Service Manual

Vela
Ventilator Systems

L1534 Revision B December 2004

Revision History

Date	Revision	Pages	Changes
March 2002	X1	All	Initial Draft
April 2002	X2	All	Added Engineering Drawings, Theory of Operation, Calibration and PM procedures
June 2002	X3	All	Added Extended Functions and UVT Test Screens. Added Error Codes.
August 2002	A	All	Final review & engineering release. Modified OVP, Calibration and screens.
December 2004	B	39	Replaced Figure 3.13 Umbrella Check Valve with Figure 3.13 Umbrella Check Valve (P/N 21950)

Warranty

THE Vela ventilator systems are warranted to be free from defects in material and workmanship and to meet the published specifications for two (2) years or 8,000 hours, whichever occurs first. The turbine only is warranted to be free from defects in material or workmanship for five (5) years or 40,000 hours whichever occurs first.

The liability of VIASYS Healthcare, Critical Care Division, (referred to as the Company) under this warranty is limited to replacing, repairing or issuing credit, at the discretion of the Company, for parts that become defective or fail to meet published specifications during the warranty period; the Company will not be liable under this warranty unless (A) the Company is promptly notified in writing by Buyer upon discovery of defects or failure to meet published specifications; (B) the defective unit or part is returned to the Company, transportation charges prepaid by Buyer; (C) the defective unit or part is received by the Company for adjustment no later than four weeks following the last day of the warranty period; and (D) the Company's examination of such unit or part shall disclose, to its satisfaction, that such defects or failures have not been caused by misuse, neglect, improper installation, unauthorized repair, alteration or accident.

Any authorization of the Company for repair or alteration by the Buyer must be in writing to prevent voiding the warranty. In no event shall the Company be liable to the Buyer for loss of profits, loss of use, consequential damage or damages of any kind based upon a claim for breach of warranty, other than the purchase price of any defective product covered hereunder.

The Company warranties as herein and above set forth shall not be enlarged, diminished or affected by, and no obligation or liability shall arise or grow out of the rendering of technical advice or service by the Company or its agents in connection with the Buyer's order of the products furnished hereunder.

Limitation of Liabilities

This warranty does not cover normal maintenance such as cleaning, adjustment or lubrication and updating of equipment parts. This warranty shall be void and shall not apply if the equipment is used with accessories or parts not manufactured by the Company or authorized for use in writing by the Company or if the equipment is not maintained in accordance with the prescribed schedule of maintenance.

The warranty stated above shall extend for a period of FIVE (5) years from date of shipment or 40,000 hours of use, whichever occurs first, with the following exceptions:

1. Components for monitoring of physical variables such as temperature, pressure, or flow are warranted for ninety (90) days from date of receipt.

2. Elastomeric components and other parts or components subject to deterioration, over which the Company has no control, are warranted for sixty (60) days from date of receipt.

3. Internal batteries are warranted for ninety (90) days from the date of receipt.

The foregoing is in lieu of any warranty, expressed or implied, including, without limitation, any warranty of merchantability, except as to title, and can be amended only in writing by a duly authorized representative of the Company.

Contents

Notices

Copyright Notice

World Headquarters
1100 Bird Center Drive
Palm Springs, CA 92262-8099
U.S.A.
Phone: (760) 778-7200
(800) 328-4139
Fax: (760) 778-7274
www.ViasysCriticalCare.com

European Office
Rembrandtlaan 1b
3723 BG Bilthoven
P.O. Box 299, 3720 AG Bilthoven
The Netherlands
Phone: (31) 30 2289 711
Fax: (31) 30 2286 244

Trademark Notices

EMC Notice

This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instructions in this manual, electromagnetic interference may result. The equipment has been tested and found to comply with the limits set forth in EN60601-1-2 for Medical Products. These limits provide reasonable protection against electromagnetic interference when operated in the intended use environments described in this manual.

The ventilator has been tested to conform to the following specifications:

MIL-STD-461D:1993, MIL-STD-462D:1993, EN55011:1991, IEC 1000-4-2:1994, IEC 1000-4-3:1994, IEC 1000-4-4:1994, IEC 1000-4-5:1994, QUASI-STATIC:1993

This ventilator is also designed and manufactured to comply with the safety requirements of IEC 601-1, IEC 601-2-12, CAN/CSA-C22.2 No. 601.1-M90, and UL 2601-1.

MRI Notice

This equipment contains electromagnetic components whose operation can be affected by intense electromagnetic fields.

Do not operate the ventilator in a MRI environment or in the vicinity of high-frequency surgical diathermy equipment, defibrillators, or short-wave therapy equipment. Electromagnetic interference could disrupt the operation of the ventilator.

Intended Use Notice

The Vela Ventilators are designed to provide ventilator support for the critical care management of infant, pediatric or adult patients with compromised lung function. They are intended to provide continuous respiratory support in an institutional health care environment. **They should only be operated by properly trained clinical personnel, under the direction of a physician.**

Regulatory Notice

Federal law restricts the sale of this device except by or on order of a physician.

IEC Classification

Type of Equipment: Medical Equipment, Class 1 type B
Adult/Pediatric/Infant Lung Ventilator

Declaration of Conformity Notice

This medical equipment complies with the Medical Device Directive, 93/42/EEC, and the following Technical Standards, to which Conformity is declared:

EN60601-1
EN60601-1-2
ISO 9001, EN 46001

CE 0086

EU Notified Body:

BSI (Reg. No. 0086)

Tradenames:

Vela

If you have a question regarding the Declaration of Conformity for this product, please contact VIASYS Healthcare, Critical Care Division at the number given in Appendix A.

Safety Information

Please review the following safety information prior to operating the ventilator. Attempting to operate the ventilator without fully understanding its features and functions may result in unsafe operating conditions.

Warnings and Cautions which are general to the use of the ventilator under all circumstances are included in this section. Some Warnings and Cautions are also inserted within the manual where they are most meaningful.

Notes are also located throughout the manual to provide additional information related to specific features.

If you have a question regarding the installation, set up, operation, or maintenance of the ventilator, contact VASYS Healthcare Customer Care as shown in Appendix A, Contact & Ordering Information.

Terms

WARNINGS	identify conditions or practices that could result in serious adverse reactions or potential safety hazards.
CAUTIONS	identify conditions or practices that could result in damage to the ventilator or other equipment.
NOTES	identify supplemental information to help you better understand how the ventilator works.

Warnings

Warnings and Cautions appear throughout this manual where they are relevant. The Warnings and Cautions listed here apply generally any time you operate the ventilator.

- The Vela Ventilator is intended for use by a trained practitioner under the direction of a qualified physician.
- When the ventilator is connected to a patient, a trained health care professional should be in attendance at all times to react to an alarm or other indications of a problem.
- Alarm loudness must be set above ambient sound in order to be heard.
- Always have an alternate means of ventilation available whenever the ventilator is in use.
- The operator should not touch the electrical connectors of the ventilator or accessories, and the patient simultaneously.
- Due to possible explosion hazard, the ventilator should not be used in the presence of flammable anesthetics.
- An audible alarm indicates an anomalous condition and should never go unheeded.
- Anti-static or electrically conductive hoses or tubing should not be used within the patient circuit.
- If a mechanical or electrical problem is recognized while running the Operational Verification Tests, or while operating the ventilator, the ventilator must be removed from use and referred to qualified personnel for servicing. Using an inoperative ventilator may result in patient injury.

- When a low gas supply alarm occurs, the oxygen concentration delivered to the patient will differ from that set on the O2 control setting.
- A source gas failure will change the FIO2 and may result in patient injury.
- The functioning of this equipment may be adversely affected by the operation of other equipment nearby, such as high frequency surgical (diathermy) equipment, defibrillators, short-wave therapy equipment, "walkie-talkies," or cellular phones.
- Water in the air supply can cause malfunction of this equipment.
- Do not block or restrict the Oxygen bleed port located on the instrument back panel. Equipment malfunction may result.
- Electric shock hazard - Do not remove any of the ventilator covers or panels. Refer *all* servicing to an authorized VIASYS Healthcare service technician.
- A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation. Upon loss of protective ground, all conductive parts including knobs and controls that may appear to be insulated, can render an electric shock. To avoid electrical shock, plug the power cord into a properly wired receptacle, use only the power cord supplied with the ventilator, and make sure the power cord is in good condition.

Cautions

The following cautions apply any time you work with the ventilator.

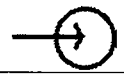
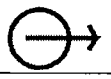
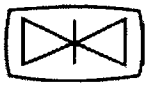
- When replacing fuses, ensure that new fuses are of the same type and value as those being replaced. Incorrect fuses can cause damage to the ventilator.
- A battery that is fully drained (i.e. void of any charge) may cause damage to the ventilator and should be replaced.
- All accessory equipment that is connected to the ventilator must comply with CSA/IEC601/UL2601.
- To avoid damage to the equipment, clean the air filter regularly.

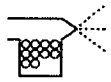
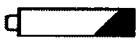
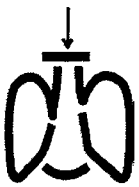
The following cautions apply when cleaning the ventilator or when sterilizing ventilator accessories.

- Do not sterilize the ventilator. The internal components are not compatible with sterilization techniques.
- Do not gas sterilize or steam autoclave tubing adapters or connectors in place. The tubing will, over time, take the shape of the adapter, causing poor connection and possible leaks.
- DO NOT submerge the ventilator or pour cleaning liquids over or into the ventilator.

Equipment Symbols

The following symbols may be referenced on the ventilator or in accompanying documentation

Symbol	Source/Compliance	Meaning
	Symbol #03-02 IEC 60878	Indicates ATTENTION, consult ACCOMPANYING DOCUMENTS
	Symbol #5016 IEC 60417	This symbol indicates a FUSE.
	Symbol #5034 IEC 60417 Symbol #01-36 IEC 60878	This symbol indicates INPUT.
	Symbol #5035 IEC 60417 Symbol #01-37 IEC 60878	This symbol indicates OUTPUT
	Symbol #5019 IEC 60417 Symbol #01-20 IEC 60878	This symbol indicates protective EARTH (ground).
	Symbol #5021 IEC 60417 Symbol # 01-24 IEC 60878	This symbol indicates the EQUIPOTENTIAL connection used to connect various parts of the equipment or of a system to the same potential, not necessarily being the earth (ground) potential (e.g., for local bonding).
	Symbol # 5333 IEC 60417 Symbol #02-03 IEC 60878	This symbol indicates TYPE BH equipment, which indicates equipment that provides a particular degree of protection against electric shock, particularly with regards to allowable leakage current and reliability of the protective earth connection.
	Symbol #5032 IEC 60417 Symbol #01-14 IEC 30878	This symbol indicates the equipment is suitable for alternating current.
	Symbol# 5049 IEC 60417	This Symbol indicates the ON condition for a part of the equipment. When pressed the ventilator will operate from the MAINS voltage (if connected) or internal or external batteries if the battery charge is within operating specifications.
	Symbol #5007 IEC 60417 Symbol #01-01 IEC 60878	Indicates ON (Power)
	Symbol #5008 IEC 60417 Symbol #01-02 IEC 60878	Indicates OFF (Power)
 ACCEPT	Symbol #0651 ISO 7000	Horizontal return with line feed. Indicates ACCEPT entered values for a specific field.
 CANCEL	Graphical Symbol in general use internationally for "DO NOT"	This symbol indicates CANCEL. Do not accept entered values. The ventilator continues to operate at previous settings.
	Symbol #5467 IEC 60417	Pressing the button with this symbol will FREEZE the current display.
	Symbol #5569 IEC 60417	This symbol indicates a CONTROL LOCK.

Symbol	Source/Compliance	Meaning
	VIASYS Healthcare symbol	This symbol represents a NEBULIZER.
	Symbol #5319 IEC 60417	This symbol indicates ALARM SILENCE
	Symbol #5307 IEC 60417	This symbol indicates ALARM RESET
	VIASYS Healthcare symbol	Increase OXYGEN
	VIASYS Healthcare symbol	Indicates VARIABLE ORIFICE FLOW SENSOR
	Symbol #5031 IEC 60417	This symbol indicates DIRECT CURRENT (DC)
	Symbol #5546 IEC 60417	This symbol indicates the INTERNAL BATTERY STATUS display
	VIASYS Healthcare symbol	This symbol indicates INSPIRATORY HOLD
	VIASYS Healthcare symbol	This symbol indicates EXPIRATORY HOLD
	VIASYS Healthcare symbol	This symbol indicates MANUAL BREATH

Chapter 1 Introduction

General Instructions

When disassembling or assembling the Vela, refer to the pneumatic schematic, tubing diagram, and the wiring diagram shown in Appendix B and the appropriate schematics and assembly drawings for each assembly. The illustrations shown in this manual are for reference only, current revisions of these diagrams and schematics are available to qualified personnel from VIASYS Healthcare, Critical Care Division, Technical Support.

Always take standard ESD precautions when working on Vela ventilator systems.

Ensure the ventilator is disconnected from the AC power supply before performing and repairs or maintenance. When you remove any of the ventilator covers or panels, immediately disconnect the internal battery "quick release" connector (see figure 3.1) before working on the ventilator.

Recommended Tools & Equipment

Note

Before using any test equipment [electronic or pneumatic] for calibration procedures, the accuracy of the instruments must be verified by a testing laboratory. The laboratory master test instruments must be traceable to the NIST (National Institute of Standards Technology) or equivalent.
When variances exist between the indicated and actual values, the calibration curves [provided for each instrument by the testing laboratory] must be used to establish the actual correct values. This certification procedure should be performed at least once every six months. More frequent certification may be required based on usage.

Long & short Philips screwdrivers	Pressure Manometer (cmH2O and psig)
Flat bladed screwdriver	Adult Test Lung P/N 33754
¼" Nut Dirver	Adult Patient Circuit P/N 10684
5/16" Nut Driver	Variable Orifice Flow Sensor assembly P/N 15972
7/8" Nut Driver	Valve Body P/N 20005
11/32" Nut Drivel	Tapered nipple P/N 00680
Digital Volt Meter	Hex nut P/N 00822
Tack puller or Needle nosed pliers	Regulator P/N 6754
Diagonal cutters	1/8" ID Tubing tee P/N 00358 D (10pk)
1" and ¾" open ended wrenches	1/8" ID silicone tubing P/N 04029 X (50ft)

Recommended Maintenance Schedules

Schedules

Every 500 hours , the fan and ambient air filters should be cleaned and replaced if necessary.

Every 5000 hours, VIASYS recommends that the following Preventive Maintenance procedure be performed (see chapter 4 for instructions). This procedure includes:

- Replacement of the fan filter, the ambient air filter, the cone filters in the high & low pressure gas inlets and the turbine mufflers/filter.
- Perform verification procedures described in Chapter 4
- Calibration of the transducers & solenoids if necessary.

Every 10,000 hours or every two years, whichever occurs sooner, the internal oxygen sensor should be replaced.

Maintenance on the Vela should only be carried out by a trained and authorized service technician. VIASYS Healthcare will make available to qualified technicians, service manuals and such items as circuit diagrams, component parts lists, calibration instructions and other information to assist in repair of those parts of the ventilator designated by the manufacturer as repairable items.

The drawings, diagrams and schematics included in this manual are for reference only and may be updated separately from this manual after publication. For current revisions of all documentation, contact VIASYS Healthcare Tech Support at the numbers provided in Appendix A.

Chapter 2 Theory of Operation

General Device Description

The Vela Ventilator uses a revolutionary turbine gas delivery system with sophisticated microprocessor control. Its Graphical User Interface provides support for pediatric to adult patients. The Vela can deliver clinically advanced modes of ventilation like Pressure Support and can be powered with an internal battery or AC power for an more extensive patient range.

Pneumatic System Overview

The Vela ventilator pneumatic system is electromechanical and is comprised of four major subsystems, each containing several components. These systems are the flow delivery system, the exhalation system, the safety system and the inspiratory hold valve. Individual subsystems are discussed in detail below.

Flow Delivery System

This electromechanical system controls all inspiratory flow to the patient. The system delivers flow to satisfy criteria for many breath types, including volume controlled, pressure controlled, and pressure supported. The system comprises a turbine, differential pressure transducer, 2 auto-zero valves, and an optical encoder speed transducer. When a breath is initiated, the controller controls the speed of the turbine to achieve the required flow rate.

The speed and differential pressure transducer signals function as control inputs to ensure that the proper flow rate is delivered even when backpressure varies. Periodically, the auto zero valves activate to reference both sides of the differential pressure transducer to ambient pressure. The offset is recorded by the controller, and is used as a correction for future pressure measurements. This compensates for long term and temperature drift. Materials exposed to patient gases include compatible plastics, aluminum, and plated steel.

Exhalation System

The exhalation system controls the flow of gas from the patient's lungs during the exhalation phase of a breath. This electromechanical subsystem is made up of an exhalation valve, a flow transducer, a differential pressure transducer, an airway pressure transducer, and three auto zero solenoid valves. During exhalation, the outflow of gases is regulated by the exhalation valve to achieve the set PEEP. The exhalation valve is comprised of an electromagnetic linear actuator operating against a mechanical poppet/seat. The gas flow travels through the flow transducer. The flow transducer is a variable orifice type and creates a differential pressure proportional to flow. This differential pressure is transmitted to the differential pressure transducer, which converts the pressure signal to an electrical signal. The controller uses this signal for flow triggering and to monitor exhaled tidal volume. The airway pressure transducer reads pressure in the exhalation leg of the patient circuit. This signal is used as a feedback signal for controlling PEEP, pressure control, pressure support, and various pressure monitors. Periodically, the auto zero valves activate to reference the differential and airway pressure transducers to ambient pressure. The offset is recorded by the controller, and is used as an offset for future pressure measurements. This compensates for long term and temperature drift. Materials exposed to patient gases include compatible plastics, aluminum, and stainless steel.

Safety System

The mechanical safety system ensures that the patient can breath spontaneously from room air and that the patient pressure is limited to a maximum preset value in the event of a ventilator malfunction. This mechanical system consists of a pressure relief valve and a sub ambient relief valve. In the event of a ventilator malfunction that results in high pressure, the pressure is limited by a relief valve. The relief valve consists of a user-adjustable, spring-loaded poppet acting against a seat.

In the event the ventilator fails to deliver a breath, the patient may inspire spontaneously by drawing room air through the sub ambient relief valve.

Materials exposed to patient gas are aluminum, compatible rubber, and compatible plastics.

Inspiratory Hold Valve

The inspiratory hold valve is an electromechanical solenoid valve. If activated, the inspiratory hold valve blocks flow between the flow delivery system and the patient. This valve is activate during inspiratory hold and maximum inspiratory pressure maneuvers. Materials exposed to patient gases are aluminum and compatible rubber and plastic.

Oxygen Blending System

The optional oxygen blending system is made up of an O2 Inlet Transducer, five solenoid valves, five flow orifices, an inlet filter, and an accumulator. When a breath is initiated, the turbine draws mixed gas from the accumulator. Filtered air is drawn into the accumulator through the filter. Oxygen is supplied to the accumulator through the solenoids and orifices. The controller opens and closes the valves as required to supply the correct amount of oxygen to satisfy the O2 setting and the flow demand. The signal from the O2 inlet pressure transducer is used to compensated delivered O2 for O2 inlet pressure variations. Surfaces exposed to patient gas are constructed from compatible plastics, plated steel, and aluminum.

There is also an optional oxygen inlet port, which allows for low-flow titration of oxygen into the gas output of this device.

Electronic Overview

The Vela ventilator electronic system is comprised of several subsystems, each containing numerous components. These subsystems are the GUI System, the Power System, the Main Controller System, and the Exhalation and Flow Delivery systems. Individual subsystems are discussed in detail.

User interface module (UIM)

The UIM consists of a 10.4-inch, 800x600 active matrix LCD with an analog resistive touch screen overlay, a back light inverter, a set of membrane key panels, an optical encoder, and a Control PCB. Software and the touch screen provide a set of context sensitive soft keys. The membrane panel provides a set of hard (permanent) keys for dedicated functions. Selecting the function with a soft key and adjusting the setting using the optical encoder changes a parameter. The parameter is accepted or canceled by pressing the appropriate membrane key.

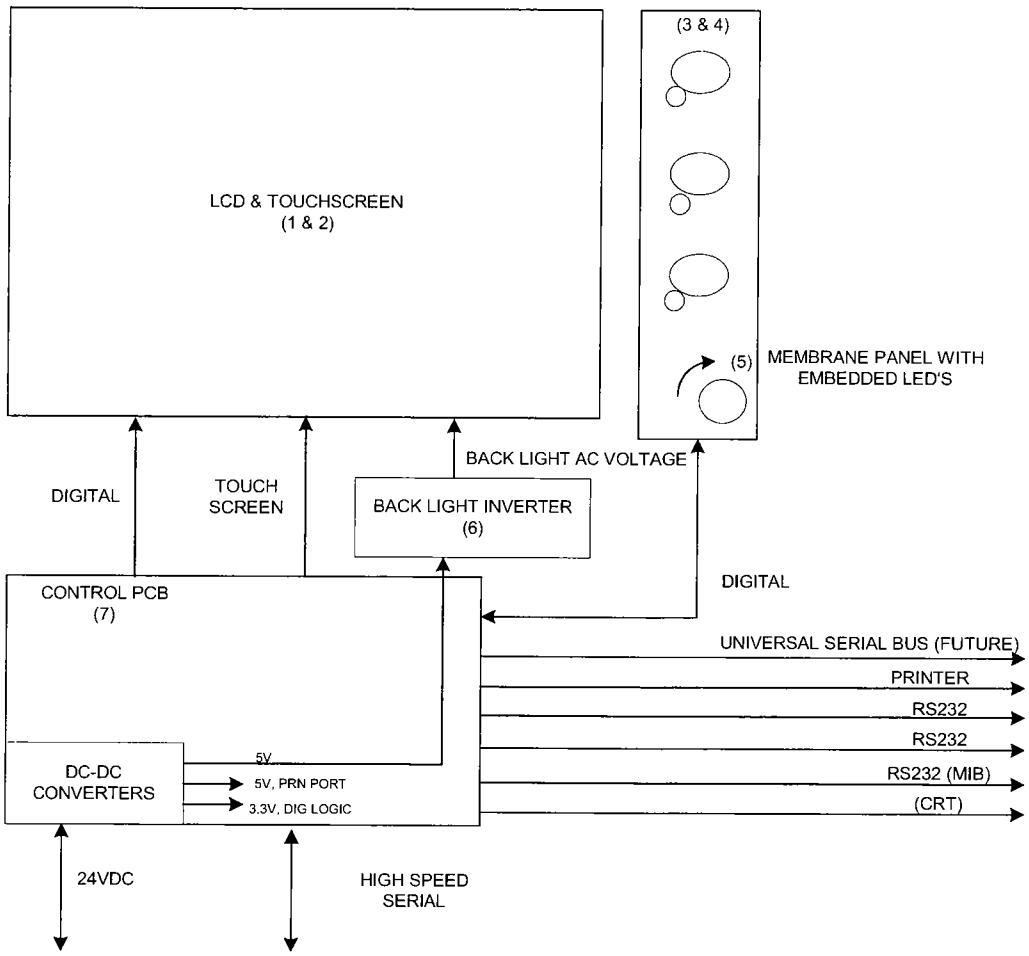


Figure 1 -- User Interface Design Module Block Diagram

The UIM performs all ventilator control functions, gas calculations, monitoring and user interface functions. The UIM uses a Graphical User Interface (GUI) via the active matrix SVGA LCD and resistive touch screen to provide system and patient information to the user and to allow the user to modify ventilator settings. The Monitor MCU handles all user interface requirements, including updating the active matrix liquid crystal display (LCD), monitoring the membrane keypad, analog resistive touch screen, and optical encoder for activity. The Monitor MCU also performs all the input/output functions of the UIM, including RS-232, printer, video output, and IEEE 1073 Medical Information Bus (MIB). Communication between the Control and Monitor MCU's is accomplished via an 8 bit dual port SRAM.

Liquid Crystal Display

The liquid crystal display (LCD) provides graphical and digital feedback to the clinician. The panel is a 10.4" SVGA, 800x600 pixel, active matrix LCD. The LCD is used to implement the graphical user interface (GUI). It provides all of the adjustable controls and alarms, as well as displays waveforms, loops, digital monitors and alarm status in real time.

Touch Screen

The touch screen is a 10.4" analog resistive overlay on a piece of glass, which is placed over an LCD screen. The touch screen and the LCD together provide a set of software configurable soft keys. The software enables the keys to be context sensitive. The touch screen has a resolution of 1024x1024. Physically, the touch screen consists of two opposing transparent resistive layers separated by insulating spacers. Touching the screen brings the two opposing layers into electrical contact. The Y coordinate is determined by applying a voltage from top to bottom on the top resistive layer. This creates a voltage gradient across this layer. The point of contact forms a voltage divider, which is read by the analog-to-digital converter. The X coordinate is determined by applying a voltage from left to right on the bottom resistive layer. Again this creates a voltage gradient and the point of contact forms a divider, which is read with an analog-to-digital converter.

Membrane Panel

The membrane panel provides a set of permanent dedicated keys, which enable control of ventilator functions. The membrane panel also provides visual display using embedded light emitting diodes (LEDs). The membrane panel consists of membrane switches, which are read by the monitor CPU. The switches form a matrix of rows and columns. A key closure causes an interrupt to the monitor CPU, which responds by scanning the key matrix to determine which key has been pressed.

Light Emitting Diodes (Leds)

Some of the membrane keys require LED's to indicate when the key is active. The LED's are embedded into the membrane panels.

Optical Encoder

The optical encoder allows settings to be modified. The setting is selected by pressing a soft key on the LCD and then modified by turning the optical encoder (data dial) to change the value. When the encoder is rotated two pulse streams are generated, phase A and B. When the encoder is turned clockwise, phase A leads B by 90 degrees. When the direction is counter clockwise, phase B leads A by 90 degrees. The electronics uses the phase information to drive an up-down counter, which is read by the monitor CPU. The optical encoder is not interrupt-driven and therefore must be polled by the monitor CPU.

Back Light Inverter

The back light inverter converts 5 VDC into the high frequency AC voltage necessary to power the LCD back light, which is used to illuminate the LCD.

Power System

The Power System conditions and controls electrical energy from the AC line input and the internal battery. When energy is available from the AC line, the ventilator operates from this source, and also recharges the internal battery. When AC line power is not available, the power system draws energy from the internal battery. The power system uses energy efficient DC-to-DC converter technology to convert energy from the AC line or battery to appropriate voltages and currents to supply power to ventilator components and systems.

Main Controller System

The Main Controller System is comprised of three Pressure Transducers, an Analog-to-Digital Converter, two Digital-to-Analog Converters, the Input-Output Processor, Solenoid Valves, and the Watchdog and Hardware Fault Monitors.

One of the pressure transducers measures the patient circuit pressure. This pressure is an input to the controller. A differential pressure transducer measures the pressure across the turbine. This pressure is also an input to the controller. A second differential pressure transducer is used to measure the flow at the outlet of the exhalation valve. This pressure is also an input to the controller.

Analog to digital converters are used to change the analog pressure signals into measured binary numeric values for use by the microprocessor in the controller.

Digital to Analog converters are used to change the binary numeric commands generated by the microprocessor in the controller into analog signals which drive the turbine and exhalation valve.

The Input-Output Processor is a small microcontroller which, under software control, performs several repetitive tasks such as generating the refresh signals for the display system, cycling the A-to-D converters through a pattern of measurements from the multiple signal sources, and scanning the control panel for pressed buttons. Such repetitive tasks are thereby off loaded from the Main Processor.

Solenoid Valves and Valve Drivers (including the Auto Zero valves) are employed on the Circuit Pressure transducer and on the Turbine Differential Pressure Transducer. These valves allow the controller software to compensate for long term drift and temperature induced zero shift in the pressure transducers by periodically rechecking the zero pressure readings. Similar solenoid valves are employed in the Oxygen Blending System. The valve drivers for the Auto Zero and Blender valves are similar.

The Main Processor is a 386-type CPU which controls all ventilator functions. All user settings for alarms, controls, ventilation mode, waveform, and monitoried data are stored here and are combined with measured pressure, flow, and speed data to cause the ventilator to function. The algorithms, formulae, and control functions which define ventilator behavior are contained in the software program executed by the CPU.

The Watchdog Timer and Hardware Fault

Monitors shut down the ventilator if a malfunciton is detected. The Watchdog Timer consists of two timers and a PAL containing a state machine. The Main Controller CPU must communicate with a state machine at intervals within a time window set by the two timers. The CPU must obtain a key from the PAL and send the correct address and data response back to the state machine at each interval. If the response is incorrect, or comes at an invalid time, the Watchdog shuts down the CPU and forces the ventilator hardware to a safe state. The Hardware Fault Monitors check the status of the power supplies to the ventilator electornics. If any is out of the safe operationg range, the ventilator will shut down and cannot be made to operate until the fault is corrected.

Exhalation System

The electrical portion of the exhalation system is comprised of the Exhalation Valve Driver Circuitry. The driver converts the low voltage signal output by a D-to-A converter into a controlled constant current which energizes the linear solenoid positioner in the exhalation valve.

Flow Delivery System

The electrical portion of the flow delivery system is comprised of a 3 Phase Brushless Motor Driver, and an Optical Speed Transducer.

The 3 Phase Brushless DC Motor Driver converts the low voltage signal output by a D-to-A converter into three controlled currents which energize the three motor phases and cause the motor to create a torque, resulting in motor rotation. The torque generated is a function of current, and therefore of the control voltage from the D-to-A converter. The speed of rotation is monitored by the optical Speed Transducer. The transducer outputs a train of pulses with a frequency proportional to the rotational speed of the motor. This pulse train is a control feedback input to the controller.

Oxygen Blending System

The electrical portion of the optional oxygen blending system is made up of a safety solenoid, a pressure regulator set to 40 PSI, an O2 Inlet Transducer, five Solenoid Valves, one Nebulizer solenoid, and the driver circuitry for the solenoid valves.

The Oxygen Inlet Pressure Transducer measures the incoming gas pressure so that O2 delivery can be compensated for inlet pressure fluctuations.

The Solenoid Valves are energized and deenergized under software control by the Main controller to supply the correct amount of oxygen to satisfy the current O2 setting and current gas flow demand.

The driver circuitry translates the binary logic signals presented by the controller to larger voltage and currents suitable for energizing the Solenoid Valves.

Chapter 3 Disassembly & Assembly

General Instructions and Warnings

When performing the procedures in this chapter, refer to the Vela wiring and tubing diagrams. Reference copies of these are located in Appendix B of this manual. Ensure that you follow these safety warnings and precautions:

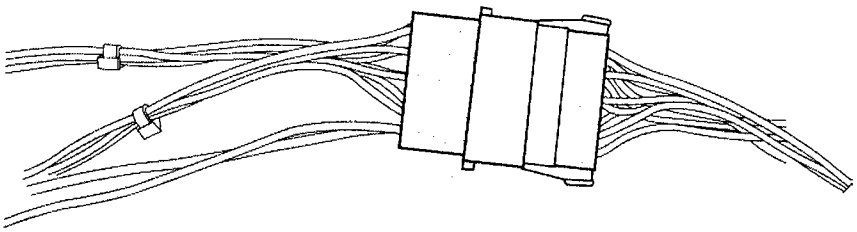


Figure 3.1 Battery Disconnect Molex Connector

WARNING

Always disconnect the main power cable before removing the instrument cover and disconnect the battery once the top cover and battery tray have been removed to prevent injury and/or damage to the VELA Ventilator System (see figure 3.1).

CAUTION

The Vela contains ESD susceptible components. Ensure you are properly grounded before performing any service or maintenance procedures and store ESD susceptible electrical components in an anti-static bag to prevent damage to the component.

Note

When the batteries are disconnected, the system will automatically re-set the battery status memory and will initiate an 18-hour re-charge cycle upon re-connect. During this period, the red DC status light will remain on. If the DC status light remains lit after the initial charging period has expired, contact VIASYS tech support as described in Appendix A for a replacement battery.

Note

Do not cut the main harness tie wraps since the entire harness is regarded as one component.

Note

The terms left and right refer to a view from the front of the unit looking towards the rear.

Required Tools

Long & short Philips screwdrivers	11/32" Nut Driver
Flat bladed screwdriver	Digital Volt Meter
¼" Nut Dirver	Tack puller or Needle nosed pliers
5/16" Nut Driver	Diagonal cutters
7/8" Nut Driver	1" and ¾" open ended wrenches

Disassembly and Reassembly Procedures

To perform a complete disassembly of the unit, follow all of the steps in each *removal* section, in the order presented in this chapter. To reassemble the unit, follow all of the steps in each *installation* section, starting with the last component and finishing with the power cable installation instructions.

Power Cable

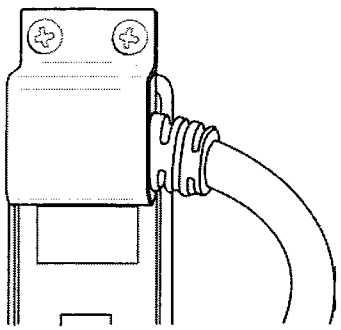


Figure 3.2 Power Cable Connector with Guard

Removal

1. Remove the (2)Phillips pan-head screws in the top portion of the power cable guard at the rear of the unit (see figure 3.2)
2. Remove the guard and unplug the power cable.

Installation

1. Plug the power cable into the rear of the unit.
2. Install the power cable guard with the (2) Phillips pan-head screws in the top portion.

Top Cover Part number 15893

Removal

1. Remove the power cable.
2. Remove the (3) Phillips pan-head screws in the upper rear of the front panel (if present).
3. Remove the (4) Phillips pan-head screws in the back panel.
4. Remove the (3) screws from the bottom of each side of the ventilator (if present).

Note

The configuration of the screws securing the cover will depend on the model of Vela that you are working with.

5. When all screws have been removed, slide the top cover towards the rear of the unit and lift off.

CAUTION

The SVGA output ribbon cable lies directly beneath the top cover assembly running from the front of the Vela to the rear. It can be damaged if care is not taken when removing the cover. Make sure that the cover clears this cable before sliding it back.

Installation

1. Install the top cover by sliding it toward the front of the unit, over the side rails, and snap into place.
2. Install the (4) Phillips pan-head screws in the back panel.
3. **Do not** re-install the (3) Phillips pan-head screws in the upper rear of the front panel if present. They have been removed from later versions of the Vela.
4. Install the power cable.

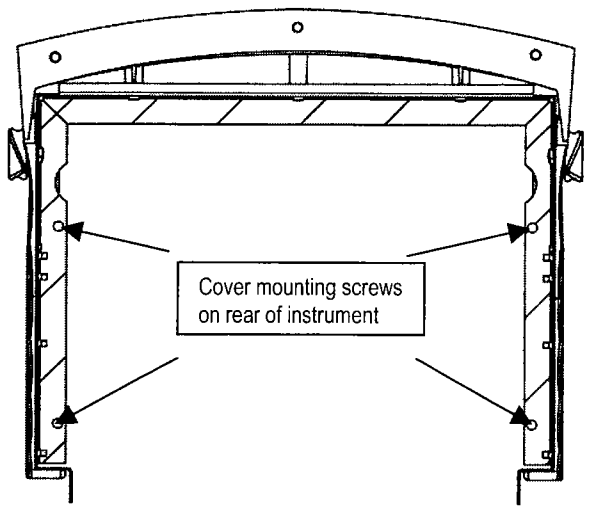


Figure 3.3 Cover Assembly from the rear

Battery Tray Part Number 10633

Removal

1. Remove the power cable and top cover.
2. Remove the (4) Phillips pan-head screws in the battery tray.
3. Lift the battery tray out of the unit.
4. Disconnect the batteries from the white Molex DC power connector (see figure 3.4

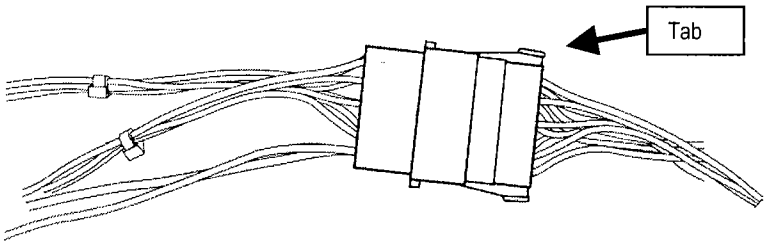


Figure 3.4 Large white Molex battery disconnect

To release connector, push in locking tabs

To attach push until locking tabs engage.

Note

When the batteries are disconnected, the system will automatically re-set the battery status memory and will initiate an 18-hour re-charge cycle upon re-connect. During this period, the red DC status light will remain on. If the DC status light remains lit after the initial charging period has expired, contact VIASYS tech support as described in Appendix A for a replacement battery.

Installation

1. Connect the white Molex DC power connector.
2. Ensure the Molex connector is pushed down into the unit behind the muffler tubes and install the battery tray. The tray is correctly installed when the wires run towards the rear of the unit.
3. Secure the battery tray to the left & right panels with (4) Phillips pan-head screws.
4. Install the top cover and re-connect the power cable and the power cable guard.

Battery Tray Parts List

Item	Part number	Description	Qty	UM
1	21363	Tray, battery	1	Ea
2	52000-00190	Grommet 11/16 id	0	Ea
3	21543	Battery 12v, 2.7 Ahr, ni-mh	4	Ea
4	15719	Cable assy, battery tray	1	Ea
5	20742	Bracket, capacitor	2	Ea
6	21068	Foam pad, capacitor bracket	2	Ea
7	64084	Capacitor elect 0.1f 63vdc	1	Ea
8	04383	Washer, lock int #6	4	Ea
9	07212	Nut, 6-32 x .093 depth	8	Ea
10	05038	Tie, strap	4	Ea
11	08231	Mounting bracket, cable tie	2	Ea
12	07803	Cable tie	2	Ea
14	09349x	Tape, adh-2s,2" x .045"	0	Ft

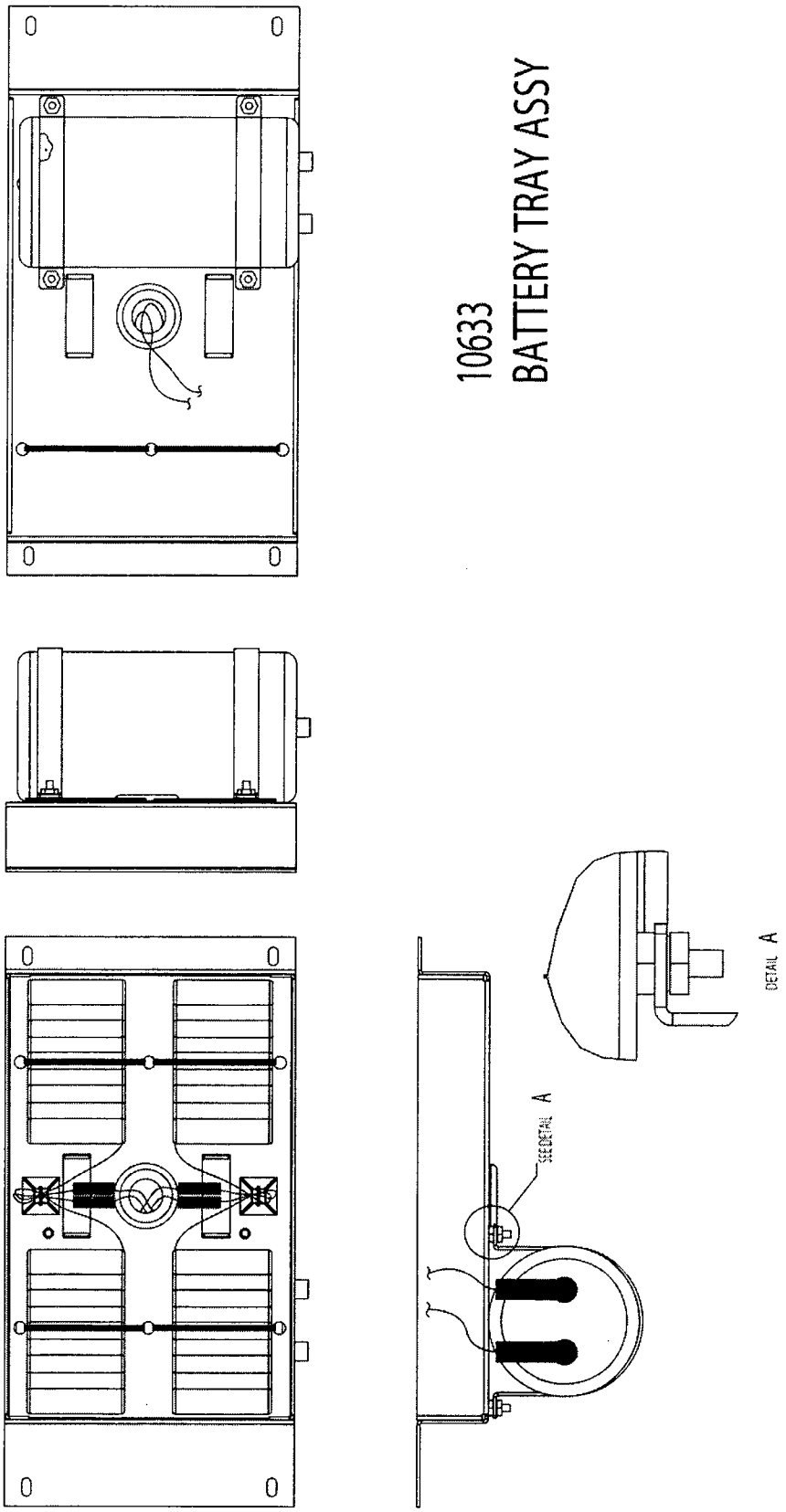


Figure 3.5 Battery Tray and large capacitor assembly

PCMCIA Cards

The PCMCIA card is located inside the unit. It contains the Vela software.

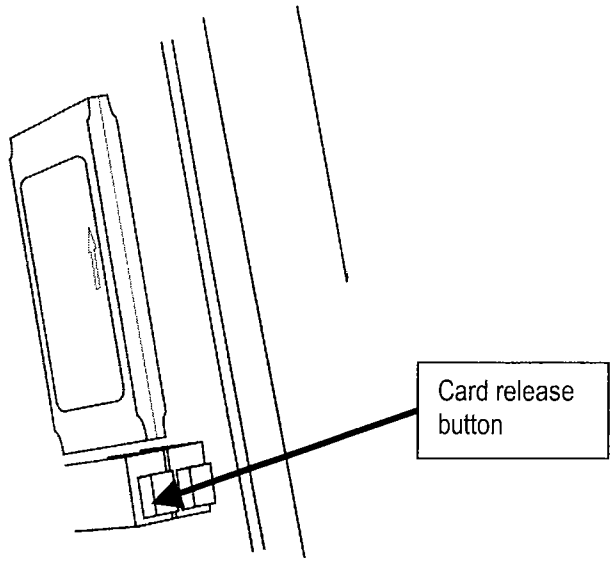


Figure 3.6 PCMCIA Card in place

Removal

1. Remove the power cable, top cover, and battery tray.
2. Push in the button under the card to release. (see figure 3.6)
3. Gently slide the card out of its socket.

Installation

1. Slide the card into the socket in the direction of the arrow printed on the card.
2. Click card into place.
3. Install the battery tray, top cover, and power cable.

Left Panel

The left panel is structural only and has no components attached to it.

Removal

1. Remove the power cable, top cover, and battery tray.
2. Remove the (2) Phillips countersink screws at the rear of the panel.
3. Remove the (1) Phillips countersink screw in the upper front of the panel.
4. Lift out the left panel.

Installation

1. Slide the front of the left panel behind the lip on the front panel and align the back of the panel with the rear panel edge.
2. Install the (2) Phillips countersink screws in the rear of the right panel.
3. Install the (1) Phillips countersink screw in the upper front of the right panel.
4. Install the battery tray, top cover, and power cable.

Right Panel Containing the Power PCB P/N 15894

Note

The internal battery fuse is located on the power PCB. Call Viasys if this fuse needs replacing.

Removal

1. Remove the power cable, top cover, and battery tray.
2. Remove the (2) Phillips countersink screws from the right side of the rear panel.
3. Remove the (1) Phillips countersink screw in the upper front of the right panel.
4. Remove the (1) Phillips pan-head screw in the lower center of the right panel.
5. Gently lift out the panel and the power PCB. Lay the panel flat and make the following disconnections:

Ref on Pwr PCB	Connector Desc	Connection made	Cable Assy P/Number
J1	26-pin ribbon cable	to J2 on main PCB	P/N 15494
J2	3-pin	to fan assembly	
J5	14-pin	to J5 on main PCB (in main harness)	
J6	10-pin	to P2 on turbine motor driver PCB	
J7	small 2-pin	to main power switch	
J300	large 2-pin	to battery DC power (in main harness)	
J400	4-pin quick disconnect	to SVGA PCB	
P1-L/N	AC line in	to power (black-power, white-neutral)	P/N 15890
		to ground lug (ground)	

Note

Do NOT remove the connector from J4 of the power PCB.

Installation

Make the following connections to the Power PCB.

Ref on Pwr PCB	Connector Desc	Connection made	Cable Assy P/Number
J1	26-pin ribbon cable	from J2 on main PCB	P/N 15494
J2	3-pin	from fan assembly	
J5	14-pin	from J5 on main PCB (in main harness)	
J6	10-pin	from P2 on turbine motor driver PCB	
J7	small 2-pin	from main power switch	
J300	large 2-pin	from battery DC power (in main harness)	
J400	4-pin quick disconnect	from SVGA PCB	
P1-L/N	AC line in	to power (black-power, white-neutral)	P/N 15890
		from ground lug (ground)	

WARNING

Ensure that the power cables are correctly connected to prevent injury and/or damage to the unit.