between the test lung and the exhalation valve.
2. Connect the tubing from the T-connector to a calibrated pressure gauge.

3. Press the ▲**Up** control button to select "**Paw P M B**" in the Message Display Window.
4. Press the **On/Standby** button to begin ventilation.

Whenever an alarm message is in the Message Display Window, the pressure or volume measurements for display cannot be selected.

5. Set t_I to 2.0 seconds.
6. Verify that the peak pressure displayed on both the calibrated pressure gauge and the Message Display Window (i.e. "**P**") are within 10% of each other.
7. Leave calibrated pressure gauge connected.

5.13 P trig

➔ **To set the Ptrig:**

1. Set tI to 1.0 second and set *ƒ* to 1 b/min
2. Trigger breaths by squeezing the test lung hard enough to create a negative pressure equal to or greater than 1 cmH2O/mbar.
3. Verify the P trig indicator blinks and the ventilator delivers a mandatory breath with each successful squeeze of the test lung.
4. Set *ƒ* to 15 b/min and Ptrig to 0.2 cmH2O/mbar. Verify that there is no auto-triggering.

5.14 PEEP / CPAP

➔ **To set the PEEP/CPAP:**

1. Connect the Rp50 parabolic resistor between the T-connector and the test lung.
2. Set Volume Control to 250 mL, PEEP to 5, and Ptrig to 1.0.
3. After a few breaths, verify that the baseline pressure measurements for the Paw meter and the Message Display Window are both 5 ±1 cmH2O/mbar.
4. If necessary, increase Ptrig level until there is no auto triggering. Verify the Ptrig level does not exceed 1.5 cmH_2O/mbar.
5. Set PEEP to 15. After a few breaths, verify that the baseline pressure measurements for the Paw meter and the Message Display Window are both 15 ±2 cmH_2O/mbar.
6. If necessary, increase Ptrig level until there is no auto triggering. Verify the Ptrig level does not exceed 2 cmH_2O/mbar.

5.15 Pressure Control

➔ **To test the pressure control:**

1. Set ventilator to Standard Test Settings.
2. Press the **Pressure Control** button.
3. Adjust the Pressure Control setting to 15 cmH_2O/mbar. Set t_I to 3.0 seconds.
4. Verify both the Message Display Window and the calibrated pressure gauge indicate 15 ±2 cmH_2O/mbar.
5. Set Pressure Control to 30 cmH2O/mbar.
6. Verify the Message Display Window and the calibrated pressure gauge indicates 30 ±3 cmH_2O/mbar.
7. Remove T-connector, leaving the Rp50 inline

5.16 Exhalation Valve Sealing

➔ **To test the exhalation valve sealing:**

1. Set the FLIGHT 50 Ventilator to Standard Test Settings. Set the *ƒ* to 5.
2. Change the Volume Control setting so that the Paw meter reaches 70 ±5 cmH_2O/mbar during inspiration.
3. Verify there is no gas leakage from the exhalation valve during inspiration.

5.17 Manual Inflation

➔ **To test the manual inflation:**

1. Set ventilator to the Standard Test Settings.
2. Set *ƒ* to 1, then press and release the Manual Inflation button.
3. Verify that a manual inflation occurs each time the Manual Inflation button is pressed.
4. Verify inflation is terminated when the button is released. Set *ƒ* to 15.

5.18 High Paw Alarm

➔ **To test the HIGH ▲Paw ALARM:**

1. Set High ▲Paw alarm to 20 cmH_2O/mbar.
2. Verify that (1) an audible and visual High ▲Paw alarm occurs, (2) inspiration is terminated, and (3) maximum pressure displayed on the Paw meter is 20 ±4 cmH_2O/mbar.
3. Set the High ▲Paw back to 99 cmH_2O/mbar and Press the Silence/Reset button to clear the visual alarm.

5.19 Low Paw Alarm

➔ **To test the LOW ▼Paw ALARM:**

1. Disconnect the test lung from the breathing circuit.
2. After 2 breaths confirm both an audible and visual Low ▼Paw Alarm occurs.
3. Attach the test lung to the breathing circuit and verify that the audible alarm ceases.
4. Press the **Silence/Reset** button to clear the visual alarm.

5.20 Check Prox Line Alarm

➔ **To Check Prox Line Alarm:**

1. Disconnect the Proximal Airway Pressure Line at the ventilator connection
2. Confirm that both an audible and visual Check Prox Line Alarm occurs.
3. Reconnect the Proximal Airway Pressure Line to the ventilator.
4. Verify that the audible alarm ceases.
5. Press the **Silence/Reset** to clear the visual alarm.

5.21 Battery Test

➔ **To test the battery:**

Before carrying out this test, ensure that the FLIGHT 50 Ventilator has been connected to an external power source for the purpose of charging the Int. Battery.

1. Press and hold the **Int. Battery** button.
2. Verify the charge level on the Paw meter is in the blue area, and there is no "**Charge Fault**" message in the Message Display Window.
3. Disconnect the A.C. power cord and verify the "**Ext. Power**" visual and audible alarm occurs, the charging indicator illuminates red, the Int. Battery indicator turns on, and "**No Ext. Power**" message is displayed in the Message Display Window.
4. Silence the alarm.
5. Press and hold the **Int. Battery** button and verify the charge level on the Paw meter is in the blue area after 5 minutes.
6. Reconnect the AC. power cord, verify the Int. Battery LED turns off and the Ext. Power LED indicator changes to green.
7. Repeat steps 3-6, allowing 90 seconds to elapse prior to reconnecting to AC power.
8. Verify the FLIGHT 50 Ventilator switches back to A.C. power between 30 and 90 seconds later.

5.22 Humidifier

➔ **To test the humidifier:**

1. Connect the temperature probe to the ventilator.
2. Attach an empty humidifier bottle to the ventilator (no water or heat sink).
3. Use the FLIGHT 50 Ventilator On/Standby button to enter the Settings condition.
4. Press the **Humidifier On** button and adjust the set target temperature to 39 ºC.
5. To accept, press the **Humidifier On** button.
6. Verify the continuously displayed temperature is stable and is approximately room temperature for at least 5 seconds.
7. Use the FLIGHT 50 Ventilator **On/Standby** button to enter the ON condition.
8. Verify the continuously displayed temperature is stable and is approximately room temperature for at least 5 seconds.
9. Disconnect the humidifier bottle.
10. Verify that the audible and visual "**Humidifier Fail**" alarm occurs.
11. Gently reconnect the humidifier bottle.
12. Clear the alarm message by tapping the **Silence/Reset** button, then press the **Humidifier On** button.
13. Disconnect the temperature probe from the Temp Probe inlet jack beneath the Mainflow Outlet Manifold.
14. Verify that the audible and visual "**Temp Probe**" alarm occurs.
15. Reconnect the temperature probe.
16. Clear the alarm message by pressing the **Silence/Reset** button.
17. Remove the humidifier bottle and replace the heat sink.
18. Reinstall the bottle on the FLIGHT 50 Ventilator.

6 Periodical Maintenance

6.1 Introduction

The FLIGHT 50 Ventilator requires routine maintenance for best performance and technical maintenance every 15,000 hours or every three years, whichever occurs first.

If the primary internal battery is used to LOW BATTERY alarm level on a routine basis, the battery life will be shortened.

It is recommended that the secondary internal battery be replaced every 24 months

If the battery no longer meets the time requirements of the user, it should be replaced.

When 15,000 hours has elapsed, the FLIGHT 50 Ventilator's Message Display Window will indicate "**Service Needed**" after the next power up.

After every technical maintenance, the Operation Verification Procedure (OVP) (Section 5) must be performed successfully before returning the FLIGHT 50 Ventilator to patient use.

Lethal voltages are present inside the ventilator. To prevent electrical shock, use extreme caution when working on the ventilator with the front or bottom cover panel opened.

When preparing to return service replacement parts clearly identify them as such, and return them to FLIGHT MEDICAL with the following information:

- Date
- Ventilator serial number
- Contact name
- Organization name
- Organization address
- Reason for replacement

- Copy of completed OVP test record (Section 5)

Follow the shipping instructions detailed in Section 10 of this manual.

6.2 Required Equipment

- Computer with PCS download program
- Download cable P/N V23-00001-29
- #10 Torx screwdriver
- Philips head screwdriver
- 7/64" Allen wrench
- Torque screwdriver (for #10 Torx & 7/64" Allen)

All Allen head and #10 Torx screws are tightened to 12 inch/lbs.

6.3 Scheduled Maintenance

Manifold

The manifold should be replaced every 15,000 hours or 3 years, whichever occurs first. The manifold should also be replaced if it exhibits any unusual noise or if it appears to malfunction in any way.

Replace the Manifold Assembly and set "**Next Service Due Meter**" as per the instructions in Chapter 4.9.

Primary battery

Check the Primary internal battery manufacturing date. If over 3 years replace the battery.

Secondary battery

Check the Secondary internal battery manufacturing date. If over 2 years replace the battery.

Front panel

Check the front panel buttons, displays, alarms and the analog meter. Replace front panel if any malfunction.

Do not use agents containing acetone, toluene, halogenated hydrocarbons, or strong alkalines on the face panel or ventilator housing.

Alcohol may be used to sanitize the face panel and ventilator housing. Care should be taken not to allow liquids to penetrate the ventilator.

7 Troubleshooting

7.1 Introduction

This troubleshooting guide is intended to assist a FLIGHT MEDICAL-approved service technician troubleshoot and repair the FLIGHT 50 Ventilator.

Refer to the Troubleshooting section of the Operating manual for more clinically oriented ventilator problems.

Hazardous voltages are present inside the ventilator. Disconnect oxygen sources and electrical power before attempting any disassembly. Failure to do so could result in injury to service personnel or equipment.

Further questions or problems should be addressed to the Technical Service Department at FLIGHT MEDICAL Instruments.

email: Support@flight-medical.com

Table 5 - Troubleshooting

PROBELM	POTENTIAL CAUSE	SUGGESTED CORRECTIVE ACTION
Ventilator fails System Leak Test.	Manifold is pulling in air from around the air inlet filter cover.	Verify that the filter media is positioned within the counterbore of the cover and that the thumbscrews are tightened securely.
	Muffler Assembly is disconnected or leaking or is cracked.	Verify Muffler Assembly is securely connected to both the Manifold inlet and the air intake. With the air intake filter cover removed, verify that the end of the muffler is flush with the ventilator housing. Visually inspect muffler assembly for cracks. Replace if cracked.
	Silicone cuff around ends of muffler may be old.	Replace as needed.
Ventilator fails Pressure Transducer and/or Pressure Relief Valve calibration.	Leak in the patient circuit Assembly	Make certain that the humidifier chamber is bypassed for these tests. The breathing circuit tubing should be directly connected to the GAS OUTPUT connector. Also, verify that the exhalation valve is not leaky at the highest pressure level. If so, replace exhalation valve.
	 When performing the Pressure Relief Valve calibration, if an alternate Flight Medical approved exhalation valve is used it may begin to leak at lower maximal pressures than the permanent blue exhalation valve. This is a limitation of the exhalation valve and the FLIGHT 50 Ventilator driving pressure. The ventilator is performing appropriately.	
	Torn or improperly sealed manifold diaphragm.	Remove manifold Manifold and inspect diaphragm. Replace if damaged.
Low proximal pressure (Paw), but normal flows.	Faulty patient breathing circuit.	Check breathing circuit for leaks and/or proper connections.
	Humidifier chamber leaking.	Bypass chamber and retest. If problem is solved, loosen, reposition, and tighten chamber cover. Retest.
	Pressure transducer out of calibration.	Calibrate entire FLIGHT 50 Ventilator (see Section 5)
	Faulty exhalation valve.	Recalibrate exhalation valve (Section 5). If problem persists, replace valve.
	Pressure relief valve or emergency intake valve leaking.	Check both valves for proper sealing. Perform the Pressure Relief Valve calibration (Section 5).

Low proximal pressure (Paw) and low flows at Gas Output connector.	Pressure relief valve or emergency intake valve leaking.	Check both valves for proper sealing. Perform the Pressure Relief Valve calibration (Section 5).
	Air inlet filter clogged	Replace air inlet filter.
	Internal leak in the Manifold (i.e. ruptured diaphragm, leaking one way valve).	Check diaphragm, replace if damaged. Tighten 4 screws connecting the Manifold to the left side. If problem persists, replace the Manifold Assembly.
"Motor Fault" Device Alert alarm, or no Device Alert alarm, but proximal pressure is rising slower than expected.	Blocked air inlet.	Replace air inlet filter
	High FIO selected on Air/O mixer, 22 and oxygen supply is depleted.	Verify sufficient oxygen supply. Replace as needed. If problem continues, remove Air/O mixer. If problem is resolved, replace 2 Air/O mixer. If problem persists, replace 2 Manifold Assembly.
Unstable baseline.	Breathing circuit leak.	Check breathing circuit for leaks and/or proper connections. Make certain "star" tubing is not a direct connection to any FLIGHT 50 Ventilator connectors.
	Exhalation valve is not calibrated.	Calibrate the exhalation valve (Section 5). If the valve fails calibration, replace. If valve passes but problem persists, try a new valve.
	Internal solenoid is not functioning properly. (**Note:** Solenoid is part of the Manifold.)	Verify that both ends of the tubing connected to the solenoid are secure. Verify that the tubing from the Gas Output connector and the internal pressure transducers are secure. Calibrate the exhalation valve. Retest for baseline stability. If the problem persists, replace the Manifold Assembly.
Baseline shows PEEP w/ PEEP set to zero.	Water inside exhalation valve diaphragm.	Disconnect the exhalation drive line tubing, then turn exhalation valve upside down to allow any water that is trapped to exit. If problem still persists, replace exhalation valve.
	Kinked or obstructed exhalation or proximal pressure tubing.	Check and correct as needed. Replace inline proximal filter.
	Paw meter needs calibration.	Calibrate. (See Section 5.)
	Contaminated solenoid.	Replace Manifold Assembly. (**Note:** Solenoid is part of the Manifold)
Proximal pressure returns to baseline very slowly.	Kinked or obstructed proximal pressure line.	Check and correct as needed. Replace inline proximal filter.
	HME causing resistance to exhalation.	Remove/change HME.

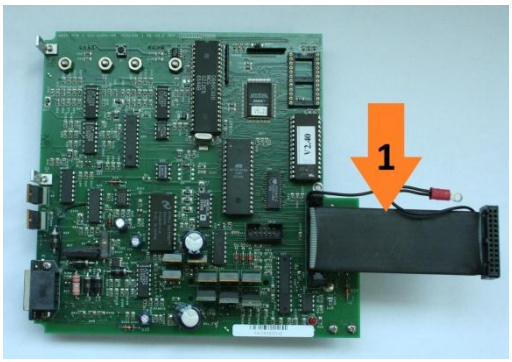
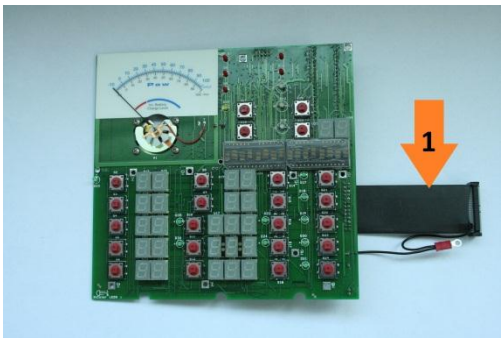
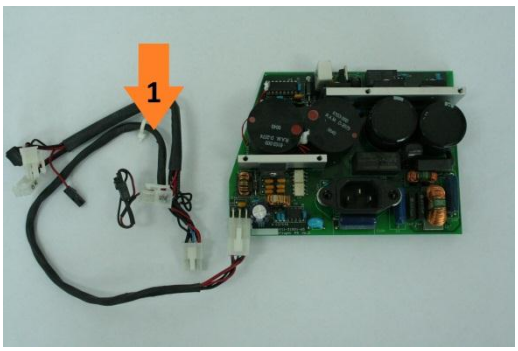
Manifold is emitting "squeaking" noise.	Contamination on the piston rods.	Using alcohol and a non-residue type material (i.e. gauze), gently clean piston rods. If problem is not corrected, replace Manifold Assembly.
Manifold is emitting "ticking" noise.	Loose bearing.	Replace Manifold Assembly
Manifold loudness seems to be much greater than normal.	Large leak in breathing circuit.	Resolve leak.
	Internal muffler is disconnected.	Open lower case and make sure that the muffler is connected securely at both ends with the appropriate silicone cuff. Perform System Leak Test in Section 5.
	Problem with Manifold Assembly	Replace Manifold Assembly
Vibration noise (i.e. bezel, humidifier, retaining arm, etc.)	Improper Assembly	Secure all external screws to 12" lbs. Tighten all thumbscrews or knobs securely.
Front panel cover is loose, rattling, or not shutting properly	Physical damage to the front panel cover.	Remove and replace front panel cover. Verify that the springs are present on both ends of the cover.
Unit triggers with PEEP set > 0	Leak in circuit.	Check circuit for leaks.
	Exhalation valve not calibrated.	Calibrate Exhalation Valve
Ventilator does not operate on internal battery.	Battery fully discharged.	Connect FLIGHT 50 Ventilator to A.C. power, allowing battery to charge for several hours, then check charge level. If the battery does not seem to be charging, disconnect the battery wiring harness from the charger. Check the voltage across the battery wiring harness connector. If voltage is > 0 volts but < 8 volts, replace battery.
	Battery fuse defective.	Check the voltage across the battery wiring harness connector. If voltage is 0 volts, replace fuse.
	Defective Main PCB.	Replace Main PCB.
Ventilator is unable to switch from DC power back to AC power.	Defective Power Supply PCB.	If ventilator functions normally on internal battery, replace Power Supply PCB.
	Defective Main PCB.	Replace Main PCB.

10 V SHUTDOWN Device Alert Alarm	Defective Main PCB.	Replace Main PCB.
OCCL. SHUTDOWN Device Alert Alarm	Prox line kinked or prox filter occluded.	Replace prox line filter and check prox line for obstruction.
	Defective Solenoid.	Replace Manifold Assembly.
	Defective Main PCB.	Replace Main PCB.
SYSTEM ERROR Device Alert Alarm	EPROM not seated firmly.	Make certain EPROM is firmly in the socket.
	Battery completely empty or disconnected during ventilation.	Check battery connectors and fuse. Charge battery.
	Defective Main PCB.	Replace Main PCB.
MOTOR FAULT Device Alert Alarm	Manifold is unable to get sufficient air intake.	Check air intake filter. Replace as needed. If using Air/O mixer, verify sufficient tank 2 supply pressure.
	Defective Manifold Assembly	Replace Manifold Assembly.
	Defective Main PCB.	Replace Main PCB.
Meter does not calibrate.	Meter is holding static charge.	Using a cloth with alcohol, gently wipe the surface area of the front panel that covers the meter. Recalibrate.
	Defective meter.	Replace panel PCB.
Humidifier Fail alarm (FLIGHT50-H)	Loss of A.C. power.	Restart humidifier when A.C. power is available.
	Improper installation of the chamber or temperature probe.	See Operating manual for installation instructions.
	Defective temperature probe.	Replace temp. probe.
	Humidifier heater Assembly is defective.	With humidifier chamber firmly secured, disconnect the square four pin connector on the Main PCB. Using an ohmmeter, measure the resistance between the pins of the two blue wires. Resistance should be < 3000 ohms, but > 0. Next, measure the resistance between the pins of the two black wires. Resistance should be approx. 4 ohms. If either of these measurements are incorrect, replace the heater Assembly
High Prox Temp alarm (FLIGHT50-H)	Defective temperature probe.	Replace temp. probe.
	Defective connection to Main PCB.	Using an ohmmeter, verify continuity from probe connector to Main PCB.
	Defective Main PCB.	Replace Main PCB.
LED(s) and or control panel button(s) do not function.	Ribbon cable not securely fastened.	Verify that both ends of the ribbon cable are securely fastened.
	Defective Panel PCB.	Replace Main PCB.

Unit auto triggers	Relief valve set too high or pressure transducers out of calibration.	Perform a complete FLIGHT 50 Ventilator calibration (see Section 5)

8 Flight 50 Ventilator Spare parts

8.1 Electronics

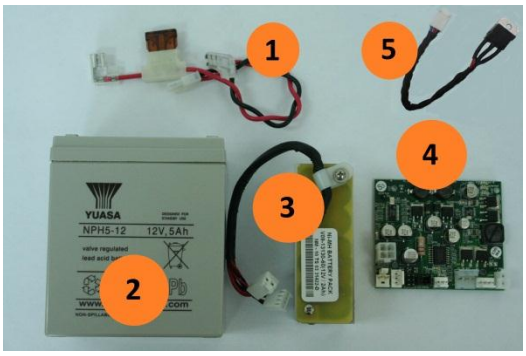
Main Board **V09-60000-65** ***Connecting cable – not part of the board:*** ***1*** ***Shielded flat cable*** ***V11-78001-69***	
Panel Board **V11-71000-65** ***Connecting cable – not part of the board:*** ***1*** ***Shielded flat cable*** ***V11-78001-69***	
Power Supply **V11-31001-65** ***Connecting cable – not part of the board:*** ***1***	
Main Buzzer **V11-37000-69**	

Dual Battery

V09-13000-60

Items:

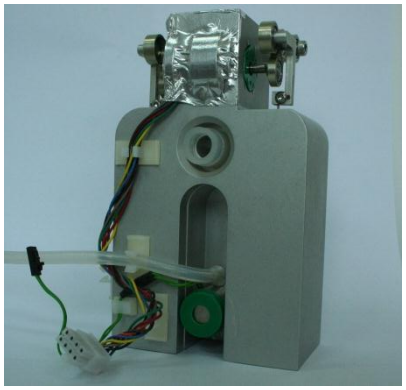
1	***Battery wire***	***V11-11200-69***
2	***Lead Acid Battery***	***G19-00001-29***
3	***NiMH Battery***	***V09-13130-60***
4	***Battery Board***	***V09-13120-60***
5	***Transistor cable***	***V09-13120-29***



8.2 Mechanical

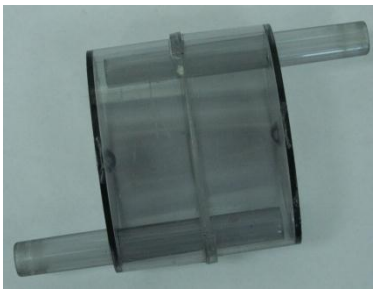
Manifold

V50-21000-60



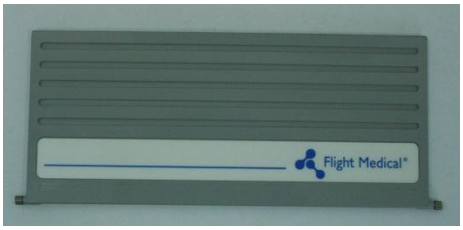
Muffler

V11-33000-67



Control panel cover

V11-75002-90



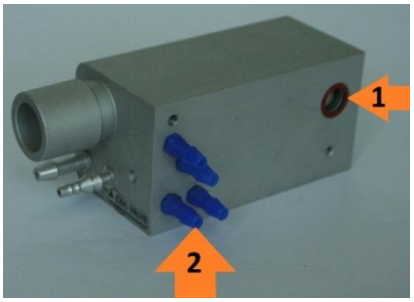
Front panel

V11-72100-63

Outlet assembly

V11-24000-63

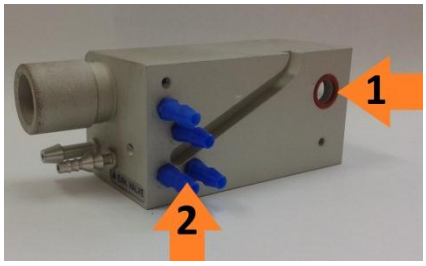
1	*O-ring*	*V11-24600-26*
2	*Fitting*	*G27-00008-27*



Outlet assembly (humidifier)

V10-24000-63

1	*O-ring*	*V11-24600-26*
2	*Fitting*	*G27-00008-27*

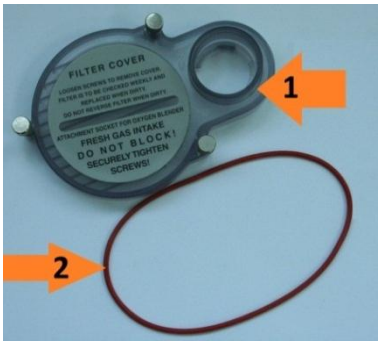


Solenoid Assembly

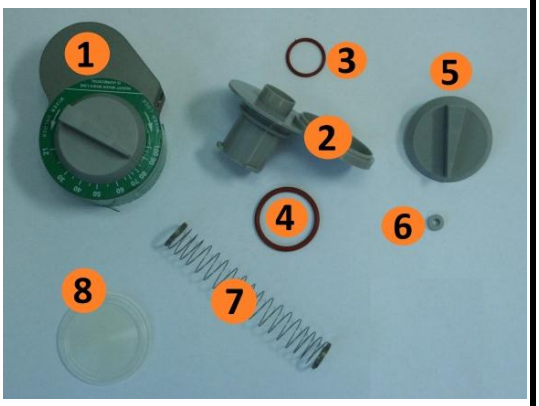
1	Solenoid	V11-21400-69
2	O-ring	V11-24600-26

Filter Cover assembly

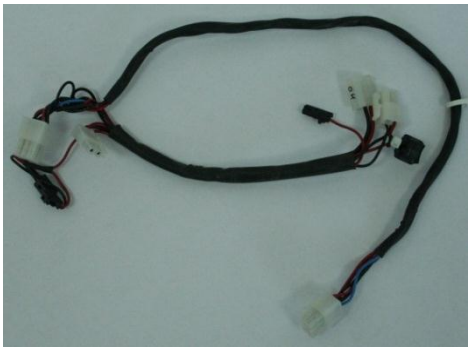
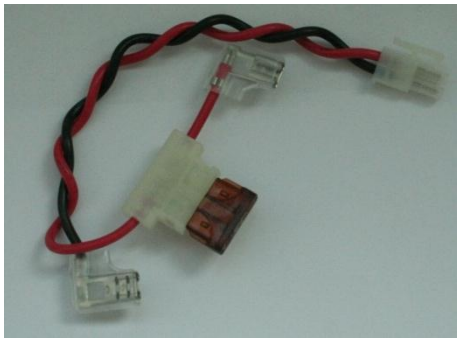
1	F50 Filter Cover	V11-35001-63
2	O-ring	V11-36000-26

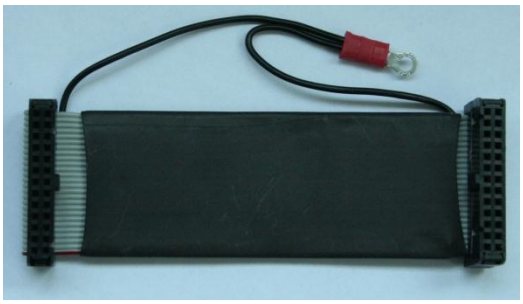
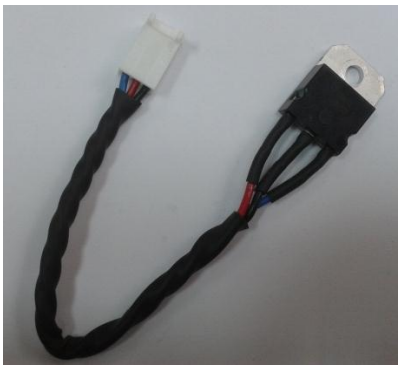


Air/Oxygen Entrainment mixer V13-00010-60		
1	O_2 Mixer	V13-00010-60
2	Bayonet Connection	V13-16200-07
3	O-Ring 2/122	V13-16400-26
4	O-Ring 2/017	V13-16300-26
5	Control Knob	V13-14100-07
6	O_2 Mixer Washer	V13-15000-07
7	O_2 Mixer Spring	V13-13300-03
8	O_2 mixer Diaphragm	V13-19300-06



8.3 Cables

F50 Main cable assy. V09-13000-29	
Battery Wire (with fuse) V11-11200-69	

Shielded flat cable **V11-78001-69**	
Battery Transistor cable **V09-13120-29**	

9 Repackaging And Shipping Instructions

9.1 RGA (Return Goods Authorization)

- All returned items must have a Return Goods Authorization (RGA) number, assigned by FLIGHT MEDICAL.
- To obtain an RGA number, email a completed RGA form (filled in its entirely) to support@flight-medical.com. Also include the ventilator's EON PCS log file and a detailed description of the failure analysis and the repair efforts undertaken.

Items can be returned only after an RGA number was provided by FLIGHT MEDICAL.

Copies of the RGA form, EON PCS log file and the Service Call should be included with the returned item.

9.2 Packaging

Use the following guidelines when returning a FLIGHT 50 ventilator:

- The original box and packaging must be used.
- Remove all accessories from the ventilator.
- Do not ship any accessories unless they are requested by FLIGHT MEDICAL.
- When returning a module, place it in the original box and packaging. If not available, place it in a box large enough to allow for it to be wrapped in a sufficient amount of packaging material.
- Write the RGA number on the shipping label.

9.3 Shipping

Ship RGA items to: FLIGHT MEDICAL INNOVATIONS Ltd.
13 Hamelacha St
Lod 71520, ISRAEL
Tel: +972-8-923-5111

Address any technical questions or problems to FLIGHT MEDICAL:

FLIGHT MEDICAL INNOVATIONS Ltd.
Address: 13 Hamelacha St., Lod 71520, ISRAEL
Tel: +972-8-923-5111
Fax: +972-8-923-6111
Email: support@flight-medical.com
Website: www.flight-medical.com

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