CareFusion

Avea® ventilator system

Service manual

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CE 0086

Literature number: L1524 Revision D

Revision History

Date	Revision	Changes
August 2002	A	Released Engineering Document Control ECO
July 2003	B	Add Exception button and Exception screen to Error Log screen. Add list of error codes. Add OVP kits and instructions. Add Software upgrade instructions. Add heliox Smart connector instructions. Add Compressor upgrade instructions. Add cart instructions (both). Add external battery pack instructions. Add Insp and Exp transducer Cal instructions. Add ref to Communications Protocol. Add unpacking and setup instructions. Reorganize chapters, add chapter 3, add chapter 5 (OVP), add software upgrade info (chapter 6), add chapter 9, add chapter 10, add appendix D.
January 2006	C	Updated the company name.
		Added external batteries to the Limitation of Liability.
		Added symbols for the battery and for HeOx.
		Updated the General Description.
		Changed the references of the Tracheal Catheter and the Esophageal Balloon.
		Changed “O2 bottle” to “O2 tank.”
		Changed the Monitor MCU description.
		Updated the description of the power supply system and the Transducer / Alarm PCB.
		Updated the description of the heated expiratory system.
		Updated the standard-stand carton contents table.
		Updated the procedure for setting up the Customer Transport Cart kit.
		Updated figures.
		Added part number references to “E Cylinder Bracket Assembly Instructions.”
		Added Pediatric Patient Circuit to the list of equipment.
		Removed the note regarding the UIM.
		Replaced the word “arm” with “neck.” Removed the note regarding the UIM.
		Added a note regarding the screws to the Metal Top Cover section.
		Updated the Gas Delivery Engine Removal procedure.
		Updated the fuse specifications.
		Updated the Compressor /Scroll Pump section.
		Changed the part number of the Enhanced Patient Monitor board.
		Added the fan assembly and power supply part numbers.
		Added part numbers to step 1 of the removal procedure.
		Changed step 5 of the Installation procedure to include the part number.
		Added references to PSI to the Setup procedure.

Date	Revision	Changes
		Updated the Manual Alarms Testing section.
		Added two steps to the Testing Guidelines section.
		Added step 22 to the Membrane Switch test.
		Op. Verification Checklist
		Updated the Checkout Sheet.
		Replaced figure A-1
		Updated the MIB Connection section.
		Added the Blender Bleed section.
		Added the Sound Levels section.
		Updated the Water Trap section.
		Updated the Message Bar Text table.
		Added the Monitor Ranges and Accuracies table.
		Added the Sensor Specifications and Circuit Resistance table.
		Added the Hot Wire Flow Sensor Specifications table.
		Added the Circuit Resistance section.
March 2010	D	Clarified component removal directions (compressor, fan, power supply). Corrected the heater removal/assembly instructions. Clarified the OVP tests. Clarified VT accuracy verification directions. Corrected the battery-charge indicator specifications. Added Battery Performance Verification to the OVP checklist. Clarified the software upgrade instructions. Added the Coldfire service screens. Clarified the transducer screens. Clarified the Flow Characteristic Test. Clarified the Exhalation Valve Characteristics Test. Added instructions for removing the O_2 sensor. Corrected the battery specifications. Added the Coldfire UIM to Digital Communication. Labeled the internal battery fuse on the rear panel diagram. Removed software descriptions. Added barometric pressure for the Coldfire UIM. Added $EtCO_2$ parameters to “Monitor Ranges and Accuracy” in the appendix. Added $EtCO_2$, OVP, GDE, and EPM to the glossary. Added “component removal” and “components of OVP” to the index. Clarified the Compressor test in OVP.

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 an 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 Avea 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 13485

CE 0086

EU Notified Body:

BSI (Reg. No. 0086)

Trade names:

Avea Ventilator

If you have a question regarding the Declaration of Conformity for this product, please contact CareFusion at the number given in Appendix A.

Warranty

THE Avea® ventilator systems are warranted to be free from defects in material and workmanship and to meet the published specifications for TWO (2) years or 16,000 hours, whichever occurs first.

The liability of CareFusion, (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 TWO (2) years from date of shipment or 16,000 hours of use, whichever occurs first, with the following exceptions:

- Components for monitoring of physical variables such as temperature, pressure, or flow are warranted for ninety (90) days from date of receipt.
- 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.
- Internal batteries are warranted for ninety (90) days from the date of receipt.
- External batteries are warranted for one (1) year 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


Avea

Chapter 1 Introduction

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 Respiratory Care customer care as shown in Appendix A, Contact and 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 work on the ventilator.

- Alarm loudness must be set above ambient sound in order to be heard.
- 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 until the problem has been identified and resolved.
- 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 – Ensure the ventilator is disconnected from the AC power supply before performing and repairs or maintenance. When you remove any of the ventilator cover panels, immediately disconnect the internal battery "quick release" connector before working on the ventilator. If the ventilator has an external battery installed, ensure that the external battery is unplugged from the rear panel before proceeding
- 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.

The following warnings must be read and understood before performing the procedures described in this manual.

- Under no circumstances should this medical device be operated in the presence of flammable anesthetics or other volatile materials due to a possible explosion hazard.
- Liquid spilled or dripped into the unit may cause damage to the unit or result in an electrical shock hazard.
- Oxygen vigorously accelerates combustion. To avoid violent ignition, do not use any gauges, valves, or other equipment that has been exposed to oil or grease contamination.

- Do not use this device if any alarm/alert function is inoperative. To do so could result in a malfunction without warning, possibly resulting in personal injury, including death or property damage.
- All tubing and fittings used to connect high pressure gas from the source to the test equipment and from the test equipment to the device being tested must be capable of withstanding a minimum supply pressure of 100 psi (7.03 kg/cm2). The use of tubing and fittings not capable of withstanding this pressure could cause the tubing to rupture, resulting in personal injury or property damage.
- When verifying the operation of this medical device, do not breathe directly from the machine. **Always** use a fresh bacterial filter and test circuit. Failure to do so may constitute a hazard to the health of the service person.
- If any of the procedures outlined in this document cannot be verified, do not use this device and refer it to CareFusion or a CareFusion authorized service facility or a CareFusion trained hospital service technician.

Cautions

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

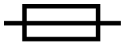
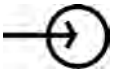
- Ensure that the voltage selection and installed fuses are set to match the voltage of the wall outlet, or damage may result.
- A battery that is fully drained (i.e. void of any charge) may cause damage to the ventilator and should be replaced.
- All accessory equipment that is connected to the ventilator must comply with CSA/IEC601/UL2601.
- To avoid damage to the equipment, clean the air filter regularly.

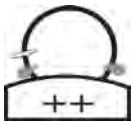
The following cautions apply when cleaning the ventilator or when sterilizing ventilator accessories.

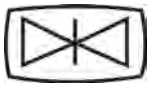
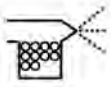
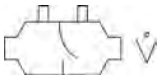
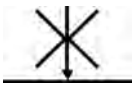
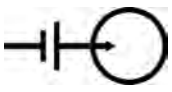
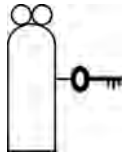
- Do not sterilize the ventilator. The internal components are not compatible with sterilization techniques.
- Do not gas sterilize or steam autoclave tubing adapters or connectors in place. The tubing will, over time, cause poor connection and possible leaks.
- DO NOT submerge the ventilator or pour cleaning liquids over or into the ventilator.
- Do not use MEK, Trichloroethylene or similar solutions as damage to surface may result. Do not allow any liquid to spill or drip into the ventilator.
- Circuit boards are subject to damage by static electricity. Do not touch components, circuit, or connector fingers with hands. Handle only by edges.

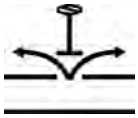
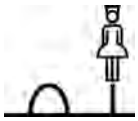
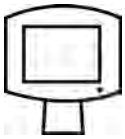
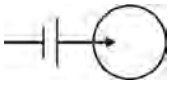
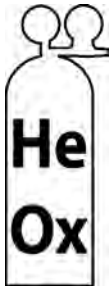
Equipment Symbols

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 B 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 is located on the rating plate. It indicates the equipment is suitable for alternating current.
	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.
	CareFusion Symbol	Indicates PATIENT EFFORT
	CareFusion symbol	Indicates MANUAL BREATH

Symbol	Source/Compliance	Meaning
	CareFusion Symbol	MAIN SCREEN
	Symbol #417 IEC 5102	EVENT READY
	CareFusion Symbol	MODE
	CareFusion Symbol	ADVANCED SETTINGS
	CareFusion Symbol	SET-UP for patient Data
	CareFusion Symbol	SiPAP Duration
CE	MDD Directive 93/42/EEC	CE Mark
	Symbol #5307 IEC 60417	ALARM RESET
	Symbol #5319 IEC 60417	ALARM SILENCE
	CareFusion symbol	ADULT patient
	CareFusion symbol	PEDIATRIC patient
	CareFusion symbol	NEONATAL (Infant) patient
 CANCEL	Graphical Symbol in general use internationally for “DO NOT”	CANCEL, do not accept entered values.
	CareFusion symbol	Select DISPLAYED SCREEN function.

Symbol	Source/Compliance	Meaning
	Symbol 5467 IEC 60417	FREEZE the current display.
	CareFusion symbol	Enable the ALARM LIMITS screen
	CareFusion symbol	This symbol indicates a CONTROL LOCK.
	CareFusion symbol	NEBULIZER port
	CareFusion symbol	Increase OXYGEN
	CareFusion symbol	PRINT SCREEN
	CareFusion symbol	SUCTION port
	CareFusion symbol	VARIABLE ORIFICE FLOW SENSOR connection
	CareFusion symbol	HOT WIRE FLOW SENSOR connection
	CareFusion symbol	ANALOG IN/OUT connection
	CareFusion symbol	Display the MAIN SCREEN
	CareFusion symbol	DO NOT BLOCK PORT
	CareFusion symbol	EXTERNAL BATTERY connection
	CareFusion symbol	Indicates GAS ID port
	CareFusion symbol	OXYGEN SENSOR connection

Symbol	Source/Compliance	Meaning
	CareFusion symbol	OVERPRESSURE relief
	CareFusion symbol	REMOTE NURSE CALL connection
	CareFusion symbol	UNIVERSAL INTERFACE MONITOR connection
	CareFusion Symbol	This symbol indicates an EXTERNAL BATTERY INPUT
	CareFusion Symbol	This symbol indicates an INTERNAL BATTERY FUSE
	CareFusion Symbol	This symbol indicates ALARM LOUDNESS
	CareFusion Symbol	Operating on Battery Indicator
	CareFusion Symbol	Operating on Heliox


Avea

Chapter 2 Theory of Operation

General Description

Avea is a software driven, servo-controlled ventilator designed to meet the requirements of neonate to adult patients. The design intent of the device is to provide a high performance software-driven gas delivery engine, which is capable of providing a full range of volume and pressure ventilation including dual limb NIPPV. This affords the flexibility of developing new modes of ventilation with no impact to the basic gas delivery engine. In addition, the device will contain a graphical user interface (GUI) that utilizes a 12.1-inch SVGA color LCD screen with integral touch screen. The GUI will be used to change settings and operating parameters as well as providing real time waveforms, digital monitors, and alarms. The device also contains an internal battery that serves as a backup in case of loss of hospital AC power. The Custom Cart may be equipped with tank holder, external batteries and battery tray for use of the Avea during inter-facility transport.

There are three models of Avea; comprehensive, plus and standard. These are shown in table 2.1 based on the same basic platform. Additional models may be developed in the future by adding or removing software and/or hardware features to the existing platform.

The Avea is a fourth generation, servo-controlled, software-driven ventilator. It has a dynamic range of breathing gas delivery that provides for neonatal through adult patients. Its revolutionary user interface module (UIM) provides maximum flexibility with simple operator interaction. It has a flat panel color LCD with real time graphic displays and digital monitoring capabilities, a touch screen for easy interaction, membrane keys and a dial for changing settings and operating parameters. A precision gas delivery engine with servo controlled active inhalation and exhalation improves performance over previous generations.

The Avea has been designed to function using most commonly available accessories. It is easy to clean and its design does not allow liquids to pool on the casing, reducing the likelihood of fluid leakage into the body of the ventilator.

There are three models of Avea to choose from: The Comprehensive, Plus, and the Standard. The following matrix details the standard and optional functions available with each model.

Table 2.1

Functions and Accessories	**Standard**	**Plus**	**Comprehensive**
Modes	All	All	All
Proximal Hot Wire Flow Sensing	☒	☒	☒
Synchronized Nebulizer	☒	☒	☒
24 Hour Trending	☒	☒	☒
Internal Battery	☒	☒	☒
Full Color Graphics Display	☒	☒	☒
Loops and Waveforms	☒	☒	☒
Standard Cart	☒	☒	
Proximal Variable Orifice flow sensing		☒	☒
Proximal Airway Pressure Monitoring		☒	☒
Tracheal Pressure Monitoring			☒
Esophageal Pressure Balloon			☒
Internal Compressor			☒
Heliox Delivery			☒
Optional Functions and Accessories			
Custom Cart	Option	Option	Included
External Battery (on custom cart only)	Option	Option	Option
Gas Tank Holder (on either cart)	Option	Option	Option
Internal Compressor	Option	Option	Included
Heliox Delivery	Option	Option	Included

High Level Design

Avea has been designed with three basic modules, the user interface module (UIM), the pneumatics module (PM), and the stand (see Figure 2.1). The UIM contains a graphical user interface (GUI) which utilizes a 12.1-inch SVGA color LCD screen with integral touch screen. The UIM also contains a control PCB that has two microprocessors, control and monitor. The monitor processor manages the GUI, while the control processor has the real time control system that controls all of the mechanical valves in the PM. The UIM communicates with the PM via a high-speed serial channel (HSSC). The HSSC also provides power to the UIM.

The pneumatics module (PM) contains all of the mechanical valves, sensors, analog electronics, power supply including the internal batteries, and the optional internal compressor. The pneumatics module takes high-pressure air or 80/20 heliox and oxygen from an external wall source or other high-pressure source. It filters the gas and blends them through a stepper motor controlled blender according to the front panel settings. It then delivers the appropriate pressure or volume via a high-speed proportional solenoid with flow sensor feedback. The high-speed control system occurs every 2 msec and is computed in the control microprocessor in the UIM. The delivered gas flows to the patient through a safety valve that has a mechanical over pressure relief valve as well as a sub-ambient valve. The gas is forced into the patient by closing the servo-controlled voice coil exhalation valve, which is also controlled by the control microprocessor in the UIM. The patient is allowed to exhale by the voice coil exhalation valve, which also maintains baseline pressure or PEEP. The exhaled gas exits the patient through the expiratory limb of the patient circuit to an integral heated expiratory filter to an external flow sensor and out the exhalation valve to ambient air.

The pneumatics module has several additional capabilities. First it uses either air or 80/20 heliox for an input gas, and corrects all blending, volume delivery, volume monitoring and alarming, and FiO_2 monitoring and alarming based on the correct gas density. The system knows what the gas is, by a patent pending gas ID that identifies the appropriate inlet DISS fitting with the gas that is being delivered, which creates an inherently safer system for delivering heliox. The second capability is the optional back up compressor that is battery backed up for a minimum of 30 minutes by a fully charged internal battery, which allows for uninterrupted ventilation during a loss of AC power. The third feature is the ability to monitor volume either at the expiratory limb of the machine or at the patient wye. This allows for more accurate patient monitoring especially in infants while allowing the convenience of an expiratory limb flow sensor protected by a heated filter. Finally, the fourth feature is the ability to measure tracheal and esophageal pressures, which is currently commercially available only on other CareFusion ventilators.

The stand is used to support the ventilator at an ergonomically correct height. It may contain an optional external battery for extended use with AC power (custom stand only). It also has an optional O_2 tank bracket so that the unit can be used without wall oxygen during inter-hospital transport. The stand does not contain active electronic or mechanical components other than the optional external batteries, which are charged when connected to A/C Power.

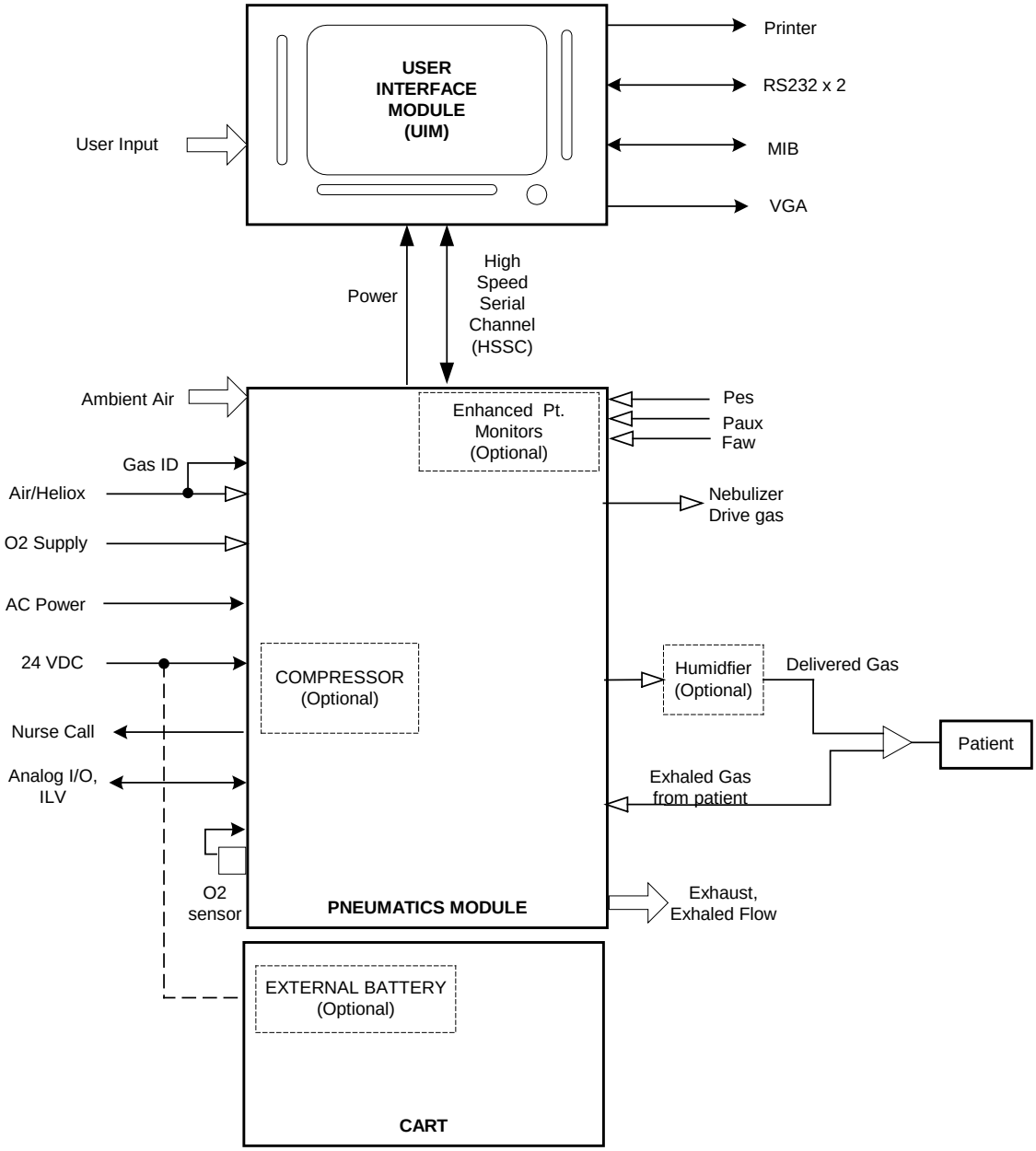


Figure 2.1 High End Device Modular Diagram

Detail Design

User Interface Module (UIM)

The UIM consists of a 12.1-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.

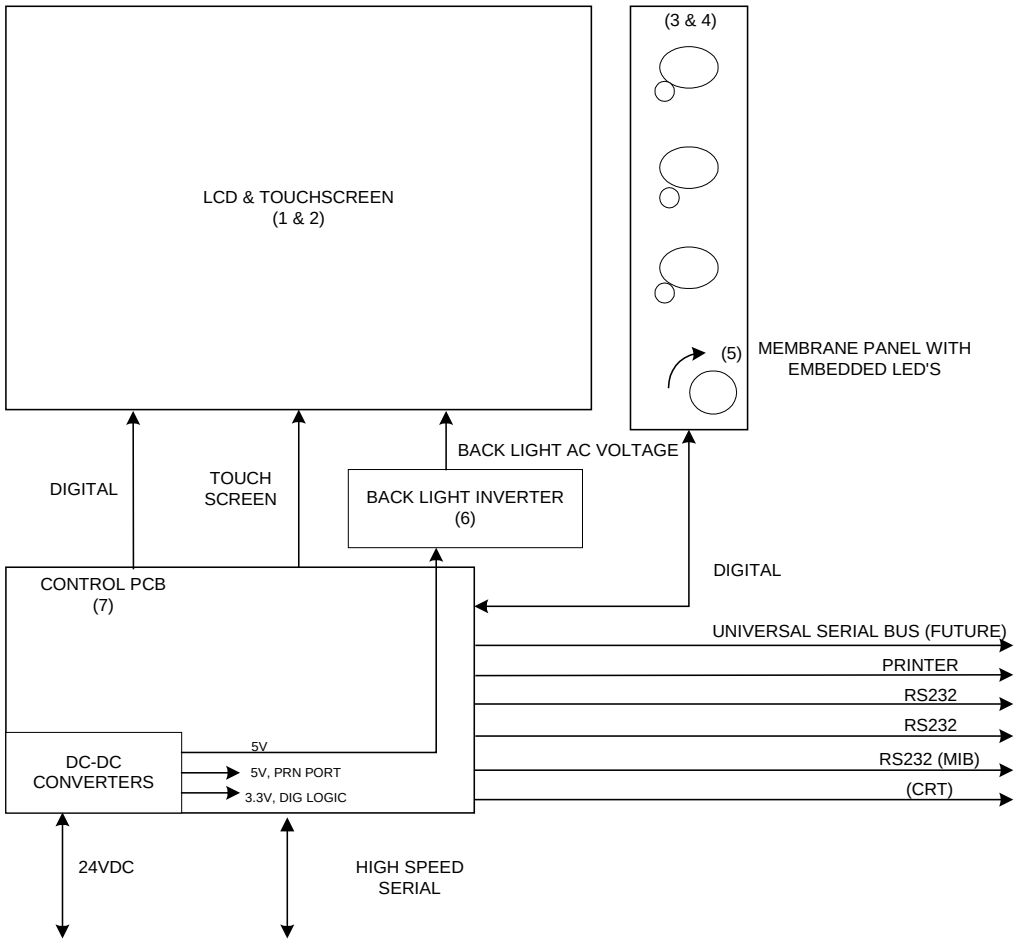


Figure 2.2 User Interface Design Module Block Diagram

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 Control PCB (with two micro-controllers, RAM, ROM and support electronics) provides all ventilator functions. The Control micro-controller (MCU) performs all gas calculations; controls all valves, solenoids, and electronics required to deliver blended gas to the patient. 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 communication to patient monitors. Communication between the Control and Monitor MCU's is accomplished via an 8 bit dual port SRAM. In addition, both MPU's monitor each other and both are independently capable of activating the fail safe system.

The UIM is self-contained and is tethered to the pneumatics module with a high-speed data and power cable. All valves are contained in the pneumatics module; the control MCU controls all ventilator functions via the high-speed serial channel (HSSC). The Monitor MCU provides additional input/output functions contained in the ventilator. These functions include analog outputs, independent lung ventilation, and nurse call and are updated by the Monitor MCU via the HSSC.

Liquid Crystal Display

The liquid crystal display (LCD) provides graphical and digital feedback to the clinician. The panel is a 12.1" 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 in conjunction with the LCD provides a set of software configurable soft keys. The software allows the keys to be context sensitive. The touch screen is a 12.1" analog resistive overlay on a piece of glass, which is placed over the LCD. It has a resolution of 1024x1024. Physically the touch screen, consists of two opposing transparent resistive layers separated by insulating spacers. Actuation 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 allow the clinician to change certain ventilator functions. The membrane panel will provide visual status to the clinician via 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 the clinician to change settings. The setting to be changed is selected by pressing a soft key on the LCD and then turning the optical encoder 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.

Control PCB

The control PCB consists of two micro-controllers, the control CPU and the monitor CPU, both of which are 100 MHz ELAN 410's. The control and associated circuitry (RAM, ROM, etc) micro controllers perform all ventilator control functions including the 2 msec closed loop flow control servo and the 2 msec closed loop exhalation valve control servo. The monitor micro-controller manages the GUI and performs all user input and output including the RS-232 ports, printer port, video out, and MIB port. The two processors communicate with each other via a dual port RAM. The control processor communicates with the pneumatics module via a high-speed serial channel (HSSC - 4 Mbits/sec).

Each processor has 8 Mbytes of DRAM, and one Mbyte of flash memory for program storage. In addition, the monitor circuitry also has a second one Mbyte of flash memory for saving control settings and trended data for clinical parameters. The control PCB also contains a DC-to-DC converter to regulate the incoming 24 VDC to the voltages used by the UIM. Finally, the control PCB also contains all of the circuitry necessary to scan the membrane panels, touch screen, and optical encoder, as well as the video controller necessary to drive the SVGA LCD screen.

Pneumatics Module

The pneumatics module (PM) consists of a power supply system including internal NiMH batteries, a transducer/ communication/alarm PCB (TCA PCB), the pneumatics, a heated expiratory system, a fan, an optional internal compressor, a built-in nebulizer system, and an audible alarm. The PM communicates with the UIM (User Interface Module) via the HSSC described above.

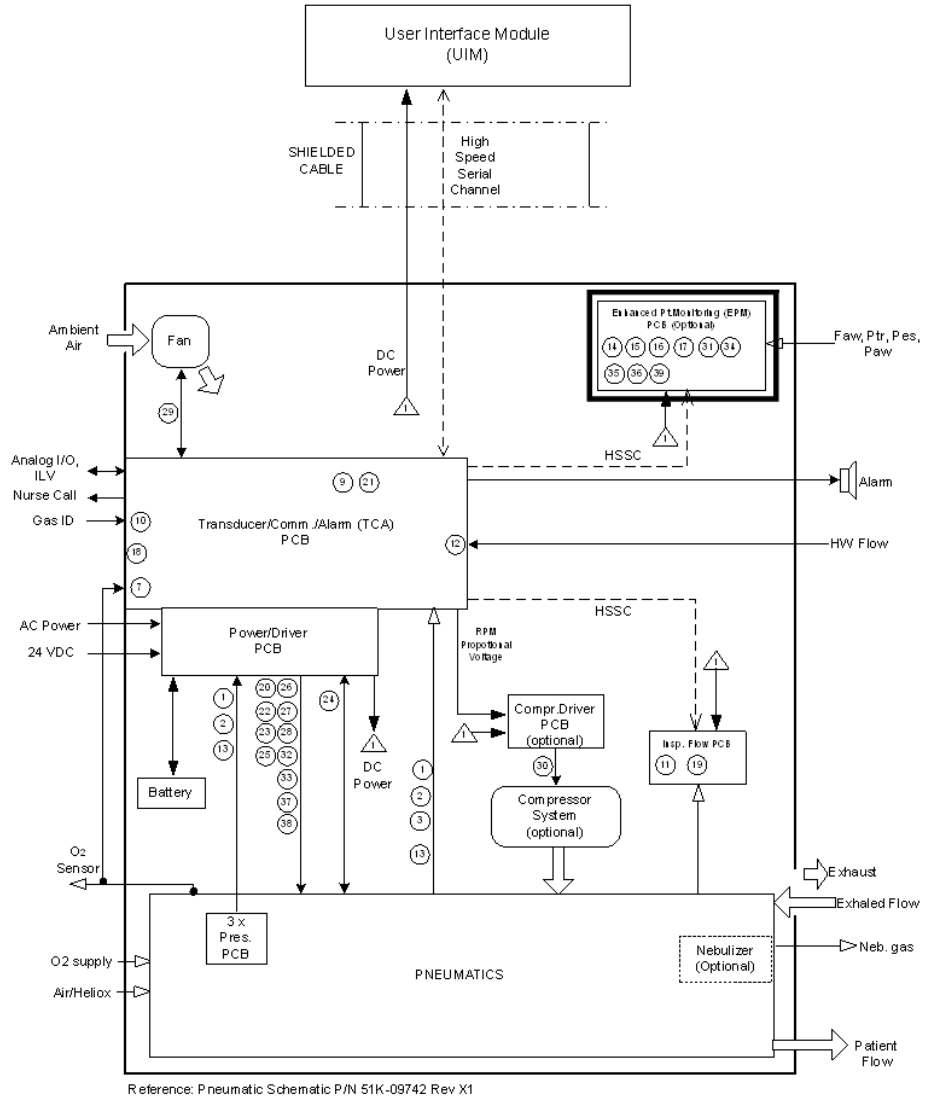


Figure 2.3 Pneumatics Module Block Diagram

Power Supply System

The power supply system, consists of a power inlet module, and a medical grade 350-watt power supply, the power driver PCB, and a set of internal 12 VDC NiMH batteries . The power inlet system accepts a standard IEC medical grade power cord and allows the system to be configured externally for use with 100 to 240 VAC 50/60 Hz power. AC power is converted to 34 VDC by the internal medical grade power supply, which is also power factor corrected. The power driver PCB converts the 34 VDC from the power supply or the 24 VDC from the internal or external batteries to the appropriate voltages used by the rest of the system. The power driver PCB also contains the charging circuit for both the internal and external batteries, as well as the drivers for the flow control, exhalation valve, and multiple solenoids. The internal 4.5 Ah NiMH batteries can power the entire system including the internal compressor for 30 minutes, or 1 hour without the compressor. When the external 12 Ah lead acid batteries are combined with the internal batteries, the entire system, including the compressor, will run for 2 hours on batteries and for 4 hours without the compressor.

Transducer/Alarm PCB (TCA PCB)

The TCA PCB consists of circuitry for the audible alarm, the wye hot wire flow sensor, the gas ID, the inspiratory and expiratory pressure transducers, the source gas pressure transducers, the exhaled flow sensor, the FiO_2 cell, and communications with the UIM. It also contains the nurse call, and analog input and output.

A 68HC705 micro-controller is used to generate alarm waveforms for an ASTM F1463-93 compliant alarm. A super capacitor is used to provide a minimum if 120 seconds of power without wall AC or a battery.

Analog circuitry is provided to signal condition the wye Hot Wire Flow Sensor signal and a 12 bit ADC is used to digitize the signal. A Flow Sensor Fail signal is provided to allow the Control Processor to determine when the flow sensor wire is broken. The Flow Sensor EEPROM is SPI bus compatible and is read at power up and when a Flow Sensor is connected.

The air inlet fitting contains a resistor for determining which gas source is connected to the Air inlet, Air (5K ohm) or Heliox (10K ohm). The type of gas connected is determined with a resistor divider, one half of the divider is contained in a connector and the other half is located on the TCA. The resistor contained in the connector is different for each gas source and therefore produces a different voltage output from the divider. The output of the divider is read via an ADC.

Inspiratory and expiratory pressure transducers and associated signal conditioning are digitized on the TCA PCB. The control processor reads the digitized data via the HSSC. The air, oxygen, and blended gas pressure transducers and associated signal conditioning are on separate PCBs for ease of mounting. The amplified signals are cabled to the TCA where they are digitized and communicated to the control processor via the HSSC.

Exhaled flow is measured with a VARFLEX® Exhaled Flow Sensor. The VARFLEX® Flow Sensor uses a variable orifice with pressure taps on either side of the orifice. The TCA uses a low-pressure pressure transducer and analog circuitry to measure the flow proportional pressure drop across the orifice.

Integrated circuit temperature sensors are signal conditioned and digitized by the TCA electronics. The exhalation and ambient temperature sensors are cabled to the TCA PCB. The output of oxygen cell is also signal conditioned and digitized on the TCA.

There are four 10-bit analog output channels on the TCA for pressure, flow, volume, and breath phase respectively. They have a full scale of 0 to 5 VDC with 10-bit resolution. In addition, there are 8 programmable analog inputs that can be used to display external signals. They are digitized with a 10 bit DAC, and are scalable from 0 to 1VDC, 0 to 5 VDC, and 0 to 10 VDC.

Finally, there is a nurse call output that can be configured as either normally open or normally closed. The nurse call shall be activated for all medium and high priority alarms except when alarm silence is activated.

Pneumatics-Gas Delivery Engine

The GDE (Gas Delivery Engine) receives and conditions supplied Oxygen, Air, or Heliox from an external and/or internal (compressor) sources. It then mixes the gas to the concentration required and delivers the desired flow or pressure to the patient.

The Gas Delivery Engine begins with the Inlet Pneumatics. The Inlet Pneumatics accepts clean O_2, Air, or Air alternate external gas; it provides extra filtration and regulates air and O_2 gas before entering the Oxygen Blender. The Oxygen Blender mixes the gases to the desired concentration before reaching the Flow Control Valve. The Flow Control Valve controls the flow rate of the gas mixture to the patient. Between the Oxygen Blender and Flow Control Valve, the Accumulator System is installed to provide peak flow capacity. The Flow Sensor provides information about the actual inspiratory flow for closed loop servo control. The gas is then delivered to the patient through the Safety/Relief Valve and Outlet Manifold.

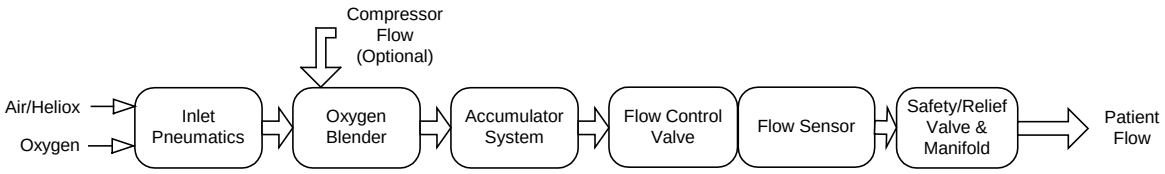


Figure 2.4 Gas Delivery Engine Block Diagram

Inlet System

The Inlet Pneumatics conditions and monitors the air, oxygen, and/or helium-oxygen mix supplies entering the ventilator. The Inlet Pneumatics has Inlet Filters that remove aerosol and particulate contaminants from the incoming gas supplies. The downstream Air Regulator and O_2 Relay combination is used to provide balanced supply pressure to the gas blending system. The Air Regulator reduces the air supply pressure to 11.0 PSIG and pilots the O_2 Relay to track at this same pressure. This system automatically regulates to 9.5 PSIG when the optional internal compressor is being used.

In the event the supply air pressure falls below the acceptable level, the internal compressor will be activated to automatically supply air to the blender. Without an optional internal compressor, the Crossover Solenoid opens delivering high-pressure oxygen to the Air Regulator, allowing the Air Regulator to supply regulated O_2 pressure to pilot the O_2 Relay. In addition, the Oxygen Blender simultaneously moves to the 100% O_2 position, so that full flow to the patient is maintained.

In the event of an oxygen supply pressure drop below a pressure threshold, the Crossover Solenoid stays closed, the blender moves to 21% O_2, and the regulated air pressure provides air to the blending system.

Oxygen Blender

The Blender receives the supply gases from the Inlet Pneumatics System and blends the two gases to the user-selected value. It consists of three sub-systems, valve, stepper motor, and drive electronics. The Oxygen Blender PCB provides the electronics needed to control the Oxygen Blender stepper motor. The stepper motor controls the oxygen blender and is stepped in 1.8-degree increments. The Blender has a disk, which is positioned during

calibration. One end of the disk will interrupt the optical interrupter when the valve position is closed and the other end will only interrupt in case the Blender goes approximately one full revolution due to loss of position. An EEPROM will be used to store the number of steps required to travel from the home position to the full open position of the valve, the PCB revision, and manufacturing date.

Accumulator

The Accumulator stores blended gas supplied from either regulated wall gas or an optional internal compressor. The accumulator provides the capability to achieve volume capacity at relatively lower pressure, resulting in lower system power requirements. It stores blended gas during patient exhalation cycles which maximizes system efficiency. The Accumulator gas pressure cycles between 3 and 11 PSIG depending on the Tidal Volume. The system efficiency is improved because a smaller compressor can be used to meet Tidal Volume while the accumulator provides the extra gas needed to meet the patient's peak flow demand. A 6-L/MIN accumulator bleed orifice allows gas concentration in the accumulator to match the oxygen blender setting in a maximum time of 1 minute. A pressure relief valve will provide protection from pressure exceeding 12 PSIG to the accumulator.

Flow Control System

The Flow Control System provides the desired flow rate of gas to the patient. Real time feedback from the Flow Sensor through the Control System provides flow correction in the Flow Control Valve. The Flow Control System consists of a Proportional Voltage Servo Valve controlled by the real time measurement (2 ms) of flow through a variable orifice Flow Sensor. The variable orifice effect is created by a thin circular shaped piece of stainless steel that is mounted from an extended side in the flow stream. The flow will bend the metal creating a variable orifice. The flow proportional pressure drop is characterized and used for flow measurement. The Servo Control Electronics/Software receives and sends the control signals to the Flow Control System Components. Flow Control Valve adjustments are made for gas temperature, gas density, and backpressure.

Safety/Over Pressure System

The Safety/Pressure Relief Valve prevents over-pressure in the breathing circuit, and provides a connection between the patient and ambient air during a gas delivery failure from the Ventilator. A Check Valve downstream of the Safety/Pressure Relief Valve prevents flow from the patient back into the Ventilator. Pressure Relief around the Check Valve is accomplished through an orifice installed in parallel to the Check Valve. The Safety/Relief Valve allows the patient to breathe room air in the event of a ventilator or power failure. It also acts as an independent relief valve, which limits the maximum pressure the ventilator can deliver.

Hour Meter

The Hour Meter provides a means of monitoring the number of hours the ventilator is in use. In addition, it is used by the ventilator to track compressor hours of operation. A Curtis 201-hour meter is used. The hour meter is active as long as 5 volts is available. The hour meter outputs a continuous stream of serial data. The control processor reads the data by synchronizing to the start pulse of the data stream and then reading each successive bit. The hour meter does not have a visible readout and therefore must be read by software. The hour meter is hard mounted in the pneumatics module and is cabled to the TCA PCB.

Heated Expiratory System

The heated expiratory system consists of a heated filter contained in a chamber with a micro-controller controlled heater, a water collector, an exhalation flow sensor, and a servo-controlled exhalation valve. The expiratory system is located at the end of the patient circuit. The Exhalation Valve regulates gas flow out of the patient circuit, and the diaphragm position of the voice coil type active Exhalation Valve controls the exiting gas flow rate and patient circuit pressure with precision. Pressure feedback data is sent to the Electronic Control Unit continuously, which interprets the data, and based upon current ventilator settings, signals back to position the Exhalation Valve Diaphragm. Since the ventilator will be used in neonate, pediatric and adult ranges, the exhalation servo can be optimized for each circuit type to be used. The Water Collector and Filter remove contaminates from the gas flow before they reach the Flow Sensor, Exhalation Valve, or the environment. Also, warm air exhausts through the Exhalation System enclosure to the atmosphere. The system incorporates a resettable fuse.

The expiratory flow sensor determines flow by measuring the pressure difference across a variable orifice. The variable orifice is created with a thin circular shaped piece of stainless steel that is mounted on a hinge in the flow stream from an extended side. As flow increases and decreases the hinged flap creates the variable orifice effect. The pressure drop across the orifice is measured by a pressure transducer on the TCA and converted to flow by the software in the control micro-controller.

As stated earlier, the exhalation valve is a voice coil with a diaphragm. The exhalation valve controls circuit pressure, permits only one-way flow, and provides pressure relief above a set level during inspiration. The exhalation valve is controlled with a closed loop servo contained in the control micro-controller and is updated every 2 msec.

The water collector stores water that condenses in the expiratory limb of the patient circuit protecting the filter and exhalation valve system. The water collector consists of a vial and an inlet and outlet shaped fitting. A male 22 mm outside taper (15mm inside taper) connector is provided for the patient circuit connection and a 22 mm female connector is used for the heated filter.

The bacteria filter removes particles from the gas that exceed 0.3μm in size. The excess water drains into the water collector reducing the risk of contamination of the exhalation valve system. Warm heated air flows past the outside surface of the filter reducing condensation in the filter. The filter is an off-the-shelf purchased part.

Fan

A 40 cfm fan runs at all times to keep the internal temperature of the pneumatics module as close to ambient as possible. In addition, the fan forces flow out past the expiratory filter. A heater heats the gas as it exits in order to heat the filter as described above.

Compressor System (Optional)

The Compressor System provides 3 to 9.5 PSIG air pressure to the system when wall air is not available. The Compressor has two opposing machined aluminum involutes that are called Scrolls. One scroll orbits a fixed scroll forming air pockets that get progressively smaller as they travel from the outer to inner regions of the involute, compressing the gas. The shaft rotation from a brushless DC motor powers the orbiting scroll within the fixed scroll through an eccentric shaft. It operates at 800 to 3,000 RPM using about 100 watts at 24 VDC. A Pressure Servo improves power efficiency and noise by matching ventilator demand with supplied compressed air. While the accumulator is the device which handles the peak flow demand, the servo operates the compressor at a level which matches the minute ventilation of the patient.

Nebulizer System

The Nebulizer system provides a 10 PSIG source of blended gas for an external nebulizer. The gas will only be delivered during the inspiratory cycle of a breath so that the delivery of nebulized gas will be synchronized with the patient's breathing. Most manufacturers' nebulizers draw between 4 and 8 L/MIN at 10 PSIG. The Nebulizer is disabled during use of the optional internal compressor.

Enhanced Patient Monitoring PCB (Optional-EPM)

The Enhanced Patient Monitoring PCB provides Esophageal and Tracheal pressure monitoring and VARFLEX® wye flow sensing. The EPM PCB contains all of the signal condition as well as the pressure transducers for the esophageal pressure, tracheal pressure, and wye flow sensing. In addition, it contains a 12-bit serial ADC to convert the pressures to digital data. The TCA provides the chip select and solenoid control signals. Three solenoids are used to control the evacuation and filling of the Esophageal Balloon. Two solenoids are used to provide purge flow and auto zeroing of the flow sensor pressure transducer.


Avea

Chapter 3 Installation Instructions

Stand Assembly Instructions

Basic Stand Assembly Instructions (P/N 15986)

Table 3.1 Basic Stand Carton Contents

Quantity	Unit	Description
10	Ea.	5/16″ screws
10	Ea.	5/16 " lock washers
2	Ea.	½″ nuts
1	Ea.	Drag chain and modified washer

Tools required:

½ " open end socket

3/16″ Allen wrench or driver

1. Remove contents of carton.
2. Refer to (Figure 3.1 and Figure 3.2 for steps 3 through 6.
3. Attach base to pedestal using 5/16 –1″ long screws, washers and nuts as shown. The anti-static drag chain may be attached to either screw.
4. Attach pole to assembly using 5/16 – 1″ long screw and washer.
5. Attach top plate to pedestal using 5/16 – 1″ long screw and washer.
6. Place Avea Ventilator on top plate, align thumbscrews (4) and lightly start all thumbscrews to locate Avea Ventilator. Fully tighten (4) thumbscrews to secure Avea Ventilator.

Note:

Apply Loctite® 271™ Threadlocker thread adhesive or equivalent to all threaded fasteners.

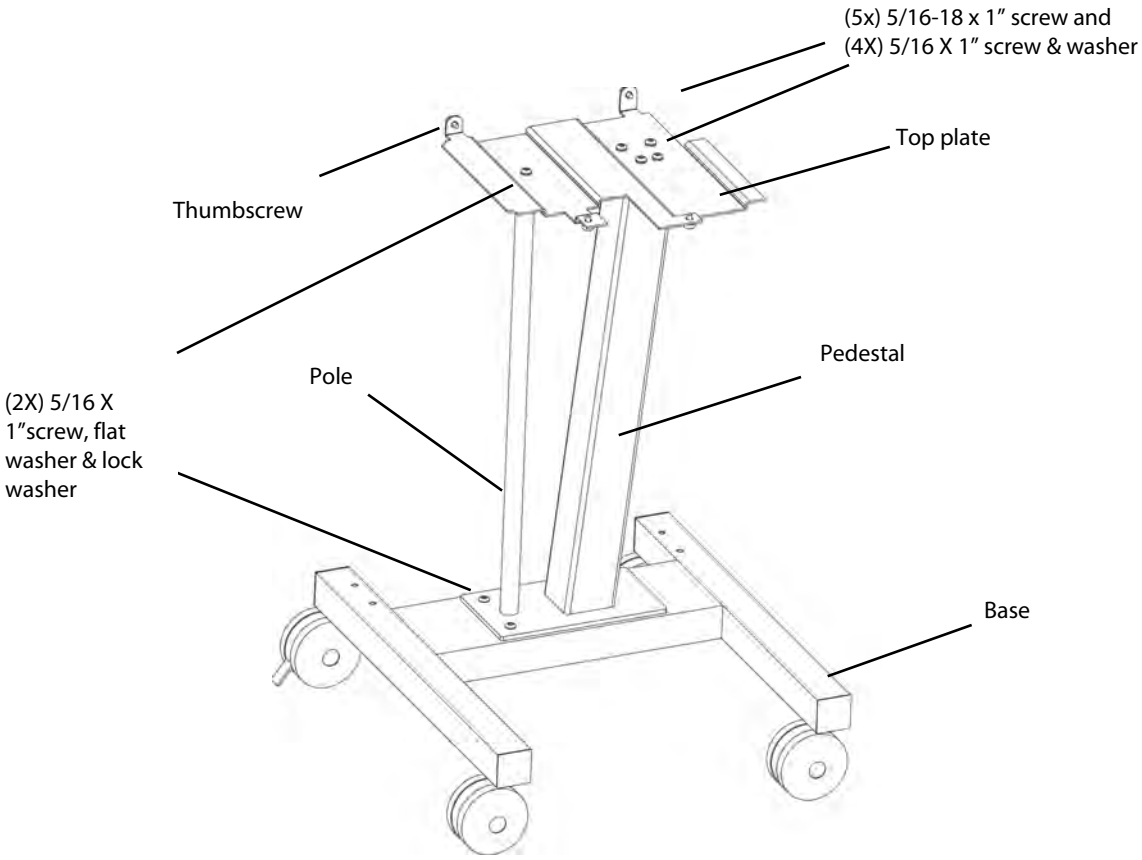

(5x) 5/16-18 x 1" screw and
(4X) 5/16 X 1" screw & washer
Top plate
Thumbscrew
Pedestal
Pole
(2X) 5/16 X
1"screw, flat
washer & lock
washer
Base

Figure 3.1

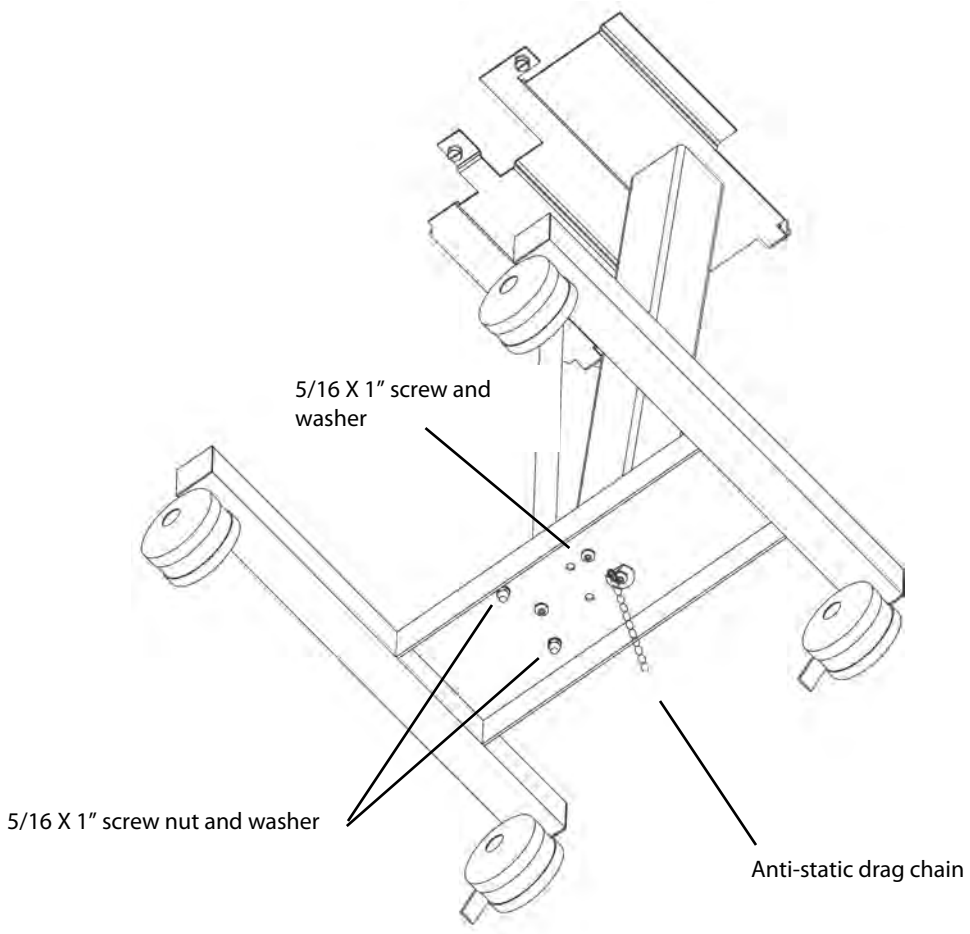


Figure 3.2

Comprehensive Stand Assembly Instructions

Refers to P/N 33976

1. Open main carton.
2. Remove the center carton that contains the pedestal, hardware and instructions and open.
3. Remove second carton that contains top plate/pole and set aside.
4. Remove the 4-legged base assembly from carton and set base on the floor. Place pedestal onto the base assembly.

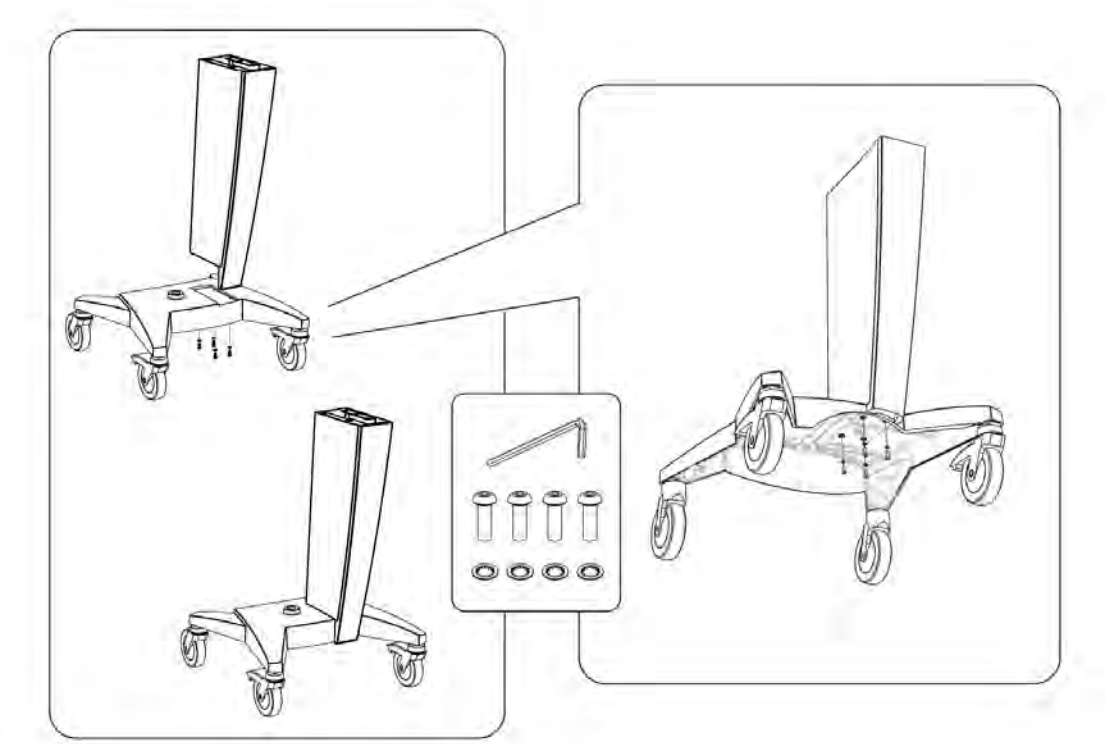


Figure 3.3

5. Using the 1/8" Allen wrench provided install and secure the 4 10/24" x ¾" screws along with the 4 star washers.

Note:

All threaded fasteners are to be assembled using Loctite® 271™ Threadlocker thread adhesive, or equivalent, except the fasteners with Vibra-Tite®.

6. Install collar set screw using the 1/8" hex wrench. Next remove pole from Top Plate carton install and secure the 1" pole using the collar set screw.

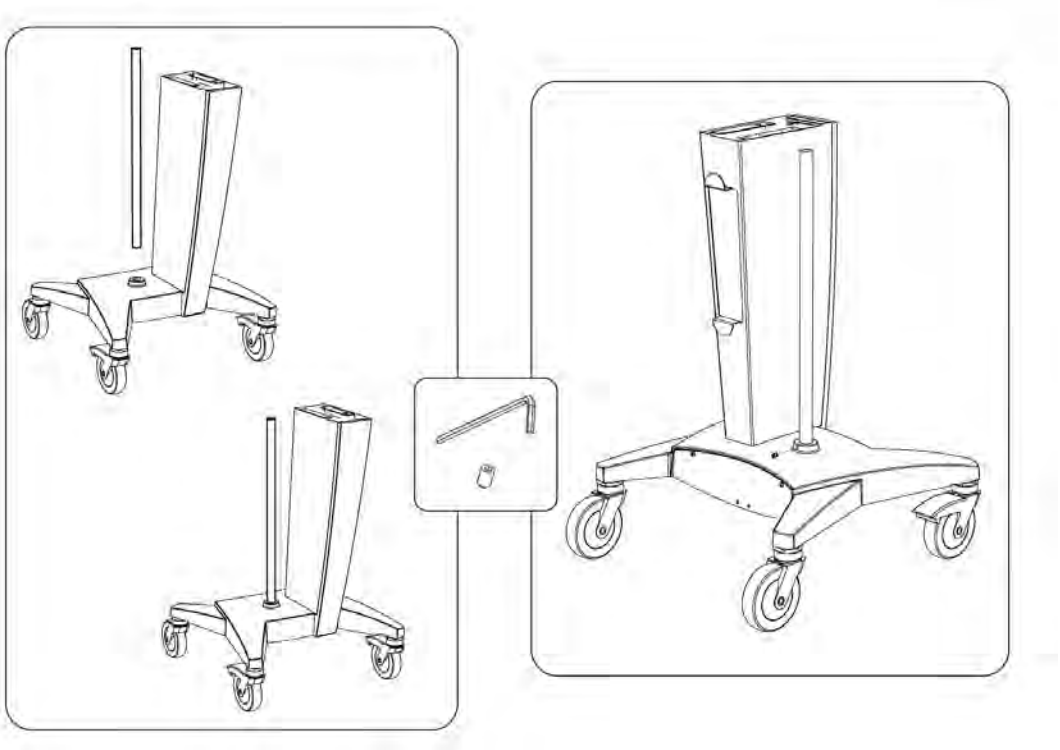


Figure 3.4

7. Remove Top Plate and set Top Plate onto the pedestal and pole. Using the 3/32″ Allen wrench provided install and secure the 4 counter sink screws as shown in Figure 3.

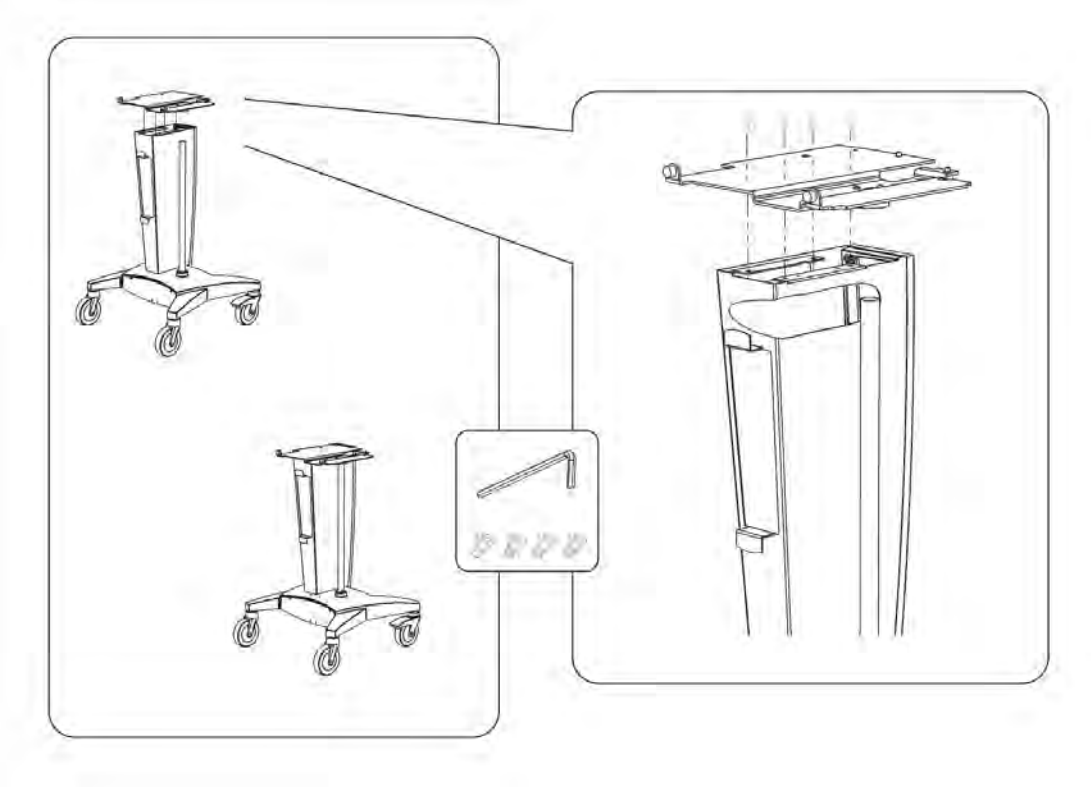


Figure 3.5

8. Using the 1/8″ Allen secure the setscrew of the upper collar into the 1″ pole.

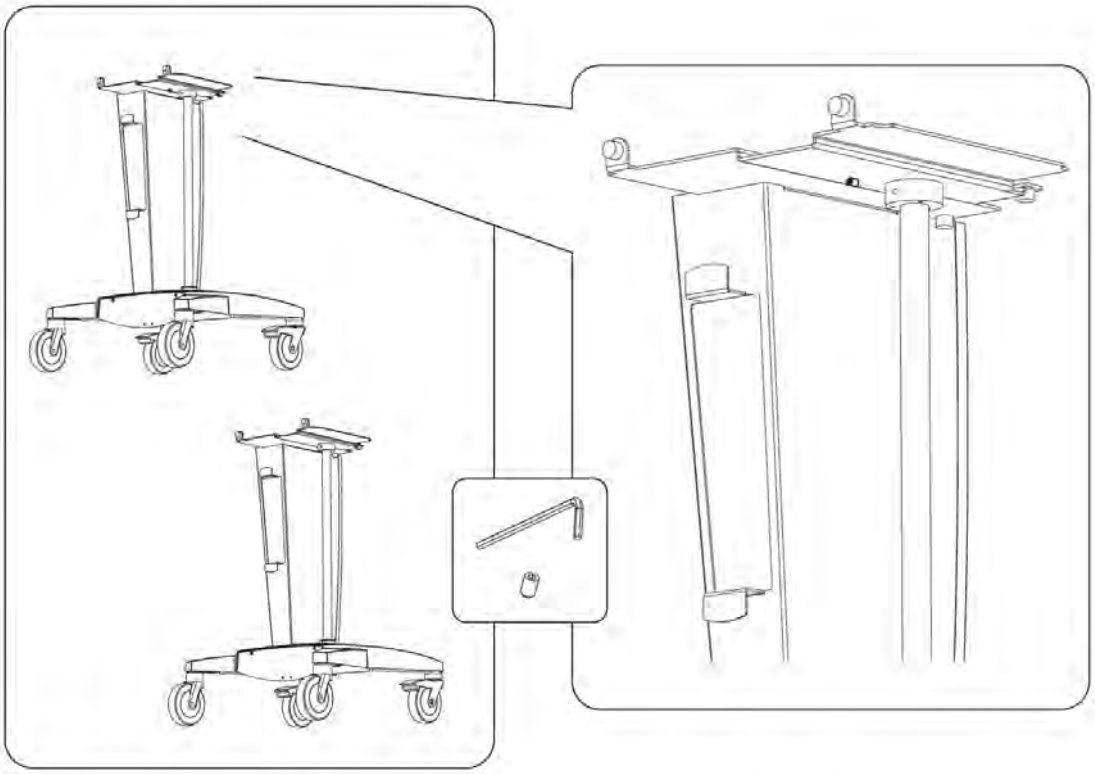


Figure 3.6

Note:

If installing external battery pack, proceed to the next section.

9. Place Avea Ventilator on top plate, align thumbscrews (4) and lightly start all thumbscrews to locate Avea Ventilator. Fully tighten (4) thumbscrews to secure Avea Ventilator.

Note:

Apply Vibra-Tite® locking and sealing coating, or equivalent, to the threads of the thumbscrews that hold the ventilator to the top plate.

External Battery Installation Procedures

Refers to P/N 11372

Before installation, verify that the following parts are in your external battery kit:

Description	Quantity	Part Number
12V lead acid battery	2	16179
Battery tray, screw (10/32 x 5/16) X2, washer #10 X 2 and nut 10/32 KEPS		33977
Wire harness	1	16217
Cable ties	10	52000-00239
Literature	1	L2353
Rack Tank Cart Assembly	1	33978
Battery tray rail plate	1	22392
Mounts	5	08231

If any parts are missing contact CareFusion Avea customer service at 800-325-0082 or 760-883-7185.

Assembly Instructions for Comprehensive cart P/N 33976 (Metal cart))

1. Unscrew the (4) thumbscrews securing the base to the ventilator body as shown. Lift the ventilator body and UIM from the wheeled base.
2. Gently set the ventilator down on a secure flat surface (see the Note on following page).
3. If attached, remove the Gas Tank holder from the base.

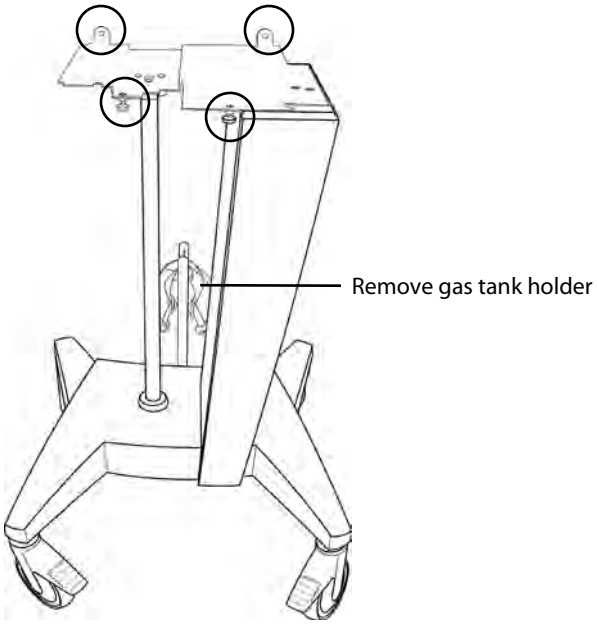


Figure 3.7

Caution!

Do not rest the ventilator on the patient breathing gas outlet. Resting the weight of the ventilator on this outlet may cause damage resulting in leaks at the site.

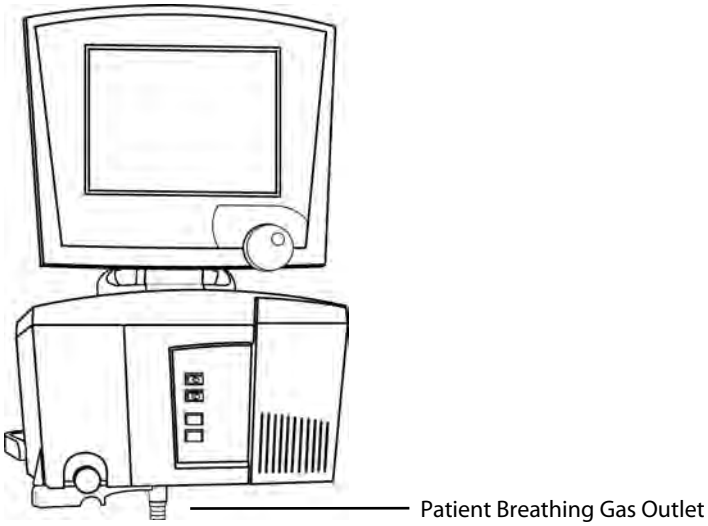


Figure 3.8

4. Detach the drop-cable portion from the main battery harness as shown.

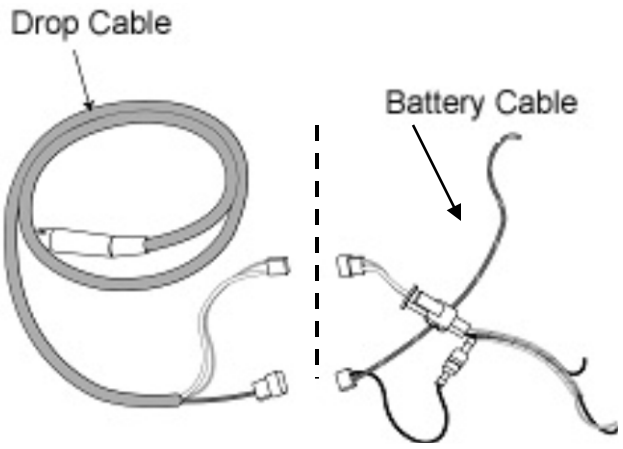


Figure 3.9

5. Remove the two screws holding the face plate between the rear wheels of the Avea cart and detach the faceplate.

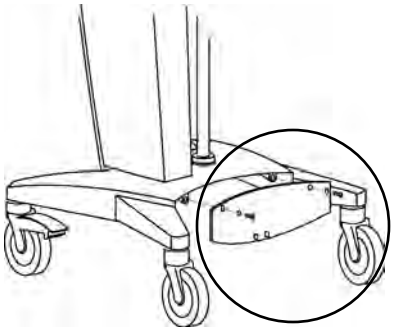


Figure 3.10

6. Thread cable harness through the cart pole.

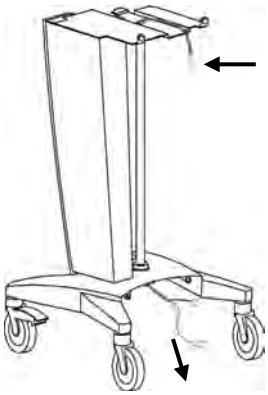


Figure 3.11

Caution!

After the cable has been threaded, inspect the cable for any cuts, abrasions or scaring.

7. Place the two batteries into the tray as shown in Photo 1.

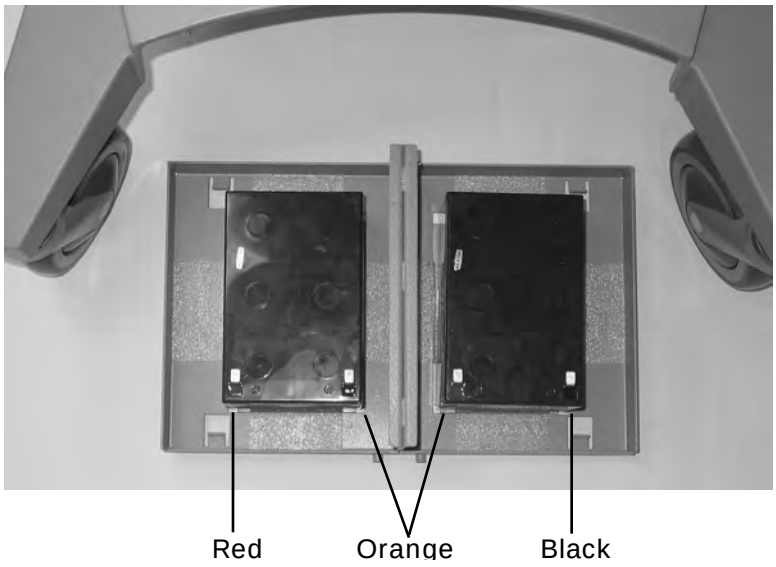


Figure 3.12 Photo 1

8. Attach harness (P/N 16217) to batteries:
    1. Connect black wire to negative post (black) on the outer right hand side battery.
    2. 2Connect the orange wire to positive post (red) on the inner right hand side battery.
    3. Feed the orange wire through the center battery support bracket opening to the left hand side battery area.
    4. Connect the single orange wire to the negative post (black) on the left hand side battery.
    5. Feed the red wire (positive) through the center battery support bracket opening to the positive post (red) on left hand side battery.
    6. Install ground lug from cable assembly to the threaded stud on the battery tray. Secure with supplied hardware.

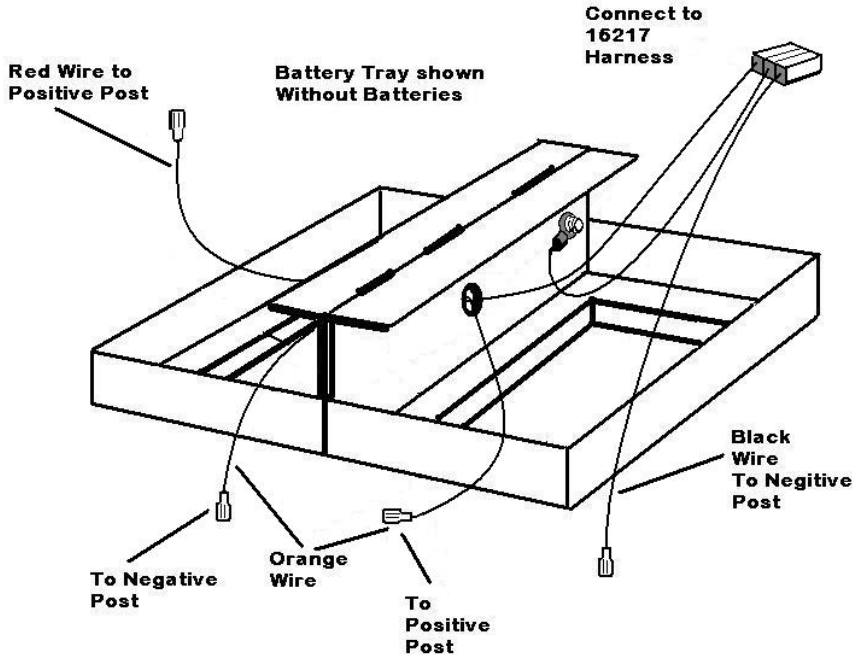


Figure 3.13

9. Slowly slide the completed battery and tray assembly onto the mount beneath the Avea stand making sure that no wires are kinked or scuffed during assembly. Maintain tension on drop cable from top of cart to prevent kinking at battery tray. Sufficient cable slack must be available at top of cart to make connection at back of ventilator.

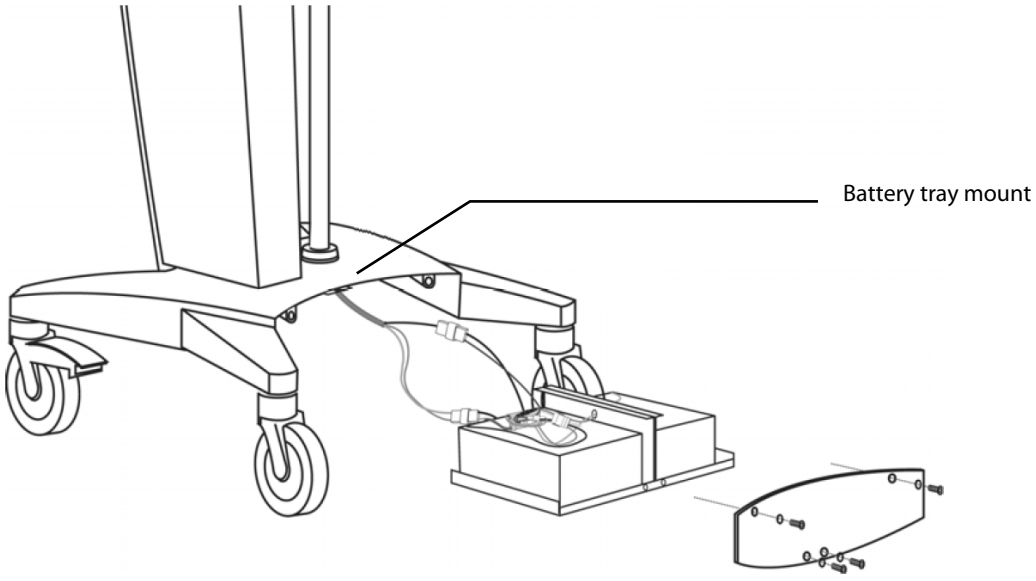


Figure 3.14

10. Attach the faceplate removed earlier in the instructions to the bottom of the battery tray with the hardware supplied.

11. Re-attach the ventilator body to the stand making sure the external battery cable lays untwisted in the cable slot and emerges at the rear of the ventilator.

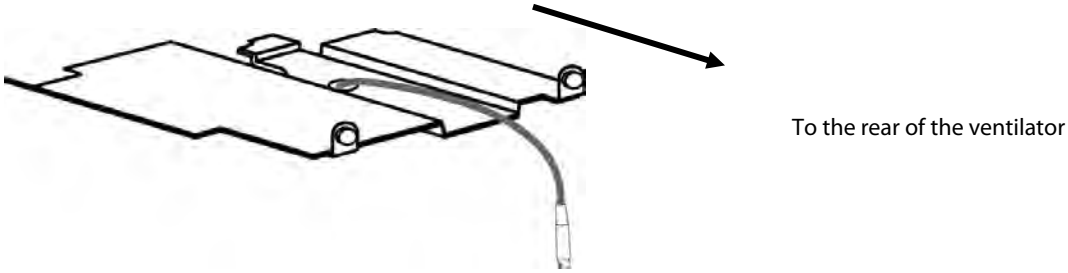


Figure 3.15

12. Connect the external battery cable to the connection labeled EXT BATT on the rear panel of the Avea.

Figure 3.16

13. Plug the Avea into a grounded AC outlet and apply power to the ventilator.
14. Check that the battery status display on the front panel indicates that the ventilator is connected to External battery power.

Note:

The battery status will indicate red immediately after the external batteries are connected and the unit is powered up. If the batteries are fully charged, the battery status should indicate green (charged) within one hour of connection. If the batteries are not fully charged, it may take up to 48 hours to indicate green. Refer to your operator's manual for recommended battery charging.

Assembly Instructions–Comprehensive Plastic Cart (P/N 11524)))

1. On the back side of the Upright/mount assembly there is a metal plate with four screws securing it to the plastic mount. Remove the four screws from this plate.
2. Inside the mount at the top is a single screw securing the top plate to the front of the mount, this screw needs to be loosened, but not removed.
3. The top plate can now be separated from the mount to be able to slide the metal backing away from the mount exposing the cable slots on the rear right side of the mount.
4. Lay the cable in the grooves, along the side of the mount until the connecter can be placed through the hole in the bottom of the mount. The large ventilator connector end will lay in the groove at the upper right corner as shown in the illustration below.

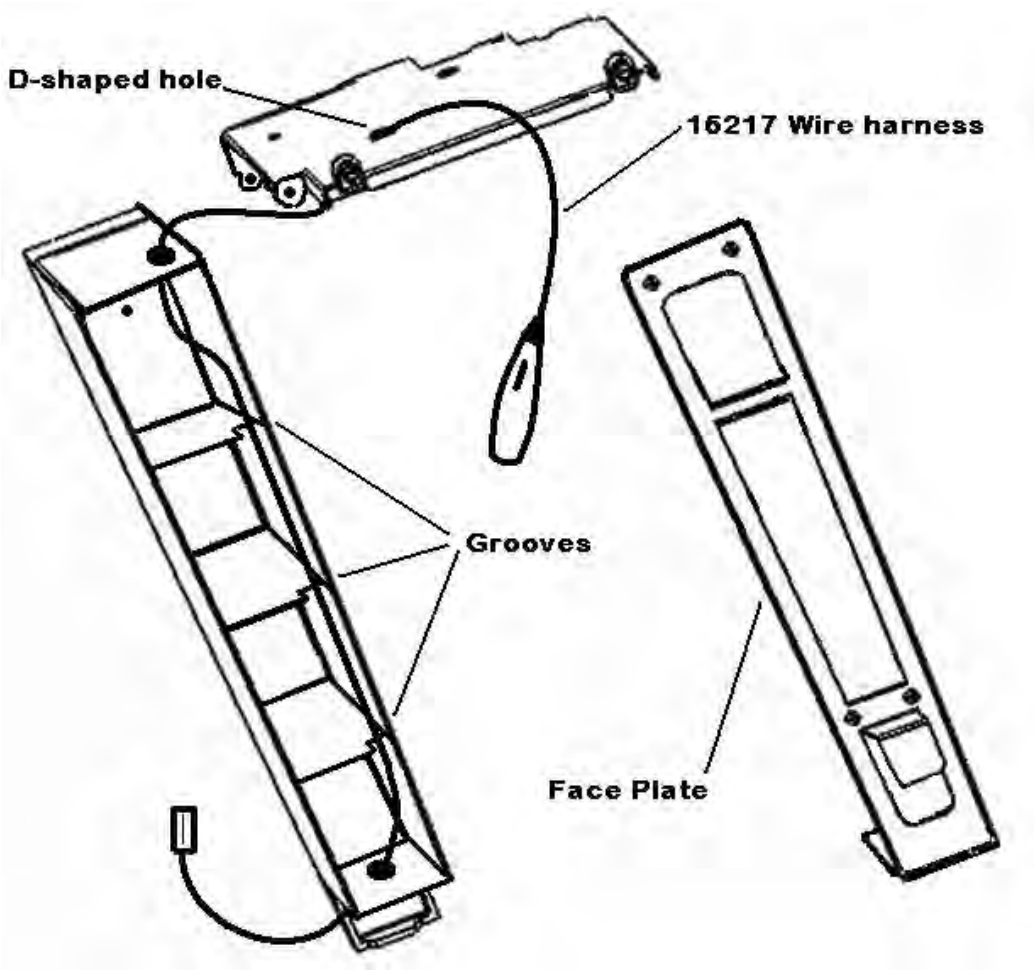


Figure 3.17

5. Replace the Metal face plate onto mount ensuring the harness wire is laying in the mount grooves. Install the top plate in position and secure screws in metal face plate. Tighten the top front internal screw of the mount securing the top plate to the front mount.
6. After completing the cart assembly per instructions P/N L2932. Continue with step 7.

7. With ventilator removed from cart carefully turn the completed cart assembly to access the bottom of the base/caster subassembly as shown in the illustration below.

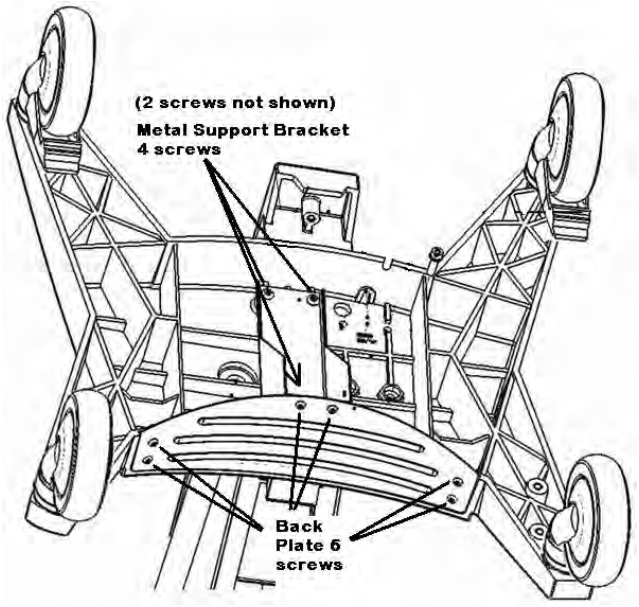


Figure 3.18

8. Remove the rear plate by removing the six screws securing it to the Wheel Base assembly. Save screws for re-installation
9. Remove the support bracket by removing the four screws securing it to the bottom of the Wheel Base. Save screws for battery tray rail.
10. Install the Battery Tray Rail Plate as shown in illustration below. Secure it with the screws removed from the metal support bracket.

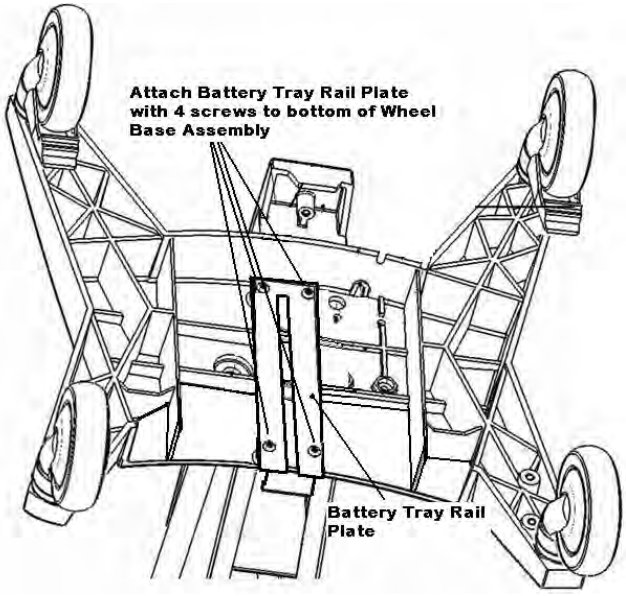


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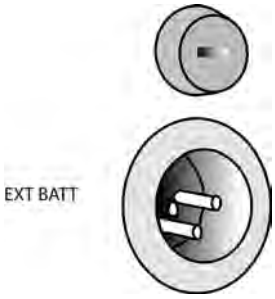
Figure 3.19

11. Turn the cart upright and apply brakes on the front casters to prevent the stand from rolling.
12. Prepare the battery tray as it is shown in the Metal Cart instructions on page 19 of this document.
13. After connecting the battery connecter to the harness of the external batteries, lift the tray and begin to insert it into the back of the cart resting the mount slide on the tray rail.
14. You will have to tilt the batteries toward the middle of the tray without moving them out of their cutout. As you tilt them slide the tray into the mount rail.
15. Install the Back Plate with the four 5/32" screws on either side.
16. Install two 1/8" screws in the two center hole securing the battery tray.
17. Install ventilator making sure cable does not get damaged.
18. Connect the external battery cable to the connection labeled EXT BATT on the rear panel of the Avea.



19. Plug the Avea into a grounded AC outlet and apply power to the ventilator.
20. Check that the battery status display on the front panel indicates that the ventilator is connected to External battery power.

Note:

The battery status indicates red after the external batteries are connected, the power is cycled off and back on, and the unit is allowed to charge for several minutes to achieve the minimum charge required to illuminate the red LED. If the batteries are fully charged, the battery status should indicate green (charged) within one hour of connection after power cycling. If the batteries are not fully charged, it may take up to 48 hours to indicate green. Refer to your operator's manual for recommended battery charging.

"E" Cylinder Bracket Assembly Instructions

Kit Contents

Qty.	Description
1	Saddle
1	Center post with Velcro cylinder straps
2	¼"-20 counter-sink Allen-head screws
4	¼"-20 round-head Allen screws
4	Lock washers

Tools required for assembly:

1 each 5/32" Allen wrench/driver

Ruler

Center punch

Drill

Drill bit

Assembly Instructions for Basic Stand Bracket

1. Install center post in tank bracket using two flathead ¼-20 thread screws.

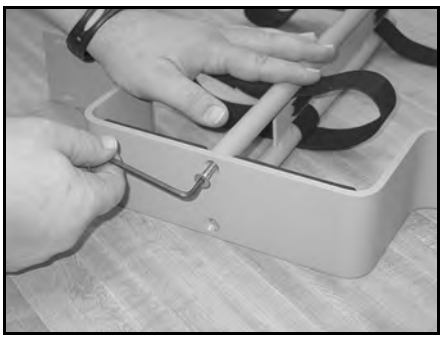


Figure 3.20

Note:

Apply Loctite® 271™ Threadlocker thread adhesive or equivalent to the two flathead ¼–20 screw threads.

2. Place assembled tank bracket on short side of "H" stand legs.

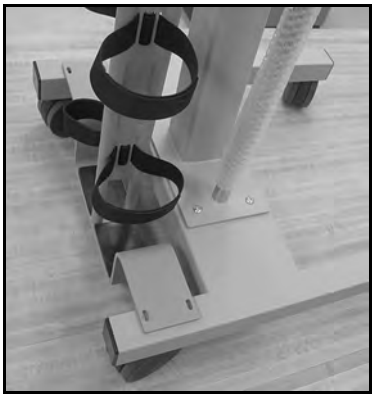


Figure 3.21

Note:

If your stand has pre-drilled holes with threaded inserts, move to Step #8.

3. Place tape measure under bracket. Slide bracket back ¾" from the edge of the "H" cross piece.

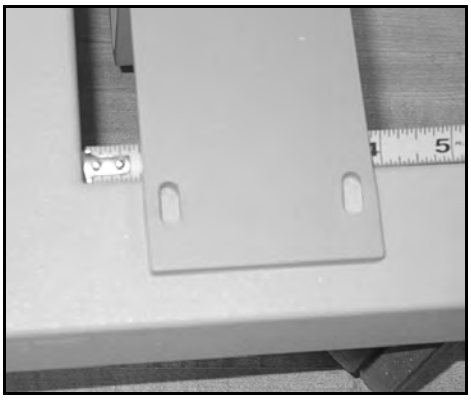


Figure 3.22

4. Center the bracket on the two legs of the "H". The bracket should be positioned approximately 11/16" in from the outside edge of each leg. Recheck the initial ¾" dimension measurement.

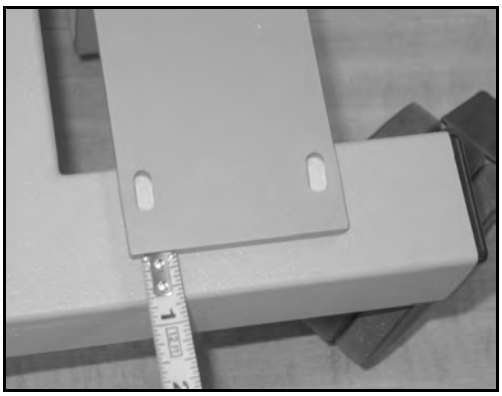


Figure 3.23

5. Using a pencil, mark location of tank bracket in center of slotted holes on the bracket.

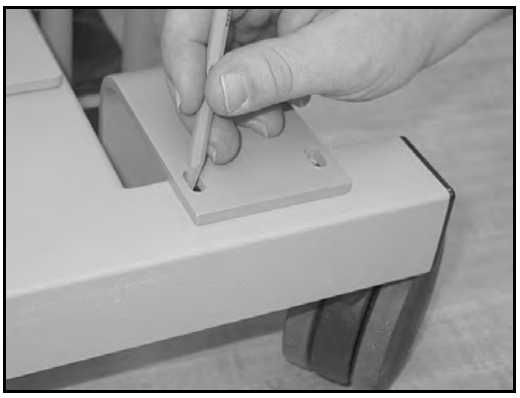


Figure 3.24

6. Center punch-marked locations. Before drilling, move rear wheels out of the way, to prevent damage.

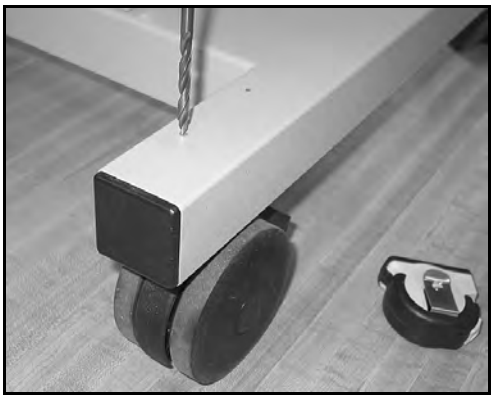


Figure 3.25

7. Using 17/64" (.265) drill bit, drill through both bracket walls.

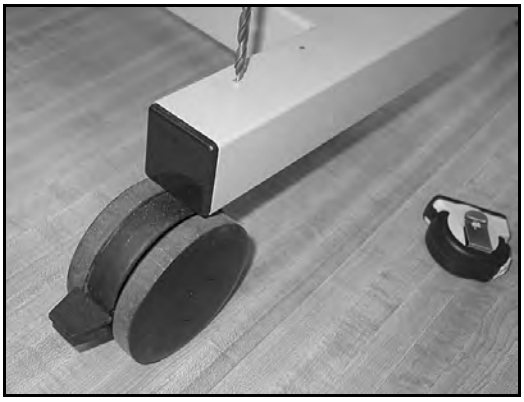


Figure 3.26

8. Remove burrs from drilled holes and insert screw from bottom, guiding through both holes in tubing and tank bracket.

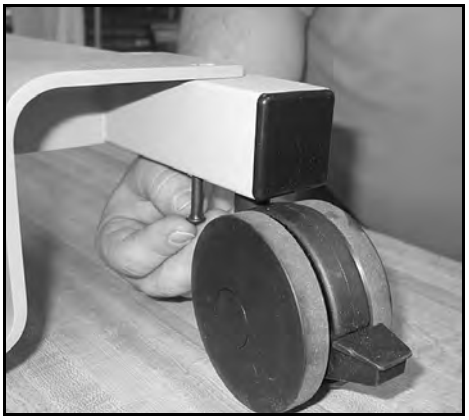


Figure 3.27

9. Place washer (x4) and nuts (x4) over screws and tighten securely.

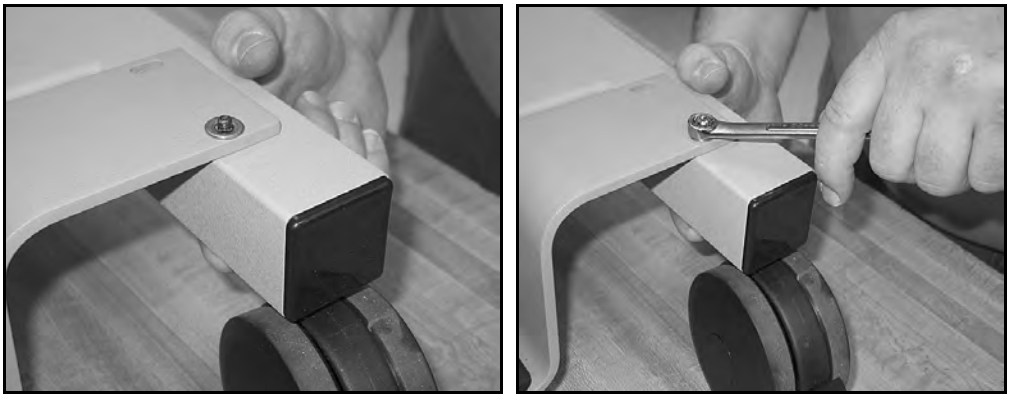


Figure 3.28

Note:

Apply Loctite® 271™ Threadlocker thread adhesive or equivalent to the two flathead ¼–20 screw threads.

Assembly Instructions–Comprehensive Metal and Plastic Stand Bracket

1. Place the comprehensive stand on a flat surface with the rear of the stand facing up.
2. Align the saddle with the 4 stand mounting holes as shown in the photos below (Figure 3.29 and Figure 3.37).

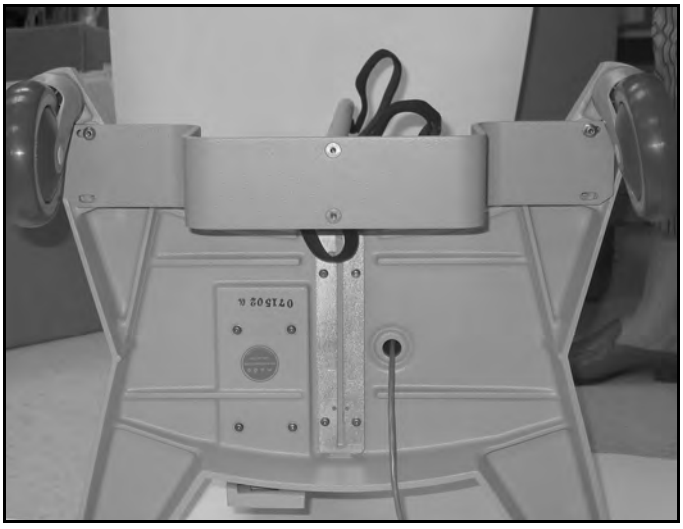


Figure 3.29

Figure 3.30

3. With the 5/32 Allen wrench, install and secure the 4 screws, flat washers, and lock washers to attach the saddle to the stand. Apply Loctite® 271™ Threadlocker thread adhesive or equivalent to all threaded fasteners.

Caution!

Ensure that the saddle is in no way touching the wheels/casters of the stand.

Avea Unpacking Instructions

Introduction

The Avea is packaged in two parts for safe shipping. A small amount of assembly is required. All literature and instructions to enable you to safely assemble, set up and check out your Avea are included in the box with your ventilator.

Unpacking

Caution!

The Avea shipping container is designed to be moved or positioned by a forklift or pallet jack only. **Do not attempt to lift or manipulate the container manually as damage or injury could result.**

Note:

The Avea Cart shipped with your ventilator must be assembled first. To reduce the risk of damaging the ventilator, make sure the cart is ready before you unpack the instrument.

Note:

Your Operator's Manual and other important literature are packed beneath the Avea. **Do not discard!**

1. Remove all outer securing straps by cutting them. Discard.
2. Open the box and remove the top layer of packaging material.

Figure 3.31

3. Remove the Avea accessory box. Place it on a secure surface.

Figure 3.32

4. To remove the cardboard cover, lift the box straight up. Do not pull or tilt the cover until you are sure it has cleared the ventilator.
5. Remove the protective packaging from the sides of the ventilator and carefully remove the plastic.

Figure 3.33

6. Apply the brakes on the cart that has been previously assembled by pressing down on the foot pedals.

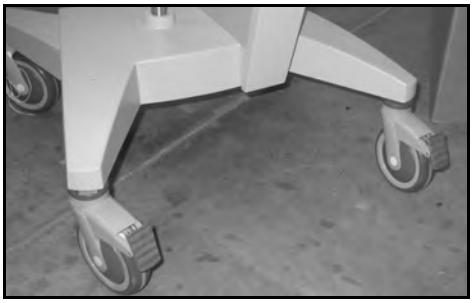


Figure 3.34

7. With assistance, lift the Avea from the box and carefully position the unit on the top plate assembly of the cart. Secure the unit using the 4 thumbscrews (Figure 3.35 and Figure 3.36).

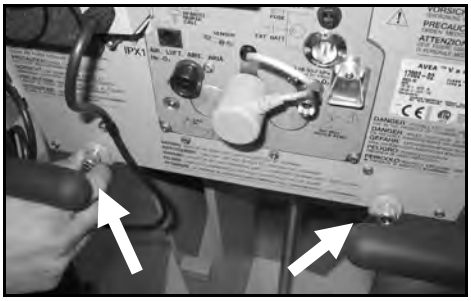


Figure 3.35

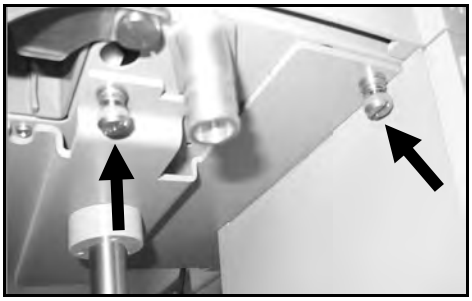


Figure 3.36

Note:

Make sure the external battery cable lays untwisted in the cable slot and emerges at the rear of the ventilator (if applicable)

Note:

It is suggested that the 2 thumbscrews in the back of the ventilator be secured loosely, followed by the 2 thumbscrews on the bottom front of the unit. Tighten all 4 once all in place.

Medical Gas Connector Kit Installation Instructions

Air "Smart" Connector Installation Instructions Refers to (P/N 51000-40897)

Note:

If you have not ordered the Heliox option, you will receive only the Air "Smart" connector and the appropriate air hose for your configuration. The Air "Smart" connector comes pre-assembled with the integral water trap/filter as shown in (Figure 3.37). It attaches to the fitting located to the left of the Oxygen cell on the rear panel of the Avea.

Caution!

Always consult your Operators Manual for instructions and clinical recommendations concerning the use of Avea accessories.

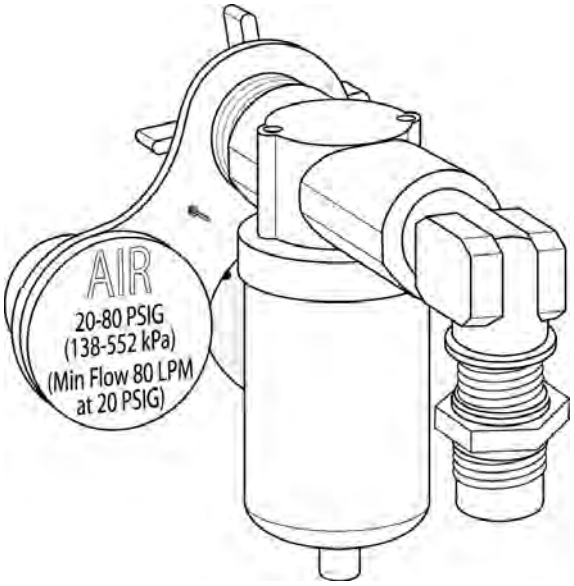


Figure 3.37

1. Carefully align and seat the 'smart' connector pin and the gas fitting.
2. Tighten the threaded collar on the Avea onto the male gas fitting of the "smart' connector assembly.

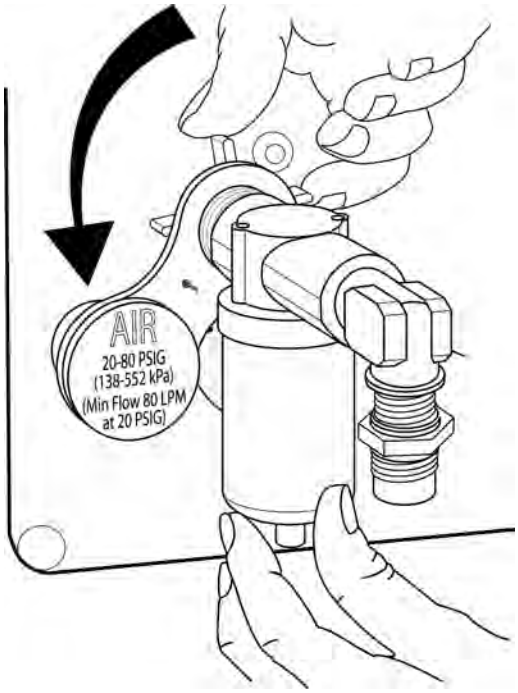


Figure 3.38

3. Attach the Air hose appropriate for your gas configuration (female DISS fitting is shown here).

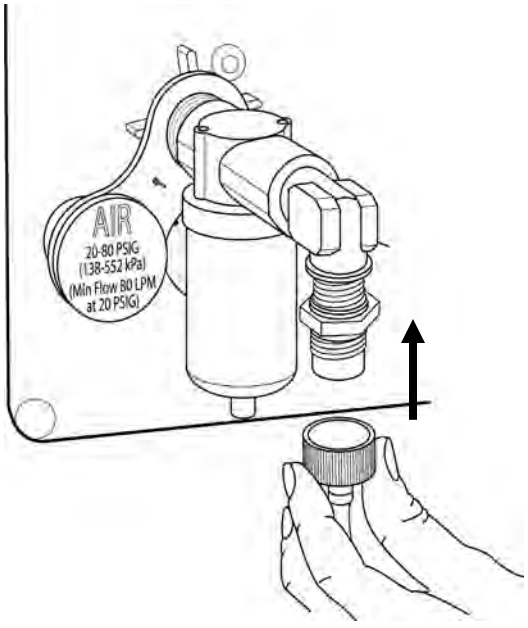


Figure 3.39

Chapter 4 Assembly and Disassembly

General Instructions and Warnings

After the removal and installation of major subassemblies, an OVP is to be performed. Transducer calibrations are to be checked and performed if necessary. Refer to chapters 5 and 7 for instructions.

When disassembling or assembling the Avea, refer to the tubing diagram, P/N 51000-40841, the wiring diagram P/N 51000-40839 and appropriate schematics and assembly drawings located in Appendix B of this manual. The illustrations shown here are for reference only, current revisions of these diagrams and schematics are available to qualified personnel from CareFusion Technical Support.

Warning!

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

Assume that you are adequately earth grounded prior to handling and working inside of the Avea ventilator.

Caution!

Ensure the ventilator is disconnected from the AC power supply before performing repairs or maintenance. When you remove any of the ventilator covers or panels, disconnect the internal battery "quick release" connector before working on the ventilator. If the ventilator has an external battery installed, ensure that the external battery is unplugged from the rear panel before proceeding.

Recommended Tools and 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 and short Philips screwdrivers

Flat bladed screwdriver

3/8" nut driver

11/32" nut driver

Needle nose pliers

Digital volt meter

Adult test lung (Siemens), P/N 33754

Adult patient circuit (72”), P/N 16045

Infant test lung, P/N 34057

Infant patient circuit

Pediatric patient circuit

Oxygen analyzer

Rubber stopper

Stop watch

Side cutters

User Interface Module (UIM)

P/N 16259 Domestic (P/N 16260 International)

Removal

1. Remove the ‘rubber collar’ located at the UIM rear neck, by grasping one of the two rubber tabs at the bottom. Pull firmly in an “arcing” motion.
2. Pull UIM forward and look for the Phillips Screw on the front arm cover. Remove (1) Phillips screw from the front arm cover. Remove the front arm cover.
3. Remove the two mounting screws now visible inside the ‘back arm cover’. Tilt the UIM down and remove the ‘back arm cover’.
4. Remove the (4) 11/32 KEP nuts that secure the ‘plastic top cover’ opening onto the chassis.
5. Remove (2) Phillips screws that secure the ‘plastic top cover’ to the rear chassis.
6. Slide the top ‘plastic top cover’ upward and forward away from the chassis.

Note:

Make sure the cover is completely free of front chassis prior to moving it forward to prevent damage to plastic cover.

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7. Remove the (2) Phillips screws and washers that secure the HSSC Cable on the GDE. Unplug the HSSC Cable.
8. Carefully feed the HSSC Cable through the ‘plastic top cover’ opening.
9. While continuously supporting the UIM, remove (4) 3/8 nuts that fasten the UIM support arm onto the pneumatics.
10. Lift UIM off of pneumatics and set aside.
11. Remove plastic cover and set aside.

Installation

1. Place plastic cover onto top of pneumatics
2. While continuously supporting the replacement UIM, position the UIM's four threaded mounting studs into the 'support arm', mounting plate and secure it with (4) 3/8 nuts.
3. Carefully lift the plastic cover and feed the HSSC Cable through the plastic top cover opening, towards the rear of the chassis.
4. Slide the plastic top cover back in place.
5. Install (2) Phillips screws and washers into the HSSC Cable and secure it to the connector on the GDE.
6. Install (2) Phillips screws to secure the 'plastic top cover' to the rear chassis.
7. Use (4) 11/32 KEP nuts to secure the 'plastic top cover' opening onto the chassis.
8. Tilt the UIM down and install the 'back arm cover'. Install two mounting screws inside the 'back arm cover' and tighten them.
9. Install the 'front arm cover'. Install (1) Phillips screw into the 'front arm cover' and tighten it.
10. Install the 'rubber collar' around the UIM rear neck.

Warning!

Always disconnect the white battery quick disconnect once the top cover is removed to prevent injury and/or damage to the Avea Ventilator System.

Note:

Prior to complete reassembly, UIM may be temporarily installed for testing and calibration.

Exhalation Corner Assembly

Removal

1. If installed, remove the exhalation filter assembly. Rotate the metal locking lever on the lower right of the ventilator body forward to an open position. Remove the exhalation filter assembly from the ventilator body by pulling straight down.
2. Using a long Phillips screwdriver, remove the (1) Phillips screw located at the top of the exhalation filter assembly well, if applicable.
3. Remove the (1) Phillips screw located at the exhalation port marked EXH, if applicable.
4. Remove (1) Phillips screw from the outside of the plastic cover.
5. Remove the (1) Phillips screws on the front left wall and the (1) Phillips screw on the right side wall and set plastic cover aside.
6. Remove the (3) Phillips screws on the metal re-enforcement cover, if applicable, and set aside.

Installation

1. Secure the metal re-enforcement cover, if applicable, with the 3 Phillips screws.
2. Secure the plastic cover onto the vent with the (3) Phillips Screws, one on the front left inside wall, one on the right inside wall, and one outside.
3. Secure the (1) Phillips screw located at the exhalation port marked EXH, if applicable.
4. Using a long Phillips screwdriver, secure the (1) Phillips screw located at the top of the exhalation filter assembly, if applicable.

Metal Top Cover

Removal

Remove the following:

1. Exhalation corner
2. UIM and plastic cover
3. If applicable, remove the metal top cover of the exhalation assembly.
4. Remove the 19 SEMS screws, (3) on the left side (5) on the right side and (11) on top.

Note:
The screws along the back of the metal top cover are different—flat head.

Note:
For ease in removal of these screws it is recommended to use a power screw driver.

5. Remove metal top cover and set aside.
6. Disconnect the internal battery 2 pin Molex connector.

Warning!
Always disconnect the white battery quick disconnect once the top cover is removed to prevent injury and/or damage to the Avea Ventilator System.

Warning!
Assure that the work area is Electro Static Discharge (ESD) protected. The Printed Circuit Board Assemblies (PCB's) have integrated circuits (IC's) that can be severely damaged by static electricity. Work surface must be certified as anti static or grounded before removing covers and while working on the ventilator. Wear a properly grounded and tested anti-static strap prior to handling PCB's.

Installation

1. Reconnect internal batteries
2. Place metal cover onto unit and feed into the grooves on the side of the pneumatics.
3. Secure the19 screws, top 11 screws, 3 on left side and 5 on right.
4. If applicable, secure the metal top cover over exhalation assembly.
5. Replace:

- Exhalation corner
- UIM and plastic cover

Gas Delivery Engine P/N 16222A

Gas Delivery Engine Removal

1. Referring to the previous instructions remove the following:
   - Exhalation corner assembly
   - UIM and plastic cover
   - Metal cover
2. Disconnect internal battery.
3. If applicable, disconnect the 4-pin connector from the battery monitor board to the gas delivery engine (51000-40022 Only).
4. Disconnect the four-pin connector from the exhalation valve.
5. Disconnect the four-pin connector going to the On/Off switch in the gas delivery engine.
6. Disconnect the connector going to the ETM on the chassis.
7. Disconnect the connector going from the TCA board to the transition board near the fan.
8. Remove the four SEMS screws located at each corner of the rear panel.
9. Remove A/C power cord bracket.
10. Cut the tie wrap and remove the metal tubing support bracket on the accumulator hose and disconnect the tube from the accumulator outlet by releasing the compression fitting.
11. Completely remove the hose between the gas delivery engine assembly and the scroll pump/compressor filter.
12. Squeeze to remove the two small ribbon cables near the front of the gas delivery engine assembly (the 10-pin ribbon cable connector from the flow sensor assembly and the 20-pin ribbon cable connector from the front interface panel).

Caution!

Never pull on a cable during disconnection. Damage to the connector wiring may result. Always pull on the connector body to disconnect.

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13. Unscrew the luer-lock fittings the clear tubing from F4, and the black striped tubing from G4.

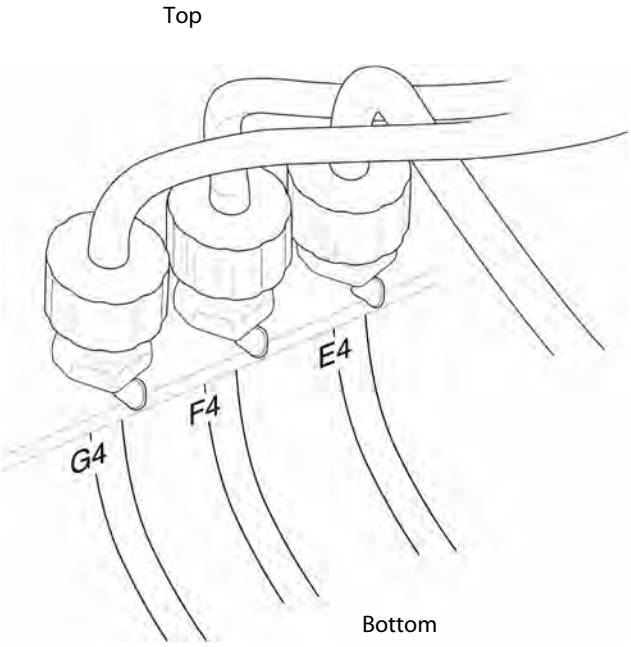


Figure 4.1 G4 and F4 luer connections

G4 (high side of expiratory flow and expiratory pressure XDCR 3 and 2)

Clear silicone tubing with black line

Top – goes to the expiratory flow sensor bulkhead

Bottom – goes to the expiratory manifold on the TCA

F4 (low side of expiratory flow)

Clear silicone tubing

Top – goes to the expiratory V sensor bulkhead

Bottom – goes to the expiratory manifold on the TCA

E4

Yellow tubing

Top – inspiratory pressure line that goes to the SOPR manifold

Bottom – inspiratory pressure that goes to the transducer on the TCA (XDCR 1)

14. Disconnect the yellow bleed tubing from C4 by releasing the compression fitting, as in Figure 4.2.
15. Disconnect the large blue tubing to the nebulizer from H4 by releasing the compression fitting.

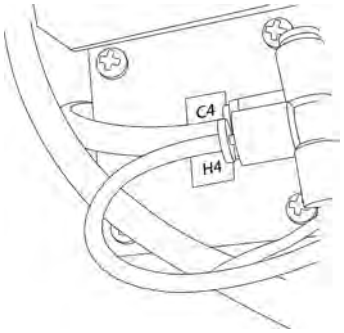


Figure 4.2 C4 and H4 compression fittings

Note:

With replacement of the GDE, the position jumper J3 on the Secondary Alarm Board must be reviewed for proper placement.

16. Disconnect the yellow tubing from (D4) that feeds the EPM board.
17. Loosen the 11/32 nut securing the assembly to the base at the bottom front left and right of the GDE.
18. Ensure all cables and tubing are tucked into the gas delivery engine assembly and slide the assembly out of the unit towards the rear. You will here a distinct "pop" as the assembly disconnects from the driver transition board connection.
19. Remove the power cord support bracket, if applicable.

Note:

You may need to pull firmly as you slide out the gas delivery engine assembly because it is attached to the 120-pin connector on the driver transition board.

If you are removing Gas Delivery Engine P/N 510000-40022 please continue with the next step. If you are removing Gas Delivery Engine P/N 16222 please continue at step number 1 of Installation.

20. Locate the internal battery pack and cut the 2 purple wires located at the battery pack to 1.5" (inches).
21. Fold back onto itself, 1 of the wires that has been cut ¼" (inch).
22. Cut the wire that was not folded even with the wire that was folded, so that they are now even in length.
23. Cut a piece of heat shrink tube that has been supplied to 1" (inch) in length.
24. Slide both purple wires that have been folded and cut into the heat shrink tube.
25. Ensure that both wires are inside the heat shrink tube and that neither wire is showing through the end of the heat shrink tube.
26. Using a heat gun or equivalent device, warm the heat shrink tube until it shrinks tight to the 2 purple wires that have been cut and folded previously.

27. Locate the Compressor power board located next to the compressor pump.
28. Remove the one 11/32″ nut securing the ground wire from the compressor power board.
29. Remove the 2 11/32″ nuts securing the compressor power board to the unit case.
30. Raise the compressor board up and away from the unit enough to allow disconnection of the 2 wire harnesses.
31. Cut the ground wire 1″ (inch) from the compressor power board.
32. Fold back onto itself, the cut wire ¼″ (inch) that is attached to the Compressor Board.
33. Cut a piece of heat shrink tube that has been supplied to 1″ (inch) in length.
34. Slide the wire that has been folded and cut into the heat shrink tube.
35. Using a heat gun or equivalent device, warm the heat shrink tube until it shrinks tight to the wire that was cut and folded previously.
36. Reconnect the 2 wire connectors to the Compressor Power Board.
37. Re-install the Compressor Power Board to the unit case using the 2 11/32″ (inch) nuts.
38. Cut all tie straps securing Battery Monitor Board P/N 16105.
39. Disconnect the 2 pin connector of the battery monitor board from the 2 pin connector containing wires #12 and #13.
40. Disconnect the 4 pin connector from the battery monitor board to the battery.
41. Disconnect wire #14 from the black wire of the battery monitor board.
42. Disconnect the 2 wires from the fuse holder. The battery monitor board will now be free to remove from the unit.
43. Connect wire # 14 to the straight terminal of the fuse holder.
44. Connect wire harness (internal battery upgrade cable assembly) P/N 16243 2 pin connector to the 2 pin connector containing wires # 12 and #13. Secure using cable tie P/N 05038.
45. Connect the black wire from cable harness P/N 16243 to the right-angle terminal connector of the fuse holder.
46. Connect the 4 pin connector of the internal battery to the 4 pin connector of P/N 16243. Secure 4 pin connector using cable tie P/N 05038.

Installation

Warning!

Prior to re-installing the GDE, insure that C31 is not touching the Flow Control Valve or that there is insulation material between the two. (C31 is the orange capacitor located closest to the top of the FCV).

1. Ensure all cables and tubing are tucked into the gas delivery engine assembly and slide it as far into the unit as required to hold the assembly. Do not yet connect the assembly to the driver transition board.

2. Connect yellow hose (D4) to the EPM board.
3. Connect the yellow bleed tubing from the sensor assembly; the yellow tubing to C4, and the blue tubing to H4.
4. Connect the clear tubing from the sensor assembly to F4 luer lock fitting, and the black striped tubing to G4 luer lock fitting.
5. Connect the two ribbon cables located at the front of the ventilator (the 10-pin ribbon cable to J17 and the 20-pin ribbon cable to J16).
6. Connect the 4-pin battery monitor board, if applicable, to the gas delivery engine and the 4-pin connector to the exhalation valve.
7. Connect the four-pin connector to the On/Off switch.
8. Connect the four-pin connector going to the ETM board.
9. Connect the four-pin connector from the TCA board to the transition board near the fan.
10. Remove the rubber manifold block, pour some rubbing alcohol into the rubber manifold block for lubrication, and replace manifold block onto the chassis.
11. Engage the gas delivery engine to the driver transition board by ensuring proper alignment of the two alignment pins and the connector. Press firmly into place.

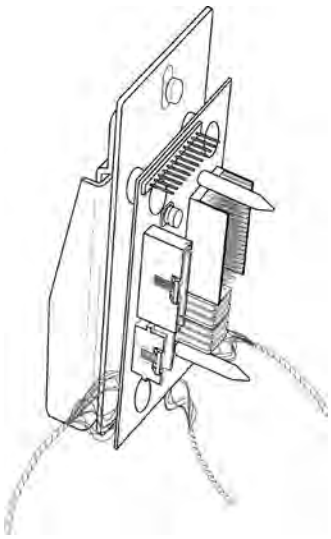


Figure 4.3 Gas Engine Connector on Driver Transition PCB

Caution!

It is essential to ensure correct alignment to the 120-pin connector on the driver transition board before pushing home the gas delivery engine. Failure to do so may result in damage to the connector and the unit may not power up or operate properly.

12. Attach and secure the (4) SEMS screws on the four corners of the rear panel.
13. Replace the hose from the gas delivery engine to the compressor filter.

14. Connect yellow hose from the accumulator into the compression fitting. Replace the metal stabilizer bracket, and secure with a new tie wrap.
15. Tighten the 11/32 nut at bottom right and left of the Gas Delivery engine and tighten down.
16. Attach the UIM and HSSC Cable.
17. Perform and EST and Operational Verification Procedure as per the service manual.
18. Once all tests are preformed, remove the UIM.
19. Reconnect the internal batteries.
20. Replace the following:

- Metal cover
- Plastic Cover and UIM
- Exhalation Corner Assembly

Note:

Perform the Extended Service Test (EST) once the unit is completely re-assembled and prior to patient setup

Ventilator Wheeled Base

Removal

Unscrew the (4) thumbscrews on the base to the ventilator body as shown in Figure 4.4 and detach from the wheeled base.

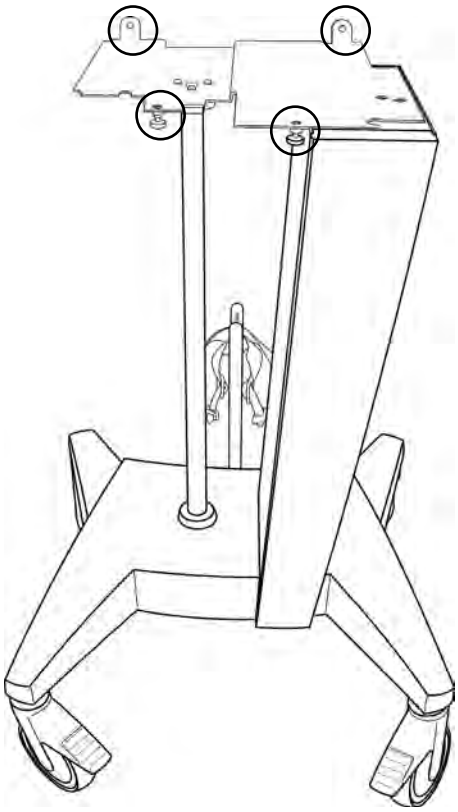


Figure 4.4 Wheeled base showing attachment points

Installation

Position the ventilator assembly onto the base by lining up the holes over the 4 spring-loaded thumbscrews and tighten the thumbscrews.

Internal Batteries P/N 68339A

Removal

1. Referring to the instructions in this chapter, remove the following components:

- Exhalation corner
- UIM and plastic cover
- Metal Cover

2. Disconnect the internal batteries
3. Disconnect the battery fuse holder by pulling straight back on the two faston connectors.
4. Remove the fuse holder and fuse from the ventilator chassis using pliers to remove nut.
5. Remove the (3) 11/32 KEPS nuts that hold the battery bracket in place; (2) KEPS nuts on the bottom and (1) on the top.
6. Slide out the retaining bracket and the batteries.
7. Disconnect the positive and negative leads from the wire harness that connects to the driver transition board.

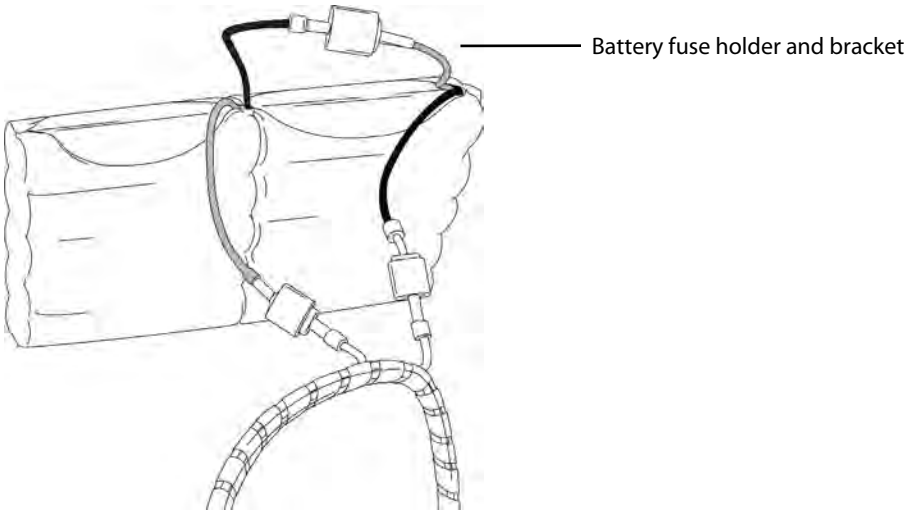


Figure 4.5 Battery Assembly

8. Cut both tie wraps that secure the battery monitor board and the 4-pin molex to the batteries.
9. Disconnect the batteries from each other.

Installation

1. Cut three 3" stripes of 1" wide double-backed adhesive tape. Place one strip on the bottom of one battery, and the other two strips on the top and bottom of the other battery.
2. Place the first battery against the chassis and the second battery on top of the first.
3. Secure the batteries into place with the retaining bracket by using (3) 11/32 KEPS nuts; (2) KEPS nuts on the bottom and (1) on the top.
4. Connect the positive and negative battery leads to the wire harness that connects to the driver transition board. (These are arranged M-F and F-M so they cannot be incorrectly connected)
5. Replace the fuse holder into the front of the chassis.
6. Connect the lug connectors to the two battery fuse terminals using either combination of wires.
7. Referring to the instructions in this chapter, install the following components:

- Reconnect the internal batteries
- Metal Cover
- UIM and plastic cover
- Exhalation corner assembly

Fuses

The Avea has replaceable fuses associated with internal DC, external DC and AC power sources.

Please refer to your present power requirements which are detailed on the rear of the Avea.

Line Voltage	Fuse	Amperage (350 Watt Power Supply)	250 Watt Power Supply
100/120VAC	(2) 250 V 6.35 X 31.75mm	3.15 amp (CareFusion P/N 71692)	1.5 amp (CareFusion P/N 71698)
230/240VAC	(2) 250 V 6.35 X 31.75mm	6.3 amp (CareFusion P/N 03490)	3.15 amp (CareFusion P/N 71692)

Note:

Internal and External battery fuses are of different lengths, placing fuse in incorrect holder may result in fuse falling inside of the Avea.

Warning!

Do not remove or replace fuses or perform any maintenance tasks on the ventilator while your patient is connected. Always perform these tasks "off patient".

Battery Fuses

The internal and optional external battery fuses are 10A, 250V 5 x 20 mm fast blow type.

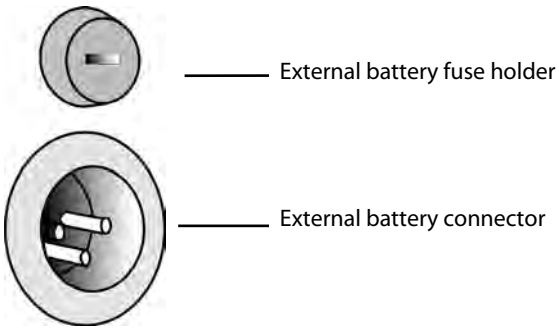


Figure 4.6 External Battery Connector and Fuse

The fuse for the optional external battery is located on the back panel next to the external battery connector and is replaceable. The fuse for the internal battery is located to the right of the UIM connection. To remove fuses, carefully unscrew with a flat blade screwdriver and pull out the fuse holder.

Warning!

To avoid fire hazard, use only the fuse specified in the ventilator's parts list or one that is identical in type, voltage rating, and current rating to the existing fuse.

Mains Fuses

The main AC power fuses are housed within the power entry module located on the back panel. They are slow blow-type. Check that the correct voltage for your mains supply is showing through the window in the power entry module.

Table 4.1 Mains fuses

Line Voltage	Fuse	Amperage
100/120VAC	250V 6.35 x 31.75mm	3.2A
230/240VAC	250v 6.35 x 31.75mm	1.5A

Replacing a Mains Electrical Fuse

Warning!

Ensure that the mains power cord is unplugged before attempting to remove or replaces fuses.

To replace mains electrical fuses, refer to Figure 4.7 through Figure 4.10 and do the following:

1. Unplug the ventilator from the mains AC power source and unplug the power cord from the power entry module on the rear of the ventilator.
2. Using a small flat blade screwdriver, pry open the cover of the power entry module, see Figure 4.7.
3. Carefully ease the red fuse holder out of the power entry module, see Figure 4.8.
4. The fuse holder contains two identical fuses, either 3.1Amp for (for 100/120 volt lines) or 2.0 Amp (for 230/240 volt lines) as shown in Table 4.1.
5. Replace the failed fuse in the fuse holder with a fuse whose type, voltage rating, and current rating is identical to the fuses supplied from the factory.
6. Carefully replace the red fuse holder into the power entry module. Check to ensure that the correct line voltage is uppermost as you re-insert the fuse holder into the power entry module (see Figure 4.7 through Figure 4.10).
7. Close the power entry module cover and check to make sure that the correct voltage is displayed through the window.

Changing the AC Fuses

1. Open the power entry module with a screwdriver and remove the fuse holder.

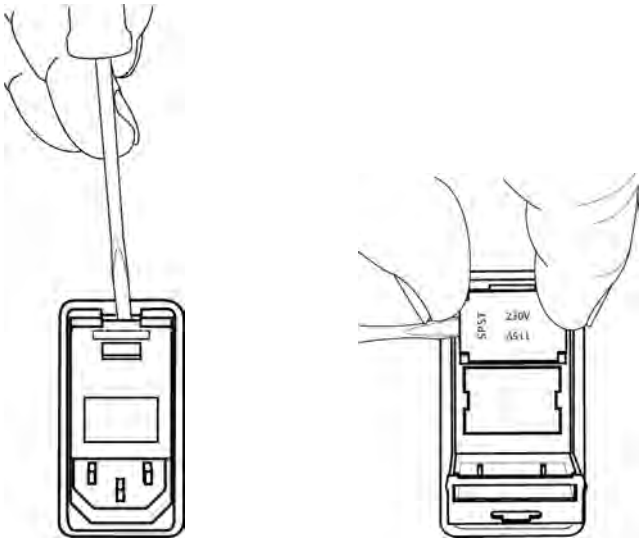
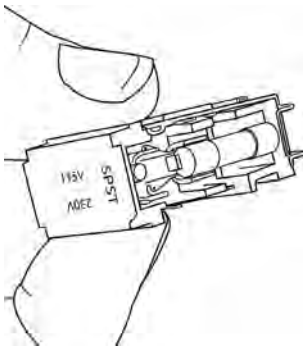
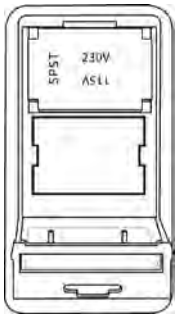


Figure 4.7



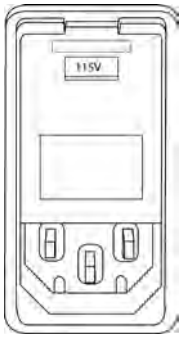
Fuse holder showing fuse placement

Figure 4.8



Fuse-holder with 230 V label uppermost for 230/240 V AC systems

Figure 4.9



Closed power entry module with 115 V showing in the window for 100/120 volt systems

Figure 4.10

Compressor/Scroll Pump P/N 51000-09750A

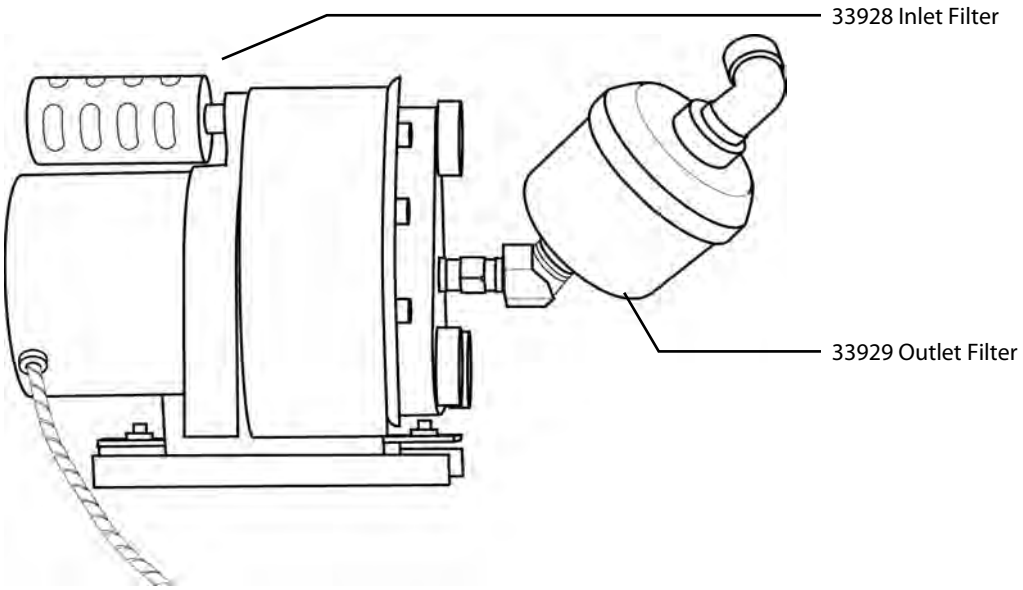


Figure 4.11 Compressor/ Scroll Pump

Removal

1. Referring to the instructions in this chapter, remove the following components:

- Exhalation corner assembly
- UIM and plastic cover
- Metal Cover.

2. Disconnect internal battery.
3. Remove high pressure hose from compressor motor at the filter outlet. Move the high pressure hose out of your working area.
4. Temporarily remove Enhanced Patient Monitoring Board (EPM) according to instructions provided later in this chapter.
5. Remove the (4) 11/32 KEPS nuts in each corner of the compressor mounting base. Remove the (1) ground wire located at the front right of the compressor.

6. Disconnect compressor wiring harness (Molex P2) from compressor driver board.
7. Access the 12-pin scroll pump connector and disconnect from the compressor driver board.
8. Remove the (2) KEPS nuts on the scroll compressor board (1) on the right and (1) on the front, and remove the compressor board.

Note:
The compressor power board should be placed in an antistatic bag.

9. Carefully lift compressor pump out of unit and set aside.

Installation

1. Slide the compressor/scroll pump in the front right side of the ventilator and position over the (4) studs.
2. Install ground wire over right front stud and secure with one of the 11/32 KEPS nuts.
3. Secure compressor using the (4) 11/32 KEPS nuts over the (4) studs.
4. Connect 8-pin Molex connector from compressor to compressor driver board.
5. Connect the 12-pin scroll pump connect to the compressor PCB.

Note:
Ensure the scroll compressor assembly is seated below the wire that runs from the driver transition board to the fan and push down the wire harness from the driver transition board under the front of the scroll pump to avoid wedging it between the scroll pump and the chassis

6. Position the scroll compressor board onto two studs and secure with (2) KEPS nuts; (1) on the right and (1) on the front.
7. Replace the Enhanced Patient Monitoring Board (EPM)
8. Reattach the high pressure hose to the filter outlet.
9. Referring to the instructions in this chapter, re-install the following components:

- Reconnect Internal Batteries
- Metal Shield
- UIM and plastic cover
- Exhalation corner assembly.

Enhanced Patient Monitor (EPM) Board P/N 51000-40848A

Removal

1. Referring to the instructions in this chapter, remove the following components:

- UIM and plastic cover
- Metal top cover
- Exhalation Corner
- Disconnect internal batteries
- Ventilator assembly (from the base)

2. Remove the flow sensor cover by removing the (3) SEMS screws.
3. Remove the (2) KEPS nuts; the brass colored EMI shield, and blue flex cable.
4. Disconnect the 10-pin ribbon cable from the front of the GDE.
5. Remove the board from chassis by removing the 2 Phillips screws.
6. Remove ventilator assembly from the stand
7. Turn the unit upside down and place on 2x4 to take weight off of the 4 standoffs..
8. Remove (7) Phillips screws; 2 from the lower back panel and (5) from the bottom panel.
9. Remove bottom panel.
10. Remove (2) screws from the top of the front panel.
11. Loosen (2) KEPS nuts from the bottom that hold the front panel.
12. Pull off front panel.
13. Loosen (1) KEPS nut from the bottom and (4) screws on the front panel.
14. Remove the blue tubing from the nebulizer to the front panel.
15. Gently pull the blue ribbon cable through the narrow slot at the top center to the front interface panel and the rest of the wiring through the recessed compartment in the chassis.

Caution!

Never pull on a cable during disconnection.

Installation

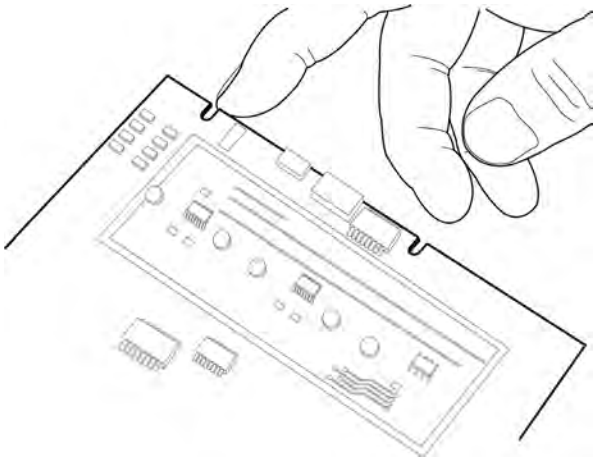


Figure 4.12 EPM Board alignment notches

Note:
Ensure that you do not pinch any tubing since this can result in damage to the Avea.

1. Gently feed the blue ribbon cable through the narrow slot at the top center of the front panel and the wiring through the recessed compartment in the chassis.
2. Attach the blue tubing from the nebulizer to the front panel.
3. Tighten (1) KEPS nut on the bottom and (4) screws on the front interface panel.
4. Position the front panel and install (2) KEPS nuts on the bottom and (2) screws on the bottom of the front panel.
5. Position the back panel and install (7) Phillips screws; (2) on the lower back panel and (5) on the bottom panel.
6. Turn the unit over and place back on stand.
7. Attach EPM board to chassis, use alignment notches as in Figure 4.14.
8. Install the (2) KEPS nuts, the EMI shield, brass bracket and ribbon cable.
9. Attach the flow sensor cover by installing the (3) SEMS screws.
10. Referring to this chapter, reconnect the internal batteries and install the following components:

- Metal cover
  UIM and the top plastic cover
- Exhalation Corner
- Fan Assembly P/N 51000-40861

Fan

Removal

1. Referring to the instructions in this chapter, remove the following components:

- UIM
- Metal top cover.

2. Disconnect internal batteries
3. Disconnect the fan cable from the wire harness of the transition board.
4. Pop off the fan filter cover.
5. Remove the filter and the filter cover.
6. Remove the (4) 2.5" Phillips screws holding the fan filter housing. Remove the fan assembly and the fan cover.

Installation

1. Insert the honeycomb shield into the shroud.
2. Insert the fan assembly into the shroud, ensuring the wire assembly is facing towards the lower outside corner of the ventilator.
3. Align the fan cover on the outside of the chassis and the fan assembly on the inside using (1) screw to assist in positioning.
4. Secure both the fan cover and the fan assembly with (4) 2.5" Phillips screws.
5. Connect the fan cable to the transition board wire harness.
6. Tuck the wire harness along side the fan between the fan and the outer wall of the unit.
7. Place the filter inside the filter cover so that the locking tabs face the chassis and snap the filter cover into place.
8. Referring to the instructions in this chapter, reconnect the internal batteries and install the following components:

- Metal top cover
- UIM

Power Supply P/N 16388

Removal

1. Referring to the instructions in this chapter, remove the following components:

- UIM and the plastic cover.
- Metal top cover
- Disconnect internal batteries
- Fan assembly
- EPM board and set aside according to the directions later in this chapter
- Compressor and compressor PCB

2. Cut and remove all cable ties that secure the wire assemblies to the power shield.
3. Disconnect the 5-pin connector at J2 and note the orientation of the wires on the connector.

Note:
It is suggested to label the (3)wires coming from the 3-pin terminal block as neutral (blue), load (brown) and ground (green and yellow) as printed on the power supply circuit board.

4. Using a Phillips screwdriver, loosen the screws of the terminal block that secures wires #1 and #3 and remove.
5. Remove and label blue (neutral) and brown (load) wires on the power entry module.
6. Remove the (4) 11/32 KEPS nuts (2) on the left and (2) on the right. Pull out the power supply including the brass bracket.

Installation

1. If installing a new power supply, you will need to install (4) cable mounts on the new power supply. Use the old power supply as a model for the location on the new power supply.
2. Reconnect the (3) wires from the power entry module to the 3-pin terminal block of the power supply board.
3. Seat the power supply and the bracket into the chassis and secure with (4) 11/32 KEPS nuts; (2) on the left and (2) on the right.
4. Reconnect the (2) wires, # 1 and #3 from the terminal block.
5. Reattach the 5-pin connector to the power supply board location J2.
6. Replace the cable ties.
7. Reinstall lock washer, ground wire and nut securely.
8. Secure wiring harness with cable ties to power supply shield.

9. Referring to the instructions in this chapter, install the following components in the order listed:

- Compressor and compressor PCB
- EPM board. (Return the EPM to its' position on the (2) mounting studs and secure using the (2) Phillips screws.
- Fan assembly.
- Reconnect internal batteries
- Metal top cover
- UIM and the plastic top cover.

Table 4.2 Avea Power supply specifications

INPUT	**OUTPUT**
TB1	TB2
6-32 3 pin terminal block	6-32 4 pin terminal block 0.375 ctr
PIN 1 AC line	Bus bar with 10-32 screw on high current models
Pin 2 AC neutral	Pins 1 and 2 +V out
Pin 3 AC ground	Pins 3 and 4 Return
	16A max recommended current per connector pin
Signals J2	
Amp PCB Header	
Mating connector	
Pin 1 DC Good	
Pin 2 Power fail	
Pin 3 Ext off	
Pin 4 + Sense	
Pin 5 -Sense	
Fan	
AMP PCB Header	Maximum screw protrusion above chassis = 0.120"
Mating Connector	
Pin 1 -	Weight 2.9 lbs (1.32Kg) max.
Pin 2 +	

To Clear EPM Board From Workspace During Replacement Of Power Supply/Compressor/Fan:

1. Remove the two Phillips screws that secure the EPM to the center bracket.
2. Pull firmly, straight up. This action will release the EPM board from the mounting studs.
3. Without disconnecting any tubes, hoses or wires, place the EPM board into an antistatic bag and set it out of the way of the compressor and power board.

Exhalation Valve P/N 16319

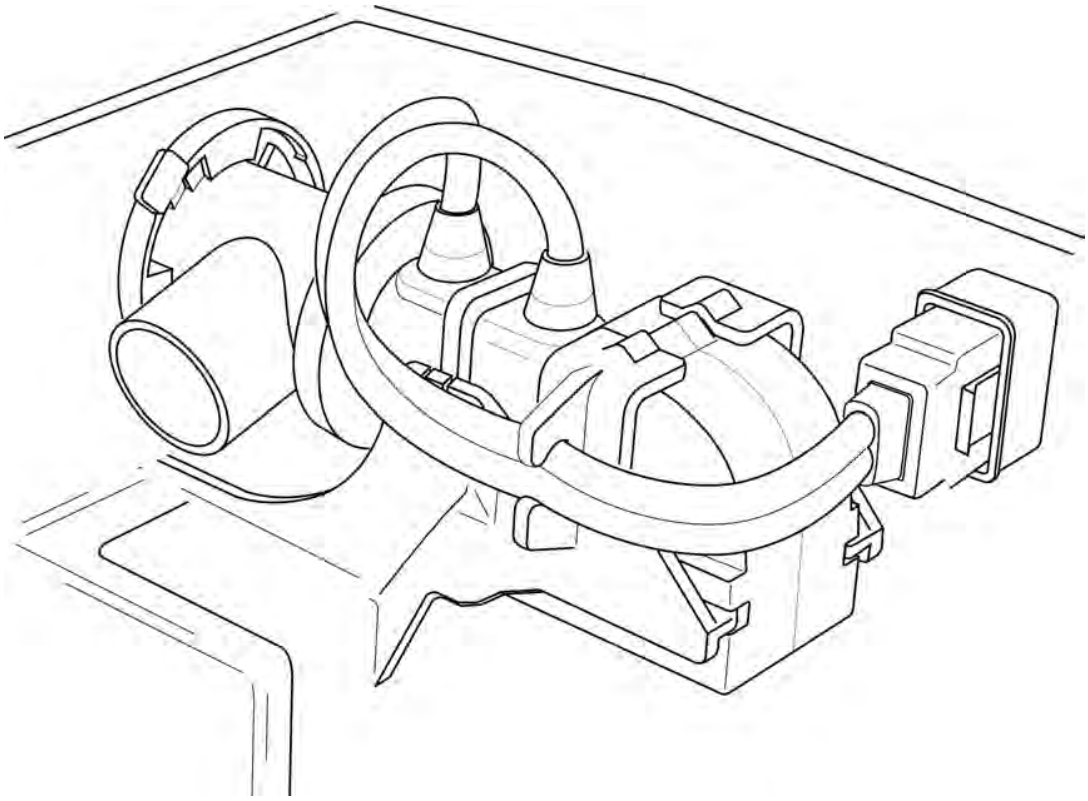


Figure 4.13 Exhalation Valve and Flow Sensor* Assembly

Removal

1. Referring to the instructions in this chapter, remove the following components:

- UIM and the top cover.
- Metal top cover
- Disconnect internal batteries
- Exhalation corner assembly

2. Pull the locking shroud of the flow sensor connector back and disconnect the sensor from the chassis.
3. Grasp the rubber elbow and slide it towards you and remove.
4. Gently remove the exhalation flow sensor by pulling straight towards you.
5. Push in the locking tab on the exhalation valve and twist the exhalation valve body counterclockwise to remove.
6. Remove the silicon diaphragm from the exhalation valve assembly.
7. Disconnect the 4 pin connector to the GDE.
8. Carefully cut the cable tie retaining the exhalation valve.
9. Remove the (2) KEPS nuts and Phillips screws from the top and bottom of the exhalation valve assembly and the bracket. (recommend using a 3/8 box or open-end wrench for this task)
10. Remove the exhalation valve by sliding it out with an up and backwards movement and slightly spreading the mount so as not to damage the wires.

Caution!

Ensure that you do not damage the small wires or locking tab when removing the exhalation valve.

Installation

1. Position the exhalation assembly onto the chassis by lining up the screw holes on the front panel and sliding it into the exhalation valve bracket.

Caution!

Ensure that you do not damage the small wires or locking tab when installing the exhalation valve.

---

2. Install the (2) Phillips screws through the top and bottom of the exhalation valve assembly and the bracket and secure with (2) KEPS nuts.
3. Connect the cables to the wiring harness.
4. Leaving room for the gas delivery engine, run the wire harness under the tab in the exhalation valve assembly bracket.
5. Insert the silicon diaphragm (P/N 16240) into the exhalation valve body by seating it into the lip with the point out.
6. Install the exhalation valve body; line up the flange on the valve body with the tabs on the receptacle and twist clockwise until secure.
7. Install the exhalation flow sensor by sliding it into the gasket with the tubing facing up and ensure the tubing is under the retaining notch.
8. Slide the rubber elbow in by lining it up with the grooves.
9. Attach the flow sensor to the connector by pulling back the plastic sleeve and pushing it into place.
10. Push the locking clip back to secure the sensor.
11. Referring to the instructions in this chapter, re-install the following components:

- Reconnect the internal batteries
- Metal Top cover
- UIM and the top cover
- Exhalation Corner Assembly.

Heater Assembly P/N 51000-40824

Removal

1. Remove the following components:

- Exhalation corner
- UIM and top plastic cover
- Top Metal cover
- Disconnect the Internal Batteries
- Exhalation valve

2. Remove (2) KEP nuts at the base of the pneumatics on the heater shield.
3. Disconnect the 3-pin and 2-pin connectors and label.
4. Remove (2) Phillips #2 screws from the front panel.
5. Remove bottom cover.
6. Remove (2) 11/32 nuts (securing the front panel) from the bottom of the pneumatics.
7. Remove (2) Phillip #1 screws holding the shield.
8. Turn the plastic corner upside down.
9. Remove the heater assembly.

Installation

When removing and installing the corner and heater assembly, do not replace the plastic piece of the front panel or the bottom piece of the ventilator until corner/heater assembly is in place.

1. Reinstall heater assembly into the shield using (4) Phillips #1 screws.
2. Turn the plastic corner back to its original position.
3. Attach corner with 2 screws.
4. Attach the front panel with (2) 11/32 nuts on the bottom of the pneumatics.
5. Attach bottom cover.
6. Attach (2) Phillips screws to the front panel and the pneumatics.
7. Connect the 3-pin and 2-pin connectors.
8. Attach (2) 11/32 nuts on back of front panel shielding.
9. Attach exhalation corner assembly.

10. Replace the following components:
    - Exhalation valve
    - Reconnect the internal batteries
    - Top metal cover
    - UIM and top plastic cover
    - Exhalation corner

Microswitch, Top Cover P/N 68294

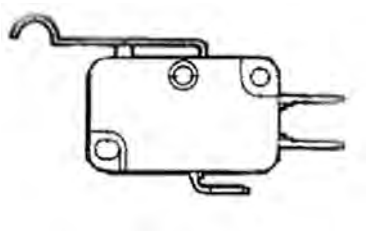


Figure 4.14 Top Cover Micro Switch

Removal

1. Referring to the instructions in this chapter, remove the following components:
    - Exhalation Corner
    - UIM and the top plastic cover.
    - Top Metal Cover
    - Disconnect internal batteries
2. Remove attachment screws, disconnect and lift off the micro switch.

Installation

3. Reattach using screws provided. Re-connect the wiring.
4. Referring to the instructions in this chapter, install the following components:
    - Reconnect Internal batteries
    - Top Metal cover
    - UIM and the top plastic cover.
    - Exhalation corner

EMI Shield

Removal

1. Referring to the instructions in this chapter, remove the UIM and the top cover.
2. Remove the protective box cover by removing the (1) Phillips screw.

3. Remove the EMI shield protective box by removing the (2) KEPS nuts that secure it.

Installation

1. Replace the EMI shield protective box and secure it with (2) KEPS nuts.
2. Replace the protective box cover and secure with (1) Phillips screw.
3. Referring to the instructions in this chapter, install the UIM and the top cover.

Front Interface Panel P/N 51000-40635

Removal

1. Referring to the instructions in this chapter, remove the following components:

- UIM and the top plastic cover.
- Metal cover
- Exhalation corner assembly
- Gas delivery engine assembly.
- Ventilator assembly (from the base).

2. Remove the flow sensor cover by removing the (3) SEMS screws.
3. Remove the (2) KEPS nuts, the EMI shield, brass bracket, and ribbon cable.
4. Turn the unit over and support it on 2x4 pieces of wood so as not to put the entire weight of the unit on the 4 standoffs.
5. Remove (7) Phillips screws; (2) from the lower back panel and (5) from the bottom panel.
6. Remove bottom panel
7. Remove (2) screws from the top of the front panel.
8. Loosen (2) KEPS nuts from the bottom that hold the front panel.
9. Pull off the front panel.
10. Loosen (1) KEPS nut from the bottom and (4) screws on the front panel.
11. Remove the blue tubing from the nebulizer to the front panel.
12. Gently pull the blue ribbon cable through the narrow slot at the top center of the front interface panel and the rest of the wiring through the recessed compartment in the chassis.

Installation

1. Gently feed the blue ribbon cable through the narrow slot at the top center of the front panel and the wiring through the recessed compartment in the chassis.
2. Attach the blue tubing from the nebulizer to the front panel.
3. Tighten (1) KEPS nut on the bottom and (4) screws on the front interface panel.
4. Position the front panel and install (2) KEPS nuts on the bottom and (2) screws on the bottom of the front panel.

5. Position the back panel and install (7) Phillips screws; (2) on the lower back panel and (5) on the bottom panel.
6. Turn the unit over.
7. Install the (2) KEPS nuts, the EMI shield, brass bracket, and ribbon cable.
8. Attach the flow sensor cover by installing the (3) SEMS screws.
9. Referring to the instructions in this chapter, install the following components:

- Ventilator assembly onto the base.
- Gas delivery engine assembly.
- UIM and the top cover.

Bottom Cover

Removal

1. Remove the following:

- Exhalation corner
- UIM and top plastic cover
- Top metal cover
- Disconnect internal batteries
- Ventilator base assembly

2. Turn unit over and support it on 2x4 pieces of wood so as not to put the entire weight of the unit on the 4 standoffs.
3. Remove the 5 screws from the base assembly and the 2 screws from the back panel.
4. Remove the cover and set aside.

Installation

1. Slide bottom cover back onto pneumatics.

Caution!

Carefully place bottom cover on as not to pinch any wires from transition board between chassis and cover, damage to the Avea may result.

2. Tighten the 5 screws on the bottom plate and the 2 on the back panel.
3. Place unit back onto stand.

4. Replace the following components:

- Reconnect the internal batteries
- Top metal cover
- UIM and plastic cover

Alarm Speaker P/N 51000-40818

Removal

1. Referring to the instructions in this chapter, remove the following components:

- UIM and the top cover.
- Ventilator assembly from the base.
- Bottom cover.
- Front panel.

Note:
When turning the unit over, support it on 2x4 pieces of wood to avoid putting the entire weight of the unit on the 4 standoffs.

2. Disconnect the wire to the driver transition board.
3. Remove the (2) 11/32 KEPS nuts that secure the speaker and lift the speaker off of the threaded studs.

Installation

1. Position the speaker onto the two threaded studs and secure with (2) 11/32 KEPS nuts.
2. Connect the wire to the driver transition board.
3. Referring to the instructions in this chapter, install the following components:

- .Front Panel
- Bottom cover
- Ventilator assembly onto the base.
- UIM and the top cover.

Caution!
Carefully place bottom cover on as not to pinch any wires from transition board between chassis and cover, damage to the Avea may result.

Nebulizer Assembly P/N 51000-40026

Note:

When turning the unit over, support it on 2x4 pieces of wood to avoid putting the entire weight of the unit on the 4 standoffs.

Removal

1. Referring to the instructions in this chapter, remove the following components:

- UIM and the top cover.
- Ventilator assembly from base.
- Bottom cover.

Note:

Nebulizer may be activated when using an external compressed air source. It is inactive during use of the optional internal compressor.

2. Turn the unit over and support it on 2x4 pieces of wood so as not to put the entire weight of the unit on the 4 standoffs.
3. Cut tie wraps on the nebulizer booster.
4. Remove wire harness.
5. Disconnect the two solenoid connectors to the driver transition board.
6. Disconnect the tubing from the accumulator.
7. Remove the (3) KEPS nuts that secure the nebulizer; (2) on the left side and (1) on the right, Maneuver the nebulizer out from behind the accumulator.
8. Disconnect blue tube just in front of the solenoid.

Installation

1. Position the nebulizer onto the three threaded studs and using long, needle-nosed pliers, secure with (3) 11/32 KEPS nuts; (2) on the left side and (1) on the right.
2. Connect the tubing from the accumulator to the left side of the nebulizer.
3. Feed the tubing from the gas delivery engine through the U-shaped notch on the left side of the chassis and connect it to the nebulizer.
4. Connect the two solenoid connectors from the driver transition board.

5. Referring to the instructions in this chapter, install the following components:

- Ventilator assembly to the base
- Bottom cover.
- Gas delivery engine assembly.
- UIM and the top cover.

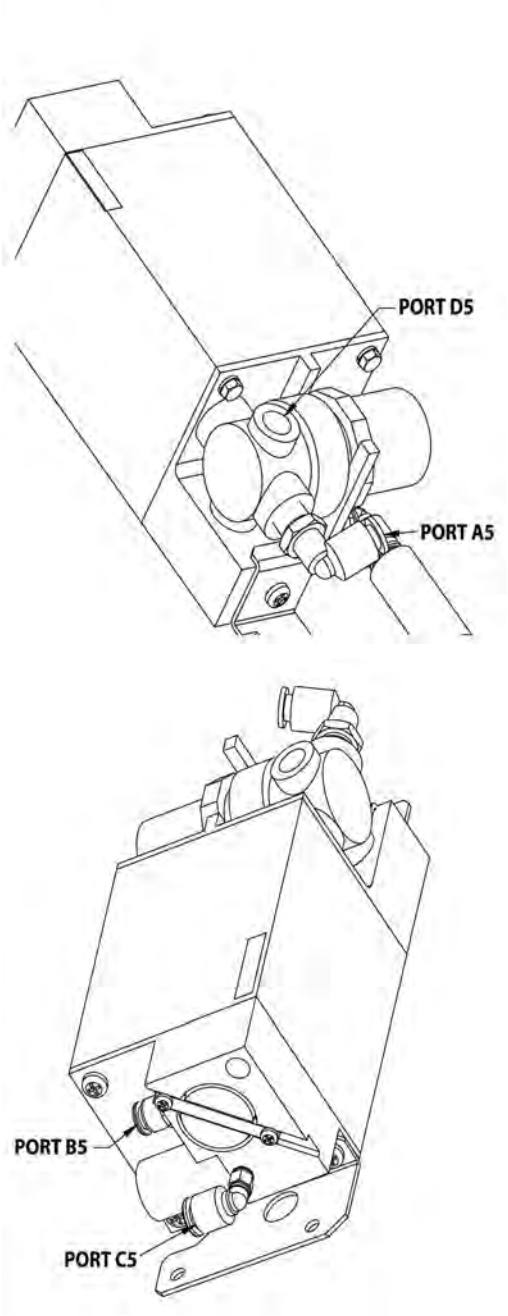


Figure 4.15 Nebulizer Assembly showing ports

Accumulator P/N 51000-40748

Removal

1. Referring to the instructions in this chapter, remove the following components

- Exhalation Corner
- UIM and the top plastic cover.
- Top Metal cover
- Disconnect internal batteries
- Gas delivery engine assembly.
- Ventilator assembly from base.
- Bottom cover.
- Front panel.
- Speaker.
- Nebulizer.

Note:

When turning the unit over, make sure to support it on 2x4 pieces of wood so as not to put the entire weight of the unit on the 4 standoffs.

---

2. Disconnect the solenoid cable from the driver transition board.
3. Disconnect the tubing from the solenoid drain panel.
4. Remove the (4) 11/32 KEPS nuts; one from each corner.
5. Remove the accumulator, twisting to carefully remove the gas delivery engine supply tubing out of the slot on the bottom left of the chassis.

Installation

1. Rotate the supply tube to the gas delivery engine into the slot on the bottom left of the chassis.
2. Position the accumulator by sliding the two notches over the threaded studs at the bottom and seating the top onto the two mounting studs.
3. Secure the accumulator with (4) 11/32 KEPS nuts, one on each corner.
4. Connect the tubing to the solenoid drain panel.
5. Connect the solenoid cable to the driver transition board.

6. Referring to the instructions in this chapter, install the following components:

- Speaker
- Front panel
- Nebulizer
- Bottom cover
- Ventilator assembly onto the base
- Gas delivery engine assembly
- Reconnect internal batteries
- Metal top cover
- UIM and the top plastic cover
- Exhalation corner assembly

Secondary Alarm Installation (Kit P/N 16316)

The purpose of the secondary (back up) alarm is to sound when a ventilator inop occurs and the secondary alarm electronics detects the primary alarm is not functioning.

Warning!

Always disconnect the white battery quick disconnect once the top cover is removed to prevent injury and/or damage to the Avea Ventilator System.

Note:

Prior to complete reassembly, UIM may be temporarily installed for testing and calibration.

1. Remove UIM
2. Remove Metal Shield Cover and set aside
3. Remove wires #14 and #63 from the fuse holder.
4. Using an 11/32" nut driver remove the 3-Kep nuts securing the battery to the chassis.
5. If necessary remove the fuse holder from the chassis.
6. Cut cable ties securing the battery connector and disconnect the battery. Carefully remove battery pack from the unit and set aside.
7. Remove pneumatic module from the stand.
8. Turn the unit over and support it on 2x4 pieces of wood so as not to put the entire weight of the unit on the 4 standoffs.
9. Remove the 5 screws from the base assembly and the 2 screws from the back panel.
10. Remove base plate and set aside.

11. Cut the cable tie that secures the wires and the blue tube to the nebulizer block. Move wires and tube out of the way for the secondary alarm installation.
12. Remove the cable tie bridge from the nebulizer block and discard.
13. Using an 11/32" nut driver loosen the 2-Kep nuts securing the speaker alarm.
14. Using an 11/32" nut driver loosen the 1- Kep nuts securing the metal front plate (this is the plate that has the battery LED's).
15. Disconnect the blue tube from the regulator and move it out of the way.

Note:

If the unit is serialized prior to ADV03500 repositioning the jumper at J3 may be required. See photo #6.

16. Install the Secondary alarm assembly as shown in photo #1 ensuring that the back of the Secondary alarm bracket is flush against the nebulizer block.

Caution!

Ensure all wires and tubes are out of the way prior to installing the Secondary alarm assembly.

17. Using an 11/32" nut driver tighten the 2-Kep nuts securing the Secondary alarm in place.
18. Using an 11/32" nut driver tighten the remaining Kep nut.
19. Connect wires from the Secondary alarm as follows:
    1. 1Wires #66 to #25 and #26
    2. Disconnect Wires #31 and #32 from the Speaker Alarm connection labeled 51000-40818.
    3. Wires #68 and #69 to Wires #31 and #32
    4. Connect wires labeled 51000-40818 to **J1** located on the Secondary alarm P.C.B.A.
20. Locate wire #70/71 this will be the longest wire with split coupling at the end.
21. Feed wire #70/71 underneath the tubes and solenoids and through the access hole in the chassis were the yellow and blue tube feed through into the GDE area. See photo #2
22. Once wire #70/71 is fed through the access hole, set the pneumatic module on its side and pull wire #70/71 all the way through the access hole.
23. Feed wire #70/71 along side the GDE and the Exhalation assembly.
24. Disconnect wire #41 from the main power switch.
25. Connect wire #41 and #70/71 together as shown in photo #3
26. Connect wires #41 and #70/71 to the main power switch as shown in photo #3

Note:

When connecting wires #41 and #70/71 press in on the main power switch from the outside of the unit to ensure that the main power switch is not pushed out. The secondary alarm assembly must be grounded to the unit chassis to ensure proper function.

27. Re-install the battery and fuse holder and re-connect the battery connector.

Functional Testing of the Secondary Alarm Assembly

Note:

Do not install the base plate at this time.

1. Place and secure the pneumatic module to the cart.

Note:

Ensure that all wires and tube located in the lower section of the pneumatic module so damage does not occur.

2. Temporarily install the UIM onto the pneumatic module.
3. Connect the circuit and test lung to the pneumatic module for testing.
4. Plug AC power cord into appropriate wall supply.
5. If the unit does not have the on board compressor connect the unit to appropriate wall gas supply.
6. Turn unit on and allow the unit to power up and press accept patient icon.
7. Clear all visual and audible alarms.
8. Approximately 15 seconds after all alarms are cleared the Secondary alarm will sound for 1 to 2 seconds.
9. After 3 minutes with no backup alarm sounding from the unit, turn unit off.

Additional Test to ensure Proper Wire Routing

1. This test requires quick action and response from the operator to ensure proper functional test of the Secondary alarm.
2. Disconnect expiratory sensor and turn unit ON. Disconnect speaker wire from J1 of the Secondary alarm P.C.B.A.
3. The secondary alarm must sound continuously approximately 20 seconds after wire is disconnected at J1
4. Reconnect speaker wire at J1 and secure all wires and tubes with cable ties as shown in photos #4 and #5.

5. Once the test has passed the bottom plate can be reattached and the unit can be placed back on the cart.

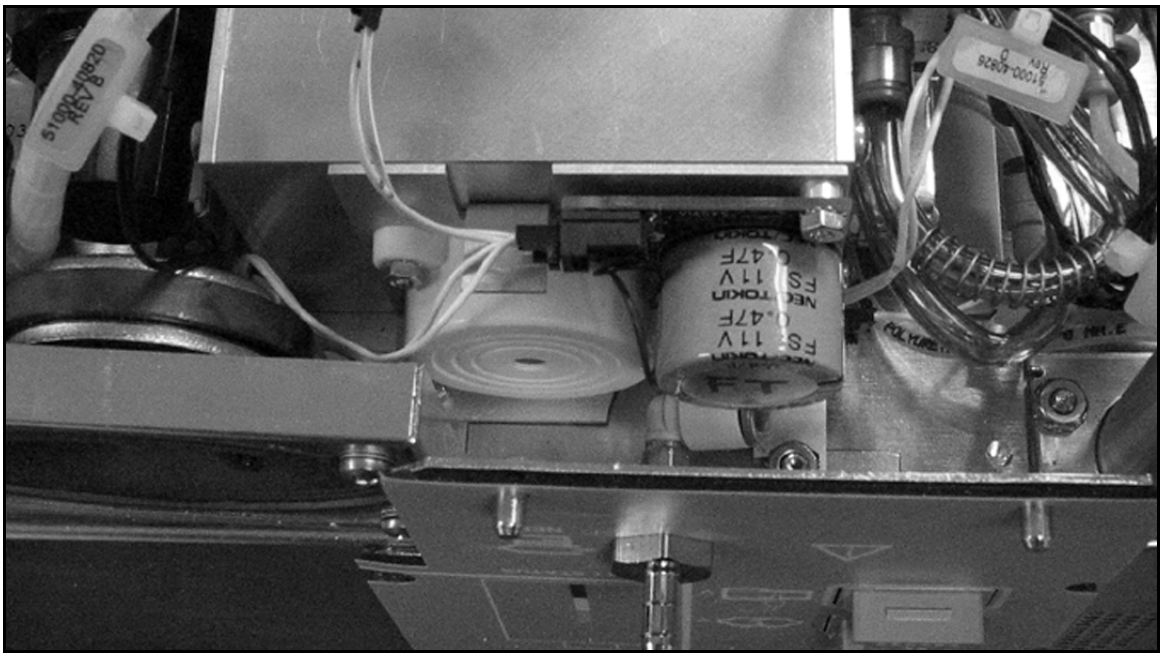


Figure 4.16 Photo #1

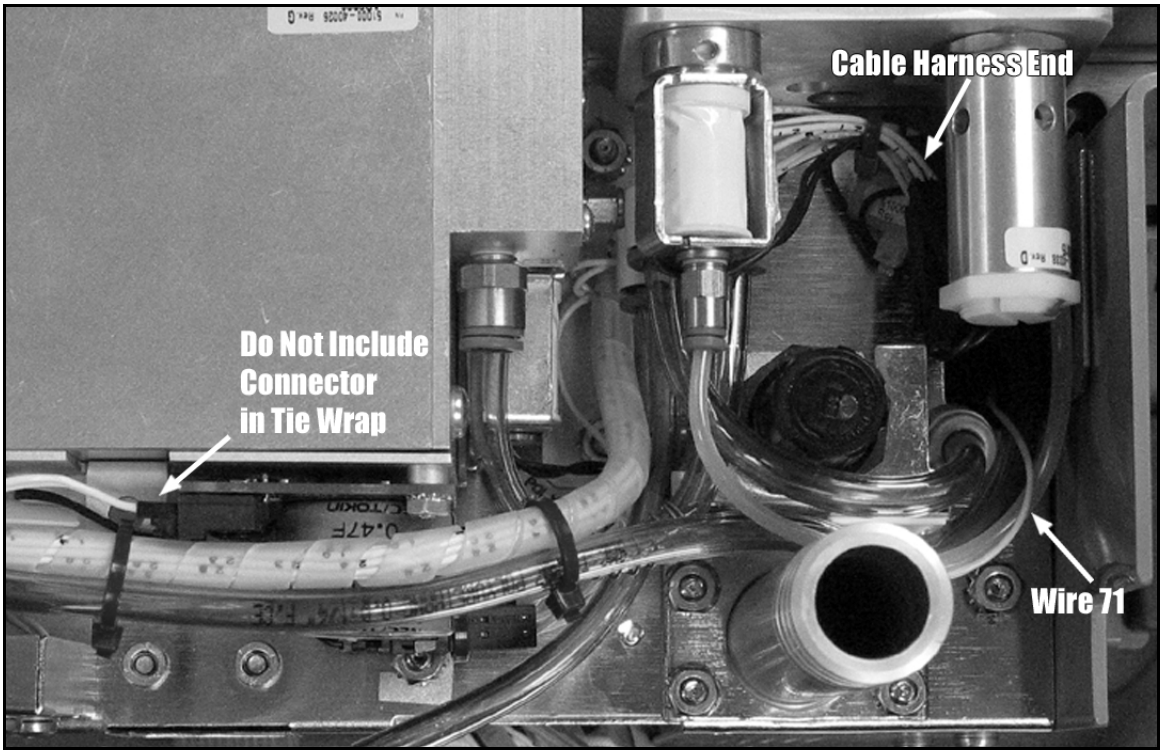


Figure 4.17 Photo #2

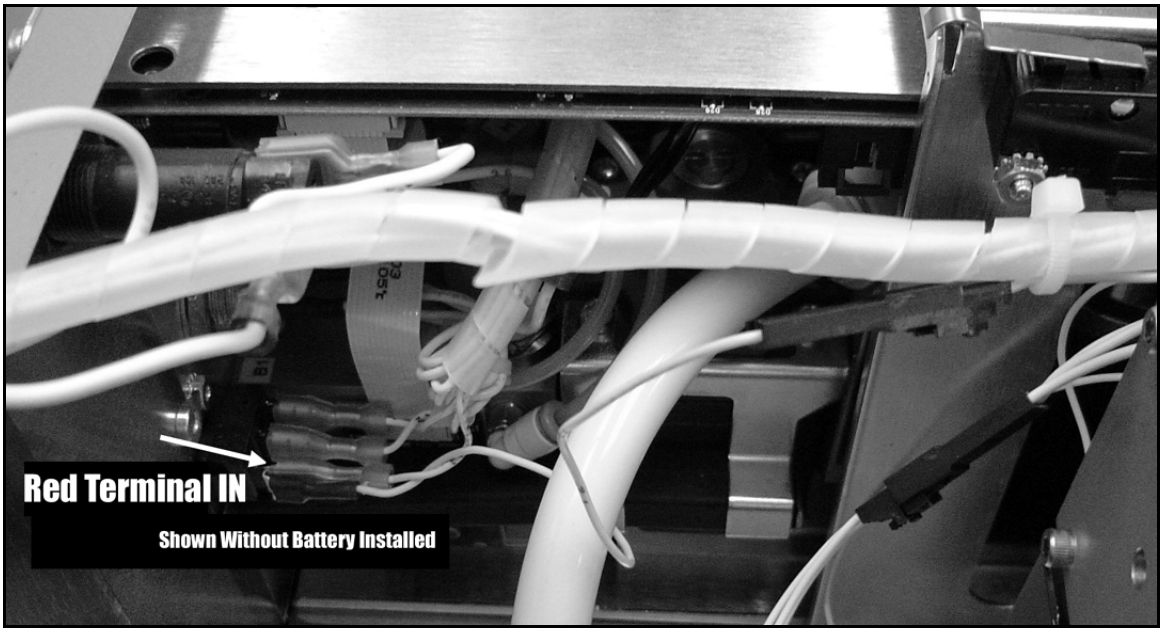


Figure 4.18 Photo #3

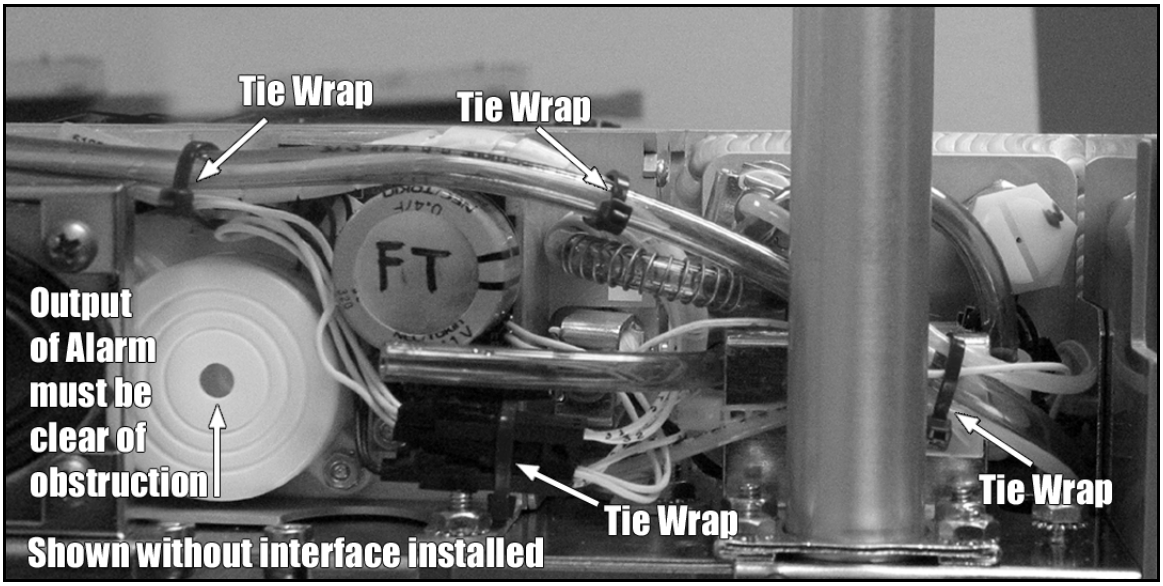


Figure 4.19 Photo#4

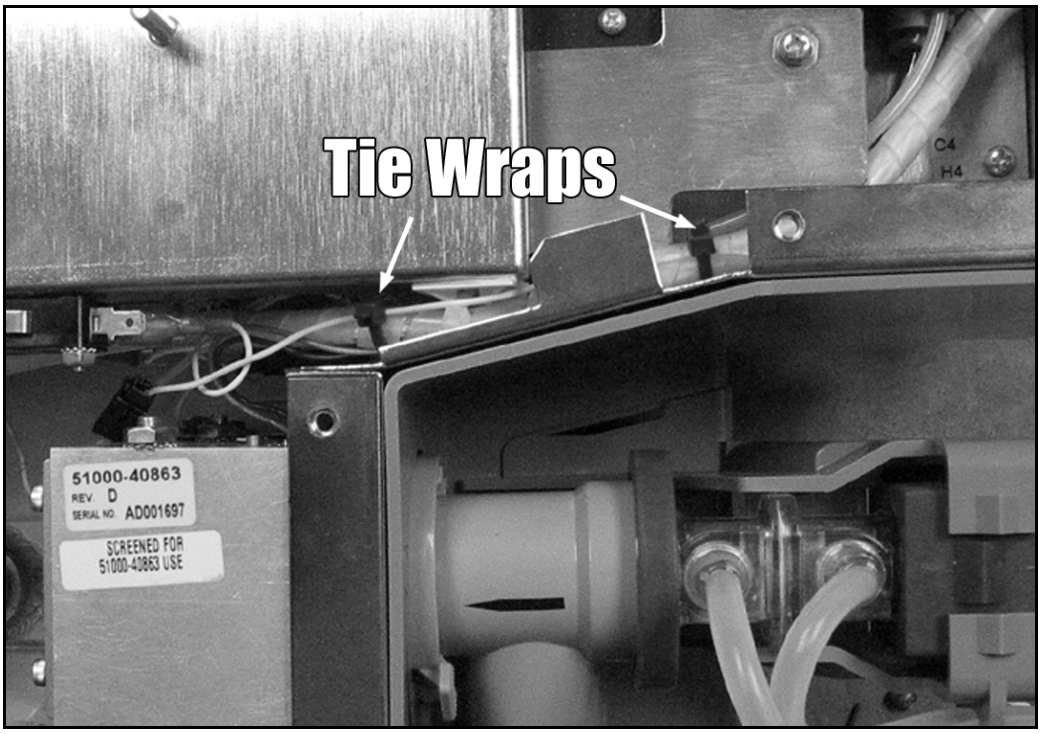


Figure 4.20 Photo #5

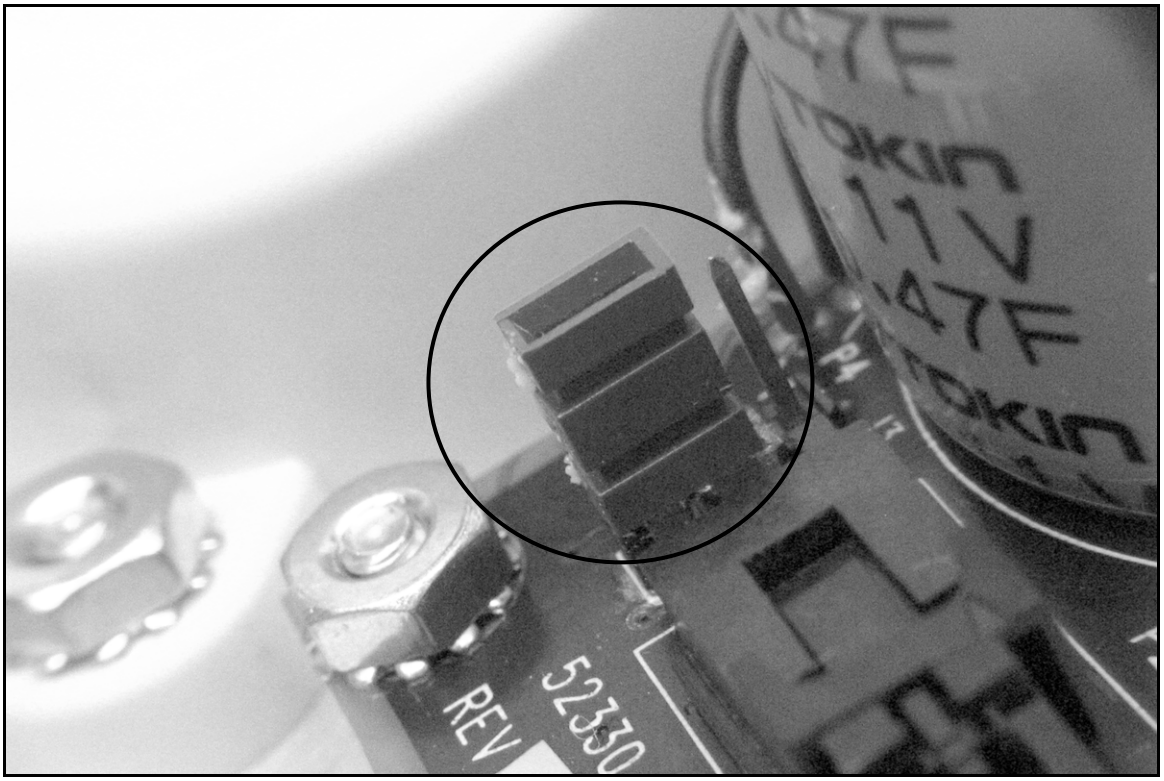


Figure 4.21 Photo #6a Prior to ventilator serial # ADV03500

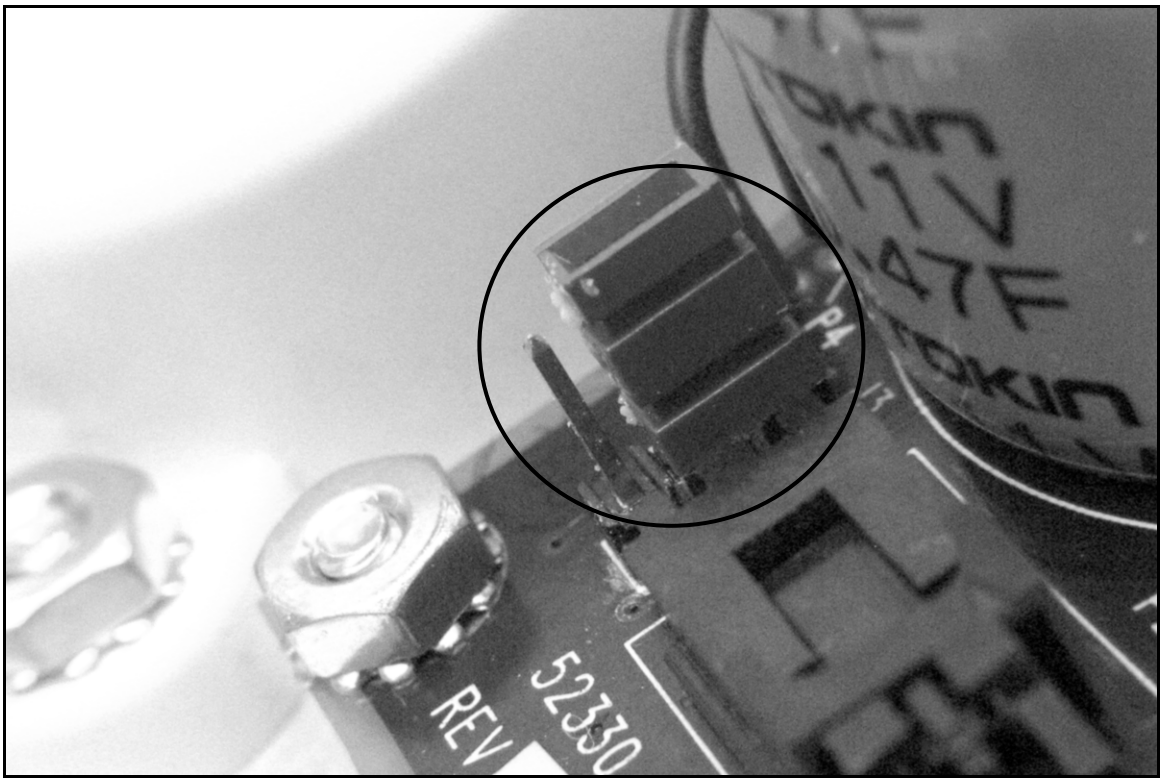


Figure 4.22 Photo #6b After ventilator serial # ADV03500


Avea

Chapter 5 Operational Verification Procedure (OVP)

Warning!

Verification Testing should always be done off patient.

User Verification Tests (UVT)

The following tests are part of the User Verification testing performed before connection to a new patient:

1. POST Test
2. EST
3. Manual Alarms test

Operational Verification Procedure (OVP)

The following tests are part of the Operational Verification Procedure:

1. POST Test	8. Battery Run Procedure
2. EST	9. Battery Performance Verification
3. Manual Alarms Test	10. Air/O_2 Inlet Verification
4. Vt Verification	11. Breath Rate Verification
5. UIM Verification	12. Blending Accuracy Verification
6. Compressor Check	13. PEEP Verification
7. Power Indicator and Charging Verification	

It is recommended that the OVP should be performed:

- During the annual PM
- After a software upgrade
- After the replacement of a part/component
- If the end user suspects the ventilator is not functioning within parameters

The POST test

The first part of the testing, the **POST** or Power On Self Test is transparent to the user and will only message if the ventilator encounters an error. This test is run automatically and performs the following checks:

- Processor Self Check
- ROM Check Sum
- RAM Test

The POST will also check the audible alarms and the LEDs at which time the audible alarm sounds and the LEDs on the User Interface Module flash.

Set up

1. Plug the Avea into a suitable AC Power source, 50 PSI oxygen source and 50 PSI medical air source.
2. Connect an adult patient circuit and an adult test lung.

Note:

CareFusion recommends the use of a non disposable adult patient circuit (P/N 16044 48″ or P/N 16045 72″) and test lung (P/N 33754) when testing CareFusion ventilation equipment:.

3. Turn power on.
4. Select ***New Patient*** when prompted. The ***Safety Valve Open*** alarm will activate. Press ***Patient Accept***. (This will re-set the controls to the default settings shown in this procedure).
5. Select ***Patient Size*** and select ***Adult***. Press ***Size Accept.*** Leave the settings at the defaults and verify that a Vent-Inop Alarm is not activated.
6. Ensure that Leak Comp and Humidifier active are off. Press Setup Accept.
7. Perform an Extended Self Test (EST).

Extended Systems Test (EST)

Note:

Ensure that the O_2 alarm is enabled. The O_2 sensor calibration portion of the EST will fail if the O_2 alarm is disabled.

1. Connect medical grade oxygen and compressed air sources to the unit (20 TO 80 psi).
2. Press the Setup membrane button to access the Setup screen.

3. Press ***Size Accept*** to pass the next displayed screen.

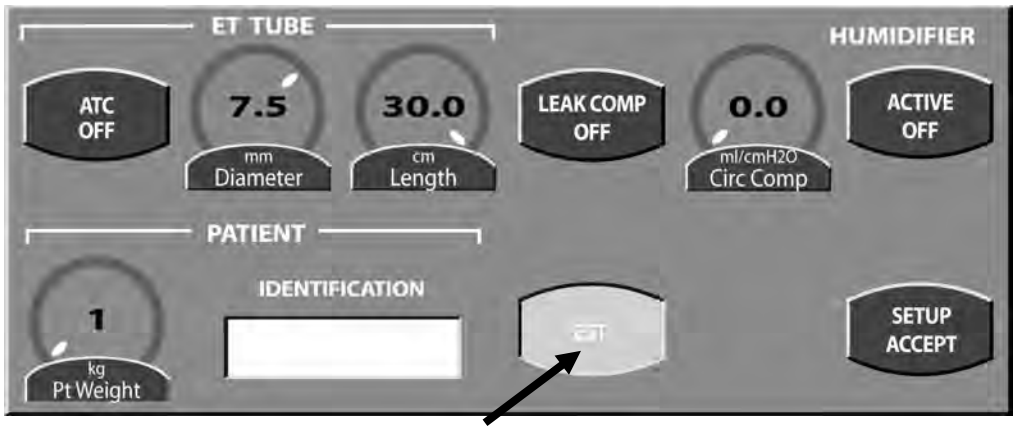


Figure 5.1

4. Press the EST touch screen icon to highlight. (A message will appear instructing you to remove the patient and block the patient circuit wye.) Remove the test lung and plug the wye connector.

Figure 5.2

5. After confirming that the patient has been disconnected and the circuit wye blocked press the Continue (Cont) button. (The ventilator will perform the EST and display a countdown clock.)

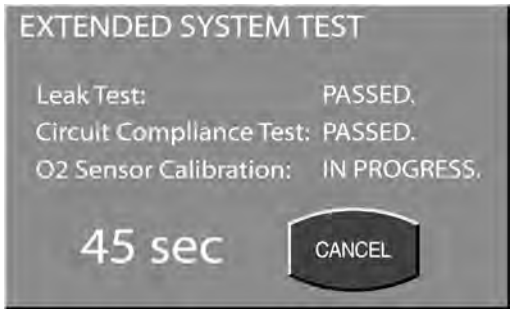


Figure 5.3

During this test the ventilator will perform:

- Patient circuit leak test
- Patient circuit compliance measurement
- Two point calibration of the oxygen sensor

The patient circuit compliance measurement and leak test are performed simultaneously with the oxygen sensor calibration. The maximum time for the EST is 90 seconds.

To restart the EST at any time select the Cancel button to return to the set up screen.

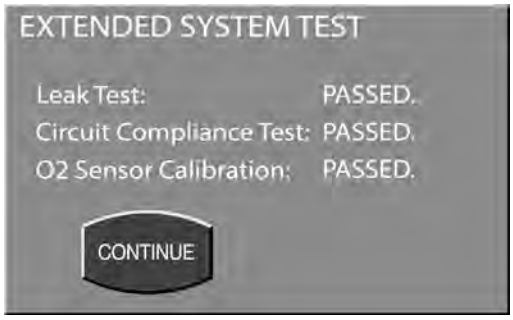


Figure 5.4

After each test is complete the ventilator will display a "Passed" or "Failed" message next to the corresponding test.

6. Once the test is complete press the continue button to return to the set up screen.

Note:

If you do not connect the ventilator to an oxygen supply, the O_2 Sensor Calibration will immediately fail.

Manual Alarms Testing

This testing verifies the following alarms:

Low PEEP alarm	Low O_2 alarm
High Ppeak alarm	High O_2 alarm
Circuit Occlusion	EXT High Ppeak alarm
Low Ve alarm	Low Vt alarm sensitivity
Loss of AC alarm	Circuit Disconnect
High Ve alarm	High Rate Alarm
High Vt alarm	Apnea Interval Alarm
Low Vt alarm	

Caution!

Although failure of any of the above tests will not prevent the ventilator from functioning, it should be checked to make sure it is operating correctly before use on a patient.

Note:

To ensure proper calibration of the oxygen sensor, you should always perform a complete EST prior to conducting Manual Alarms Testing.

Warning!

User Verification Testing should always be done off patient.

Caution!

Following each alarm verification test, ensure that the alarm limits are reset to the recommended levels shown in the following charts before proceeding to the next test.

Table 5.1 Test Setup Requirements

	Adult Setting	Pediatric Setting	Neonate Setting
Air Supply Pressure	20-80 psig (2.1 bar)	Same	Same
O2 Supply Pressure	20-80 psig (2.1 bar)	Same	Same
AC Line Voltage	Varies Internationally	Same	Same
Patient Circuit	6′ (2 m) Adult	6′ (2 m) Adult	Infant
Compliance	20 mL/cmH_2O	20 mL/cmH_2O	NA
Resistance	5 cmH_2O/Liters per second	5 cmH_2O/Liters per second	NA

Note:

Compliance and resistance values are test lung specifications.

To conduct Manual Alarms Testing on the Avea ventilator using default settings, complete the following steps (A table describing the default settings for Adult, Pediatric and Neonatal patient sizes follows).

Please refer to software release notes of the current version of software in the Avea that is being tested to obtain the specific default values. The default values listed on the following pages are those for software versions 3.7 and greater.

Table 5.2 Ventilation Setup

Vent Setup	Adult Setting	Pediatric Setting	Neonate Setting
ET tube Diameter	7.5 mm	5.5 mm	3.0 mm
ET Tube Length	30 cm	26 cm	15 cm
Artificial Airway Compensation	Off	Off	Off
Leak Compensation	Off	Off	Off
Circuit Compliance Compensation (Circ Comp)	0.0 mL/cmH_2O	0.0 mL/cmH_2O	0.0 mL/cmH_2O NOT active in Neonates.
Humidification	Active On	Active On	Active On
Patient Weight	1 kg	1 kg	1 kg

Table 5.3 Primary Controls

	Adult Setting	Pediatric Setting	Neonate Setting
Breath Type/Mode	Volume A/C	Volume A/C	TCPL A/C
Breath Rate (Rate)	12 bpm	12 bpm	12 bpm
Tidal Volume (Volume)	500 mL	100 mL	NA
Peak Flow	60 L/min	20 L/min	8 L/min
Inspiratory Pressure (Insp Pres)	NA	NA	15 cmH_2O
Inspiratory Pause (Insp Pause)	0.0 sec	0.0 sec	0.0 sec
Inspiratory Time (Insp Time)	NA	NA	0.35 sec
PSV	NA	NA	NA
PEEP	6 cmH_2O	6 cmH_2O	3 cmH_2O
Inspiratory Flow Trigger (Flow Trig)	1.0 L/min	1.0 L/min	0.5 L/min
%O_2	40%	40%	40%

Table 5.4 Advanced Settings

Adv. Settings	Adult Setting	Pediatric Setting	Neonate Setting
Vsync	0 (off)	0 (off)	NA
Vsync Rise	5	5	NA
Sigh	0 (off)	0 (off)	NA
Waveform	1 (Dec)	1 (Dec)	NA
Bias Flow	2.0 L/min	2.0 L/min	2.0 L/min
Inspiratory Pressure Trigger (Pres Trig)	3.0 cmH_2O	3.0 cmH_2O	3.0 cmH_2O
PSV Rise	NA	NA	NA
PSV Cycle	NA	NA	NA
PSV Tmax	NA	NA	NA
Machine Volume (Mach Vol)	NA	NA	NA
Volume Limit (Vol Limit)	NA	NA	300
Inspiratory Rise (Insp Rise)	NA	NA	NA
Flow Cycle	NA	NA	0
T High PSV	NA	NA	NA
T High Sync	NA	NA	NA
T Low Sync	NA	NA	NA
Demand Flow	On	On	NA

Table 5.5 Alarm Settings

	Adult Setting	Pediatric Setting	Neonate Setting
High Rate	75 bpm	75 bpm	75 bpm
High Tidal Volume (High Vt)	3.00 L	1000 mL	300 mL
Low Tidal Volume (Low Vt)	0.0 L	0.0 mL	0.0 mL
Low VTe Sensitivity	3 breaths	3 breaths	3 breaths
Low Exhaled Minute Volume (Low Ve)	1.0	0.5	0.05
High Exhaled Minute Volume (High Ve)	30.0 L/min	30.0 L/min	5.0 L/min
Low Inspiratory Pressure (Low Ppeak)	8 cmH_2O	8 cmH_2O	5 cmH_2O
High Inspiratory Pressure (High Ppeak)	40 cmH_2O	40 cmH_2O	30 cmH_2O
Low PEEP	3 cmH_2O	3 cmH_2O	1 cmH_2O
Apnea Interval	20 sec	20 sec	20 sec

Table 5.6 Auxiliary Controls

	Adult Setting	Pediatric Setting	Neonate Setting
Manual Breath	---	---	---
Suction	---	---	---
O_2	79%	79%	20%
Nebulizer	---		
Inspiratory Hold (Insp Hold)	---	---	---
Expiratory Hold (Exp Hold)	---	---	---

1. Make the appropriate connections for air and O_2 gas supply. Connect the power cord to an appropriate AC outlet. Attach an appropriate size patient circuit and test lung to the ventilator.
2. Power up the ventilator and select "NEW PATIENT" when the Patient Select Screen appears and press "PATIENT ACCEPT". This will enable default settings for the Manual Alarms Test as shown in tables 5-2, 5-3, 5-4, 5-5, and 5-6.
3. Select the appropriate patient size for your test (Adult, Pediatric or Neonate) from the Patient Size Select Screen and press "SIZE ACCEPT". Set *Humidifier Active to* off.
4. Make any desired changes or entries to the Ventilation Setup Screen and accept these by pressing "SETUP ACCEPT".
5. Press *Alarm Limits* button on the upper right of the user interface.
6. Verify that no alarms are active and clear the alarm indicator by pressing the alarm reset button on the upper right of the user interface.
7. Set the % O_2 control to 100%. Disconnect the Oxygen sensor from the back panel of the ventilator and verify that the Low O_2 alarm activates. Return the O_2 control setting to 21%, and remove sensor from back panel and reconnect the O_2 sensor. Provide blow-by to the sensor from an external oxygen flow meter. Verify that the High O_2 alarm activates. Return the % O_2 to 21%, reconnect the Oxygen sensor to the back panel. Clear all alarm messages by pressing the alarm reset button.
8. Set *PEEP* to 0. Set *Low PEEP* alarm to 0. Disconnect the patient wye from the test lung. Verify that the Low Ppeak alarm activates, followed by the Circuit Disconnect alarm. This second alarm should activate after 5 seconds for Adult/Pediatrics and 3 breaths for Neonates. Reconnect the test lung to the circuit clear the alarm by pressing the reset button. Increase PEEP level back to default setting.
9. Disconnect the AC power cord from the wall outlet. Verify that the Loss of AC alarm activates and the battery-back up symbol appears in the lower right hand corner of the UIM touch screen. Reconnect the AC power cord. The "battery" symbol should disappear. Clear the alarm by pressing the reset button.
10. Occlude the exhalation exhaust port. Verify that the High Ppeak alarm activates, followed 5 seconds later by the activation of the High Ppeak, Sust. Alarm or Ext High Ppeak Alarm. Remove occlusion.
11. Set the rate control setting to 1 bpm. Verify that Apnea Interval alarm activates after the default setting of 20 seconds. Return the breath rate control setting to its default value and clear the alarm by pressing the reset button.
12. Set the Low PEEP alarm setting to a value above the default control setting for PEEP on your ventilator. Verify that the Low PEEP alarm activates. Return the alarm setting to its default value and clear the alarm by pressing the reset button.

13. Set the High Ppeak alarm setting to a value below the measured peak pressure, or in neonatal ventilation the default control setting for Inspiratory Pressure on your ventilator. Verify that the High Ppeak alarm activates. Return the alarm setting to its default value and clear the alarm by pressing the reset button.
14. Set the Low Ve alarm setting to a value above the measured Ve on your ventilator. Verify that the Low Ve alarm activates. Return the alarm setting to its default value and clear the alarm by pressing the reset button.
15. Set the High Ve alarm setting to a value below the measured Ve on your ventilator. Verify that the High Ve alarm activates. Return the alarm setting to its default value and clear the alarm by pressing the reset button.
16. Set the High Vt alarm setting to a value below the set Vt on your ventilator. Verify that the High Vt alarm activates. Return the alarm setting to its default value and clear the alarm by pressing the reset button.
17. Set the Low Vt alarm setting to a value above the set Vt on your ventilator. Verify that the Low Vt alarm activates after the set number of breaths as determined by the Low Vte sensitivity in the Utility Screen. Return the alarm setting to its default value and clear the alarm by pressing the reset button.
18. Set the High Rate alarm to a value below the default control setting for rate on your ventilator. Verify that the alarm activates. Return the alarm to its default setting and clear the alarm by pressing the reset button.
19. Neonatal and Pediatric verification of Circuit Disconnect Alarm. Add a proximal (wye) flow sensor to an infant or pediatric patient set-up. Create a leak. When the Percent Leak ((Vti-Vte)/Vti) becomes 95% or greater for three consecutive breaths, the alarm should sound. Adult: Without a proximal flow sensor, the threshold becomes 90% leak.
20. Verification of Circuit Occlusion Alarm: Create an increased resistance on either limb of the patient circuit. Note: During adult applications, the alarm is suspended during the first 150msec of exhalation.

Note:

Repeat steps 11 through 21 in Pediatric Mode with a pediatric circuit and Siemens or Manley test lung.

Repeat steps 11 through 21 in Infant Mode with an infant circuit and an Ingmar or other suitable infant test lung.

Caution!

Although failure of any of the above tests will not prevent the ventilator from functioning, it should be checked to make sure it is operating correctly before use on a patient.

Tidal Volume Accuracy Verification

Volume Definitions

Vdel: Vdel is the total volume delivered by the machine. This value will be greater than the VTi if tubing compliance is set. It is measured by the inspiratory flow sensor inside the ventilator.

VTi: Inspired tidal volume. VTi is measured by the Inspiratory flow sensor inside the ventilator and reflects the volume without compensating for tubing compliance.

VTe: Exhaled tidal volume. Exhaled volume readings are measured by the expiratory flow sensor. This reading may be affected by the humidifier setting.

VT set: The tidal volume set.

Testing Guidelines

Use default parameters for each patient size group; adult, pediatric and infant

Refer to Table 5.1, "Test Setup Requirements" and Table 5.2, "Ventilation Setup."

Use appropriate circuit and test lung for each patient group. It is suggested that when performing VT verification in adult and pediatric ranges, a Manley test lung is used. When using a Siemens test lung, the test is to be performed without the proximal sensor.

Ensure that, artificial airway compensation, leak compensation and humidifier are off.

Select ATPD Flow Correction in the Utility Screen.

Do not use a flow sensor.

Accuracy of displayed exhaled volume is $\pm$ 10% of set VT.

Verify Vt for each setting as seen in Table 5.7.

Change to Neonate patient size for Vt 20 Volume A/C mode.

Table 5.7 VT Tolerance Ranges

VT SET	VT EXHALED
1000	900 to 1100 mL.
500	450 to 550 mL.
100	90 to 110 mL.
20	18 to 22 mL.

Return Flow Correction to BTPS upon completion of testing.

User Interface Module (UIM) Verification

Membrane Switch Tests

These tests verify the functioning of the membrane buttons surrounding the touch screen:

1. Alarm Silence (LED) - Disconnect the test lung from patient circuit. An audible alarm sounds. Press the Alarm Silence button and verify that the audible portion of the alarm is disabled for 2 minutes (± 1 second) or until the Alarm Silence button is pressed again.
2. Alarm Reset - Reconnect the test lung to the patient circuit. The alarm message should turn yellow. Press the Reset button to cancel the visual alarm message.
3. Alarm Limits - Press the Alarm Limits screen button. Press the button again to toggle the screen on and off.
4. Manual Breath - Press this button during the expiration phase of a breath. Verify that the ventilator delivers a single mandatory breath at current ventilator settings.
5. Suction (LED) - Press the Suction button. Both Suction and ↑ $\%O_2$ LEDs should Illuminate. Press Suction again. Both Suction and ↑ $\%O_2$ LEDs should disappear.
6. Increase O_2 - Press the Increase O_2 button (↑ $\%O_2$). Verify that the LED Illuminates. Press the button again and verify that the LED turns off.
7. Accept - Change any parameters, press accept and verify the new setting is entered.
8. Cancel - Change any parameters, press Cancel ensure new setting is canceled.
9. Expiratory Hold – Press and hold the Expiratory Hold button. The pressure waveform should display as a flat line for about 20 seconds in Adult and Pediatric Patient modes.
10. Inspiratory Hold - Allow to cycle then press and hold the inspiratory hold button and it will plateau at the top of the inspiratory cycle in the adult and pediatric patient modes.
11. Nebulizer - Press the Nebulizer button; verify that nebulization is synchronized with breath rate. You will feel air coming out of the nebulizer fitting. Lower peak flow < 14L/min and "neb not available" should appear. Change to Neonate population and verify nebulizer is inactive.
12. Mode - Press the Mode button. Verify that the Mode sub screen appears.
13. Patient Size - Select a Patient size from the menu. Ensure the correct LED is displayed for the patient size currently selected. Change patient size to Pediatric and then to Neonate. Verify correct LED display for each one.
14. Panel Lock - Press the Lock button and verify no access to screen functions. Verify manual breath, suction, increase O_2 and alarm silence buttons **are** functional during panel lock.
15. Set-up - Press the Setup button and verify that the Setup screens appears. Press Size Accept and Set up Accept.
16. Advanced Settings - Press the Advanced Settings screen button. Toggle the screen on and off. Verify that the screen responds correctly.
17. Event - Press Events and verify the sub screen appears, press again to check that the Main screen reappears.
18. Freeze - Press the Freeze button. All graphics screen update should cease, the waveforms freeze. Measurement bar appears. Press again and ensure normal refresh of the waveform sweep continues in the Main screen.

19. Screens and Main buttons - Press the Screens button and the Screen Select screen should appear. Press Monitor and monitor screen should display. Press Main and the screen should go back to Main Screen.

Compressor Check

Note:
Use of an appropriate test lung for volume of 2.0L is recommended.

1. Ensure a regulated wall air supply is on prior to start of test.
2. Attach an adult patient circuit and test lung to the test ventilator.
3. Turn on the ventilator and leave on adult default parameters.
4. Turn off the wall air supply.
5. Verify that the compressor activates at approximately 18-20 PSI.
6. Verify that the “scroll” symbol is displayed in the bottom right corner of the UIM.

7. Verify ventilator continues to ventilate and no alarms are activated.
8. Allow ventilator to continue to cycle using the compressor for approximately two minutes.
9. Disconnect the expiratory limb of circuit. Verify High Priority alarms activate.
10. Reconnect circuit and test lung.
11. Change the scale on Flow waveform graphic display to 150- 300 L/min.
12. Maximize the High Ppeak alarm setting and change the Flow waveform to Square in Advanced Settings.
13. Change the following ventilator settings:

Control	Setting
Rate	19 bpm
Peak Flow	150 L/MIN
Tidal Volume (Vt)	2.0 L
PEEP	0.0

14. Allow to cycle for one minute and then press the Freeze button.
15. Verify the flow at the end of inspiration is 135 L/min or greater.
16. Re-connect wall air supply.
17. Verify compressor shuts off and ventilation continues uninterrupted using the wall air supply.

Power Indicators and Charging Verification

1. Power the unit up. Verify the Power On indicator is lit. It will be green.
2. Ensure that when the unit is connected to AC Power the AC indicator is lit. It will be green.
3. If the unit is equipped with an external battery, check and verify the external battery charging and status indicators.
4. Check the internal battery (standard feature) charging and status indicators.

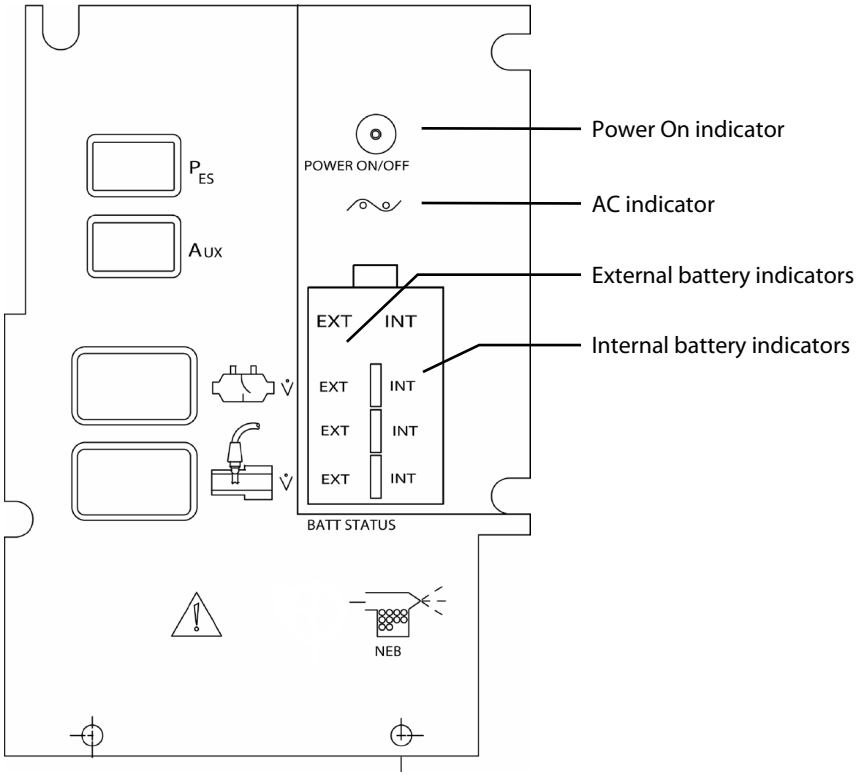


Figure 5.5

The charging status indicators are:

- Green: (80% or more charge remaining for external battery, 90% or more charge remaining for the internal battery).
- Yellow: (Less than 80% for external battery, less than 90% for the internal battery)
- Red: (Less than 40% for external battery, less than 20% for the internal battery)

Proceed with the rest of the O.V.P testing.

Note:

Depending on the type of front panel installed on the Avea, there may be two sets of LED charge indicators, one for external and one for internal batteries.

Battery Run Procedure

1. Plug unit in, turn power on and adjust settings as follows:

- *Mode*: Pediatric, Volume A/C
- *Settings:* 40 BPM, Volume 200mL, Peak Flow 30 L/min, PEEP 5cmH_2O, Flow Trigger 20 L/min, and FIO_2 21%.
- *Advanced Settings:* Vsync off, Waveform Square, Bias Flow 3 L/min, and Pressure Trigger 20cmH_2O.

2. Verify battery indicator LED's function and progressively charge from Red to Yellow to Green.
3. Disconnect A/C power to verify external batteries. The Power status indicator "EXT" should be illuminated indicating that ventilator is running on the external batteries.
4. To verify internal batteries: Turn power switch off. Disconnect external batteries, and turn power switch on and resume previous settings. Verify that the power status indicator "INT" is illuminated and that the "on screen" battery indicator is displayed.

5. Turn unit off. Reconnect external batteries and turn unit on. Verify that the LED for the Int and Ext batteries are on.

Caution!

External batteries should never be disconnected while the Avea is running; all power to the Avea may be lost and unit may shut off as a result.

Battery Performance Verification

1. Connect adult circuit and test lung, disconnect external batteries if equipped, turn on power and select "New Patient" and "Adult" patient size. If the unit has an internal compressor, disconnect wall air.
2. Adjust the breath rate to 40 bpm, and set the Low VE alarm limit to 0. All other settings are to remain as default.
3. Record the start time of the test.
4. Unplug the unit from AC power source and confirm unit is running off of internal battery power.
5. Verify that unit runs for 30 minutes with compressor or 1 hour without compressor.
6. Turn unit off, reconnect external batteries if applicable, and recharge batteries.

Air/Oxygen Inlet Pressure Verification

Note:

All gases used for testing the Avea should be verified clean medical grade gas sources. The ventilator should be operating in Adult patient mode with all settings at defaults.

1. Apply a regulated 50 PSI medical air source to the Avea Air Inlet on the rear panel of the ventilator.
2. Apply regulated 50 PSI medical O_2 Source to the O_2 Inlet. (Verify the Air and O_2 Inlet monitors read 50 PSI (+/- 3 PSIG). You can check this by scrolling to the air inlet and O_2 inlet monitored parameter displays on the left of the Main screen or by pressing the screens button, and selecting the Monitor screen and scrolling to the air inlet and O_2 inlet Parameters.

3. Lower the air inlet pressure gage to 18 psi. The compressor should turn on in a unit with compressor. In a unit with no compressor, the Loss of Air alarm should activate.
4. Change the O_2 percentage to 60%.

5. Lower the O_2 inlet pressure gage to 18 psi. The Loss of O_2 alarm should activate.

Breath Rate Verification

Note:
Make sure the ventilator is set to Adult size and default settings.

1. Allow the ventilator to cycle and using a stopwatch, count the cycles and ensure the breath rate matches the Rate setting of the Avea.
2. Verify the following rates(±2):

   5 bpm

   20 bpm

   60 bpm

Blending Accuracy Verification

Verification should be done with wall air and O_2, and wall O_2 and compressor, if applicable.

Note:
Make sure the ventilator is set to Adult size and default settings.

Record the readings from the external O_2 Analyzer and the Avea FIO_2 (% O_2) monitor/setting. Check the FiO_2 (% O_2) readings per table below to compare set FIO_2 to analyzed FIO_2.

Table 5.9: FiO_2 Readings

O_2%	Tidal Volume	Breath Rate	Peak Flow	% Tolerance
21%	0.50L	25	30 L/min	±3%
30%	0.10	50	30 L/min	±3%
30%	0.50	25	30 L/min	±3%
60%	0.10	50	30 L/min	±3%
60%	0.50	25	100 L/min	±3%
90%	0.10	50	30 L/min	±3%
90%	0.50	25	30 L/min	±3%
100%	0.50	25	30 L/min	±3%

PEEP Verification

1. Connect an Adult test lung and accept the default settings.
2. Change the Rate to 4 bpm. Using the Paw (cmH_2O) portion of the wave form screen, freeze and measure baseline pressures at each of the following PEEP settings: (The tolerance is +/- 3.5 % of reading or +/- 2 cm.) Compare to digital monitored reading.

   6 cm H_2O 20 cmH_2O 40cmH_2O

Avea Assembly and Operational Verification Test Checklist

This is a checklist ONLY. Please refer to detailed Installation, Assembly and OVP Instructions.

Unit Serial Number: _____UIM Serial Number: _____

Hours_____ Software Revision_____ Other_____

If any parts are missing contact CareFusion Customer Service at 1-800-231-2466.

ASSEMBLY	COMPLETED	
Stand Assembly		
External Battery Installation		
"E" Cylinder Bracket Assembly		
Unpacking and Mounting the Avea		
Installation of Medical Gas Connector(s)		
Exhalation Filter and Water Trap Assembly		
TESTS	**PASS**	**FAIL**
User Verification Tests (UVT)		
POST Test		
Extended Systems Test (EST)		
Manual Alarms Testing		
Adult		
Pediatric		
Infant		
VT Accuracy Verification		
UIM (User Interface Module) Membrane Switch Tests		
Compressor Check		
Power Indicators and Charging Verification		
Battery Test: Battery Run Procedure		
Battery Performance Verification		
Air/Oxygen Inlet Pressure Verification		
Breath Rate Verification		
Blending Accuracy Verification		
PEEP Verification		

Warning!

Verification Testing should always be done off patient.

Checklist completed by_____

Signature_____Title_____

Facility_____


Avea

Chapter 6 Avea Software Upgrade

Note:

Avea has two different UIM options: ELAN and Coldfire. Each UIM has a different software revision. Before upgrading the software, verify the type of installed UIM.

Coldfire Software Upgrade Directions

The following directions are for the Software Upgrade to the Avea Coldfire units. Only Coldfire software may be used to upgrade a Coldfire UIM. This document provides a brief overview of the procedure to upgrade ventilator software using the RS232 serial port of the Avea. The HyperTerminal utility available within the Windows environment is used here as an example. Any suitable terminal emulation software would work as well.

Requirements:

Computer with a serial port (COM1: or COM2:)

Terminal Emulation Software (for example, HyperTerminal works well) configured for serial connection 115Kb,8,N,1 flow control OFF (see the instructions below)

Avea ventilator with Software Upgrade Utility Version 3.0 or higher installed

A Serial cable to connect the computer to the serial port of the ventilator
(A straight-through cable with null modem adapter or null modem cable with gender changer both work fine).

New binary files for the ventilator: 63603X.bin (Monitor) and 63602X.bin (Control)
“X" indicates the revision of the released software in alphabetic characters e.g. "63603F" is revision F.

1. Establish a HyperTerminal connection with the following settings:

- Connect using: COM1
- Port Settings:
  - Bits per second: 115200
  - Data bits: 8
  - Parity: None
  - Stop bits: 1
  - Flow control: None

2. Power on the ventilator unit while holding down the EXP HOLD button on the UIM.

When a target connection is established, the HyperTerminal window displays a list of commands.

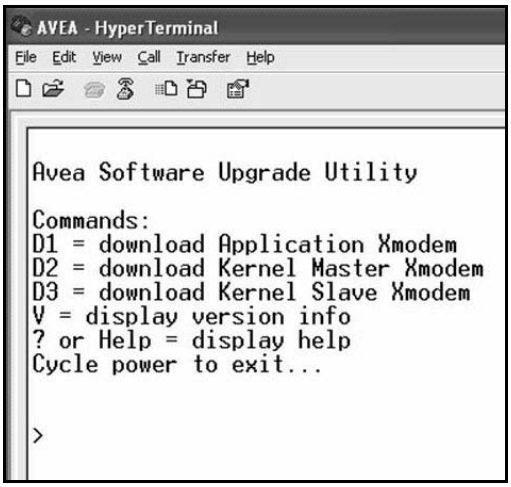


Figure 6.1

The commands available include:

- D1, D2, D3 are commands to download application/kernel software to the target.
- V is the command to display the versions of software installed on the target.
- ? and Help are commands to display the above help information.

3. At the command prompt, type a command (D1, D2, or D3) to download the corresponding software to the target.

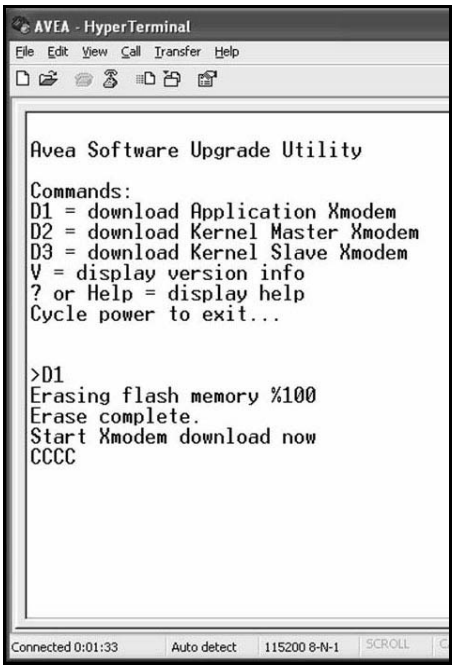


Figure 6.2

Note:

Before proceeding to the next step, wait for the "Start Xmodem download now" message to appear, which indicates that erasing of the flash memory is complete.

4. On the Transfer menu, click **Send File** to open the Send File dialog box.

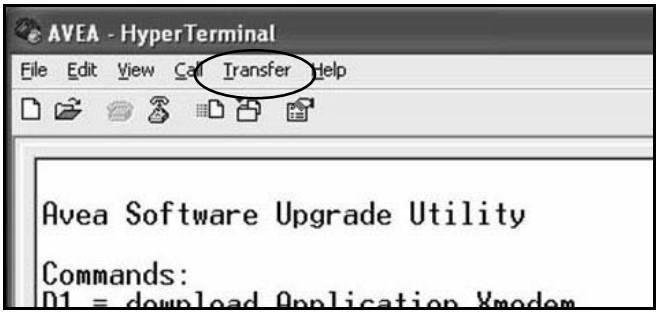


Figure 6.3

5. Click the **Browse** button and navigate to and select one of the following files:

- Application: 63703-X.bin for D1 command
- Kernel Master: 63704-X.bin for D2 command
- Kernel Slave: 63705-X.bin for D3 command

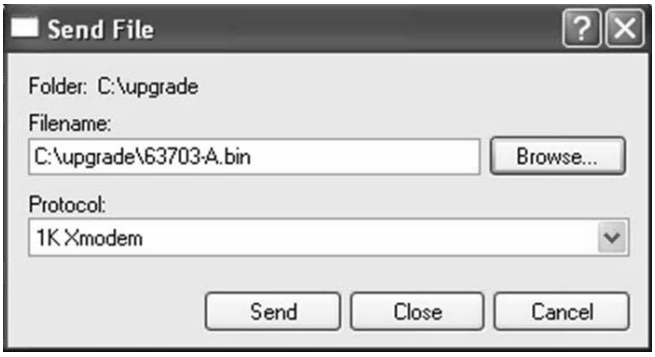


Figure 6.4

Note:

The X in the file name indicates the revision of the released software. For example, "63703-A.bin" is revision A.

6. Under **Protocol**, click the arrow button and select **1K Xmodem** from the list, and then click the **Send** button.

   The dialog box shown in the following figure opens to show the download progress.

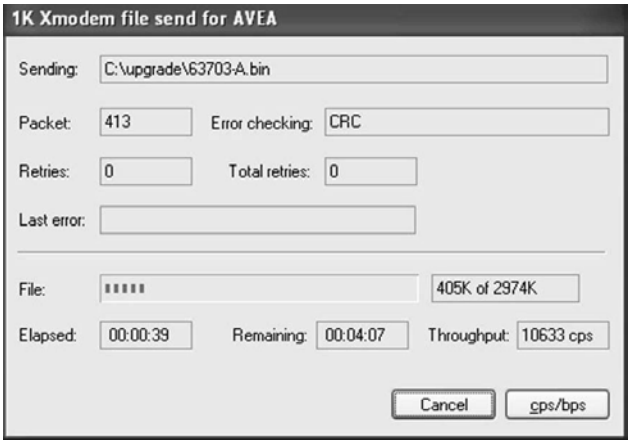


Figure 6.5

A message in the HyperTerminal window indicates when the download process is complete.

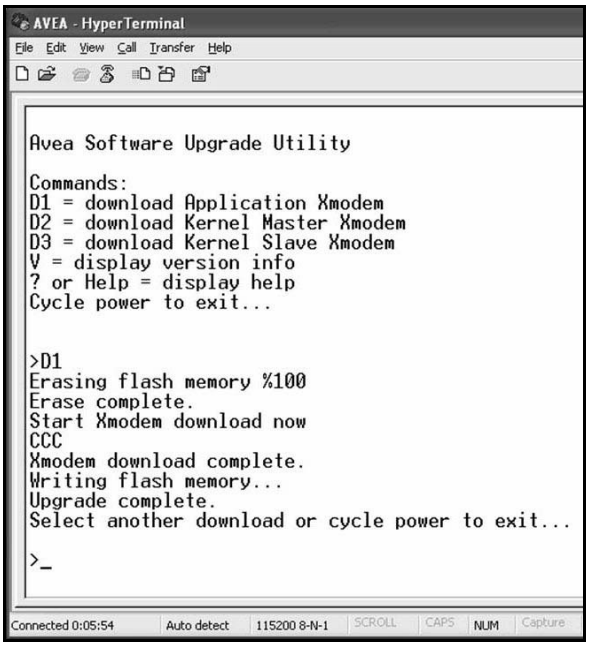


Figure 6.6

7. Type V at the command prompt to view and confirm the downloaded versions.

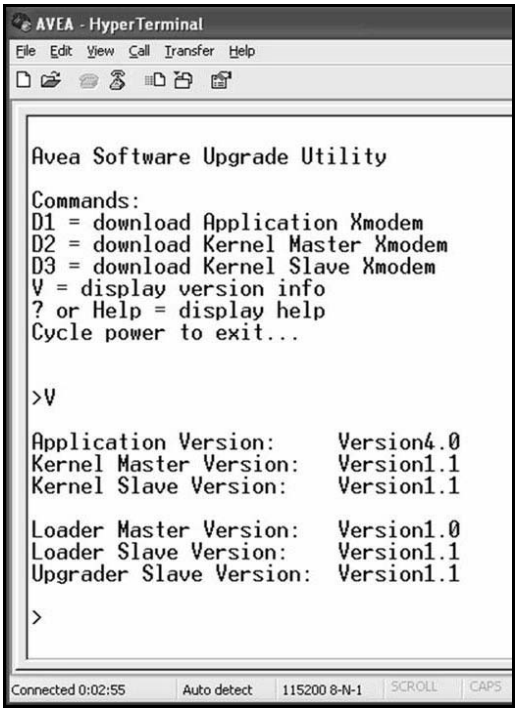


Figure 6.7

ELAN Software Upgrade Instructions

The following directions are for Software Upgrade to the Avea ELAN units. Only ELAN software can be used to upgrade an ELAN UIM. This document provides a brief overview of the procedure to upgrade ventilator software using the RS232 serial port of the Avea. The HyperTerminal utility available within the Windows environment is used here as an example. Any suitable terminal emulation software would work as well.

Requirements

- Computer with a serial port (COM1: or COM2:)
- Terminal Emulation Software (for example, HyperTerminal works well) configured for serial connection 115Kb,8,N,1 flow control OFF (see the instructions below)
- Avea ventilator with Software Upgrade Utility Version 3.0 or higher installed.
- A Serial cable to connect the computer to the serial port of the ventilator.
  (A straight-through cable with null modem adapter or null modem cable with gender changer both work fine).
- New binary files for the ventilator: 63603X.bin (Monitor) and 63602X.bin (Control). "X" indicates the revision of the released software in alphabetic characters e.g. "63603F" is revision F.

  Upgrading software to 3.3 or below:

- Avea ventilator with Software Upgrade Utility Version 1.0 or higher installed.

- New binary files for the ventilator: 63603X.bin (Monitor) and 63602X.bin (Control).

  Upgrading software to version 3.4 or above:

- Avea ventilator with Software Upgrade Utility Version 3.0 or higher installed.
- Binary files for the ventilator target specific language groups.
- Group A (P/N 16402-X.bin (Control) and 16403-X.bin (Monitor):
  - English
  - Francais (French)
  - Deutsch (German)
  - Italiano (Italian)
  - Portugues (Portuguese)
  - Espanol (Spanish)
  - (Chinese)
  - Nederlands (Dutch)

Procedure

1. Copy the files to the desktop

From a CD

With the CD inserted in the computer, copy the new software binary files (see the Requirements section) to the computer hard drive as follows:

1. Double click on “My Computer”.
2. Double click on the CD ROM Drive to open the window and display the files.
3. Right click on each of the files displayed in turn and select Copy, then right click on the computer desktop and select Paste.

   The files should appear on the desktop.

   Remove the CD ROM from the computer drive.

From an e-mail attachment

1. Right click on the e-mail attachment. From the pop-up dialog box select Save As.
2. Browse to your desktop and click Save.

   The files should appear on the desktop.

2. Connect the Avea

1. Connect the serial cable to the computer COM port selected for use (usually Com1 or Com2).
2. Connect the other end to the ventilator serial port 1 shown here.

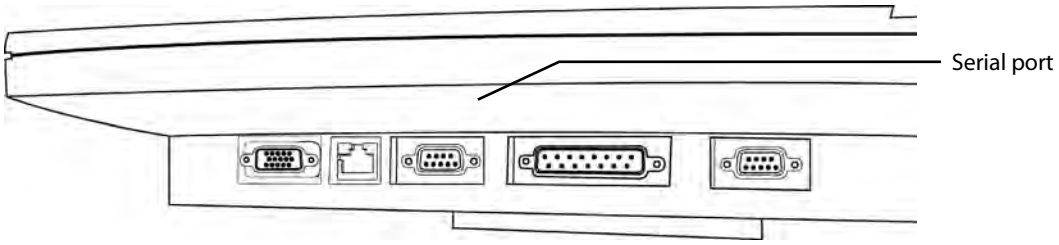


Figure 6.8

3. Open terminal emulation software (HyperTerminal is used here)

Note:

Be aware that the version information and possibly the binary file name may be different for your situation.

1. From your desktop, click the START button at the lower left of the screen.
2. From the pop-up menu, select Programs, then Accessories, then Communications. When the Communications pop-up appears, click Hyper Terminal.

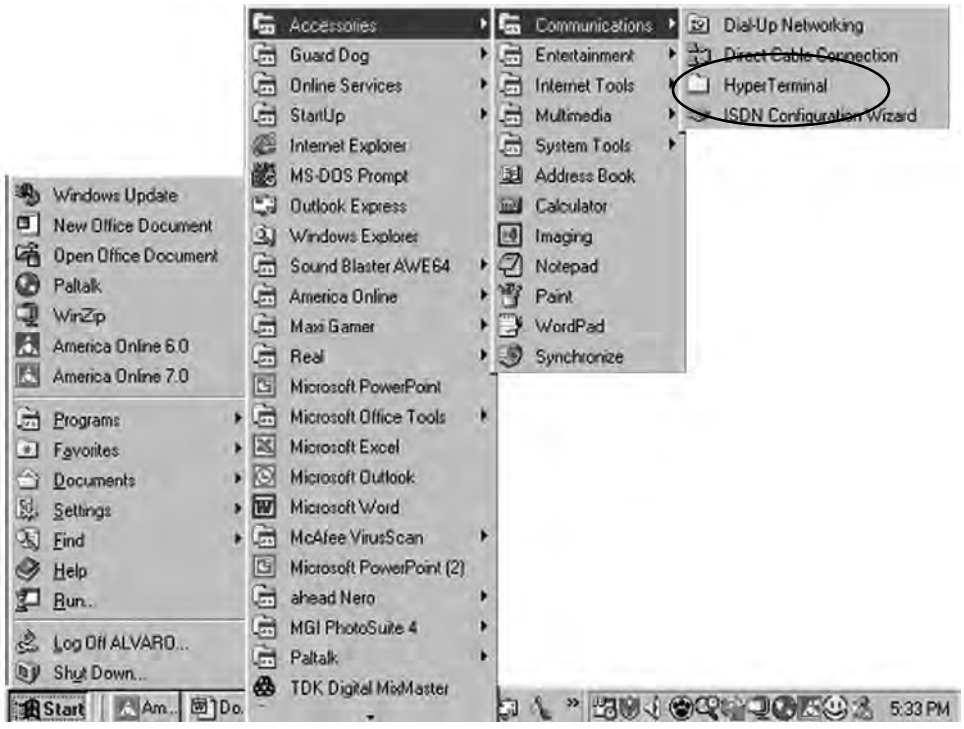


Figure 6.9

3. Double-click the HyperTerminal icon inside the HyperTerminal folder.

   The HyperTerminal window opens in the New Connection window.

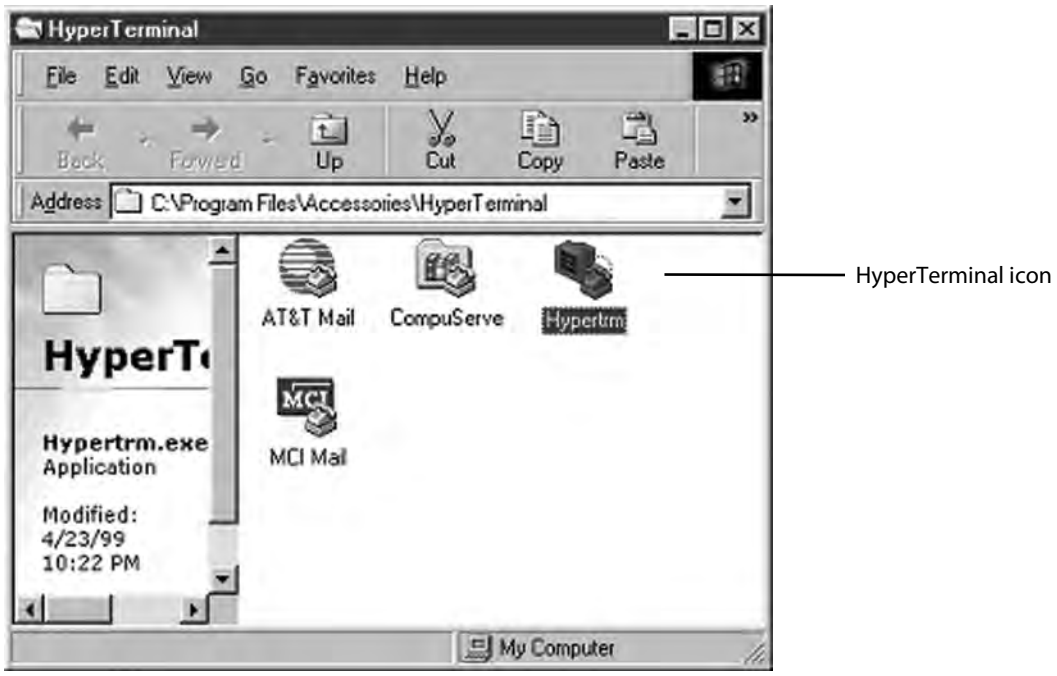


Figure 6.10

4. Type Avea into the Name bar and click OK.

   The Connectivity window opens

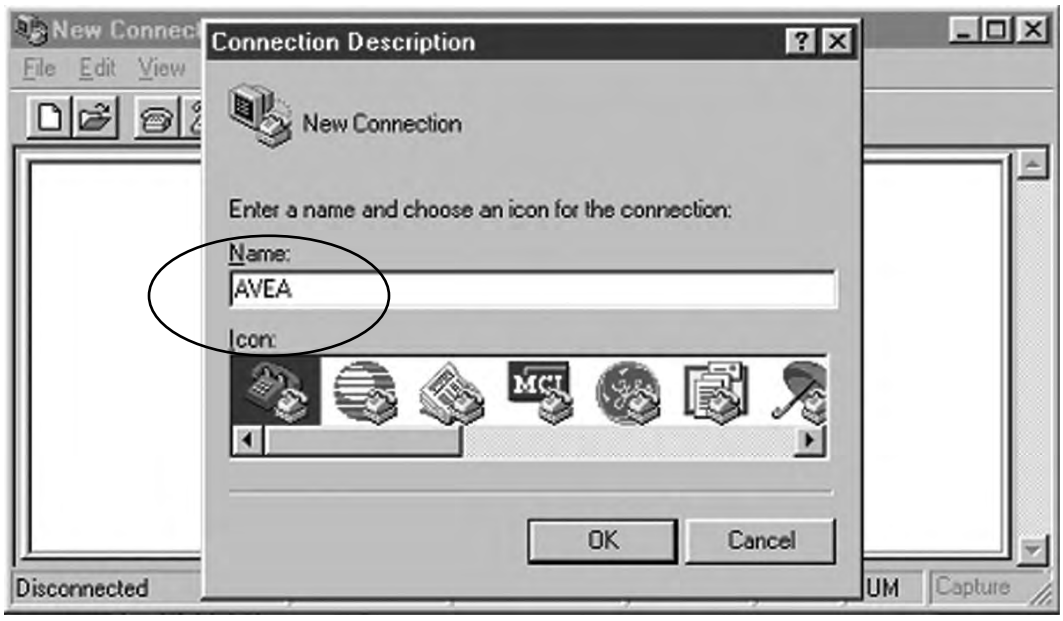


Figure 6.11

5. In the Connect Using box, type Direct to Com1 (or Com2 if that is your computer connection).
   The Port Settings window opens

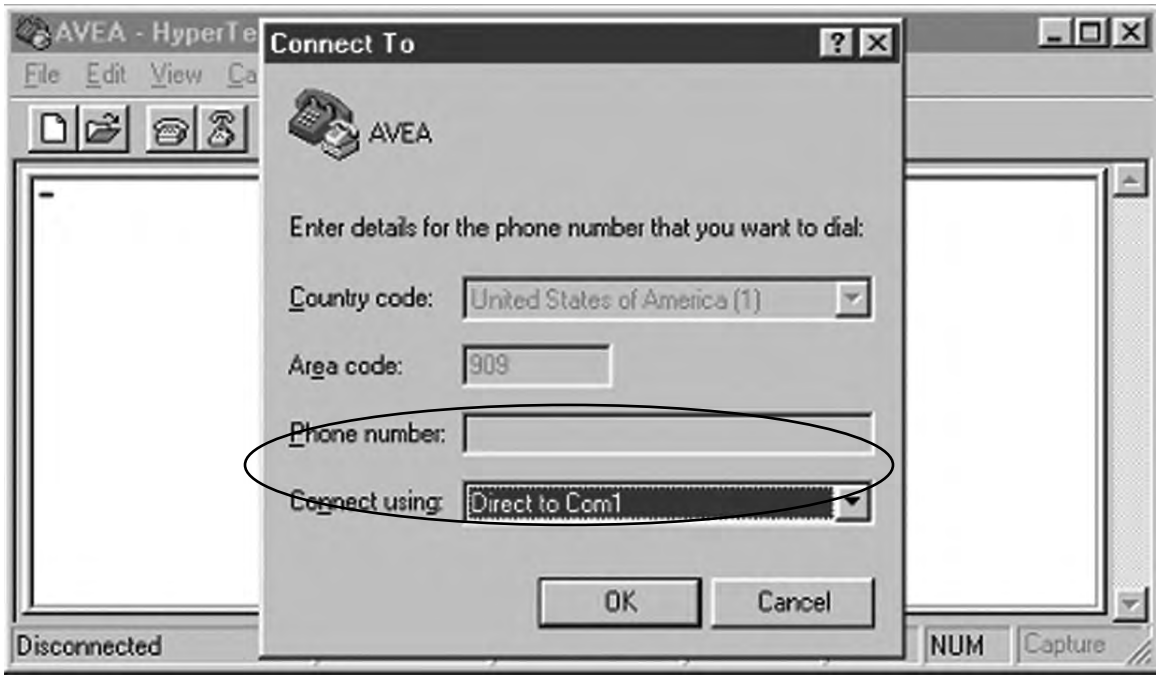


Figure 6.12

6. Enter the following values:

- Bits per second = 115200
- Data bits = 8
- Parity = None
- Stop bits = 1
- Flow control = None

7. Click OK
   The Avea HyperTerminal window opens.

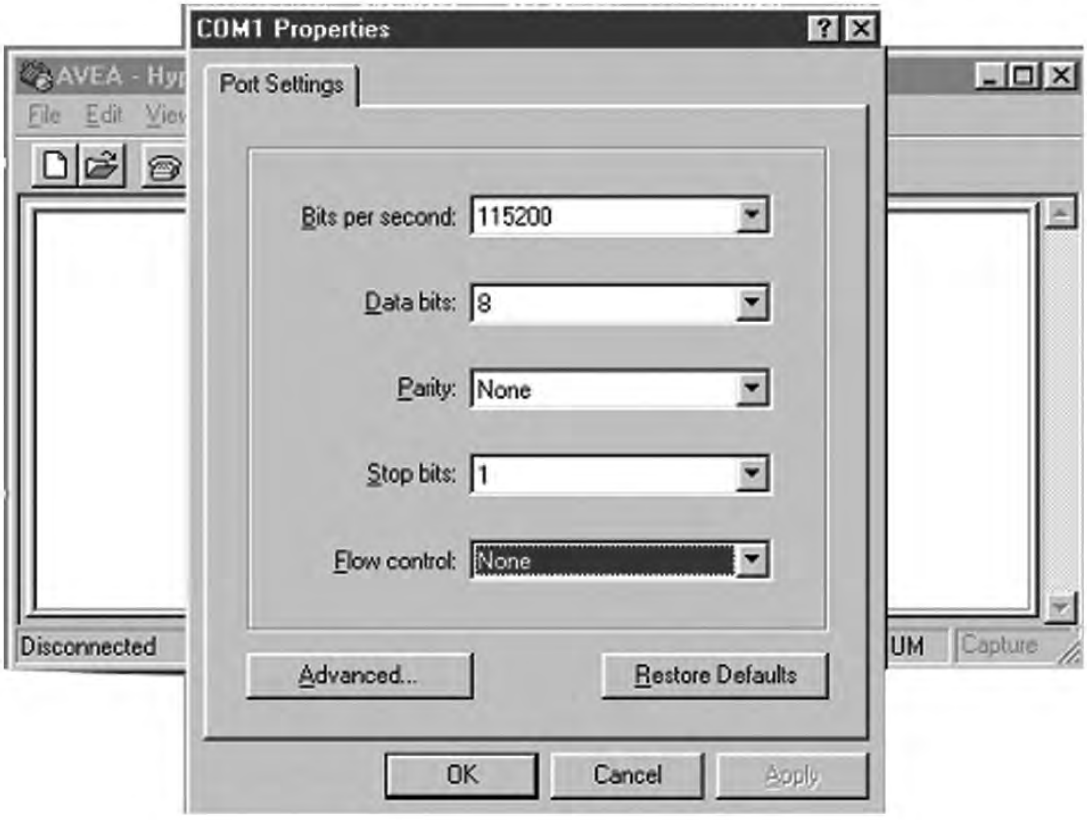


Figure 6.13

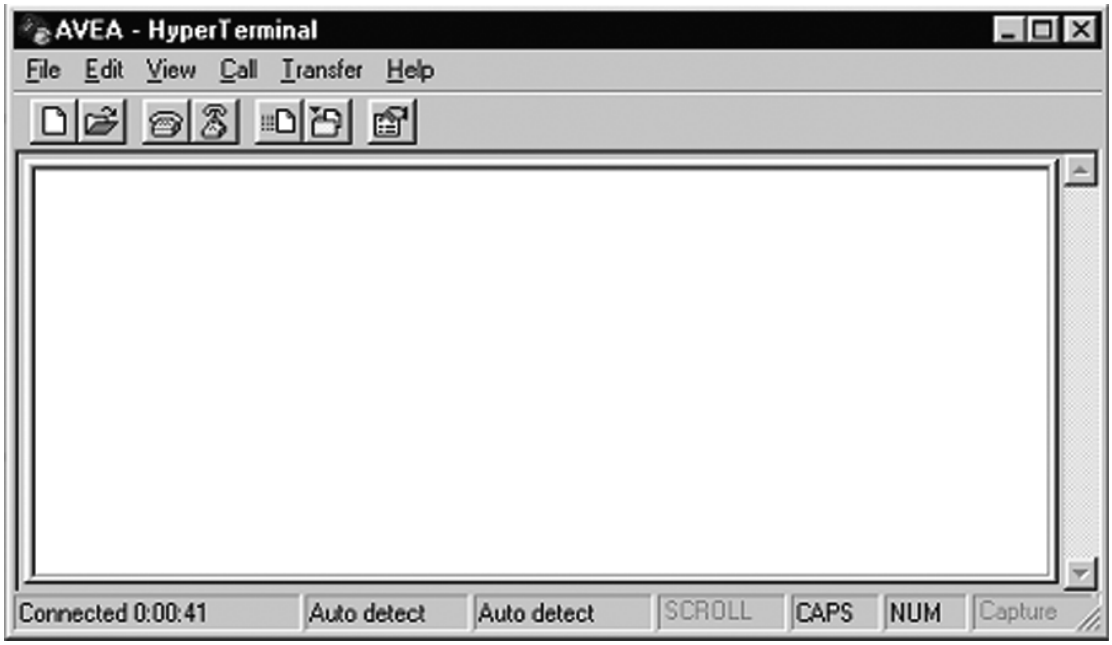


Figure 6.14

4. Power up the Avea

1. Hold down Expiratory Hold key on the front membrane panel of the Avea during the ventilator power-up sequence until the front panel LEDs light up.

   When the LEDs turn off, the Upgrade Utility banner should appear in the terminal software (HyperTerminal) window.

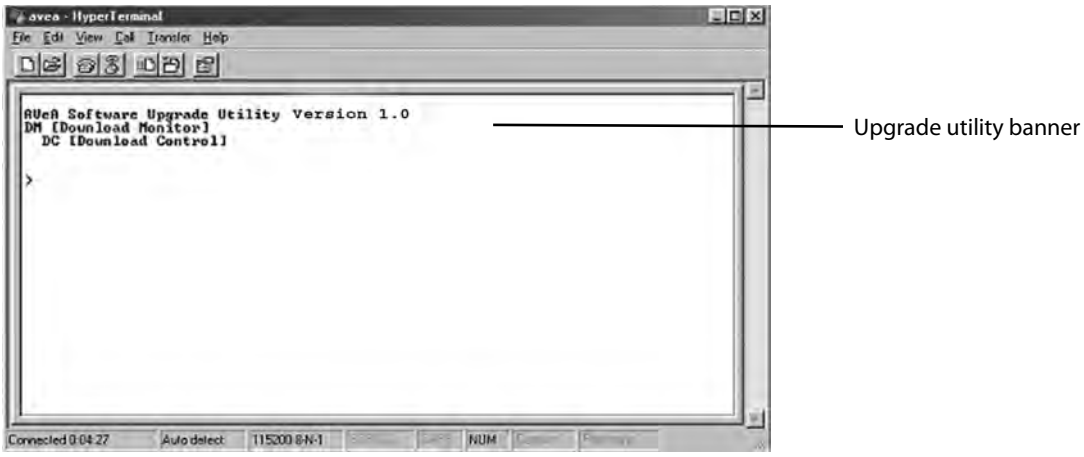


Figure 6.15

The connection is established and ready to transfer the new software.

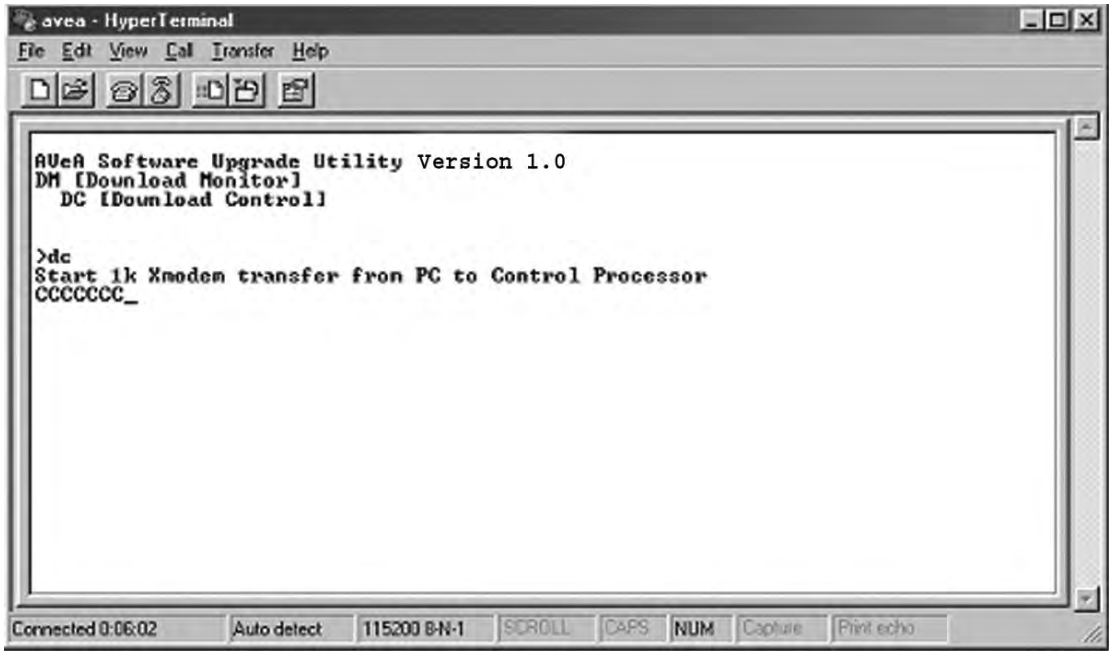


Figure 6.16

2. Type **DC** at the command prompt > and press ENTER to start the download for the Ventilator Control software.
3. From the **Transfer** menu, select **Send File**
4. Ensure the protocol is set to "**1K XMODEM**".

5. Click **Browse** and navigate to the desktop where you saved the binary files.
6. Select the Control file to transfer (e.g. 63568X, bin) and click **Send.**

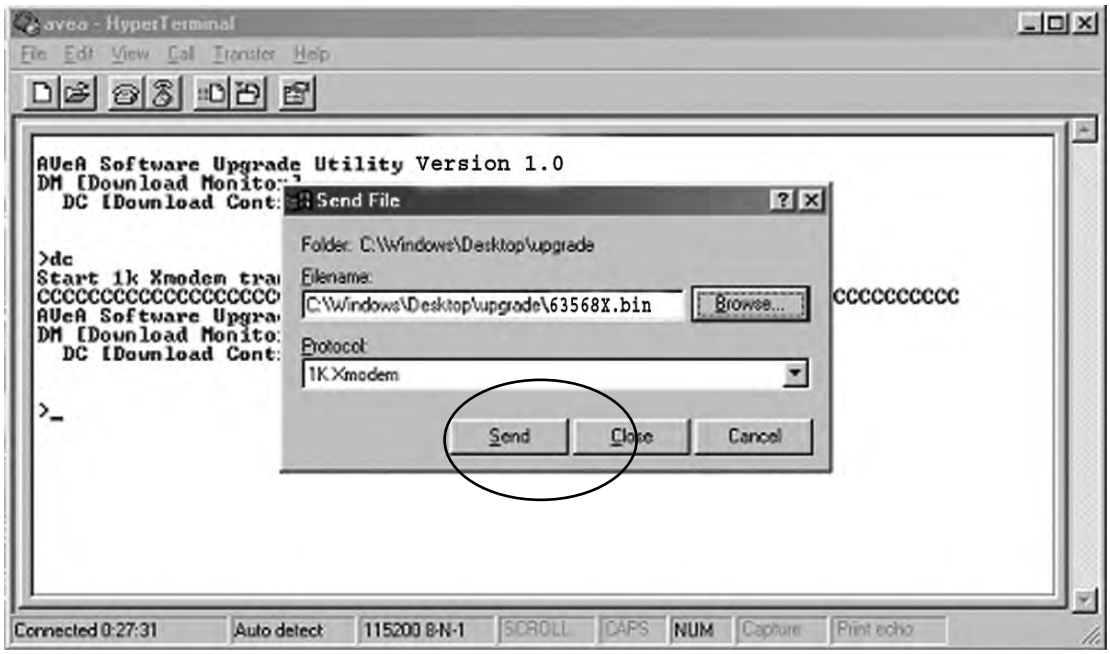


Figure 6.17

The file will begin transferring and should be monitored on the display

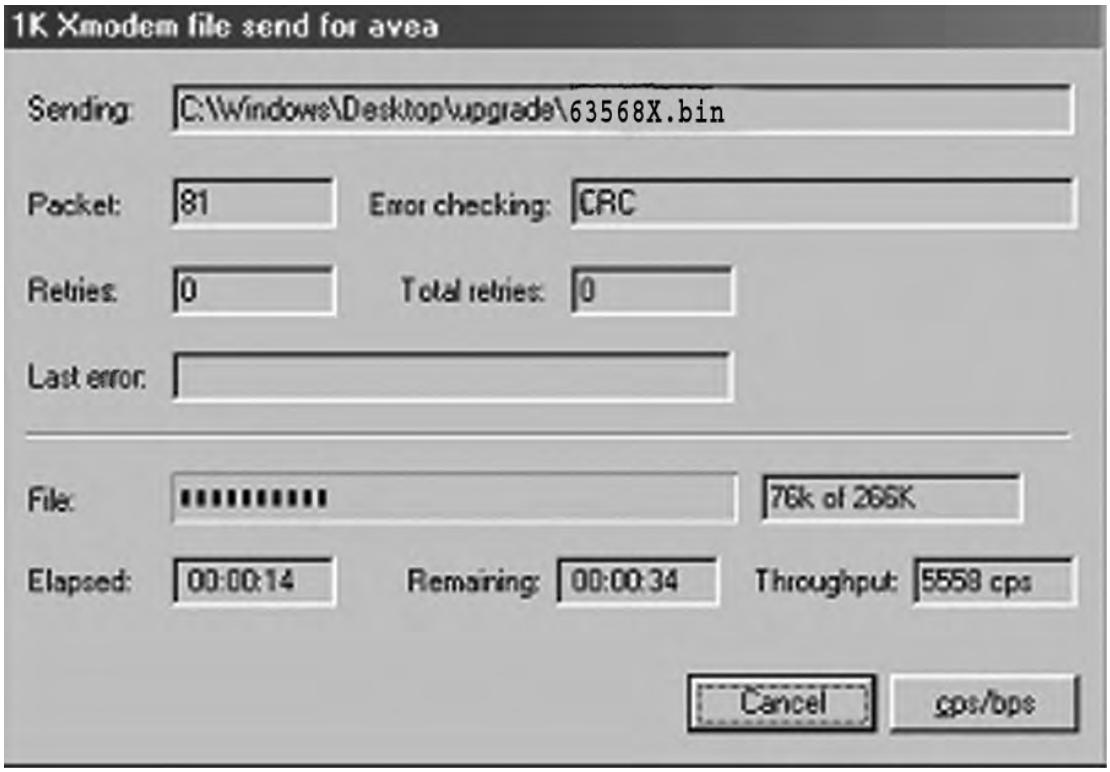


Figure 6.18

A confirmation will be displayed in the terminal window when the file has successfully transferred.

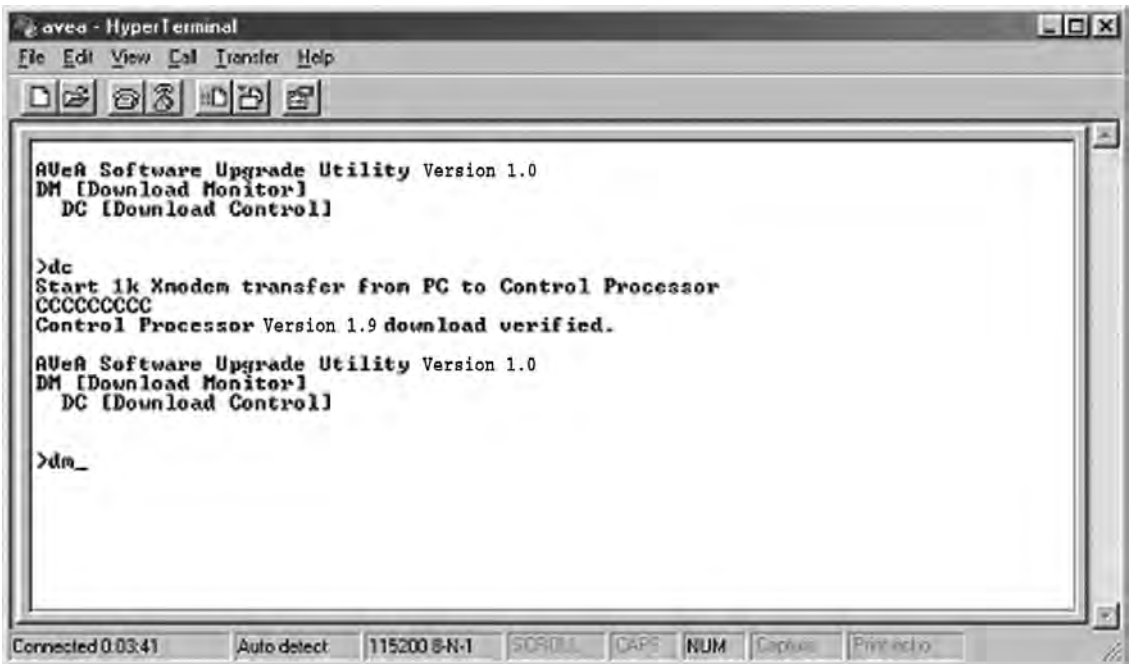


Figure 6.19

7. Repeat the process by typing **DM** at the command prompt and pressing RETURN to start the download for the Ventilator Monitoring software.
8. Select the SendFile command from the Transfer menu
9. Ensure the protocol is set to "1K XMODEM".
10. Select the Monitor file (e.g. 635X.bin) as the file to send for the monitor program.
11. When the transfer is complete, power-down the ventilator and disconnect from PC.

    The upgrade is complete.

Checks

When you turn the Ventilator Back "ON" the Power On Self Tests (POST) will be performed automatically as detailed in the Operator's Manual.

When the MAIN screen displays, you will see the new version displayed on the bottom of the Touch Screen.

Confirm active waveforms are displayed on the MAIN screen.

Complete the checklist for this procedure and return or FAX to:

CareFusion
Technical Support
22745 Savi Ranch Parkway
Yorba Linda, CA 92887
USA
FAX: 1.714.283.8471

IMPORTANT:

The User Verification Tests (i.e. The EST and Manual Alarms Checks) detailed in the operator's manual, should be performed prior to patient connection.

Software Install Verification Avea Ventilators

Date: _____ Model: Standard ☐ Plus ☐ Comprehensive ☐

UIM Serial # _____ Ventilator Serial # _____

Prior Software Version (from MAIN screen) _____

New Software version _____

Installation Verification

Monitor processor _____* verified ☐

Control processor _____* verified ☐

* Insert version indicated by device

Confirmation checks

Ventilator power up and POST ☐

New software version displayed ☐

Waveforms on MAIN screen ☐

Unit is VENT INOP ☐

Signature: _____ Date:_____

Title: _____

Verification and Calibration

1. Once the software has been loaded turn unit OFF.
2. Remove download cable, turn unit ON and verify the following.

- The standard Avea alarm sound during normal power up.
- That the version as labeled on the CD briefly flashes on the bottom of the UIM.
- The RED vent inop indication appears in the upper right hand of the UIM.
- Warning Default Screen appears, Press Continue.
- Patient select screen appears, Press Patient Accept icon.

3. Turn the unit OFF.
4. Power up the unit while holding the set up button.
5. Verify the following:

- The current version of software briefly flashes on the bottom of the UIM.
- The SERVICE FUNCTION screen appears.
- The vent inop alarm appears in YELLOW.
- Pressing the ALARM RESET clears the YELLOW vent inop and is replaced by the solid GREEN bar.

6. Press the OVP icon and verify the following:

- The OVP screen appears.
- All alarms are silenced.

7. Perform a screen calibration as described in the section “Touch Screen Calibration Procedure” on page 131.

Test and Access of the Security System

Note:

The passwords for the calibration, mfg. setup and model number are all based on the serial number of the unit as it is displayed in the service screen. If the serial number of the device is incorrectly stored in memory then the password to change the serial must be acquired from a CareFusion Technical Support Specialist.

1. Access the SERVICE FUNCTION screen as described above and verify the following:

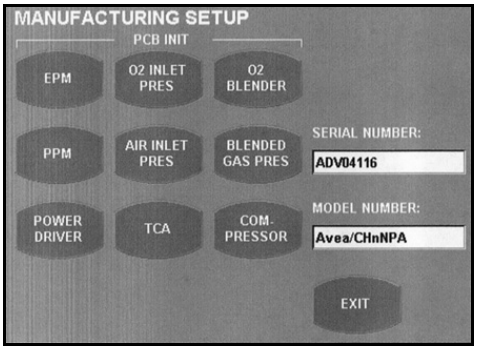
- Press the MFG SETUP icon
- Verify that the serial number as displayed matches the serial number on the back of the unit.
- If the correct serial number is not displayed, note the serial number displayed. Press the "Main" button on the UIM and note Hours Run. This information will be needed to change the serial number of the unit.

2. Contact CareFusion Technical Support for Security Codes

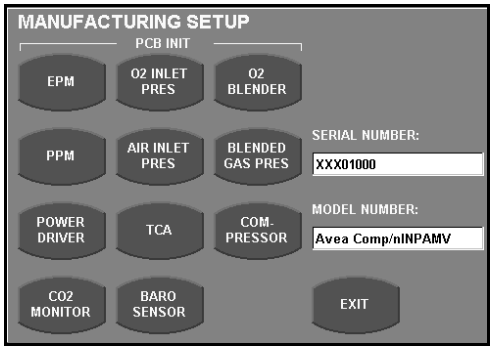
- Dial (800) 328-4139. Follow prompts.
- Give the following details to the Technical Support Person
  - The facility Name.
  - The S/N of the Unit and UIM.
  - The current Configuration of the unit (HELIOX, COMPRESSOR, Pes receptacle, etc).

3. Enter the MFG. SETUP Screen and enter the PASSWORD. Verify and perform the following:

- That the MANUFACTURING SETUP screen appears.
- That the MODEL NUMBER reads INVALID.



ELAN



Coldfire

Figure 6.20 Manufacturing Setup screen

4. Press the MODEL NUMBER window.
5. Enter Model Number PASSWORD and ensure the MODEL NUMBER window now indicates the configuration of the unit.

SERIAL NUMBER matches serial tag on pneumatic module. If the serial number does not match contact a CareFusion Technical Support Specialist.

6. Select each PCB icons and reenter all previously recorded information; REVISION, PART#, LOT # and MFG DATE if available.

Note:

If the PCB INIT information is missing it should be re-entered at this time. Refer to the PCB INIT that you previously recorded prior to installing the Software.

Note:

If the unit is equipped with the EPM PCBA then it must be initializes at this time. To initialize press the EPM icon, press the rectangular white REVISION box and enter the letter A. Press the Month, Day and Year icons entering the current date. (Today's date) Press ACCEPT in the PCB INIT window..

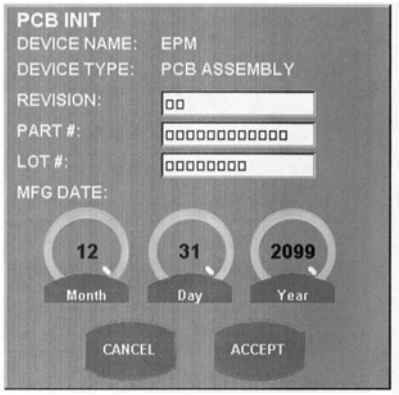


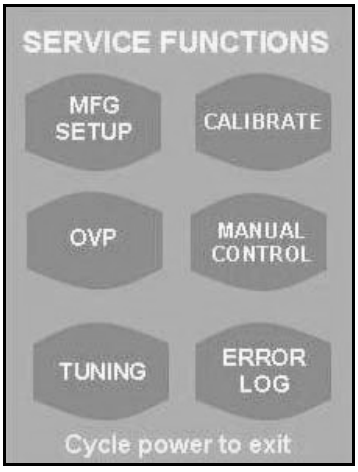
Figure 6.21

Note:

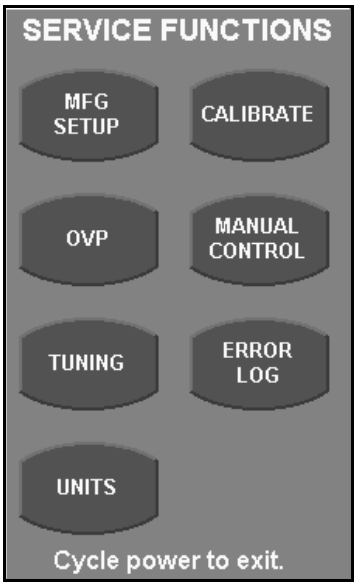
All Verification and Calibration procedures must be completed using wall gas supplies. Do not utilize the internal compressor for this procedure.

7. At the MFG SETUP screen press EXIT

8. On the Service Functions screen, press CALIBRATE, enter the PASSWORD, and press ACCEPT.



ELAN



Coldfire

Figure 6.22 Service Functions screen

Note:

During this procedure you will need to either verify or calibrate the PRESSURE TRANSDUCERS. Ensure all proper test fixture and test devices are available. Each step must be followed to ensure proper verification and/or calibration.

---

9. Press the INSP PRES icon and verify that the stored and A/D information is in the thousands range (EXAMPLE) A/D 2000, Stored: 1500, 2000, 2900 and the message INVALID CALIBRATION does not appear.

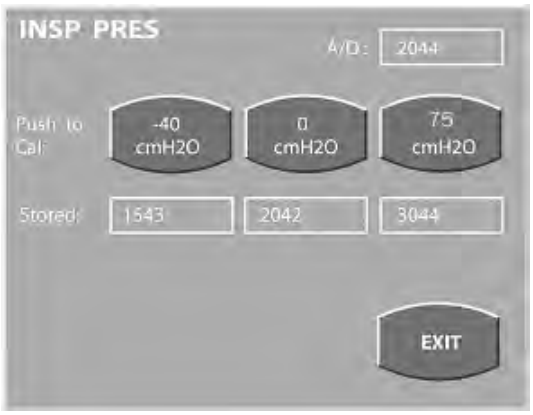


Figure 6.23

Note:

If INVALID CALIBRATION does appear then calibration of the transducer is required.

10. Press EXIT and then Press ESOPH PRES.
11. Verify that the unit is equipped with the Pes receptacle on the front of the unit. If it does not, ignore the INVALID CALIBRATION message; otherwise calibration is required.

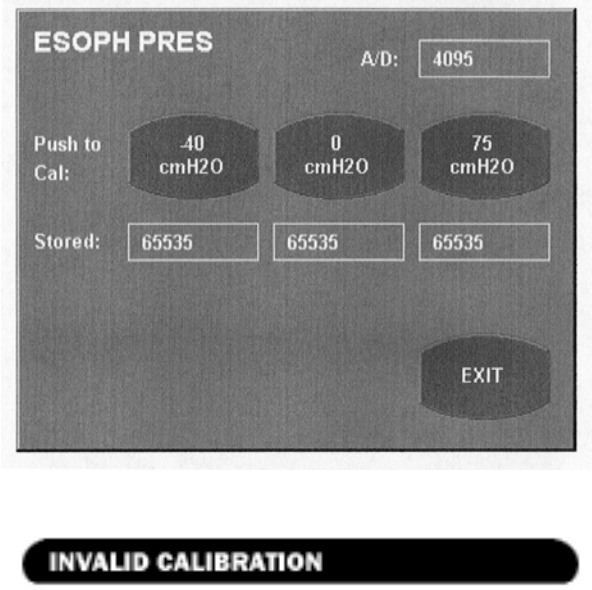


Figure 6.24

12. Press EXIT and perform this procedure for the remaining transducers.

Note:

If calibration is required it should be completed at this point. Refer to the Transducer calibration steps.

Chapter 7 Calibration

Warning!

Service functions should always be done off patient.

Touch Screen Calibration Procedure

Note

The screen calibration will be lost and must be performed under the following circumstances:

- Erasure of the flash memory
- Installation of new software
- Device configuration change

Caution!

SHOULD THE ERASE FLASH BUTTON BE PRESSED, THE INSTRUMENT MUST BE TURNED OFF AND RESTARTED IN THE SERVICE FUNCTION MODE BEFORE RECALIBRATING THE SCREEN. Failure to follow these steps will prevent the instrument from storing the screen calibration.

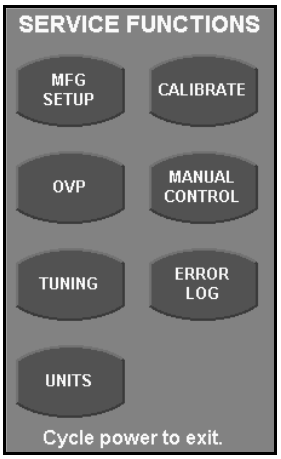
Equipment Needed

PDA Stylus or similar dull pointed instrument.

Procedure

Upload ventilator with software **Version 3.0** or greater.

1. Plug the Avea into a suitable AC power source and depress the setup key while powering up the unit.
2. Select OVP in the Service Functions screen (Figure 7.1).



ELAN Coldfire

Figure 7.1 Service Functions screen

3. Select Touch Screen Calibration button, Figure 7.2 and follow the instructions on the screen.

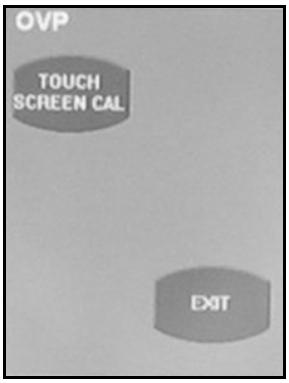


Figure 7.2 OVP Screen

You will be prompted to touch points on the upper left, lower right, and middle of the touch screen with the stylus (see Figure 7.3, Figure 7.3, and Figure 7.4).

4. Using a stylus, touch on or slightly next to each of these points until prompted to go to the next.

Caution!

DO NOT USE YOUR FINGER FOR THIS PROCEDURE. The screen will automatically go back to OVP when complete.

Note:

To ensure greatest touch screen accuracy, always perform the calibration procedure three times.

Figure 7.3 Upper Left Touch Point

Figure 7.4 Upper Right Touch Point

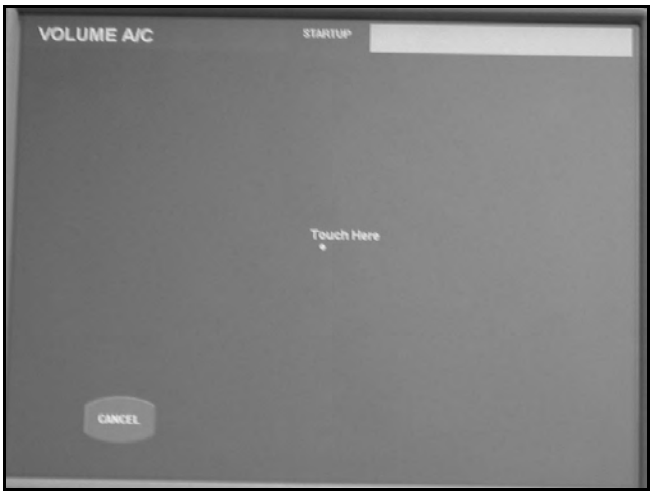


Figure 7.5 Center Touch Point

5. Power unit off and back on and perform the Manual Alarms Testing section of the Avea OVP (L2274) to insure accuracy.

Transducer Calibrations

Avea calibration tool kit P/N 03440 contains the equipment required for calibration, maintenance and software downloads.

The millivolt output of pressure transducers are amplified and conditioned prior to being fed to the Analog to Digital Converter (ADC). On the Avea ventilator, ADC counts are displayed when the ventilator is in the pressure calibration mode. The specific value of the ADC counts are specific to each pressure transducer and will vary with each manufacturer and production lot.

In order to yield the most accurate reading, test equipment and the Avea should be allowed to warm up at least a half an hour prior to calibration.

Pictorial depictions of screens are for example only and do not represent actual numbers/counts required during calibration.

The only notable change with a valid calibration will be a change in the A/D count under the value calibrated.

In the event of an invalid calibration, the Avea will alarm and an "Invalid Calibration" message will appear in the message box at the bottom of the screen.

Equipment Required

The following list of parts and tools is recommended for calibrating the Avea, and they are available in the calibration tool kit, P/N 03440.

Part Number	Description	Quantity
3001083	Catheter assy (8F)	1
51000-40094	Adult wye flow sensor (Vari-Flex, disposable)	2
51000-40096	Connector, AUX port	1
52000-01193	Tube ftg, Tee 1/16 x 1/18 x 1/18 dia	3
32040	Tube ftg 1/8 to 1/16 dia reducer	2
32067	Tube ftg, tee 1/16 x 1/16 x 1/8 dia	1
52000-01205	Luer lock, male 1/16 dia	1
33980	Tubing, poly 12mm OD	1.50ft
52000-00133	Ftg, DISS, air, male ¼ NPT	1
32002	Ftg, fem R/A Elbow 12mm OD	1
52000-00132	Ftg, Oxygen, ¼ NPT x 9/16 male	2
51000-09558	Calibration syringe	1

Calibration setup

The generic setup shown in Figure 7.6 is recommended for calibrating the low-pressure ports of the Avea.

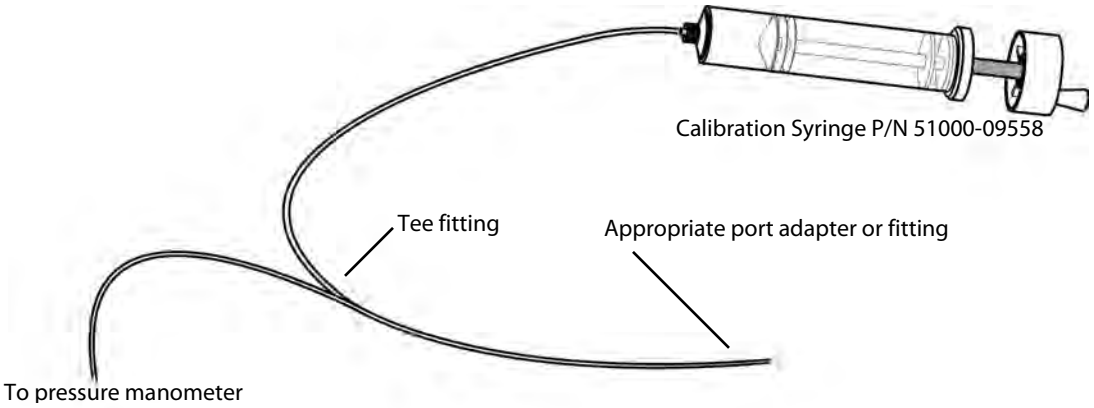


Figure 7.6 Calibration setup #1 for low-pressure gases

To calibration port. The type of connection depends on the port connectivity.

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.

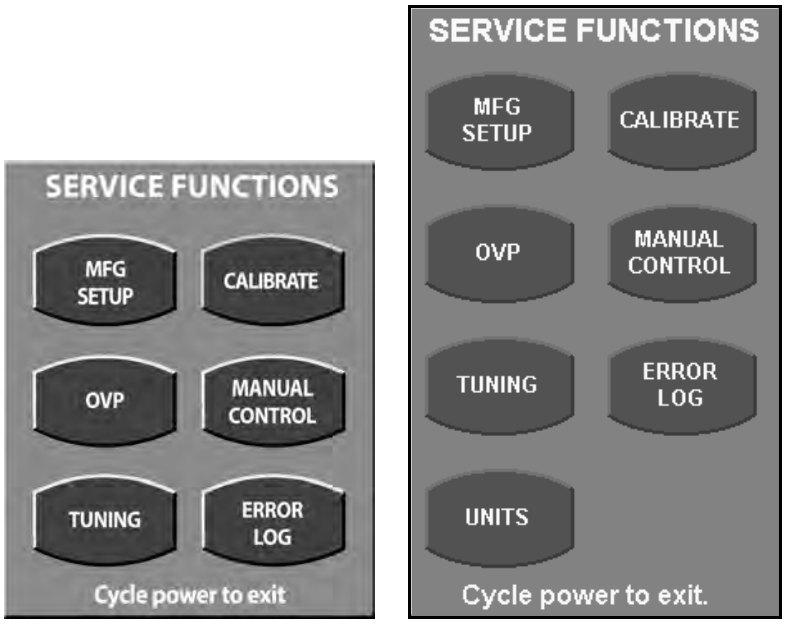
Note:

The transducers available will vary depending on the options enabled in the unit and the type of UIM in use, ELAN or Coldfire.

Accessing the Calibration Screen

To access the calibration screen:

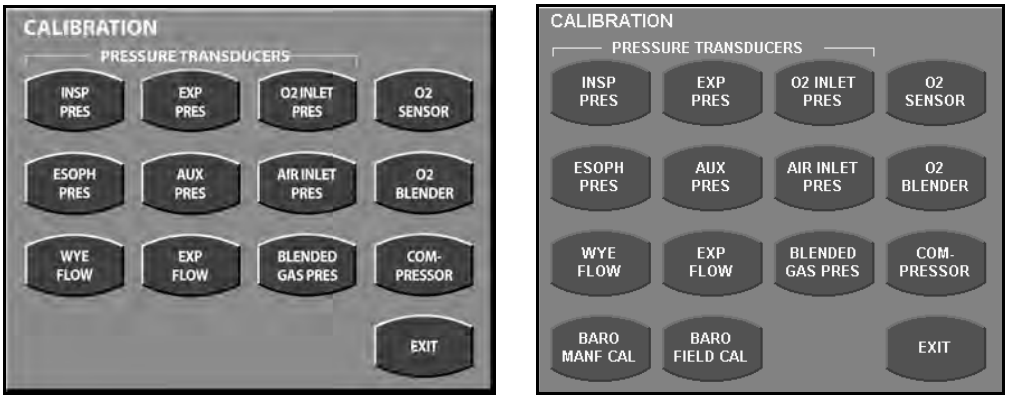
1. When the Service Functions screen appears, press Calibrate and enter password.



ELAN ***Coldfire***

Figure 7.7 Service Functions screen

2. The Calibration menu screen appears.



ELAN ***Coldfire***

Figure 7.8 ELAN Calibration menu screen

Note:

The Calibration screen that appears depends on the type of installed UIM.

Inspiratory Pressure Calibration

1. From the Calibration screen menu, press INSP PRES to access the INSP PRES screen.

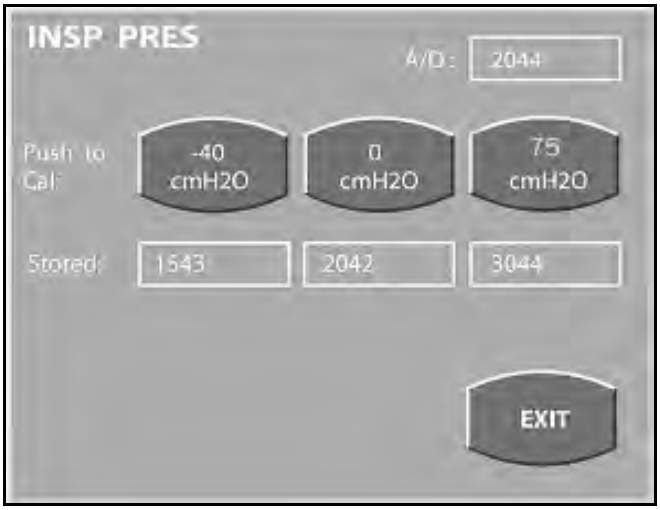


Figure 7.9 *Inspiratory pressure transducer calibration screen*

2. Disconnect the luer fitting and tube from port E4 on the gas delivery engine. See Figure 7.10 and the tubing diagram in appendix B.

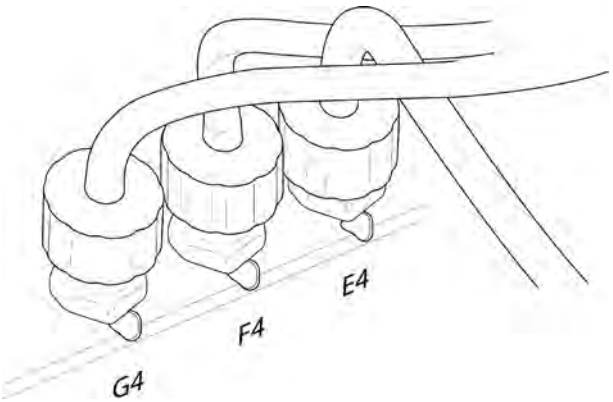


Figure 7.10

3. With NOTHING attached to the port, press the Zero (0) calibration button on the touch screen.
4. Attach the calibration assembly shown in Figure 7.11 to port E4 on the gas delivery engine.
5. Using the calibration syringe; slowly apply negative pressure to the port at E4. (Turn counter clockwise for negative pressure).
6. Refer to the reading on the calibrated Pressure Manometer (model RT200 or equivalent, recommended). When the correct reading of – 40 cmsH_2O is obtained, press the corresponding calibration button on the touch screen.
7. For positive pressure calibration, turn the syringe handle clockwise until the reading matches the 75 cmH_2O number on the touch screen then press the corresponding button.
8. Press EXIT.

9. Disconnect calibration set-up from E4.
10. Reconnect the Luer fitting and tube into port E4 on gas delivery engine.

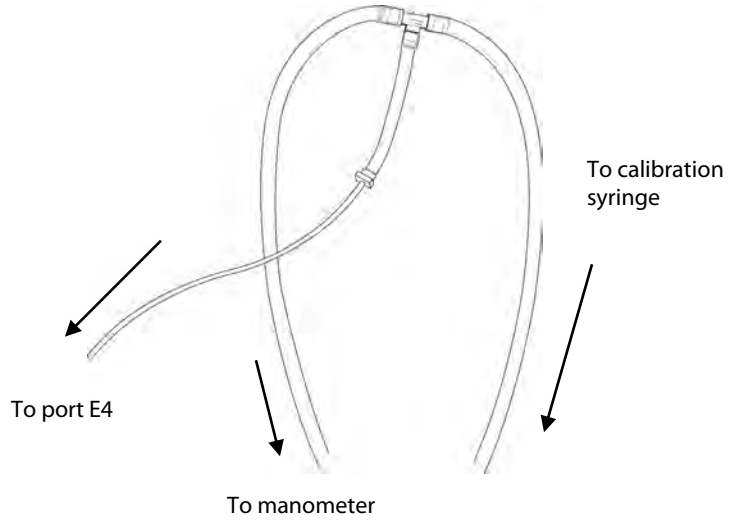


Figure 7.11

Esophageal Pressure Calibration

1. From the Calibration screen menu, press ESOPH PRES to access the esoph pressure transducer calibration screen.

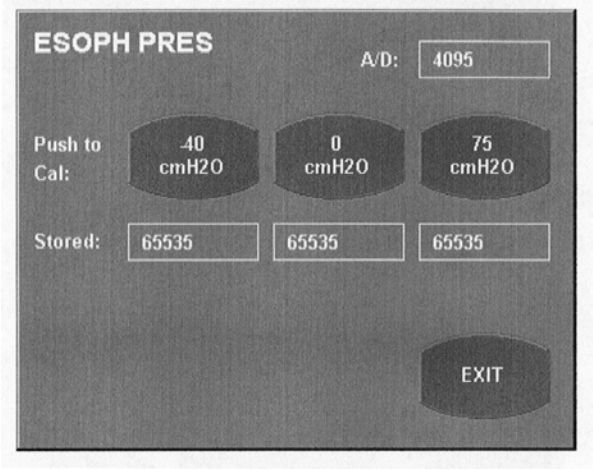


Figure 7.12 Esophageal Pressure Transducer Calibration screen

2. With NOTHING attached to the Pes port on the front panel, press Zero (0) calibration icon on the touch screen.

3. Attach the calibration assembly (Figure 7.13) to the Pes port on the front panel of the unit .

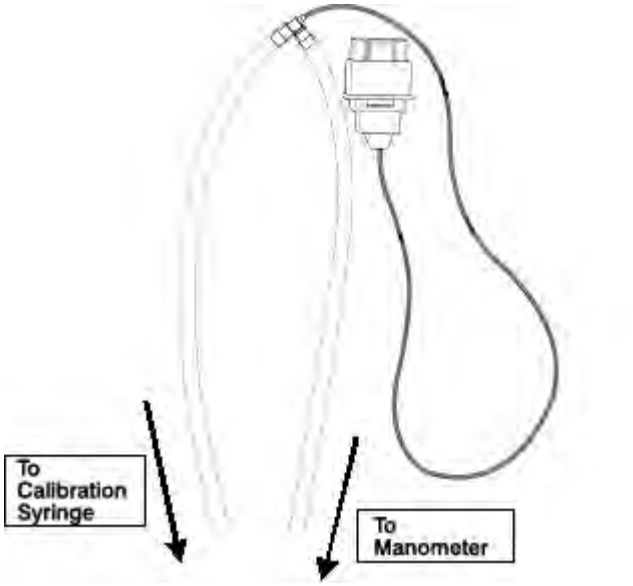


Figure 7.13

4. Using the calibration syringe, slowly apply negative pressure to –40 cmH_2O (turn counter-clockwise for negative pressure).
5. Refer to the reading on the calibrated pressure manometer. When the correct reading of –40 cmH_2O is obtained, press the corresponding icon.
6. For positive pressure, turn the syringe handle clock-wise until a reading of 75 cmH_2O is obtained, press the corresponding icon.
7. Press EXIT.
8. Disconnect the calibration set up from Pes port.

Wye Flow Sensor

1. From the Calibration Screen, press WYE FLOW to access the Wye Flow sensor calibration screen.
2. With nothing attached to the Wye Flow Sensor Port on the front panel, press the zero (0 cmH_2O) button for a zero calibration value.

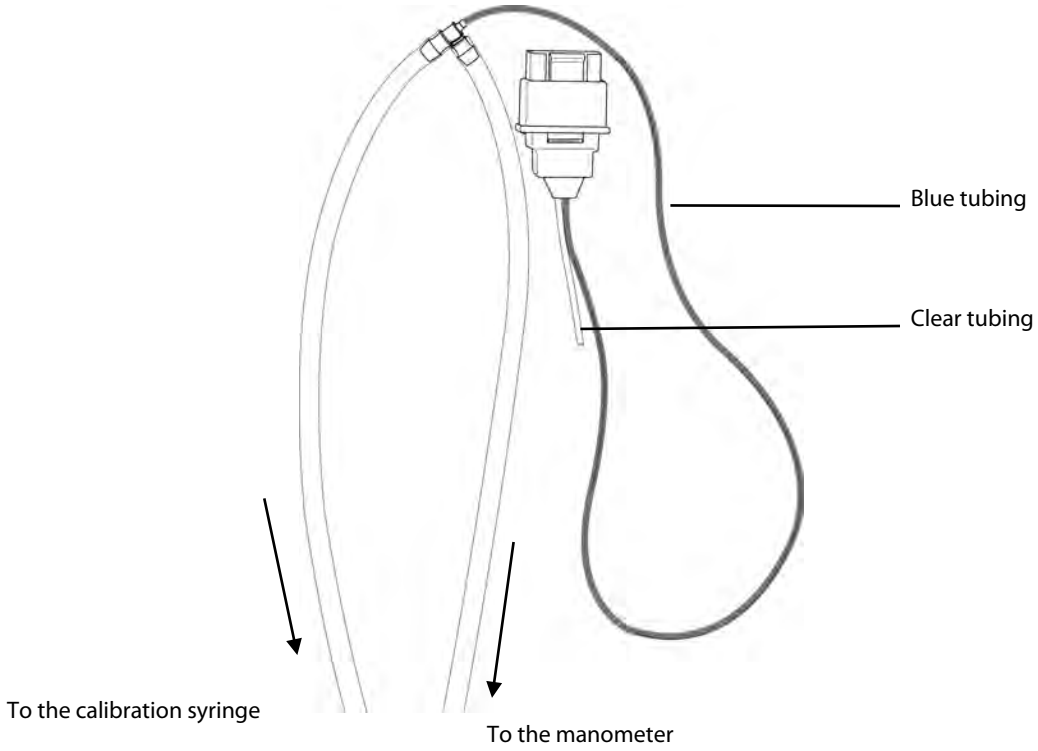


Figure 7.14

3. Attach the calibration set up (Figure 7.14) to the Wye Flow sensor port on the front of the Avea. Attach the *blue tube only* of the Wye flow sensor to the basic calibration tubing assembly using a barbed fitting. Leave the clear tube unattached as shown here
4. Turn the calibration syringe slowly counter clockwise for a negative pressure of only -4 cmH_2O for the negative calibration value and plus 4 cmH_2O for the positive value. Press the appropriate touch screen button when each value is reached to capture and store the value.
5. Press Exit.
6. Disconnect Calibration set up from Wye Flow sensor connector.

Warning!

Apply NO MORE THAN 10 cmH_2O to the port when calibrating this value. Doing so could cause damage to the Avea. If this occurs immediately contact Technical Support for instructions.

Aux Pressure

1. From the Calibration screen menu, press AUX PRES to access the aux pressure transducer calibration screen.

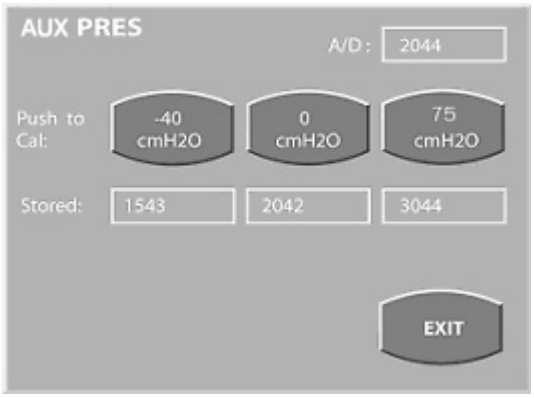


Figure 7.15 Auxiliary Pressure Transducer Calibration screen

2. With NOTHING attached to the Aux port on the front panel of the vent, press Zero (0) calibration icon on the touch screen.
3. Attach the calibration assembly to the Aux port on the front of the unit as in Figure 7.16.
4. Using the calibration syringe, slowly apply negative pressure to –40 cmH_2O (turn counter-clockwise for negative pressure).
5. Refer to the reading on the calibrated pressure manometer. When the correct reading of –40 cmH_2O is obtained, press the corresponding icon.
6. For positive pressure, turn the syringe handle clock-wise until a reading of 75 cmH_2O is obtained, press the corresponding icon.
7. Press EXIT.
8. Remove calibration set up from Aux connector

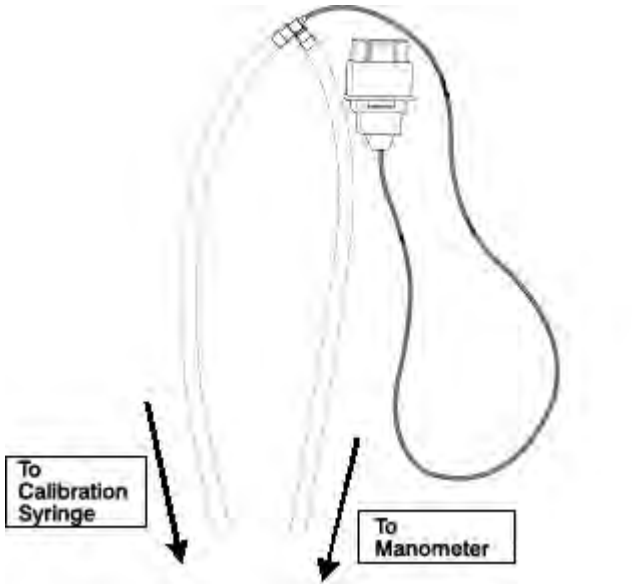


Figure 7.16

Expiratory Pressure

1. From the Calibration Screen, press EXP PRES to access the calibration screen.

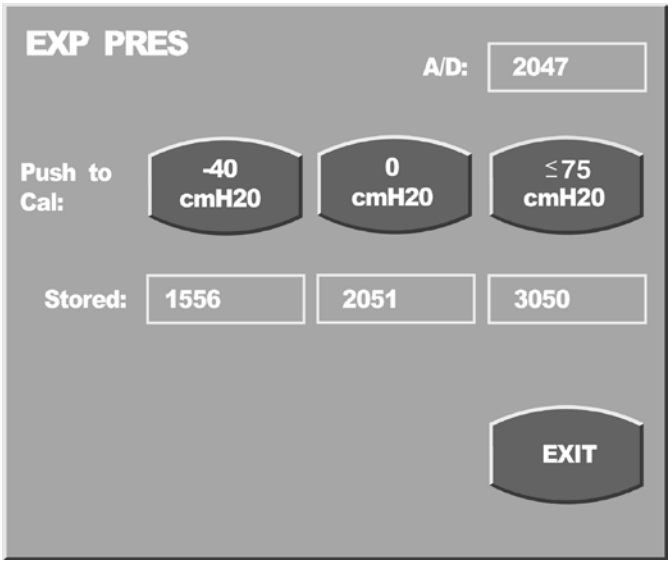


Figure 7.17 *Expiratory Pressure calibration screen*

2. Remove the expiratory flow sensor connector (see Figure 7.19).

Caution!

The expiratory sensor connector has a locking sleeve. Be sure to fully retract the sleeve before attempting to attach the connector. Failure to do so could damage the connector.

---

3. With nothing attached to the expiratory flow sensor port, press the zero (0 cmH_2O) button for a zero calibration value.

4. Attach the calibration set up as in Figure 7.18 to the expiratory flow sensor port located in Figure 7.19.

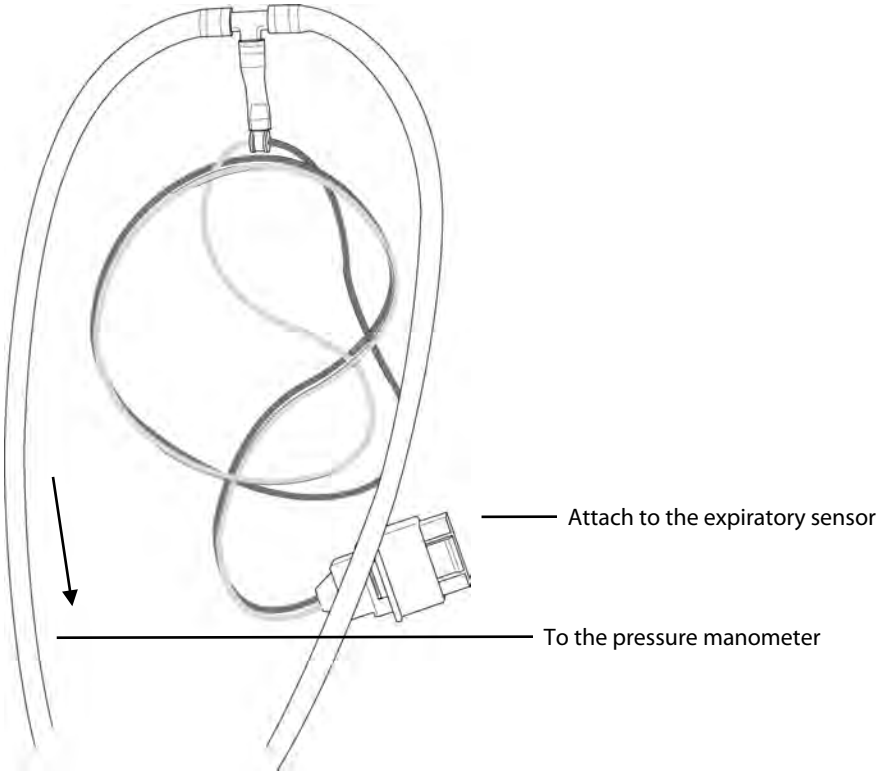


Figure 7.18

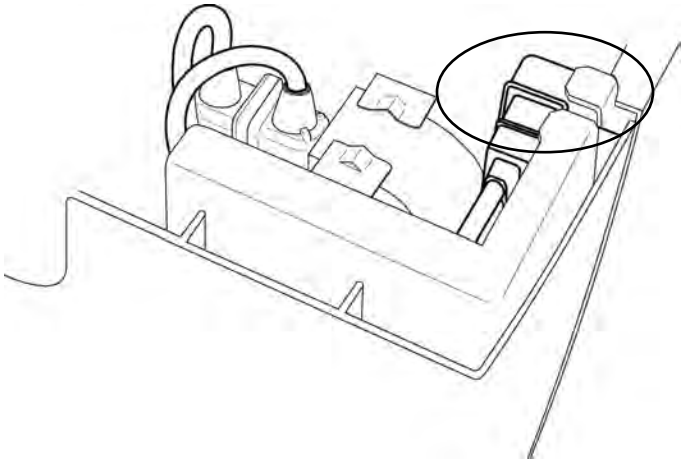


Figure 7.19 *Expiratory Sensor connector location*

5. Turn the calibration syringe slowly counter clockwise for a negative pressure of -40cmH_2O to establish the negative calibration value and plus 75 cmH_2O to establish the positive value. Press the appropriate touch screen button when each value is reached to capture and store the calibration.
6. Press EXIT.
7. Disconnect the calibration set up from the expiratory flow sensor port and reconnect the expiratory flow sensor.

Expiratory Flow

1. Press the EXP FLOW touch screen button to access the screen.

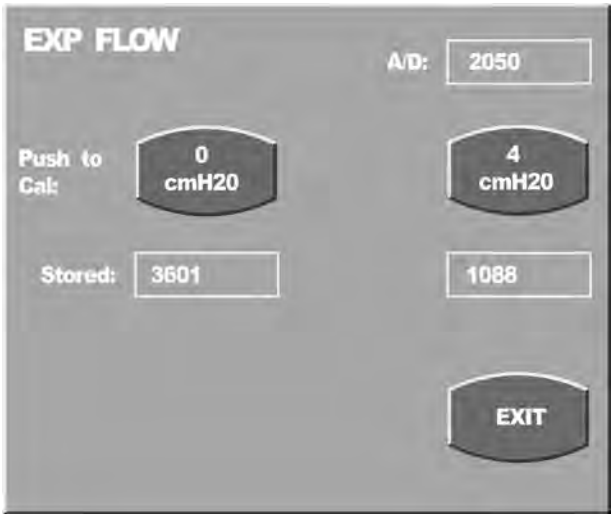


Figure 7.20 *Expiratory Flow Calibration Screen*

2. With nothing attached to the expiratory flow sensor port (Figure 7.19) press the 0 cmH_2O touch screen button.
3. Using the same sensor connector and tubing setup as the wye flow calibration (Figure 7.14), carefully attach the setup to the expiratory flow port as shown in Figure 7.19.
4. Turning the calibration syringe clockwise, apply 4-cmH_2O pos pressure and press the positive pressure touch screen button.

Warning!

Apply NO MORE THAN 10 cmH_2O to the port when calibrating this value. Doing so could cause damage to the Avea. If this occurs immediately contact Technical Support for instructions.

---

5. Press EXIT.
6. Remove Calibration set up and reconnect the expiratory flow sensor.

O_2 inlet pressure

1. Press O_2 INLET PRES from the Calibration screen to access the O_2 Inlet pressure calibration screen.

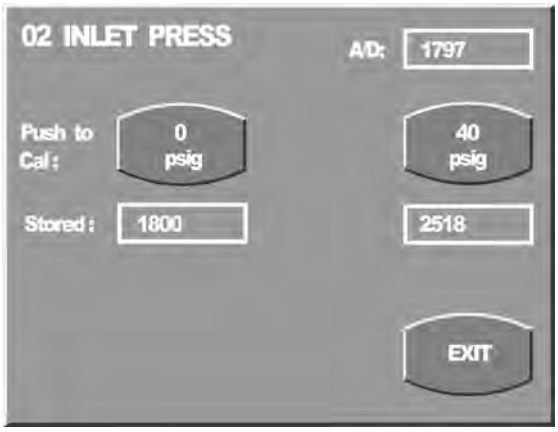


Figure 7.21 *O_2 Inlet Pressure calibration screen*

2. With nothing attached to the O_2 inlet connector on the back of the Avea, press the 0 psig touch screen button.
3. Use a calibrated 0-150 psi regulator, a wall or cylinder supply of medical oxygen, and a "Y" adapter (Figure 7.22). Attach the "Y" adapter to the regulator.

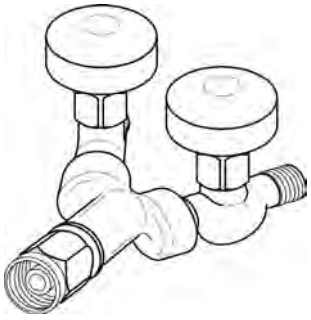


Figure 7.22 Y" high pressure DISS 1290 adapter

4. Attach one arm of the tubing to the manometer and connect the other (with the correct DISS fitting) to the high pressure O_2 inlet on the rear of the instrument shown in Figure 7.23.

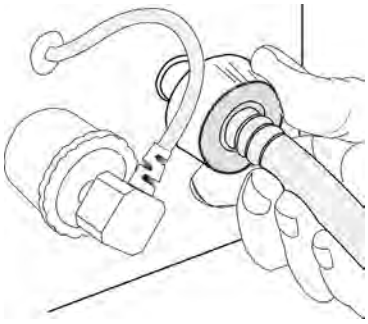


Figure 7.23 O_2 hose connection

5. Apply 40psig (2.76 bar) of pressure and press the corresponding touch screen button to calibrate.
6. Press Exit.
7. Disconnect calibration set up.

Air Inlet Pressure

1. Press the AIR INLET PRES touch screen button from the calibration screen to access the Air Inlet Pressure calibration screen as shown in figure 7.24.

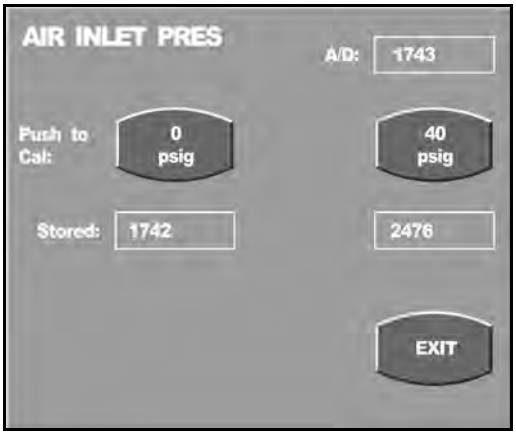


***Figure 7.24** Air Inlet Calibration screen*

2. With nothing connected to the air/blended gas inlet port on the rear of the ventilator, press the 0 psig touch screen button.
3. Attach the air inlet smart connector to the port on the rear of the ventilator, as in Figure 7.25.

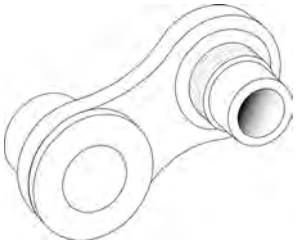


Figure 7.25 *"Smart" Connector*

4. Connect a wall or cylinder supply of medical grade air through a calibrated, 0–150 psi regulator and Y adapter (Figure 7.26) to a manometer and to the high-pressure air/heliox inlet (Figure 7.27) on the rear of the ventilator.

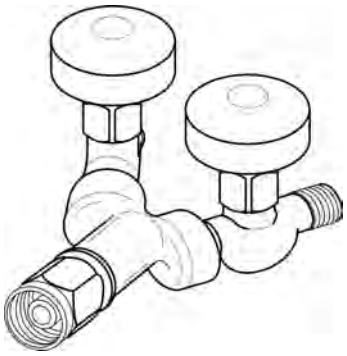


Figure 7.26 *"Y" adapter*

5. Attach the hose from the calibrated regulator on the medical grade air source to the smart connector port and apply 40psi pressure per the in-line manometer. When the correct reading is obtained, press the 40-psig touch screen button on the Air Inlet calibration screen.

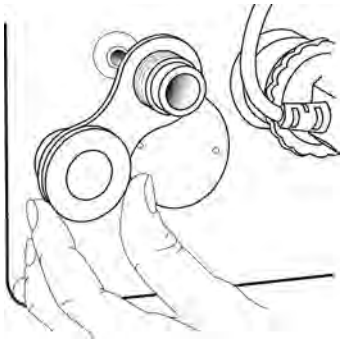


Figure 7.27 *Attaching the smart connector*

6. Press Exit
7. Disconnect calibration set up.

Blended Gas Pressure

1. Press the BLENDED GAS PRES touch screen button from the Calibration screen to access the blended gas pressure calibration screen.

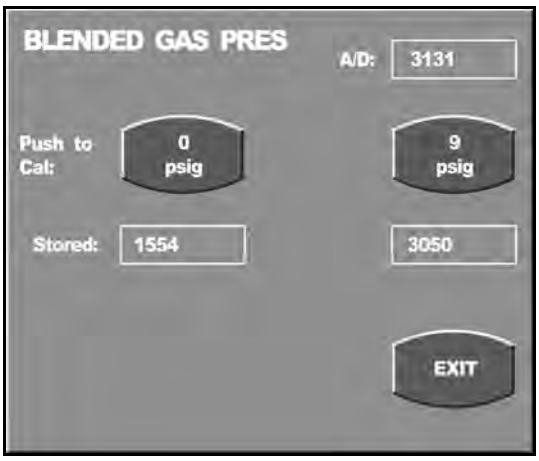


Figure 7.28 *Blended Gas Pressure Screen*

2. On accumulator hose from blender, cut cable tie, and remove metal hose stabilizer.
3. Disconnect compressor output hose.
4. Disconnect output tube from the accumulator output to the blender manifold. Touch the 0 psig icon.

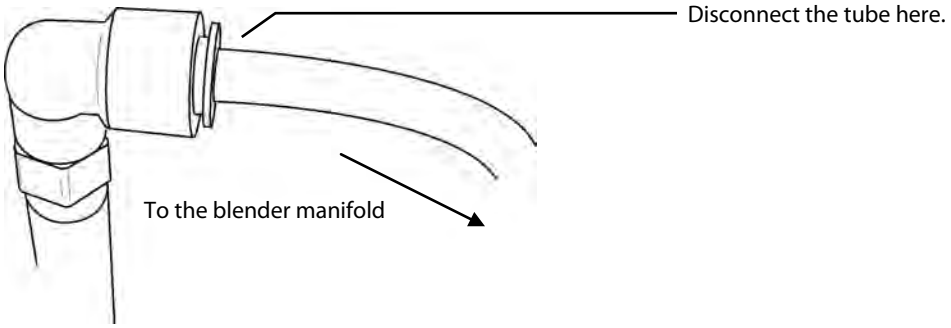


Figure 7.29 Accumulator

5. Attach the special elbow assembly to the accumulator output tubing. Attach a calibrated 0–150 psi regulator connected to the high-pressure gas source and to a manometer.

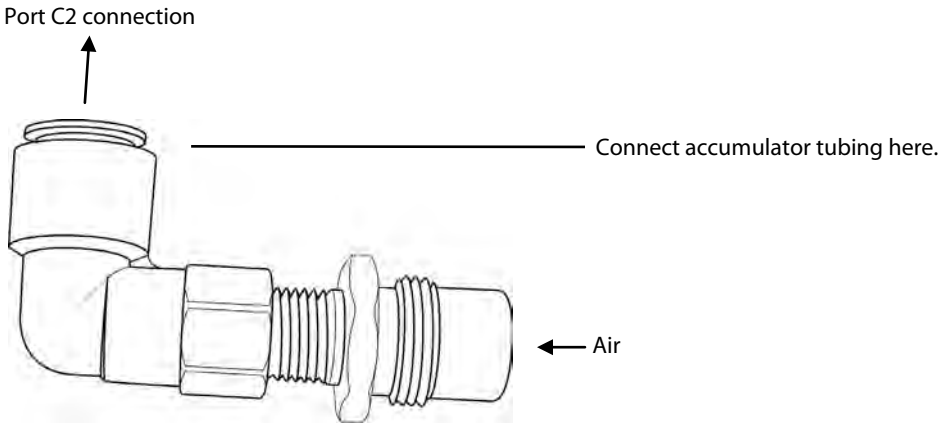


Figure 7.30 Adapter for accumulator tubing

6. Apply 9 psig from the regulator (connected to wall or bottled gas). When the correct reading is obtained on the manometer, press the 9-psig touch screen button.
7. Press EXIT.
8. Disconnect the calibration set up from the accumulator output hose.
9. Reconnect accumulator hose to accumulator output.
10. Attach the metal hose stabilizer and replace cable tie on accumulator hose.
11. Reconnect the compressor output hose.

Flow Valve Characterization Test

Note:
CHARACTERIZATION MUST BE RUN ON 50PSI WALL AIR TO PASS TESTING.

1. Connect a patient circuit and test lung.
2. Press the TUNING icon to access the SYSTEM TUNING screen.
3. After entering the password, select EXERCISE FCV icon (Figure 7.31).
4. Wait at least 10 minutes and then press the CANCEL icon.
5. Disconnect patient circuit and test lung.
6. Press CHARACTERIZE FCV icon and ensure that the message “FCV Characterization in Process” appears in the lower area of the UIM.

This test will run for approximately 30 seconds. After the test, either of the following messages will appear in the message bar in the lower part of the screen: "FCV Characterization Complete" or "FCV Characterization Failed."

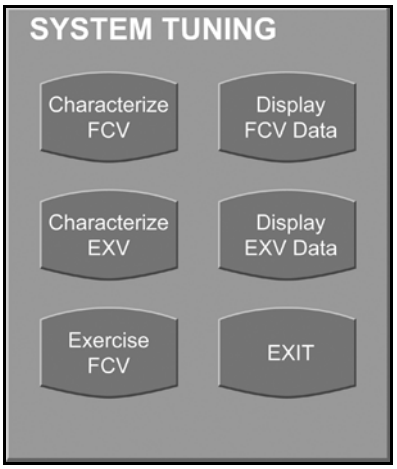


Figure 7.31

If the message reads FCV Characterization Complete the test has passed successfully. If the message reads failed, recharacterization of the FCV will be required.

Note:

After three failed attempts, the GDE will require replacement. Contact the Technical Support department and request a new GDE P/N 16222A. If the GDE is replaced all test and verification to this point will need to be readdressed.

7. Once the FCV Characterization has passed Press Display FCV Data (Figure 7.32).
8. This data is for reference use only and indicate target flow and final flow determined by the software. Press the continue icon.

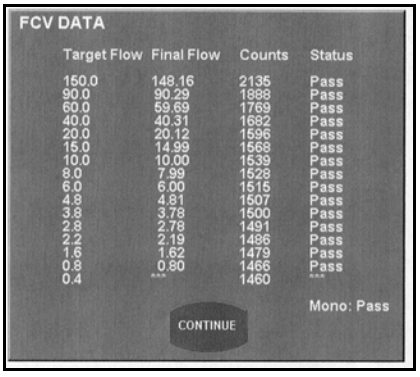


Figure 7.32

Exhalation Valve Characterization Test

Note:

For the following test it is required that the complete filter cartridge with filter and jar are installed into the unit. Characterization must be run on 50 psi wall air and O_2.

1. Connect Exhalation valve characterization tool, P/N 10136, from inspiratory outlet to expiratory outlet.
2. From the SYSTEM TUNING screen Press the Characterization EXV icon.
3. Ensure that the message EXV Characterization in process appears in the lower area of the UIM.
4. This test will run for 3 -5 minutes and the lower area of the UIM will read EXV Characterization complete or EXV Characterization failed.
5. If the message reads" EXV Characterization Complete" the test has passed successfully. If the message reads "failed recharacterization", the exhalation valve needs to have the characterization repeated.

Note:

After 3 failed attempts the Exhalation Valve will require replacement (P/N 16319).

6. Once the EXV Characterization has passed Press Display EXV Data see (Figure 7.33).
7. This data is for reference use only and indicate flow and Slope determined by the software. Press the continue icon.

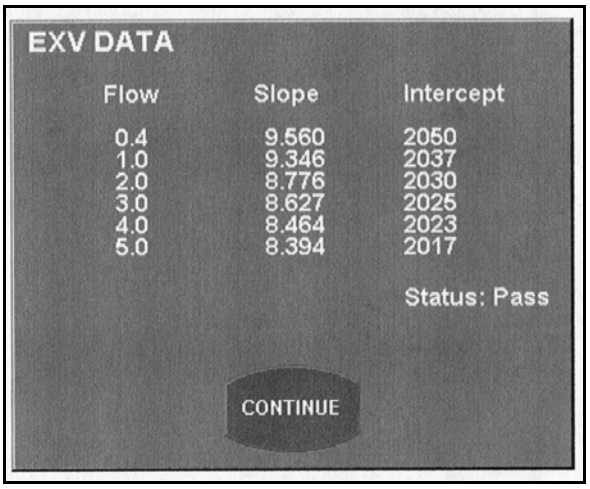


Figure 7.33

Hysteresis Test

Note:

For the following test, the set up is as described in the Exhalation Valve Characterization procedure.

1. Connect the exhalation characterization tool, P/N 10136, from inspiratory outlet to the expiratory outlet.
2. Touch the OVP icon.
3. Touch the EX VALVE TEST icon, and then the Continue icon (Figure 7.34).

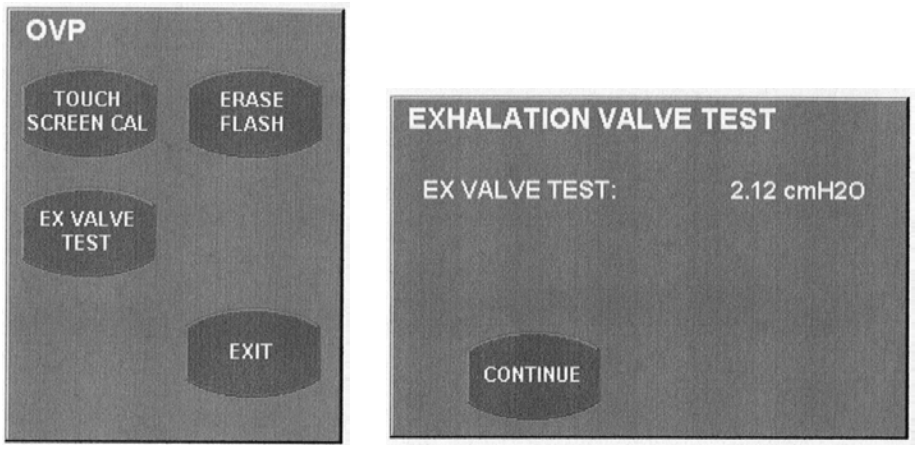


Figure 7.34

4. The test may run for up to 5 minutes.
5. The measured hysteresis must be between 1.5 cmH_2O and 4.5 cmH_2O, record the value.
6. Repeat procedure 3 times. Compare the values from each test and the maximum variation from any reading shall be no more than 0.6 cmH_2O

Note:

If the exhalation valve does not pass this test, it will require replacement.

Exhalation Valve Leak Test

1. Turn the unit OFF.
2. Attach breathing circuit and test lung to unit.
3. Turn unit ON and verify the following:

- Audible alarm sounds
- SAFETY VALVE OPEN appears in the upper right of the UIM.
- PATIENT SELECT screen appears.

4. Press PATIENT ACCEPT icon and verify the following

- The unit begins to deliver breaths.
- Alarm at the upper right goes to YELLOW.

5. Press ALARM RESET button.
6. Set the unit as follows:

- Mode Volume A/C Adult
- Breath Rate 4
- PEEP 30
- Volume at 0.50
- Peak Flow at 20
- Press ADV SETTINGS button
- Press Flow Trigger
- Set Bias Flow to .4
- Press ADV SETTINGS

7. Observe the PAW wave form and allow the unit to cycle several times. Ensure there is no auto cycle
8. Press the Freeze button and scroll cursor across the blue exhalation portion of the waveform.
9. During the exhalation phase the PEEP level must be stable and + 3.5% or 2 cm through out the expiratory phase

Air-O_2 Regulator Differential Balance Calibration

1. Set unit to CPAP Mode.
2. Set Blender FIO_2% to 60.
3. Attach Differential Pressure Test Gauge to Regulator Test Ports A4 and B4 at front of Gas Delivery Engine (GDE). Refer to Figure 7.35 below.
4. Apply 50 psi air and oxygen supplies to unit. Note: Air pressure will be indicated by High
5. Pressure Gauge and should be 11 psi (the actual air pressure reading is not critical to differential pressure calibration).
6. Air-Oxygen Regulator pressure differential will be displayed by the Differential Pressure Test Gauge. This reading should be 0 + 2 cmH_2O.
7. To adjust Air-Oxygen Regulator pressure differential, locate O_2 Relay Adjustment Screw on the top of the O_2 Relay. Note: Access to this adjustment is through a hole in the TCA PCBA (the circuit board is mounted component side down on the top of the GDE).

Note:

Early versions of the GDE will require the removal of a plug on the top of the O_2 Relay, and the installation of the Oxygen Regulator Adjustment Tool, p/n 51000-08258.

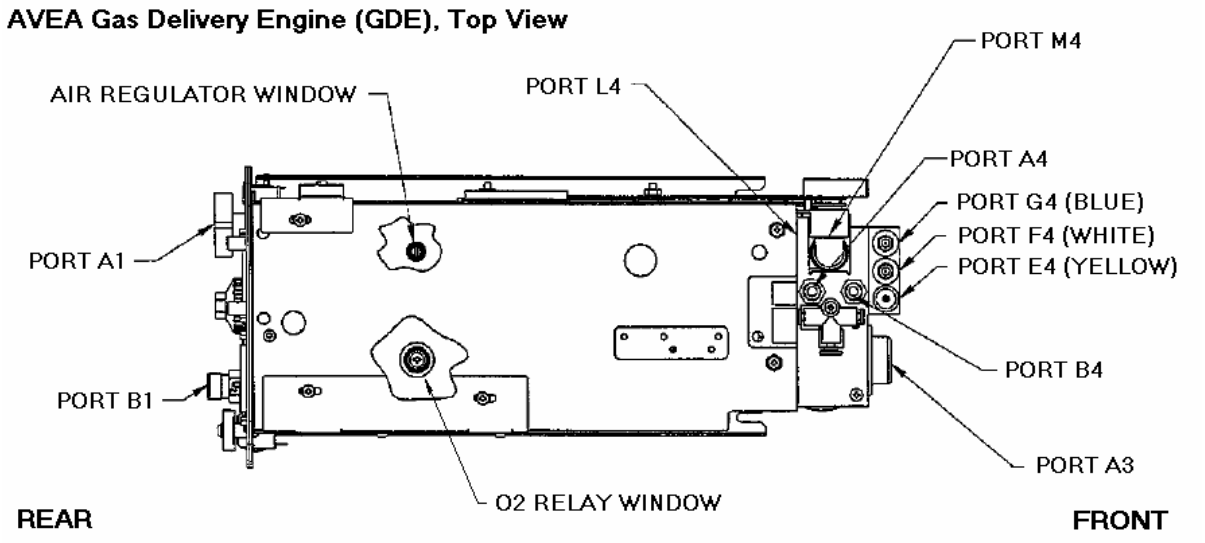


Figure 7.35

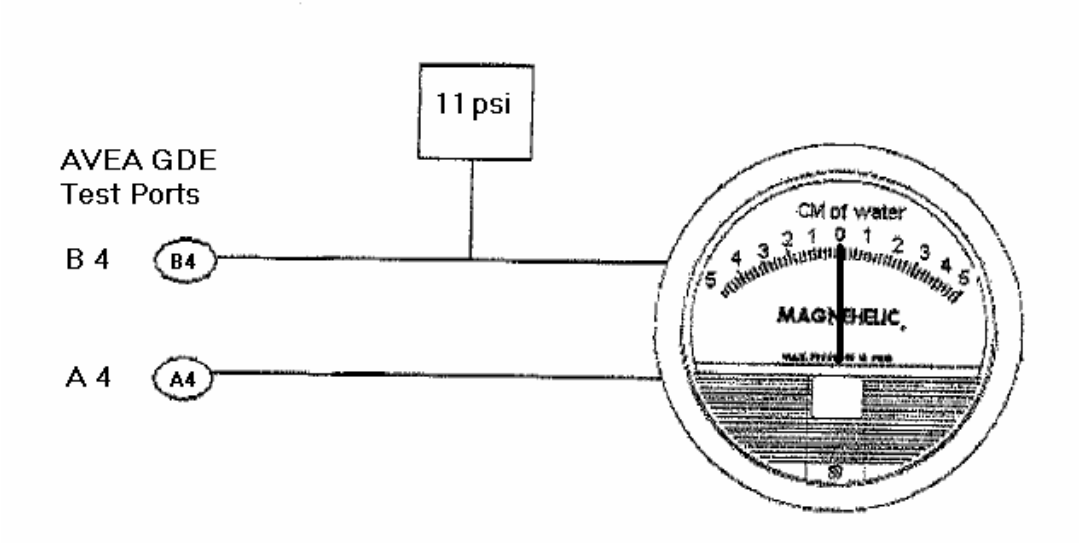


Figure 7.36

CO_2 Calibration Procedure

1. Attach end of the CO_2 sensor cable to the $ETCO_2$ connection on the bottom of the Avea UIM.
2. Attach the CO_2 sensor to the appropriate airway adaptor.
3. Access the Capnography Utilities by depressing the Screens soft button, select the Utility Screen and select the Monitoring tab.
4. Follow the procedure for zeroing the CAPNOSTAT® 5. Press Continue when the procedure is complete.
5. Press Calibration Check and then Continue.
6. Set the Temperature setting to that of the calibration gas (typically room temperature). See Figure 7.37.

Figure 7.37

7. Attach a regulated flowing gas mixture of 5% CO_2 (± 0.03%) balance nitrogen (N2) to the airway adapter. Set the flow rate of the calibration gas to 2 – 5 liters per minute.
8. Allow 10 seconds for the reading to stabilize. The expected reading is 5% ± 0.26%
9. Press Exit

Note:
The procedure is to be performed annually.

Note:
While the Calibration Check routine is in process, all CO_2 alarms are suspended. The alarms will resume when the procedure is complete.

Manufacture Barometric Calibration

Note:
This calibration MUST be done with an absolute pressure meter. Serum Datum 2207 or similar certified absolute pressure meter recommended.

1. Reinitialize EEPROM as per directions in this chapter.
2. Go to the calibration screen and enter the password. The following screen will appear.

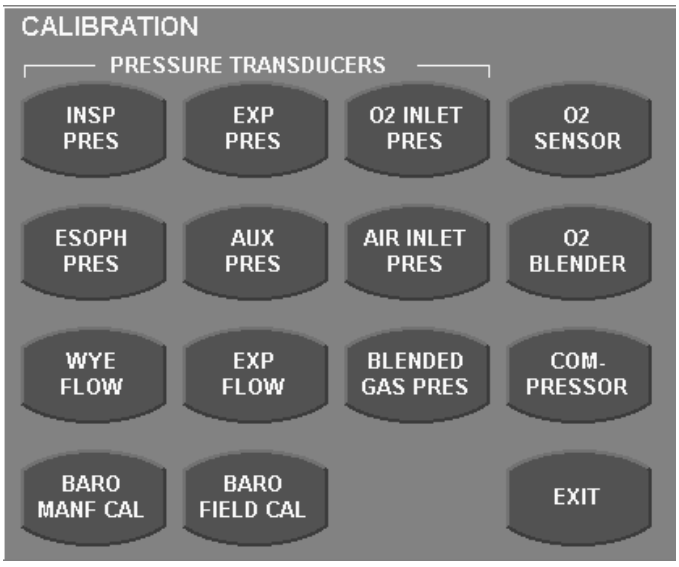


Figure 7.38 Calibration screen

3. From the Calibration Screen, press the Baro Manf Cal icon to access barometric pressure screen.

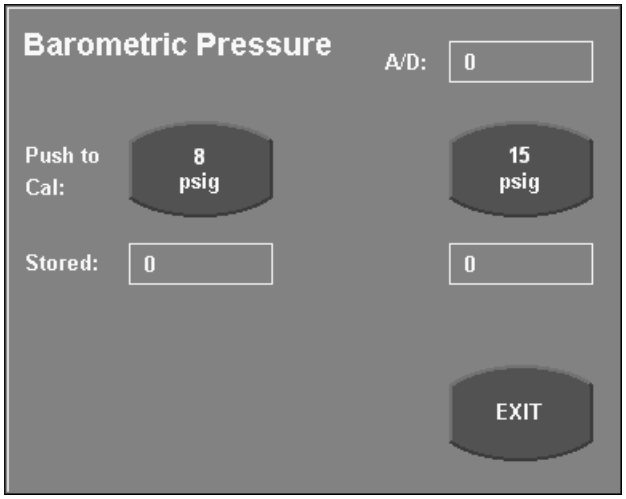


Figure 7.39 Barometric Pressure screen

4. Attach calibration assembly to Barometric Sensor Port on bottom of UIM using P/N 769288..

Figure 7.40 Barometric sensor port on the UIM

5. Using the calibration syringe, apply 8 psi to the port, refer to reading on calibrated Pressure Manometer, when it measures 8 psi, press the corresponding icon
6. Apply 15 psi to the port according to the Pressure Manometer, press the corresponding icon.
7. Press Exit
8. Disconnect calibration set up from Barometric Sensor Port.

Caution!

Remove P/N 769288 carefully from port to prevent connector from breaking off inside the barometric port and causing damage to the Avea.

Field Barometric Calibration

1. From Calibration Screen, press the Field Baro Cal icon to access Field Calibration screen..

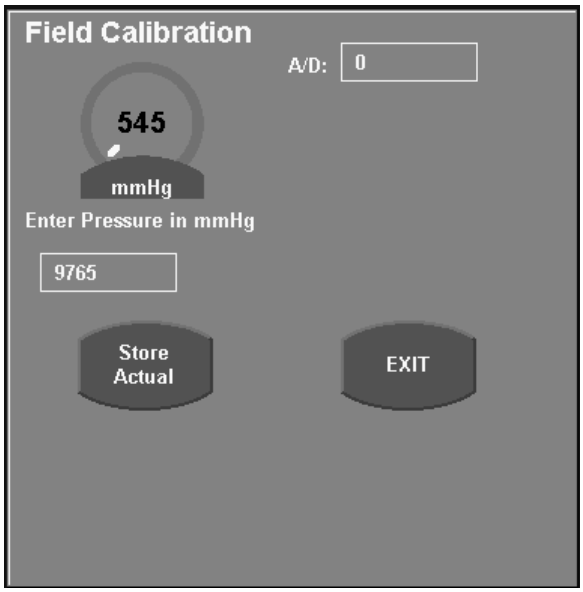


Figure 7.41 Field Calibration screen

2. With a calibrated Pressure Monitor (PF 300 recommended) measure actual barometric pressure.
3. Touch the Pressure Icon and turn data dial until value matches value on Pressure Meter and press Store Actual icon.
4. Press Exit

Change Measurement Units

1. Enter service mode and press the Units icon.

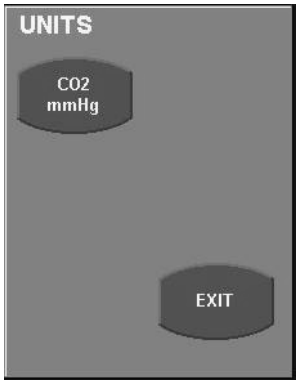


Figure 7.42

2. Press CO_2/mmHg icon to change to kPa or kPA to change to CO_2/mmHG
3. Press exit

Reinitialize EEPROM

1. Go to MFG screen and enter password. Figure 7.43 will appear.

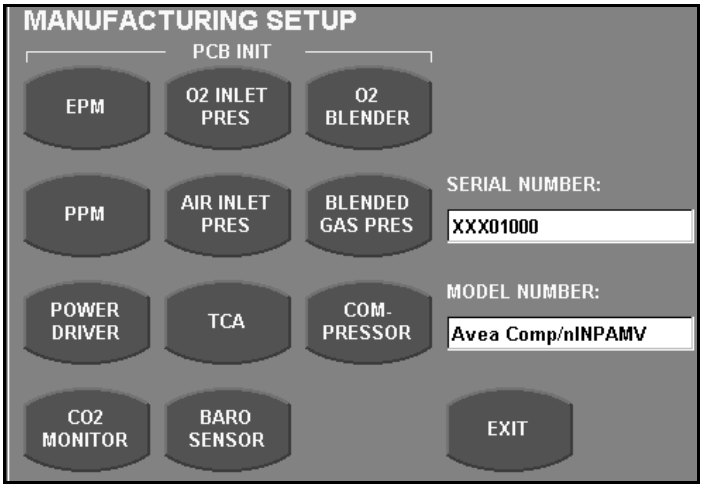


Figure 7.43

2. Press Baro Sensor Icon and the following screen will appear.

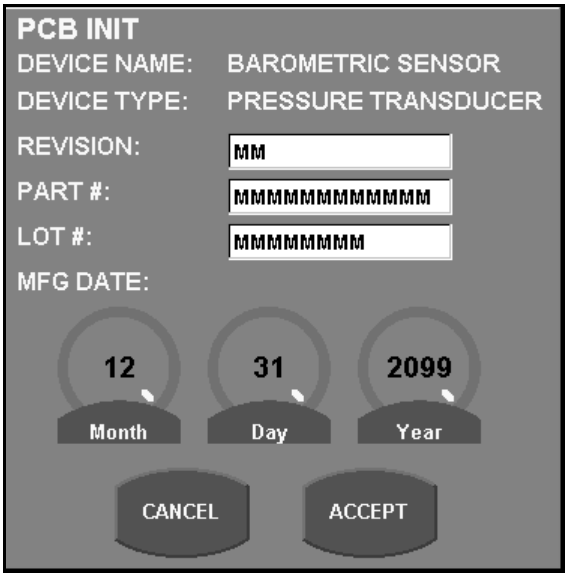


Figure 7.44

3. Press accept icon.
4. Press exit.


Avea

Chapter 8 Preventive Maintenance

The Battery Discharge Procedure is recommended to be performed quarterly.

The following parts are typically replaced on an annual basis:

- Air inlet filter
- Oxygen inlet filter
- Compressor inlet filter (if applicable)
- Compressor outlet filter (if applicable)
- Exhalation Diaphragm
- Fan filter
- O_2 Sensor

The following service procedures are recommended to be performed annually:

1. Remove and replace items described above.
   - PM Kit without compressor P/N 16137
   - PM Kit with compressor P/N 16136
   - O_2 Sensor P/N 68289
2. Check transducers for any drift, calibrate if there is a drift
3. Operational Verification Testing (OVP) to confirm the ventilator is functioning within optimum parameters.
4. Touch Screen calibration
5. CO_2 Calibration Procedure (If applicable)

The following parts are to be replaced every two years:

- Internal Batteries
- External Batteries, if applicable

Battery Discharge Procedure

1. Disconnect external batteries if installed.
2. Connect adult circuit and test lung, turn power on and select “New Patient” and “Adult” patient size. If the unit has an internal compressor, disconnect wall air.
3. Set breath rate to 40, “Low Ve” alarm to 0 and all other settings to remain as default.
4. Record the start time of the test and disconnect from wall AC power and allow unit to operate until it shuts off.
5. Verify that the unit runs for 30 minutes with a compressor or 1 hour without compressor on battery power.
6. If unit runs for specified time, plug back into AC receptacle and charge for 4 hours. If unit does not run for specified time, batteries should be replaced.

Note:

A Low Battery alarm will activate when the LED indicator on the front panel reaches red.

---

7. Reconnect external batteries, if applicable.

Replacing the O_2 and Air/Heliox filters

You can access both these gas filters from the rear panel of the ventilator.

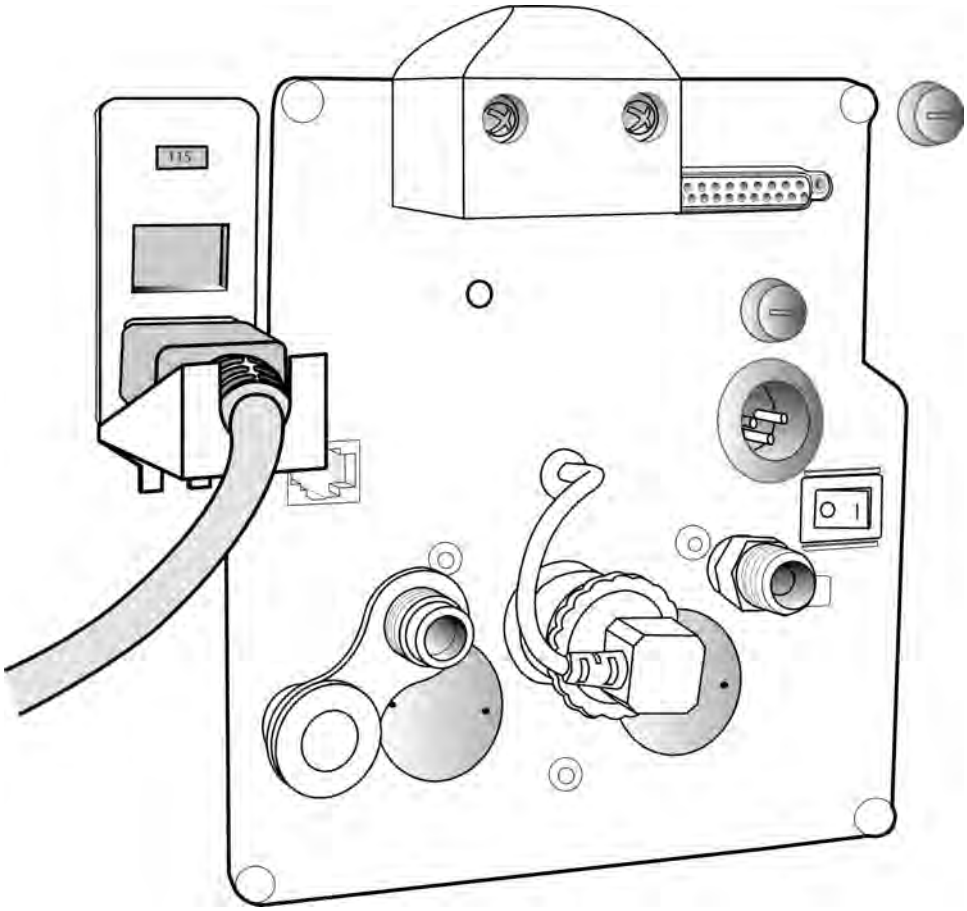


Figure 8.1 Rear panel

To remove the O_2 and Air/Heliox filter covers, you will need a filter removal tool, P/N 21735, as shown in Figure 8.1.

1. Using the filter removal tool , unscrew the filter covers to expose the filters.

Figure 8.1 Removing the filter covers

2. Using needle nosed pliers, grasp the filter firmly and pull straight out from the filter port.

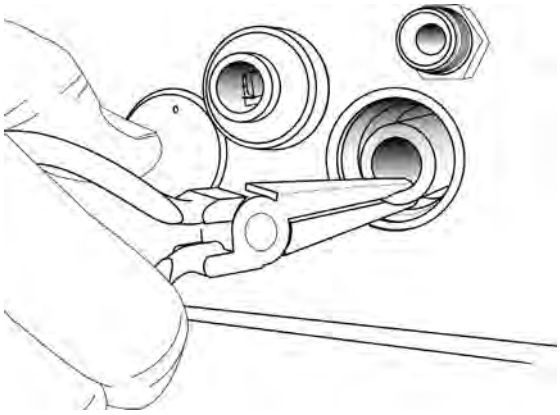


Figure 8.2 Removing the filter

3. Replace the old filters with new ones (Balston P/N 050-05) taking care to seat the filter over the filter retainer inside the port as you insert each one.

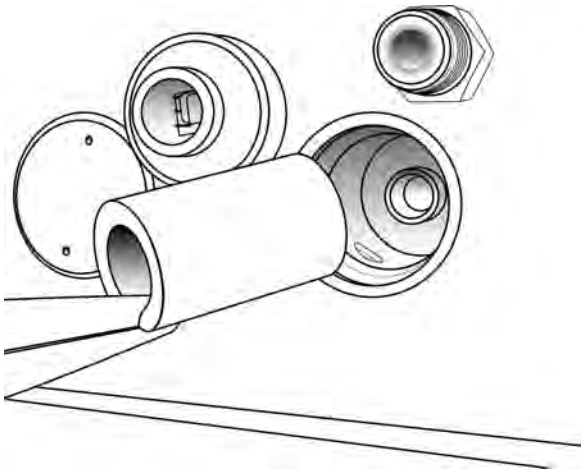


Figure 8.3 Replacing the filter

4. Align the filter retainer in the center inside the filter as you replace the cover.

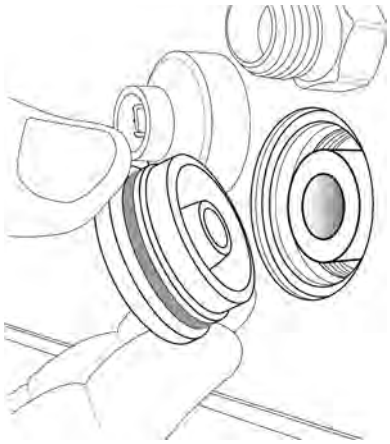


Figure 8.4 Replacing the filter cover

Replacing the Compressor Inlet and Outlet filters

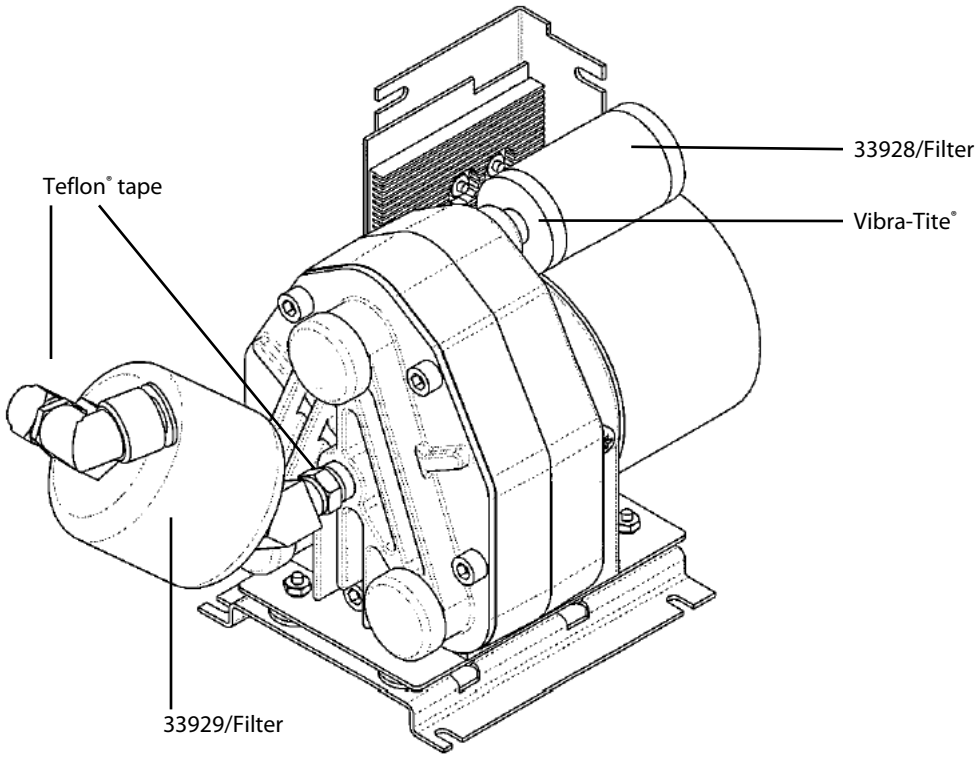


Figure 8.5 Compressor and filters

Disassemble the ventilator as shown in Chapter 4 to access the Compressor filters.

Both the inlet and the outlet filters unscrew as complete assemblies for replacement. Use only the part numbers shown above available from CareFusion.

To replace Compressor Inlet Filter:

Apply Vibra-tite to threads of the Compressor Inlet Filter and allow to dry for at least 15 minutes. Install the Compressor Inlet Filter onto the Compressor Scroll Housing.

To replace Compressor Outlet Filter:

Carefully clean tapered pipe threads of brass fittings. Re-apply Teflon tape to fittings, avoiding the first end thread. Attach the Compressor Outlet Filter and secure fittings in the direction shown.

Replacing the Exhalation Diaphragm P/N 16240

To replace the exhalation valve membrane, first remove:

1. The exhalation filter/water trap assembly.
2. The exhalation assembly (corner) cover.
3. The metal reinforcement cover, if applicable.

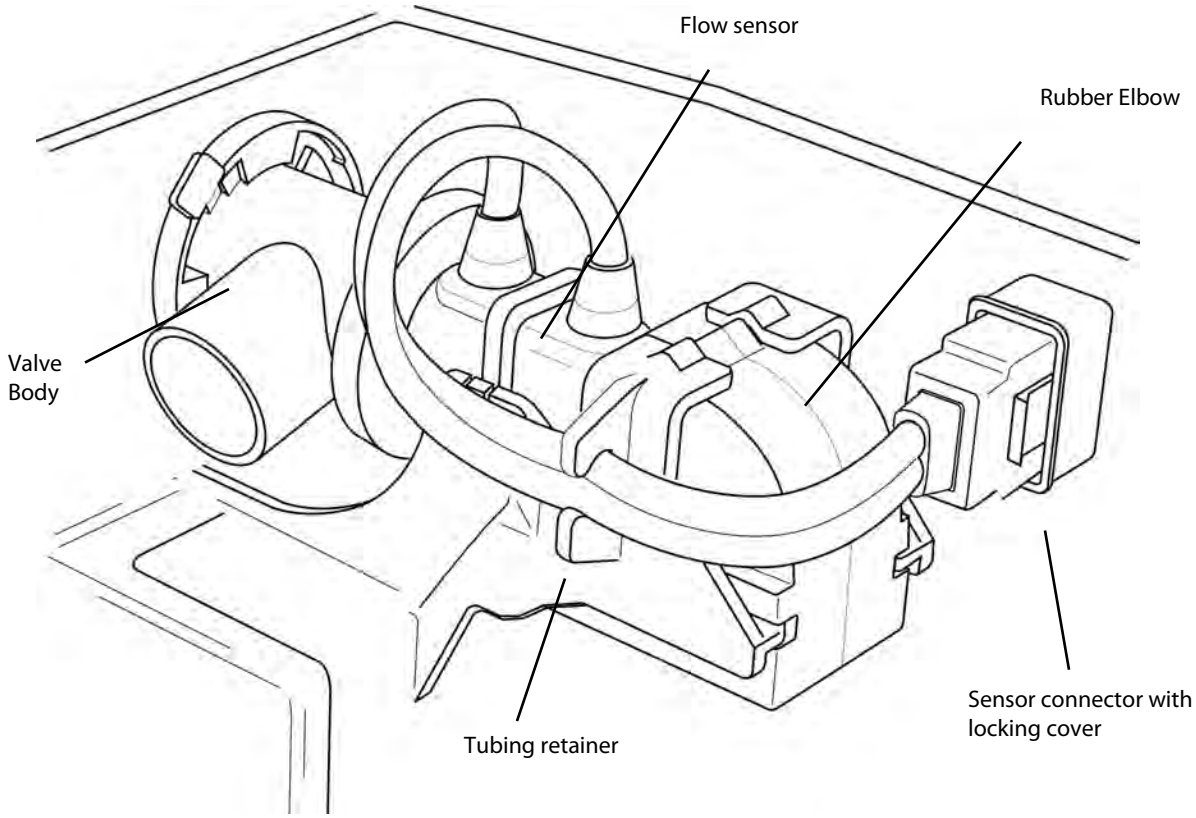


Figure 8.6 Exhalation assembly

4. Unplug the flow sensor connector from the receptacle taking care to retract the locking shroud as you do so.
5. Loosen the tubing form the tubing retainer.
6. Grasp the rubber elbow and pull firmly out towards the front of the Avea. This will expose the flow sensor. Set the rubber elbow aside.
7. Gently free the flow sensor from the exhalation valve body and pull out towards the front of the Avea. This will leave the valve body in place.
8. To remove the valve body, press down on the lever shown in figure 8.9, turn the valve body counter clockwise until the fins of the locking mechanism release and pull out. This will expose the membrane.

Figure 8.7 Disengage valve body

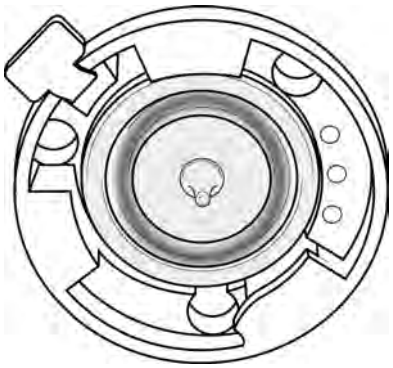


Figure 8.8 Membrane seated in the valve body.

9. To remove the membrane, grasp the nipple and gently pull away from the valve body.

Figure 8.9 Removing the membrane

10. Replace the membrane and press gently into the valve body making sure that the edges are well seated.

Figure 8.10 Seating the new membrane

11. Grasp the flow sensor by the smaller diameter orifice and insert into the cuff on the valve body.
12. Push the rubber elbow onto the smaller end of the flow sensor taking care to align the groove on each side with the corresponding rail of the molded holder.

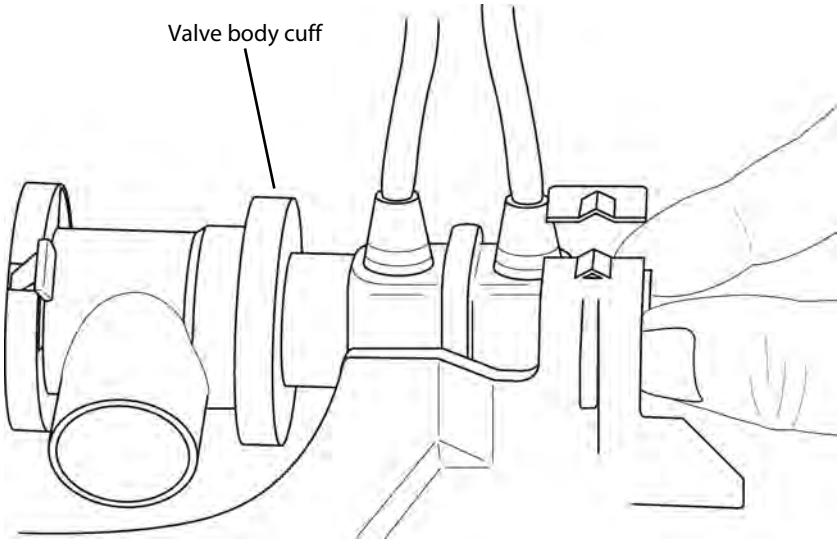


Figure 8.11 Insert the flow sensor

13. When the elbow is correctly installed, the molded protrusion on the top lines up with the protrusions on each side of the holder.

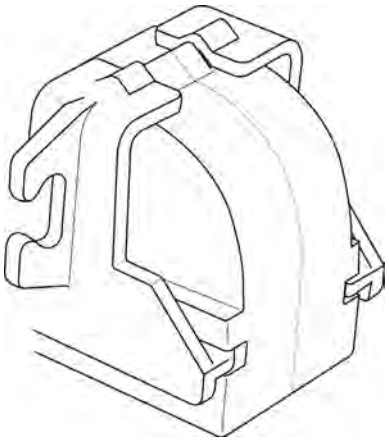


Figure 8.12 Align rubber elbow.

14. Reconnect the sensor and insert the two tubes into the tubing retainer.

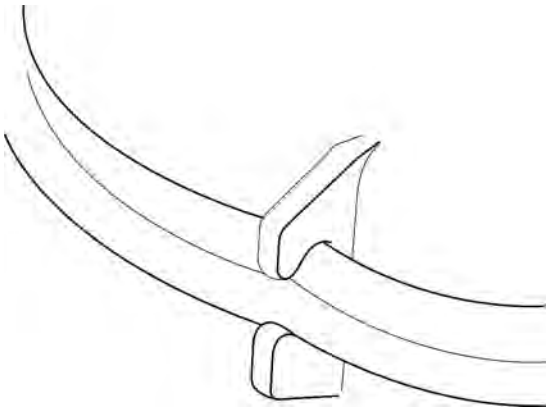


Figure 8.13 Tubing retainer

15. Replace the exhalation assembly cover and top cover. Replace and reconnect the UIM.
16. Run OVP tests after any part replacement.

Replacing the O_2 Sensor

1. Locate the rubber boot covering the sensor on the back of the GDE.
2. Gently remove the boot from the sensor, and remove the O_2 connector attached to the O_2 sensor.
3. Unscrew the O_2 sensor and remove it from the GDE.
4. Remove the new O_2 sensor from the packaging and screw it into the orifice in the GDE.
5. Connect the O_2 cell connector.
6. Replace the rubber boot onto the O_2 sensor.


Avea

Chapter 9 Troubleshooting

This section describes how to troubleshoot the ventilator if:

- The ventilator does not turn on properly.
- A Vent Inop occurs when you turn on the ventilator.
- An Operational Verification Test fails.
- A malfunction occurs.

If the Ventilator Does not Turn ON

If you turn the power switch ON and the ON indicator does not illuminate, perform the troubleshooting procedures given in Table 9-1.

Table 9.1 Troubleshooting Power-Up Problems

PROBLEM	POSSIBLE CAUSE	ACTION
Ventilator plugged into an AC source but does not power up.	No power at AC outlet or the AC Line Voltage switch is set to the wrong voltage. *	Try connecting to a known good AC power source. Insure that the voltage setting of the ventilator matches the voltage of your power source. Check the fuse assembly if the ventilator still does not power up, Contact your CareFusion Certified Service Technician. *
Ventilator attached to alternate external DC power source but does not power up.	If the external source is a battery, the battery may not be charged. *	Plug the ventilator into a known good AC source, or to a known good battery and see if it powers up. *

If a Vent Inop alarm occurs

Remove the ventilator from service and contact CareFusion Technical Support.

You may be asked to check the error log. To do this, power up the ventilator with the SETUP key depressed. When the SERVICE FUNCTIONS screen appears, press ERROR LOG. The following screen appears listing all error codes chronologically with the latest occurring at the top.

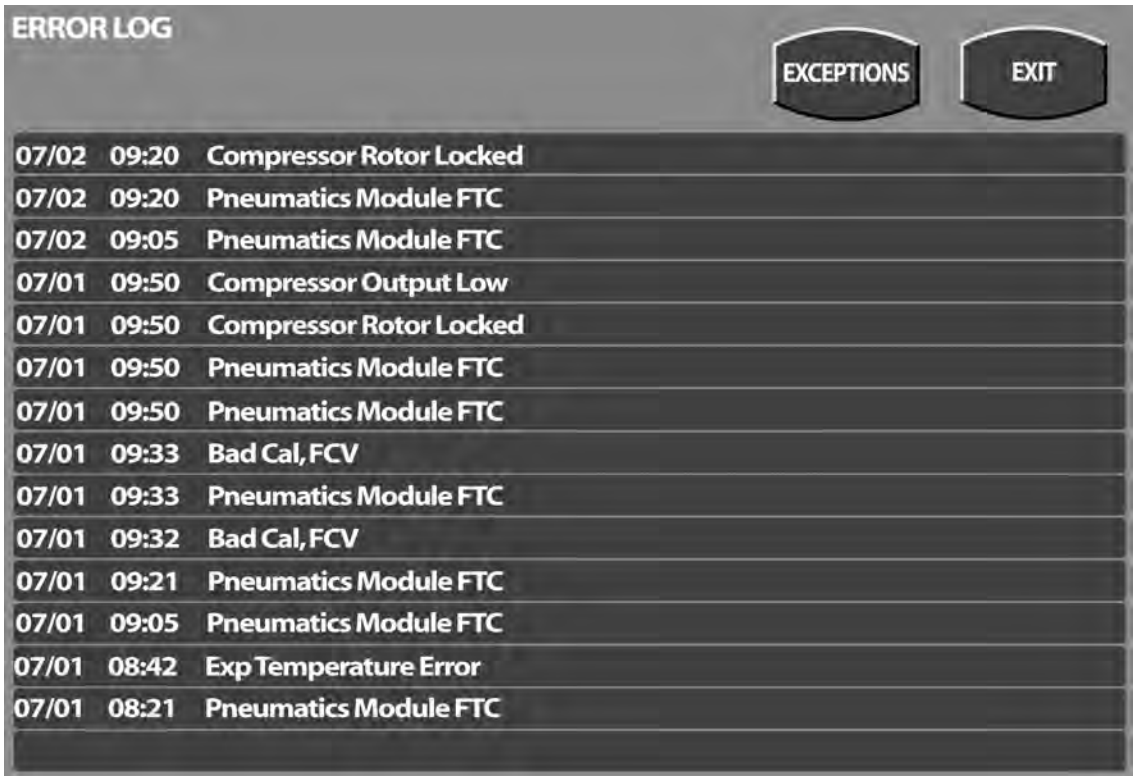


Figure 9.1 Error log

If there is more than one page of error codes, you can scroll through them using the Data Dial. In this way, you can print a page-by page record of the codes for reference or reporting purposes.

When you have captured this information, press the Exceptions key. The EXCEPTION LOG appears.

Figure 9.2 Exception Log

In the event of a fatal error, in either the Control or the Monitor processor, the date, time and address will be recorded here. You can print this and/or record the information for reporting purposes.

When you have captured the Exception log information, press Exit. **DO NOT** press Clear at this time, you may need to refer to this information again, or the factory technician may need to do so if the unit is returned for repair.

List of Possible Error Codes

Note:

Error Codes may appear with normal operation of the Avea.

Abbreviations

FTC: Fail-to-cycle

IFS: Inspiratory Flow Sensor

FCV: Flow Control Valve

EFS: Expiratory Flow Sensor

PT: Pressure Transducer

Sup: Supply

BG: Blended Gas

WFS: Wye Flow Sensor

HWFS: Hot Wire Flow Sensor

Messages

Bad Cal, Air Sup PT	Bad ID, Power PCB	FCV Overcurrent Fault
Bad Cal, Aux PT	Bad ID, TCA	Header Error, Air Sup PT
Bad Cal, BG PT	Bad ID, WFS	Header Error, Blender
Bad Cal, Blender	Bad Model Number	Header Error, Compressor
Bad Cal, Compressor	Bad Sensor Type, HWFS	Header Error, Ctrl PCB
Bad Cal, EFS	Compressor Output Low	Header Error, EFS
Bad Cal, EFS PT	Compressor Rotor Locked	Header Error, EPM
Bad Cal, Esoph PT	Compressor Runtime Data Error	Header Error, HWFS
Bad Cal, Exp PT	Config Lost	Header Error, IFS
Bad Cal, FCV	Data Error, Air Sup PT	Header Error, O_2 Sup PT
Bad Cal, FiO_2	Data Error, BG PT	Header Error, Power PCB
Bad Cal, HWFS	Data Error, Blender	Header Error, TCA
Bad Cal, IFS	Data Error, Compressor	Header Error, WFS
Bad Cal, Insp PT	Data Error, EFS	HSSC Comm Fault
Bad Cal, O_2 Sup PT	Data Error, EPM	IFS A/D Ref Fault
Bad Cal, WFS	Data Error, HWFS	IFS Voltage Fault
Bad Cal, WFS PT	Data Error, IFS	Insp Temperature Error
Bad Header, BG PT	Data Error, O_2 Sup PT	Invalid Data, Baro EEPROM
Bad ID, Air Supply PT	Data Error, TCA	Invalid Data, Pbaro Sensor
Bad ID, BG PT	Data Error, WFS	Invalid Device Code, EEPROM
Bad ID, Blender	Device Not Found, EFS	Invalid Feature, EPM
Bad ID, Ctrl PCB	Device Not Found, IFS	Invalid Header, Baro EEPROM
Bad ID, EFS	DPRAM Comm Error, Ctrl	Pneumatics Module FTC
Bad ID, HWFS	DPRAM Comm Error, Mntr	Settings Lost
Bad ID, IFS	Event Log Data Lost	TCA A/D Ref Fault
Bad ID, O_2 Supply PT	Exp Temperature Error	Trend Data Lost

Avea Mechanical Troubleshooting

Caution!

Remove the ventilator with the potential problem from patient.
Check error log (and exceptions) with any "Device Error" message on screen

Table 9.2 Battery/Power Supply

* Ensure unit is plugged in between patient use.

* Refer to “Battery Discharge Procedure” on page 162 for proper battery discharge/charging procedures.

* Check all cables/connections and voltages before replacing parts.

Symptom	Problem	Solution(s)
Unit will not power up	1. Blown/incorrect/missing A/C fuse(s) 2. Loose Internal Connections 3. Bad Power Switch 4. Bad Power supply 5. Bad Power Driver PCB 6. UIM problem	1. Check/replace A/C fuses 2. Check all connections 3. Replace Power Switch 4. Replace Power supply 5. Replace Power Driver PCB (GDE) 6. Check UIM cable. Refer to "UIM/Control" section
No battery indication (LED)	1. Excessively discharged battery state 2. Faulty/Missing batt fuse 3. Loose connections 4. Bad Battery PCB 5. Bad LED indicator panel 6. Bad battery 7. Transition Board fault	1. Charge properly-refer to battery discharge procedure in OVP section 2. Check/replace fuse 3. Check connections 4. Replace Battery PCB 5. Replace LED indicator panel 6. Check/replace battery 7. Call CareFusion Technical Support
Will not charge past yellow	1. Excessively discharged battery state 2. Loose connections 3. Bad Battery PCB 4. Bad battery 5. Bad Power Driver PCB	1. Charge properly-refer to service manual 2. Check connections 3. Replace Battery PCB 4. Check/replace battery 5. Replace Power Driver PCB (GDE)
Decreased run time on battery (internal/external)	1. Excessively discharged battery state 2. Loose connections 3. Bad Battery PCB 4. Bad battery 5. Bad Power Driver PCB	1. Charge properly-refer to battery discharge procedure in OVP section 2. Check connections 3. Replace Battery PCB 4. Check/replace battery 5. Replace Power Driver PCB (GDE)
Unit wont run on battery (internal/external)	1. Faulty/missing battery fuse 2. Loose connections 3. Bad battery 4. Bad Power PCB	1. Check/replace fuse 2. Check connections 3. Check/replace battery 4. Replace Power PCB (GDE)

Symptom	Problem	Solution(s)
Unit does not run on A/C	1. Wiring disconnect 2.Defective Power Entry Module 3. Power supply is not recognizing A/C	1. Check all connections-especially by compressor 2. Replace Power Entry Module 3. Replace Power supply
Excessive battery heat (internal only)	1. Battery PCB improperly wired 2. Bad battery PCB 3. Bad thermal fuse 4. Bad battery	1. Check wiring 2. Replace Battery PCB 3. Check/replace battery 4. Check/replace battery
Flickering LED	1. Excessively discharged battery state 2. Loose connections 3. Bad power driver PCB 4.Transition Board fault	1. Allow to charge-should self-resolve 2. Check connections 3. Replace power driver PCB (GDE) 4. Call CareFusion Technical Support
Alarms when Unit is "off"	1. Excessively discharged battery State 2. Bad LED indicator panel	1. Allow to charge 2. Replace LED indicator panel
LED red to green - no yellow (external battery only)	1. Can occur normally with ext battery charge	1. Perform discharge/recharge cycle as per OVP section
External battery not detected	1. System not detecting external battery	1. Plug unit into A/C. Connect external battery. Then, turn unit on.

Table 9.3 Compressor

! **All symptoms below assume NO wall air in use.**

* Compressor/Board must be replaced together on older units.

* Check all cables and connector before replacing parts.

Symptom	Problem	Solution(s)
No compressor function (and no indicator)	1. Standard unit - without compressor 2. Bad Air Calibration 3. Bad Blended Gas Calibration 4. Faulty fuse on compressor PCB 5. Bad compressor PCB	1. Option on Avea 200 2. Check Air Calibration 3. Check Blended gas Calibration 4. Replace compressor PCB 5.Replace compressor PCB
No compressor function (indicator present)	1. Unit is reading air pressure with none present.	1. Faulty Air Pressure Transducer. Replace Air pressure transducer.
"Loss of gas" alarms without O_2 in use	1. Low compressor output 2. Compressor leak 3. Accumulator depletion	1. Check output - replace compressor if necessary 2. Check tubing/connections 3. Check for excessive patient minute ventilation
"Loss of air" alarms with O_2 in use	1. Low compressor output 2. Compressor leak 3. Accumulator depletion	1. Check output - replace compressor if necessary 2. Check tubing/connections 3. Check for excessive patient minute ventilation
Excessive compressor noise/vibration	1. Incorrect mounting 2. Defective/worn Vibration dampeners	1. Insure mounting nuts are present and tightened 2. Replace Vibration dampeners

Table 9.4 EPM

! **All symptoms below apply to WFS, Esoph and Aux - unless otherwise noted.**

* Available in Avea Comprehensive only.

* Paux and Pesoph not available in software ver. 2.7.

Symptom	Problem	Solution(s)
Erroneous readings from sensor	1. Bad Sensor 2. Transducer(s) out of calibration 3.Leak	1.Change/Replace sensor 2.Recalibrate 3.Check all internal/external connections
No reading from sensor	1.Bad sensor (cable/connector) 2.Specified transducer out of cal 3. No communication from EPM	1. Try different sensor 2. Check error log for specific transducer and Recalibrate Esoph, Aux, or Wye Transducers 3. Check internal connections. Replace EPM if needed
"Device Error" when sensor connected	1. Bad sensor (cable/connector) 2. Specified transducer out of cal 3. No communication from EPM	1. Try different sensor 2. Check error log for specific transducer and recalibrate transducers 3. Check internal connections. Replace EPM if needed

Table 9.5 Exhalation Valve/Assembly

Symptom	Problem	Solution
Low measured exhaled volumes	1. External leak 2. Internal leak	1. Check all circuit connections, Check filter assembly, Check/Replace exhalation diaphragm 2. Reset GDE
Will not pass EST "leak test"	1. External leak 2. Internal leak	1. Check all circuit connections, Check filter assembly, Check/Replace exhalation diaphragm 2. Re-seat GDE
Valve noise	Diaphragm is out of position	Clean/re-seat diaphragm
Excessive expiratory resistance	1. Moisture in Exhalation Filter 2. Clogged/Dirty Exhalation diaphragm	1. Bypass filter and recheck. Replace if necessary 2. Clean/replace diaphragm
Abnormal expiratory waveforms	Bad expiratory valve	Replace valve

Table 9.6 Flow Sensors (inc. Wye)

Symptom	Problem	Solution(s)
Volumes become inaccurate over time	1. Foreign material on flow sensor 2. Expiratory or Wye flow out of calibration-depending on sensor used	1. Clean/replace sensor as needed 2. Re-calibrate and recheck volumes
No reading from external variable orifice sensor	1. Sensor not active in certain modes 2. Loose external connection/Bad Sensor 3. Loose internal connection Communications error	1. See operator's manual for correct sensor/mode configurations 2. Check external connection/replace sensor 3. Check all cables/connections See "EPM" troubleshooting section
No reading from internal variable orifice sensor	1. Loose external connection/Bad Sensor 2. Loose internal connection Communications error 3. Faulty TCA/PCB (GDE)	1. Check external connection/replace sensor 2. Check all cables/connections 3. Replace TCA/PCB (GDE)
No reading from external heated wire sensor	1. Sensor not active in certain modes 2. Loose external connection/Bad Sensor 3. Loose internal connection Communications error	1. See operators manual for correct sensor/mode configurations 2. Check external connection/replace sensor 3. Check all cables/connections Replace TCA/PCB (GDE)
Volume reading above baseline on test lung	Normal condition. Unit expects gas at BTPS, not ATPD	NA
Volume reading above/below baseline on patient (internal sensor)	1. Humidifier "Active on/off" set incorrectly 2. Bad Flow sensor 3. Expiratory flow out of calibration 4. Bad pressure transducer	1. "Active on" for humidifier, "Active off" for HME 2. Check for correct zero with Wye sensor. 3. If Wye sensor zeros correctly, recalibrate Expiratory flow and recheck. Replace internal sensor if needed. 4. If Internal/external sensors both zero incorrect after recalibration, bad pressure transducer-replace (GDE)

Table 9.7 Nebulization System

Symptom	Problem	Solution(s)
Nebulizer output absent	1. Unit running on compressor or flow < 15 L/min 2. Bad Nebulizer Solenoid 3. Transition PCB- bad harness connection 4. Problem on Power PCB	1. Connect wall air, increase flow (if applicable) 2. Replace Solenoid 3. Call CareFusion Technical Support 4. Replace Power PCB (if solenoid doesn't fix)*
Nebulizer output reduced/absent	1. Neb booster output low 2. Kinked tubing externally 3. Kinked tubing internally 4. Bad Neb Booster Solenoid	1. Adjust Neb booster output 2. Check/replace tubing to nebulizer 3. Check unit for kinks or disconnects 4. Replace Solenoid

* Check Voltage at Solenoid (both). Should be 12v/0v while running with cycling heard. If voltage problem is seen - suspect problem at areas.
With "*"

Table 9.8 O_2 Sensor

Symptom	Problem	Solution(s)
"***" on FiO_2 monitor	FiO_2 reading out of upper or lower range	Run EST with 50 psi oxygen source connected. Recalibrate/replace sensor
O_2 reading inaccurate	1. FiO_2 sensor out of calibration 2. Blocked sensor orifice 3. O_2/Air Relay out of balance 4. Malfunctioning Blender Assembly.	1. Run EST with 50 psi oxygen source connected or recalibrate/replace sensor 2. Insure patency of orifice 3. Calibrate O_2/Air Relay 4. Replace Blender (GDE)
O_2 will not read	1. Bad O_2 sensor 2. Bad O_2 sensor cable 3. TCA board problem	1. Replace sensor 2. Replace sensor cable 3. Replace TCA board (GDE)

Table 9.9 Pneumatic System

! Check error log (and exceptions) with any "Device Error" or "Inop" condition to diagnose component.

Component	Symptom	Problem	Solution(s)
Air Pressure PCB	Vent Inop. (communications failure)	1. Bad connections/cable 2. EPROM failure 3. Incorrect calibration	1. Check connections/replace cable 2. Replace Air PCB-recalibrate transducer 3. Recalibrate transducer
	Incorrect pressure reading	1. Bad Transducer 2. Incorrect calibration	1. Replace Air PCB-recalibrate transducer 2. Recalibrate transducer
O_2 Pressure PCB	Vent Inop. (communications failure)	1. Bad connections/cable 2. EPROM failure 3. Incorrect calibration	1. Check connections/replace cable 2. Replace O_2 PCB-recalibrate transducer 3. Recalibrate transducer
	Incorrect pressure reading	1.Bad Transducer 2.Incorrect calibration	1. Replace O_2 PCB 2. Recalibrate transducer
Blended Gas PCB	Vent Inop. (communications failure)	1. Bad connections/cable 2. EPROM failure 3. Incorrect calibration	1. Check connections/replace cable 2. Replace Blended Gas PCB-recalibrate 3. Recalibrate transducer
	Incorrect pressure reading	1. Bad Transducer 2. Incorrect calibration	1. Replace Blended Gas PCB-recalibrate transducer 2. Recalibrate transducer
Blender	Vent Inop.	1. Bad connections/cable 2. EPROM failure 3. Incorrect calibration	1. Check connections/replace cable 2. Replace Blender (GDE) 3. Recalibrate transducers

Component	Symptom	Problem	Solution(s)
	FiO_2 Inaccuracy	1. Blender Assembly Failure 2. Regulator Relay out of balance 3. Leak	1. Replace Blender (GDE) 2. Recalibrate Regulator Relay 3. Check all pneumatic connections
Flow Control Valve	Inspiratory Noise	1. FCV out of characterization 2. Defective FCV	1. Re-characterize FCV * 2. Replace FCV (GDE)
	Flow Abnormalities	1. FCV out of characterization 2. Defective FCV	1. Re-characterize FCV * 2. Replace FCV (GDE)
Inspiratory Flow Sensor	Autocycling	1. Leak at FCV/IFS 2. Bad IFS	1. Check all connections 2. Replace IFS (GDE)
	Incorrect delivery	1. Leak at FCV/IFS 2. Bad IFS	1. Check all connections 2. Replace IFS (GDE)
	Vent Inop	1. Bad Connection/cable 2. Bad IFS	1. Check all connections/replace cable 2. Replace IFS (GDE)
Safety Relief Valve	Breath delivered-no output to patient	1. Leak in safety solenoid tubing/connections 2. Bad safety solenoid 3. Problem in TCA board	1. Check all connections 2. Replace safety solenoid 3. Replace TCA (GDE)
	Mechanical overpressure release prematurely	Incorrect Setting	Reset overpressure setting * (replace)
All items marked with an "*" are done at factory.			

Table 9.10 UIM/Control System

Symptom	Problem	Solution(s)
Unit continues to run after being switched off	1. Disconnected wire on "on/off" switch 2. Bad "on/off" switch	1. Check wiring in GDE 2. Replace switch
No power to unit and UIM	Fuse/power supply problem	See "Battery/Power supply section"
Unit powers on-UIM doesn't	1.Damaged/disconnected cable-Ext./Int. 2. Bad Backlight Inverter 3. Faulty/bad fuse on TCA 4. Bad TCA Board 5. Power supply voltage drops w/load	1. Check/replace all external and internal cables/connections 2. Replace UIM 3. Replace fuse 4. Replace TCA (GDE) 5. Replace Power Supply
Membrane buttons not working	1. "Screen lock" button active 2. Loose connections/bad cable 3. Defective membrane switch assembly	1. Unlock screen 2. Check all cables/connections 3. Replace switch assembly (UIM)
Touch screen not working	1. Loose internal connection 2. Defective touch pad	1. Check all internal cables/connections 2. Replace touch pad (UIM)
No priority LED's	Bad LED PCB	Replace UIM
Optical Encoder (knob) inoperable	Bad Optical Encoder	Replace Optical Encoder
No sound with alarms	1. Speaker wire loose/disconnected 2. Bad speaker 3. Bad TCA	1. Check wiring to speaker 2. Replace speaker 3. Replace TCA board (GDE)

Table 9.11 $ETCO_2$

Symptom	Problem	Solution(s)
Invalid Data, Pbaro Sensor Message	Barometric Pressure Transducer has failed	Replace UIM
Invalid Header, Baro EEPROM	EEPROM Error	Reinitialize EEPROM and do Manufacture Field Calibration
Invalid Data, Baro EEPROM	EEPROM Error	Perform Field Barometric Calibration
Invalid Device Code, EEPROM Message	EEPROM Error	Reinitialize EEPROM and do Manufacture Field Calibration
Barometric Pressure Reading 545 or 760 (and actual BP is not those values)	Barometric Pressure Transducer is out of calibration	Perform Field Barometric Calibration

Chapter 10 Parts List

Note:

The list of components given in this manual are for reference only. For a comprehensive parts list, contact CareFusion Technical Support.

Description	Part Number
A/C BRACKET	51000-40728
ACCUMULATOR	51000-40748
ADULT PT. CIRCUIT 48"	16044
ADULT PT. CIRCUIT 72"	16045
ADULT TEST LUNG (SIEMENS)	33754
AIR "SMART" CONNECTOR DISS	51000-40897
AIR AND HELIOX TETHERED "SMART" CONNECTOR	DISS P/N 16131 NIST P/N 16132
ALARM SPEAKER	51000-40818
COMPREHENSIVE CART	11524
COMPRESSOR/SCROLL PUMP ASSEMBLY (INCLUDES PCBA)	51000-09750A
CUSTOM TRANSPORT CART KIT Rack, tank, cart assembly 12V/12 amp lead acid battery (set of 2) Battery tray (screw, washer, nut) Wire harness	11372 33978 16179 33977 16217
EPM BOARD (INCLUDES PCBA)	51000-40848A
EXHALATION CORNER Exhalation filter cartridge (holds filter) Filter capsule (non-disposable) Water trap assembly Water trap adapter Bottle, 125 mL. EXHALATION VALVE ASSEMBLY EXHALATION FLOW SENSOR ASSEMBLY Elbow, orange	 51000-40640 33987 50000-40035 22095 33985 16319A 51000-40023 51000-40525
EXTERNAL BATTERY (2 pack)	16179
FAN/CABLE ASSEMBLY	51000-40861
FRONT INTERFACE PANEL, PNEUMATIC MODULE	51000-40635
GDE Cable assembly, battery upgrade	16222A 16243
HEATER ASSEMBLY Bracket, thermal fuse	51000-40824 22018
HELIOX "SMART" CONNECTOR DISS	51000-40918

Description	Part Number
HELIOX 15 FT. HOSE	50000-40042
INFANT TEST LUNG (INGMAR)	34057
INTERNAL BATTERIES Fuse (10 amp slow blow) Fuse holder A/C	68339A 71690 68159
NEBULIZER ASSEMBLY	51000-40026
POWER DRIVER BOARD, PCBA, REV C	52290
POWER ENTRY MODULE	51000-40827
POWER SUPPLY KIT Power supply Sense cable	16230A 16230 16366
SECONDARY ALARM ASSEMBLY KIT	16316
STANDARD CART	15986
TCA BOARD, PCBA Fuse	51000-40310A 56000-20072
TOP COVER MICROSWITCH	68294
TRANSITION BOARD WITH HARNESS	16216
UIM ARM ASSY FRONT COVER	51000-40623
UIM ARM ASSY REAR COVER	51000-40622
UIM DOMESTIC	16259 CF 16702
UIM INTERNATIONAL	16260 CF 16703
UIM MOUNTING ARM ASSEMBLY	51000-40072

Table 10.1 Calibration Tool Kit Part No. 03440

Description	Part Number
1/4 " silicone tubing	54980-01903
8F Catheter assembly	3001083
Adult wye flow sensor (Var-Flex disposable)	51000-40094
Calibration syringe	51000-09558
Connector, aux port; proximal	51000-40096
Detail assy O_2 reg adj tool	51000-08258
Filter removal tool	21735
Ftg. DISS, air, male ¼ NPT	52000-00133
Ftg. Fem. R/A Elbow 12mm OD	32002
Ftg. O_2, ¼ MPT x 9/16 male	52000-00132
Luer lock, male 1/16 dia	52000-01205
RS232 printer cable (for downloading software)	71555
Tube ftg. 1/8 to 1/16 dia reducer	32040
Tube ftg. Tee 1/16 x 1/16 x 1/8 dia	32067
Tube ftg. Tee 1/16 x 1/18 x 1/18 dia	52000-01193
Tubing, poly 12mm OD	33980
In addition, with comprehensive software, you will need: Esophageal catheter extension tube (10 pack) Adult esophageal catheter (8F) / Pediatric esophageal catheter (6F)	 50000-09920 7003100 and /or 7003401
3.0 and high software rev, you will need: Tool, Exhalation Valve Characterization	 10136
For ETCO2 option, you will need:	
Barometric Port Calibration Assembly Calibration Gas Calibration Gas Regulator	769288 79043 79044

Table 10.2 Preventive Maintenance Kits

Description	Part Number
PREVENTIVE MAINTENANCE KIT WITHOUT COMPRESSOR	16137
Exhalation diaphragm	16240
Filter, inlet tube (PM requires 2 ea.)	33951
Filter, fan (5 pack)	71670
PREVENTIVE MAINTENANCE KIT WITH COMPRESSOR	16138
Compressor inlet filter	33928
Compressor outlet filter	33929
Exhalation Diaphragm	16240
Filter, inlet tube (PM requires 2 ea.)	33951
Filter, fan (5 pack)	71670
O_2 Sensor	68289
FILTER REMOVAL TOOL	21735
Note: The exhalation diaphragm may be ordered separately in a package of 10 P/N 16240D	

Table 10.3 Communications

Description	Part Number
Cable tie	07803
GSP Interface Kit	16375
Independent Lung Ventilation (ILV) Cable Kit	16124 16246
Phillips Vue Link cable	16337
Remote Nurse Call Cable/Normally Closed	15620
Remote Nurse Call Cable/Normally Open	15619

Table 10.4 Accessories

Description	Part Number
Bottle, 125 mL.	33985
Disp. neonatal flow sensor (10/pkg)	50000-40038
Disp. Neonatal flow sensor (each)	51000-40098
Disposable adult flow sensor (10/pkg)	50000-40031
Disposable expiratory filter (12/pkg)	11395
F and P pole mount kit	69302
Filter capsule (non-disposable)	33987
Neonatal Hot Wire Flow Sensor	16465
Oxygen sensor (with connector)	68289
Patient circuit support arm	10128
Proximal adapter (required for proximal pressure monitoring)	51000-40096
Support Arm Rail Clamp	52000-30101
Talced Diaphragm/poppet (10/pkg)	16240D
Tube hanger	51000-02736
Water trap assembly	50000-40035

Table 10.5 Monitoring Procedures Disposable Accessories

(Each order is in a package of 10.)

Description	Part Number
Adult esophageal catheter 8 FR	7003100
Bicore accessories kit	16401
Esophageal catheter extension tube	50000-09920
Pediatric esophageal catheter 6 FR	7003401
Tracheal catheter 5 FR. Disposable	10635
Tracheal catheter adapter	50000-40034
Tracheal catheter extension tube	50000-40040

Table 10.6 Product Literature

Description	Part Number
Modes Book	L2190
Operator's Manual (ENG)	L1523
Quick Tips Card (adult)	L2290
Quick Tips Card (infant)	L2291
User's Guide (ENG)	L2042

Chapter 11 Appendices

Contact and Ordering Information

How to Call for Service

To get help on performing any of the preventive maintenance routines, or to request service on your ventilator, contact CareFusion Customer Care:

Technical Service

Hours: 6:30 A.M. to 4:30 P.M. (PST) Monday through Friday

Phone: 800.231.2466
Fax: 714.283.8471

CareFusion Customer Care Helpline

Hours: 24 hours, seven days a week
Phone: 800.231.2466 (From within the US)

Ordering Parts

To obtain Avea Ventilator parts, contact customer service at:

Phone: 800.231.2466

Fax: 714.283.8473 or 714.283.8493

Hours: 7:00 A.M. to 3:30 P.M. (PST) Monday through Friday

Diagrams and Schematics

The drawings and schematics presented in this manual are for reference purposes only. It is possible that later versions of these documents may become available after this manual print date. CareFusion will provide upon request and to qualified persons any and all diagrams, technical drawings and other information necessary to repair, maintain or service the Avea Ventilator systems. Contact CareFusion technical support or your local CareFusion representative for information.

Avea Schematics

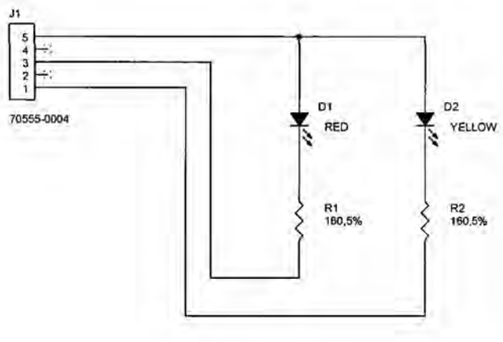
51000-40652	LED BOARD
51000-40702	HOURMETER
51000-40342	INSPIRATORY FLOW VALVE
51000-40292	O2 BLENDER
X51000-40332	EPM BOARD
50572	PATIENT ASSIST CALL
52252	CONTROL, PCBA, 32 BIT
51000-40552	PCBA, DRIVER TRANSITION
52292	PCBA, POWER DRIVER BOARD
52172	PCB COMPRESSOR WITH CONNECTORS
51000-40362	PCBA, SUPPLY PRESSURE
51000-40312	TRANS COM ALARM
51000-40370	PCBA, BLENDED GAS
68273	POWER SUPPLY

Avea Diagrams

51000-40431	PCBA, EXHALATION FLOW TRANSITION
52331	PCBA, BACKUP ALARM
51000-40841	TUBING DIAGRAM
51000-09742	PNEUMATIC DIAGRAM
21891	WIRING DIAGRAM

LED Board

REVISION HISTORY					
REV	ECO NO.	DESCRIPTION	DRAFTING	APPROVED	DATE
X1	56908	PILOT RELEASE PER ECO	RJ HALES	MVN	9.5.01
A	57359	PRODUCTION RELEASE PER ECO	RJ HALES	[illegible]	11/3/02



QTY REQD	PART OR IDENTIFYING NO. (DASH NO.)	NOMECLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	FIND NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED

A. DIMENSIONS ARE IN INCHES.

B. TOLERANCES
X ± .1 XXX ± .005
.XX ± .02 ANG ± 1.00°

C. MACH SURFACES 32 OR BETTER

D. CORNER FILLETS & RADII .005 - .010

E. DEBURR EDGES .005 - .020

F. CHAMFER FIRST & LAST THREADS BY 45°

G. INTERPRET PER ANSI Y14.5M-1982

APPROVALS		DATE
DRAWN	R.J. HALES	8.22.01
CHECKED	MV NORTH	9.5.01
APPROVED	S LANDAS	9.7.01
RELEASED	J NELSON	9.5.01

VIASYS™ HEALTHCARE CRITICAL CARE DIVISION

TITLE: SCHEMATIC, LED BOARD

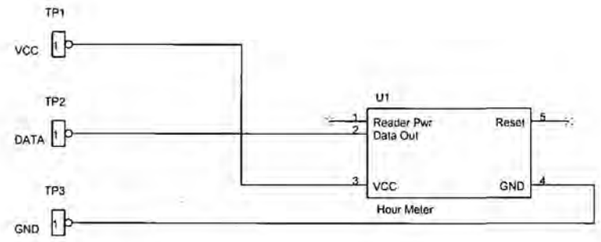
SIZE	DWG NO.	REV
C	51000-40652	A

SCALE: DO NOT SCALE DRAWING SHEET 1 OF 1

CRITICAL	☐ COMPONENT	☐ DEVICE	☒ N/A
TRACEABLE	☐ SERIAL NO.	☐ LOT NO.	☒ N/A

Hour Meter

REVISION HISTORY					
REV	ECO NO.	DESCRIPTION	DRAFTING	APPROVED	DATE
X1	56739	PILOT RELEASE PER ECO	RJH	MVN	7.30.01
A	57360	PRODUCT RELEASE PER ECO	RJH	WDM	1/31/02



TP1-TP3 are the harness holes for 22-24AWG wire

QTY REQD	PART OR IDENTIFYING NO.	NOMECLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	FIND NO.
	← DASH NO.	PARTS LIST		

UNLESS OTHERWISE SPECIFIED
A. DIMENSIONS ARE IN INCHES.
B. TOLERANCES
X ±.1 XXX ±.005
XX ±.02 ANG ±1.00°
C. MACH SURFACES 32 OR BETTER.
D. CORNER FILLETS & RADII .005 - .010
E. DEBURR EDGES .005 - .020
F. CHAMFER FIRST & LAST THREADS BY 45°
G. INTERPRET PER ANSI Y14.5M-1982

APPROVALS		DATE
DRAWN	R.J. HALES	6.20.01
CHECKED	MV NORTH	6.28.01
APPROVED	S LANDAS	7.13.01
RELEASED	H LACY	7.30.01

VIASYS™ HEALTHCARE CRITICAL CARE DIVISION

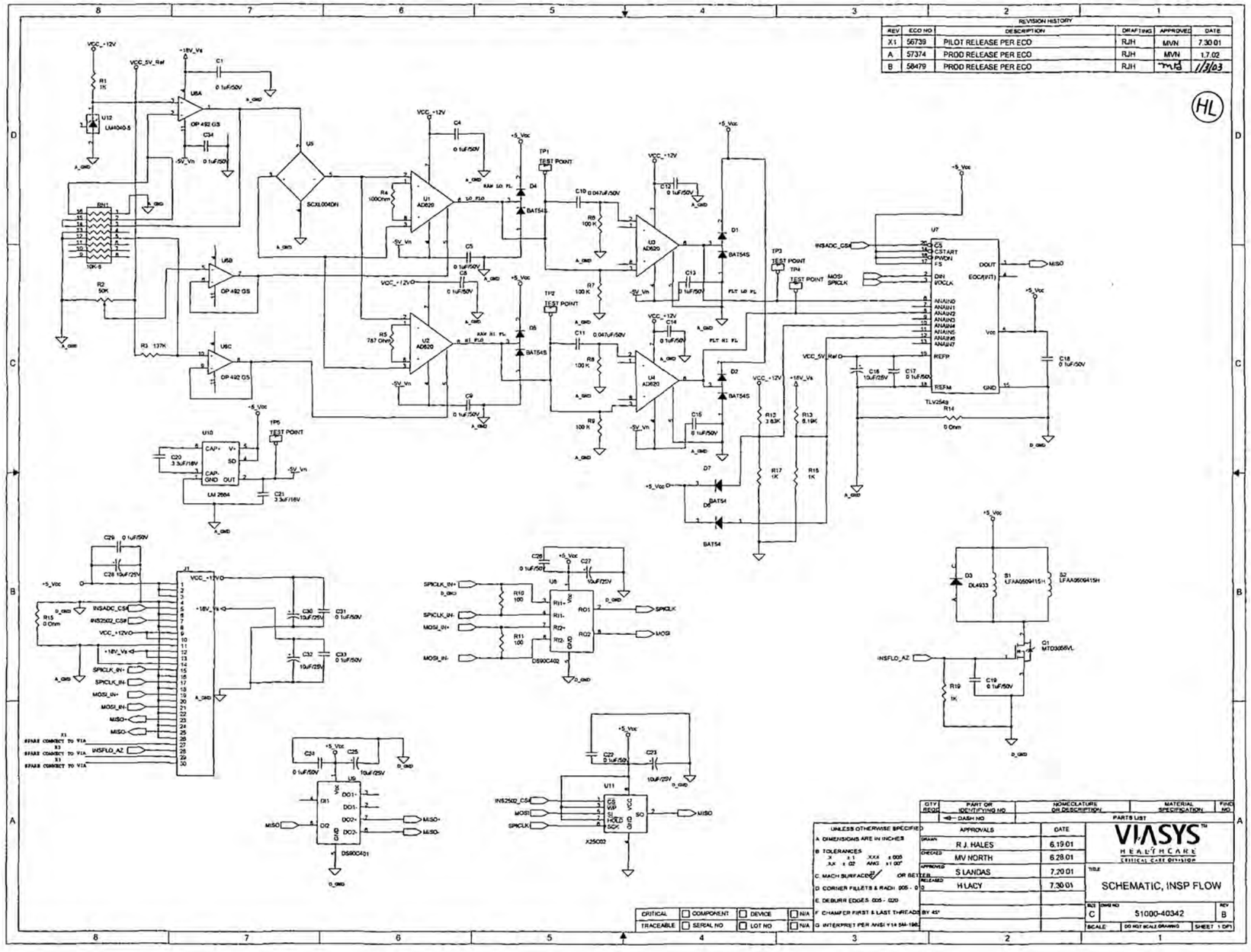
TITLE: SCHEMATIC, HOUR METER

SIZE	DWG NO.	REV
C	51000-40702	A

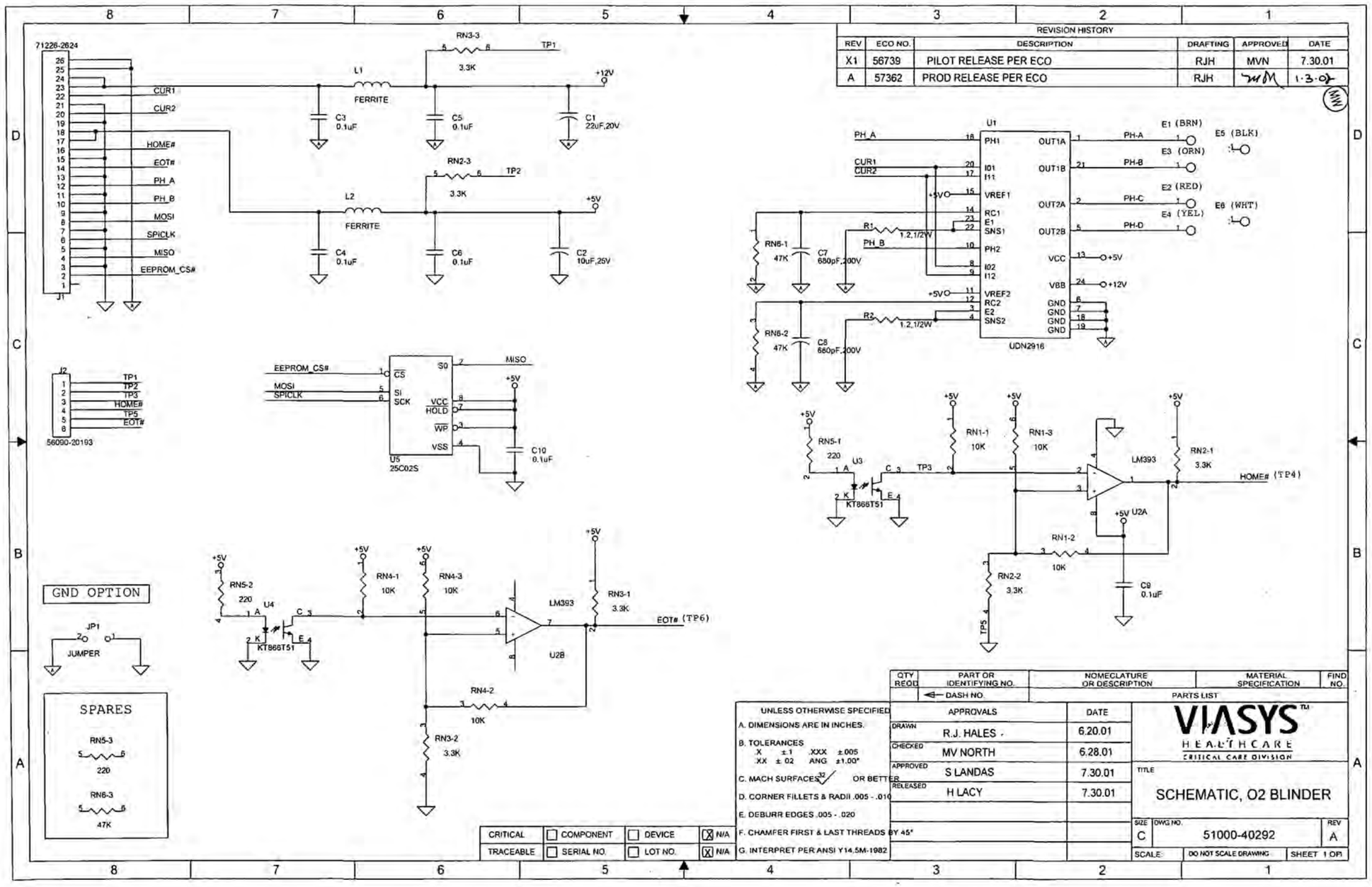
SCALE: DO NOT SCALE DRAWING SHEET 1 OF 1

CRITICAL	☐ COMPONENT	☐ DEVICE	☒ N/A
TRACEABLE	☐ SERIAL NO.	☐ LOT NO.	☒ N/A

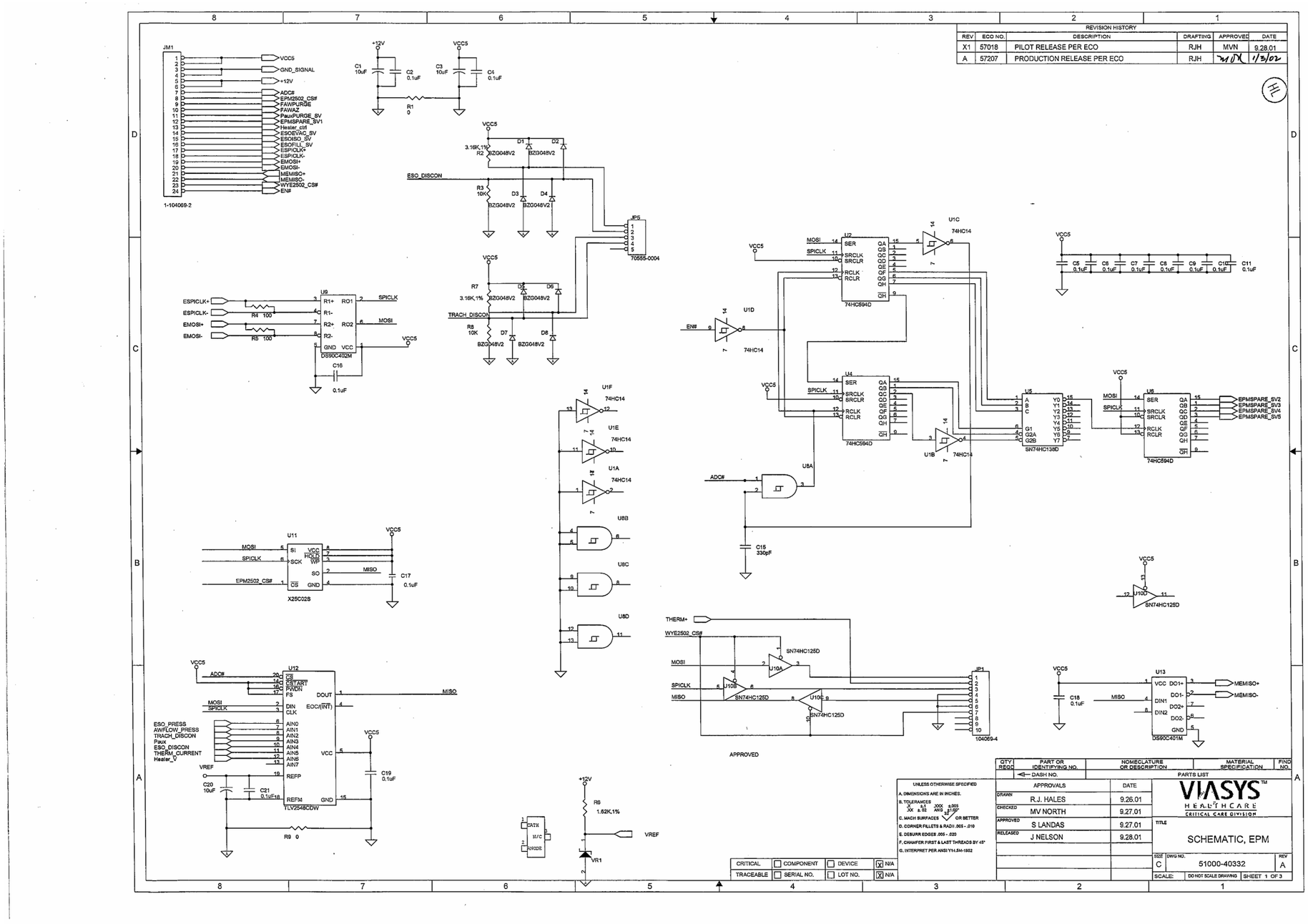
Inspiratory Flow Valve

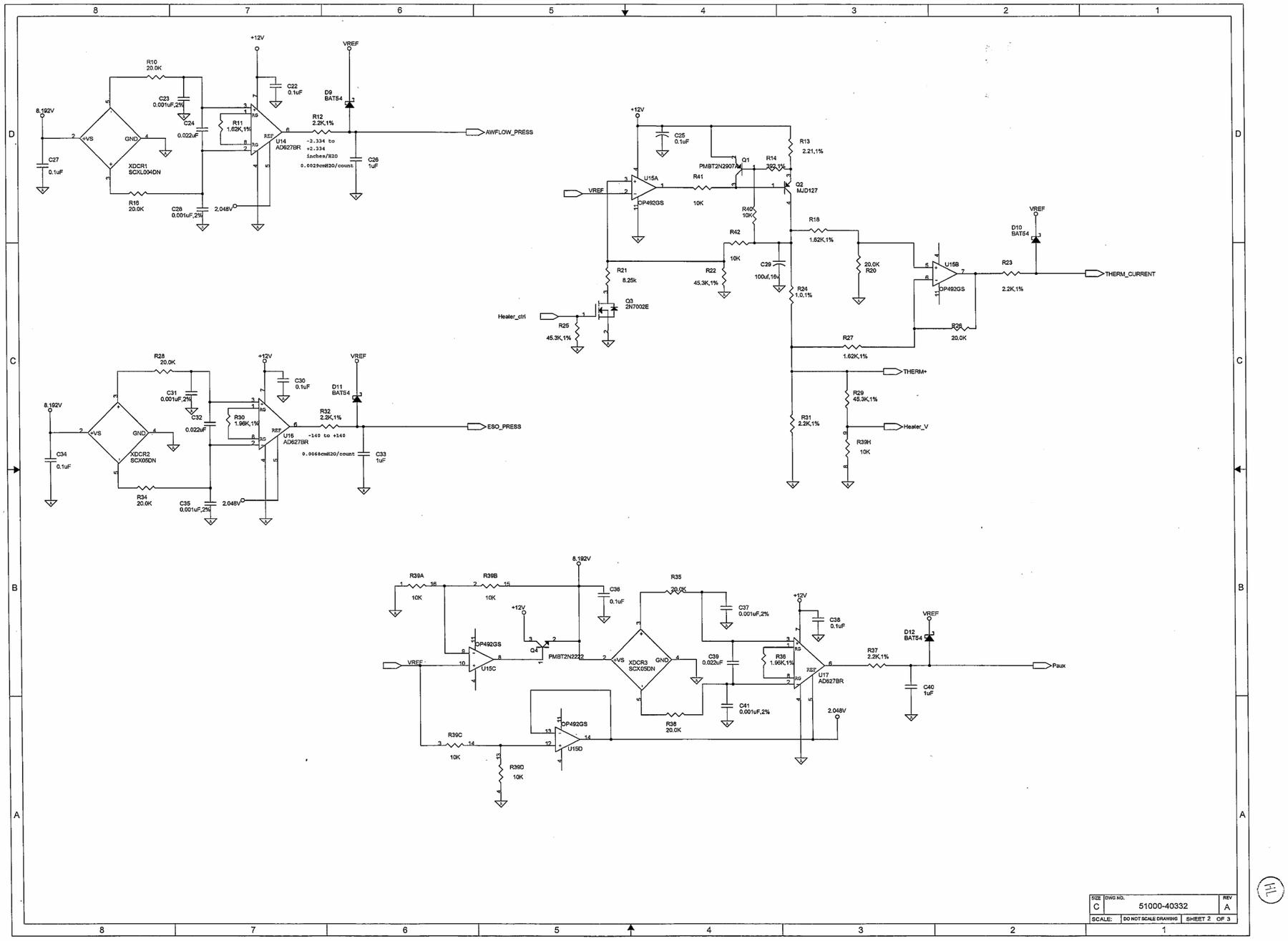


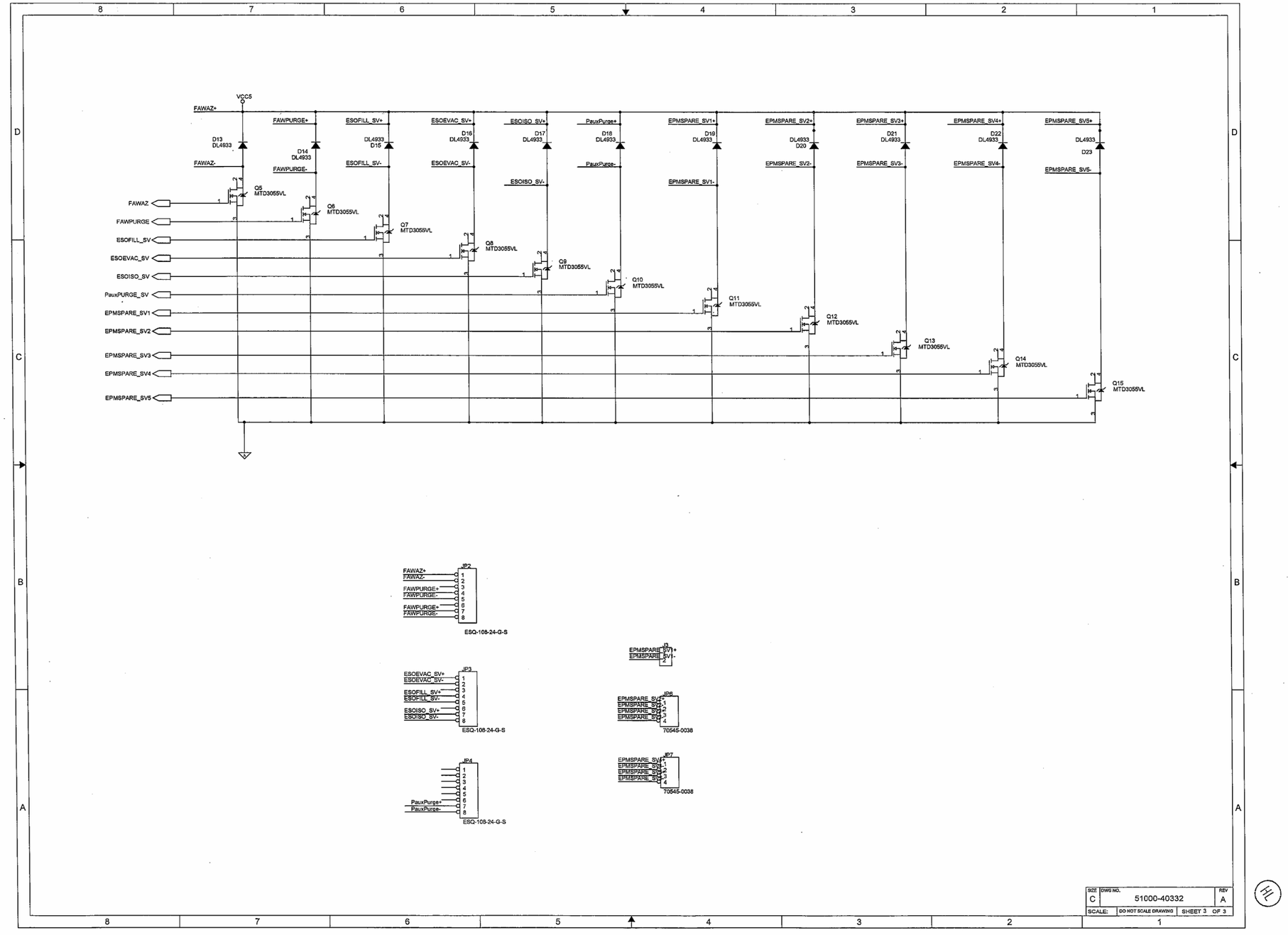
O_2 Blender


REVISION HISTORY
REV | ECO NO. | DESCRIPTION | DRAFTING | APPROVED | DATE
X1 | 56739 | PILOT RELEASE PER ECO | RJH | MVN | 7.30.01
A | 57362 | PROD RELEASE PER ECO | RJH | | 1-3-02
71226-2624
CUR1
CUR2
HOME#
EOT#
PH_A
PH_B
MOSI
SPICLK
MISO
EEPROM_CS#
L1
FERRITE
L2
FERRITE
RN3-3
3.3K
RN2-3
3.3K
TP1
TP2
+12V
+5V
C3 0.1uF
C5 0.1uF
C1 22uF,20V
C4 0.1uF
C6 0.1uF
C2 10uF,25V
J2
56090-20193
TP1
TP2
TP3
HOME#
TP5
EOT#
U5
25C02S
C10 0.1uF
U1
UDN2916
PH_A
PH1
OUT1A
PH-A
E1 (BRN)
E3 (ORN)
E5 (BLK)
CUR1
CUR2
I01
I11
OUT1B
PH-B
E2 (RED)
VREF1
RC1
E1
SNS1
OUT2A
PH-C
E4 (YEL)
E6 (WHT)
R1
1.2,1/2W
PH_B
PH2
OUT2B
PH-D
RN6-1
47K
C7
680pF,200V
I02
I12
VCC
+5V
VBB
+12V
VREF2
RC2
E2
SNS2
GND
R2
1.2,1/2W
RN6-2
47K
C8
680pF,200V
RN5-1
220
U3
KT866T51
TP3
RN1-1
10K
RN1-3
10K
LM393
RN2-1
3.3K
HOME# (TP4)
U2A
RN1-2
10K
RN2-2
3.3K
C9
0.1uF
TP5
GND OPTION
JP1
JUMPER
SPARES
RN5-3
220
RN6-3
47K
RN5-2
220
U4
KT866T51
RN4-1
10K
RN4-3
10K
LM393
RN3-1
3.3K
EOT# (TP6)
U2B
RN4-2
10K
RN3-2
3.3K
UNLESS OTHERWISE SPECIFIED
A. DIMENSIONS ARE IN INCHES.
B. TOLERANCES
.X ±.1 .XXX ±.005
.XX ±.02 ANG ±1.00°
C. MACH SURFACES 32 OR BETTER
D. CORNER FILLETS & RADII .005 - .010
E. DEBURR EDGES .005 - .020
F. CHAMFER FIRST & LAST THREADS BY 45°
G. INTERPRET PER ANSI Y14.5M-1982
CRITICAL | COMPONENT | DEVICE | N/A
TRACEABLE | SERIAL NO. | LOT NO. | N/A
QTY REQD | PART OR IDENTIFYING NO. | NOMECLATURE OR DESCRIPTION | MATERIAL SPECIFICATION | FIND NO.
DASH NO.
PARTS LIST
APPROVALS | DATE
DRAWN R.J. HALES 6.20.01
CHECKED MV NORTH 6.28.01
APPROVED S LANDAS 7.30.01
RELEASED H LACY 7.30.01
VIASYS HEALTHCARE CRITICAL CARE DIVISION
TITLE
SCHEMATIC, O2 BLINDER
SIZE C
DWG NO. 51000-40292
REV A
SCALE
DO NOT SCALE DRAWING
SHEET 1 OF 1

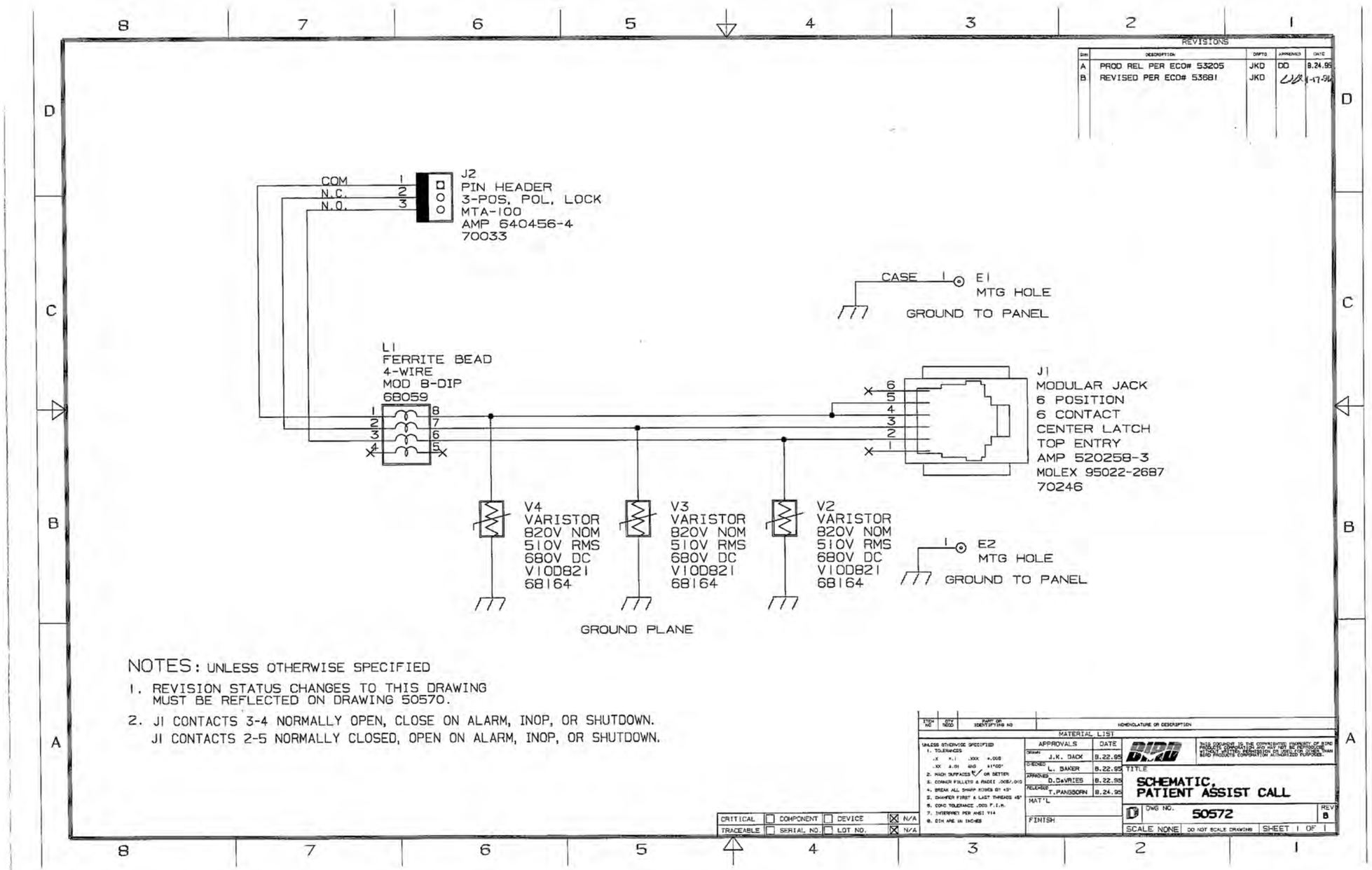
EPM Board


REVISION HISTORY
REV | ECO NO. | DESCRIPTION | DRAFTING | APPROVED | DATE
X1 | 57018 | PILOT RELEASE PER ECO | RJH | MVN | 9.28.01
A | 57207 | PRODUCTION RELEASE PER ECO | RJH | | 1/3/02
JM1
1-104069-2
VCC5
GND_SIGNAL
+12V
ADC#
EPM2502_CS#
FAWPURGE
FAWAZ
PauxPURGE_SV
EPMSPARE_SV1
Heater_ctrl
ESOEVAC_SV
ESOINSO_SV
ESOFILL_SV
ESPICLK-
ESPICLK+
EMOSI+
EMOSI-
MEMISO+
MEMISO-
WYE2502_CS#
EN#
C1 10uF
C2 0.1uF
C3 10uF
C4 0.1uF
R1 0
ESO_DISCON
TRACH_DISCON
R2 3.16K,1%
R3 10K
R7 3.16K,1%
R8 10K
D1 D2 D3 D4 D5 D6 D7 D8
BZG04BV2
JP5
70555-0004
U9
DS90C402M
R4 100
R5 100
C16 0.1uF
U1C 74HC14
U1D 74HC14
U1F 74HC14
U1E 74HC14
U1A 74HC14
U1B 74HC14
U2 74HC594D
U4 74HC594D
U5 SN74HC138D
U6 74HC594D
MOSI
SPICLK
C5 C6 C7 C8 C9 C10 C11 0.1uF
U8A
U8B
U8C
U8D
ADC#
C15 330pF
U11
X25C02S
C17 0.1uF
U12
TLV2548CDW
C19 0.1uF
C20 10uF
C21 0.1uF
R9 0
U10A U10B U10C U10D
SN74HC125D
THERM+
WYE2502_CS#
JP1
104069-4
C18 0.1uF
U13
DS90C401M
MEMISO+
MEMISO-
EPMSPARE_SV2
EPMSPARE_SV3
EPMSPARE_SV4
EPMSPARE_SV5
APPROVED
UNLESS OTHERWISE SPECIFIED
A. DIMENSIONS ARE IN INCHES.
B. TOLERANCES
C. MACH SURFACES OR BETTER
D. CORNER FILLETS & RADII .005 - .010
E. DEBURR EDGES .005 - .020
F. CHAMFER FIRST & LAST THREADS BY 45°
G. INTERPRET PER ANSI Y14.5M-1982
APPROVALS | DATE
DRAWN R.J. HALES | 9.26.01
CHECKED MV NORTH | 9.27.01
APPROVED S LANDAS | 9.27.01
RELEASED J NELSON | 9.28.01
VIASYS HEALTHCARE CRITICAL CARE DIVISION
TITLE SCHEMATIC, EPM
SIZE C | DWG NO. 51000-40332 | REV A
SCALE: DO NOT SCALE DRAWING | SHEET 1 OF 3
CRITICAL | COMPONENT | DEVICE | N/A
TRACEABLE | SERIAL NO. | LOT NO. | N/A
QTY/REQD | PART OR IDENTIFYING NO. | NOMECLATURE OR DESCRIPTION | MATERIAL SPECIFICATION | FIND NO.
DASH NO.
PARTS LIST


8.192V
+VS
GND
XDCR1
SCXL004DN
C27
0.1uF
R10
20.0K
C23
0.001uF,2%
C24
0.022uF
R16
20.0K
C28
0.001uF,2%
+12V
C22
0.1uF
R11
1.62K,1%
U14
AD627BR
REF
RG
R12
2.2K,1%
-2.334 to
+2.334
inches/H20
0.0029cmH20/count
C26
1uF
VREF
D9
BAT54
AWFLOW_PRESS
2.048V
R28
20.0K
C31
0.001uF,2%
C32
0.022uF
R34
20.0K
C35
0.001uF,2%
XDCR2
SCX05DN
C34
0.1uF
C30
0.1uF
R30
1.96K,1%
U16
AD627BR
R32
2.2K,1%
-140 to +140
0.0068cmH20/count
C33
1uF
D11
BAT54
ESO_PRESS
+12V
C25
0.1uF
U15A
OP492GS
VREF
R41
10K
PMBT2N2907A
Q1
R14
332,1%
R13
2.21,1%
Q2
MJD127
R40
10K
R42
10K
R18
1.62K,1%
R21
8.25k
R22
45.3K,1%
C29
100uf,16v
R24
1.0,1%
20.0K
R20
U15B
OP492GS
R23
2.2K,1%
D10
BAT54
VREF
THERM_CURRENT
Heater_ctrl
Q3
2N7002E
R25
45.3K,1%
R26
20.0K
R27
1.62K,1%
THERM+
R29
45.3K,1%
R31
2.2K,1%
Heater_V
R39H
10K
R39A
10K
R39B
10K
C36
0.1uF
8.192V
R35
20.0K
C37
0.001uF,2%
+12V
C38
0.1uF
VREF
D12
BAT54
Q4
PMBT2N2222
U15C
OP492GS
VREF
XDCR3
SCX05DN
C39
0.022uF
R36
1.99K,1%
U17
AD627BR
R37
2.2K,1%
Paux
C40
1uF
C41
0.001uF,2%
R38
20.0K
2.048V
R39C
10K
R39D
10K
U15D
OP492GS
SIZE
C
DWG NO.
51000-40332
REV
A
SCALE:
DO NOT SCALE DRAWING
SHEET 2 OF 3

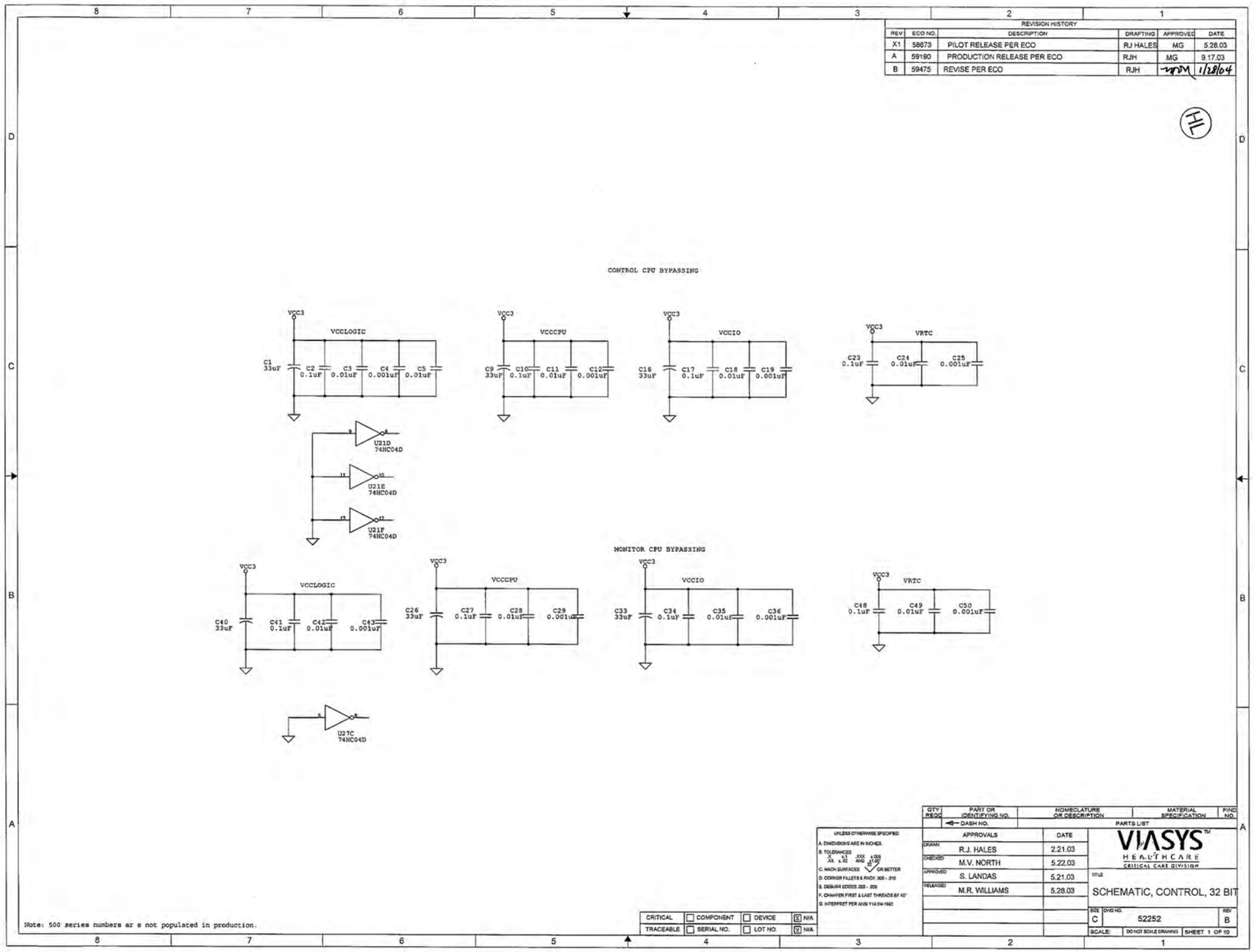

VCC5
FAWAZ+
FAWPURGE+
ESOFILL_SV+
ESOEVAC_SV+
ESOISO_SV+
PauxPurge+
EPMSPARE_SV1+
EPMSPARE_SV2+
EPMSPARE_SV3+
EPMSPARE_SV4+
EPMSPARE_SV5+
D13 DL4933
D14 DL4933
D15 DL4933
D16 DL4933
D17 DL4933
D18 DL4933
D19 DL4933
D20 DL4933
D21 DL4933
D22 DL4933
D23 DL4933
FAWAZ-
FAWPURGE-
ESOFILL_SV-
ESOEVAC_SV-
ESOISO_SV-
PauxPurge-
EPMSPARE_SV1-
EPMSPARE_SV2-
EPMSPARE_SV3-
EPMSPARE_SV4-
EPMSPARE_SV5-
Q5 MTD3055VL
Q6 MTD3055VL
Q7 MTD3055VL
Q8 MTD3055VL
Q9 MTD3055VL
Q10 MTD3055VL
Q11 MTD3055VL
Q12 MTD3055VL
Q13 MTD3055VL
Q14 MTD3055VL
Q15 MTD3055VL
FAWAZ
FAWPURGE
ESOFILL_SV
ESOEVAC_SV
ESOISO_SV
PauxPURGE_SV
EPMSPARE_SV1
EPMSPARE_SV2
EPMSPARE_SV3
EPMSPARE_SV4
EPMSPARE_SV5
JP2
ESQ-108-24-G-S
JP3
ESQ-108-24-G-S
JP4
ESQ-108-24-G-S
J3
70545-0038
JP6
70545-0038
JP7
70545-0038
SIZE C
DWG NO. 51000-40332
REV A
SCALE:
DO NOT SCALE DRAWING
SHEET 3 OF 3

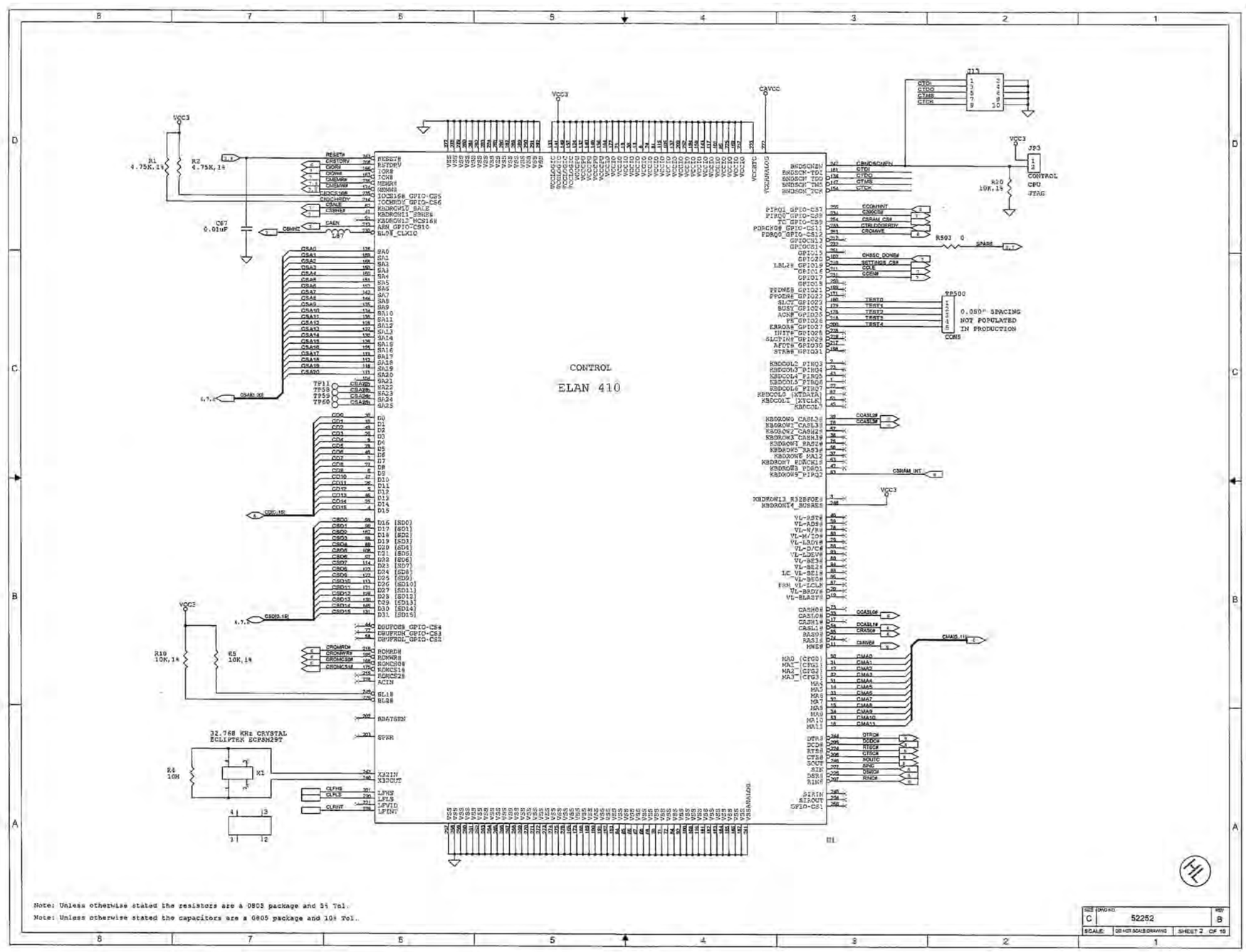
Patient Assist Call

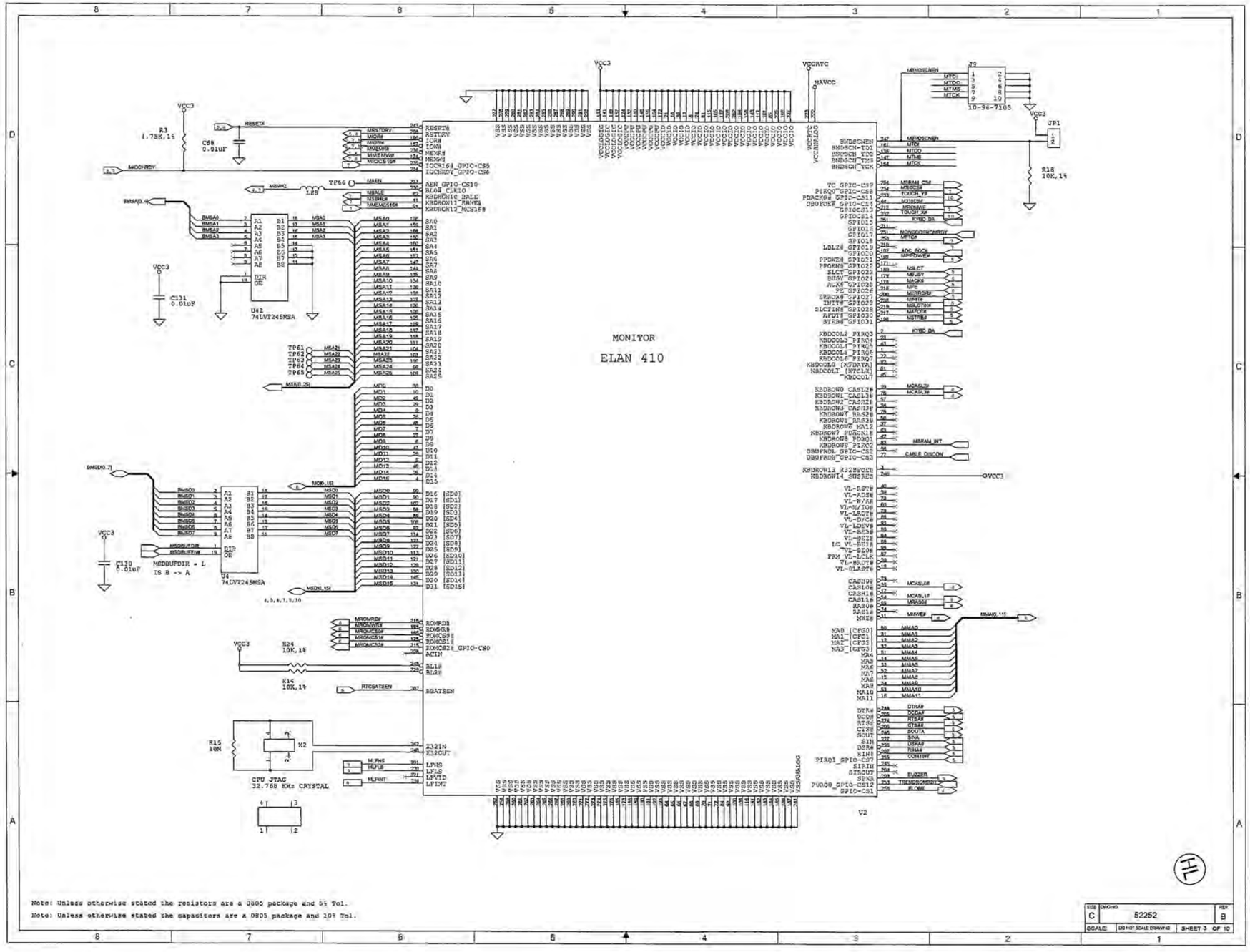


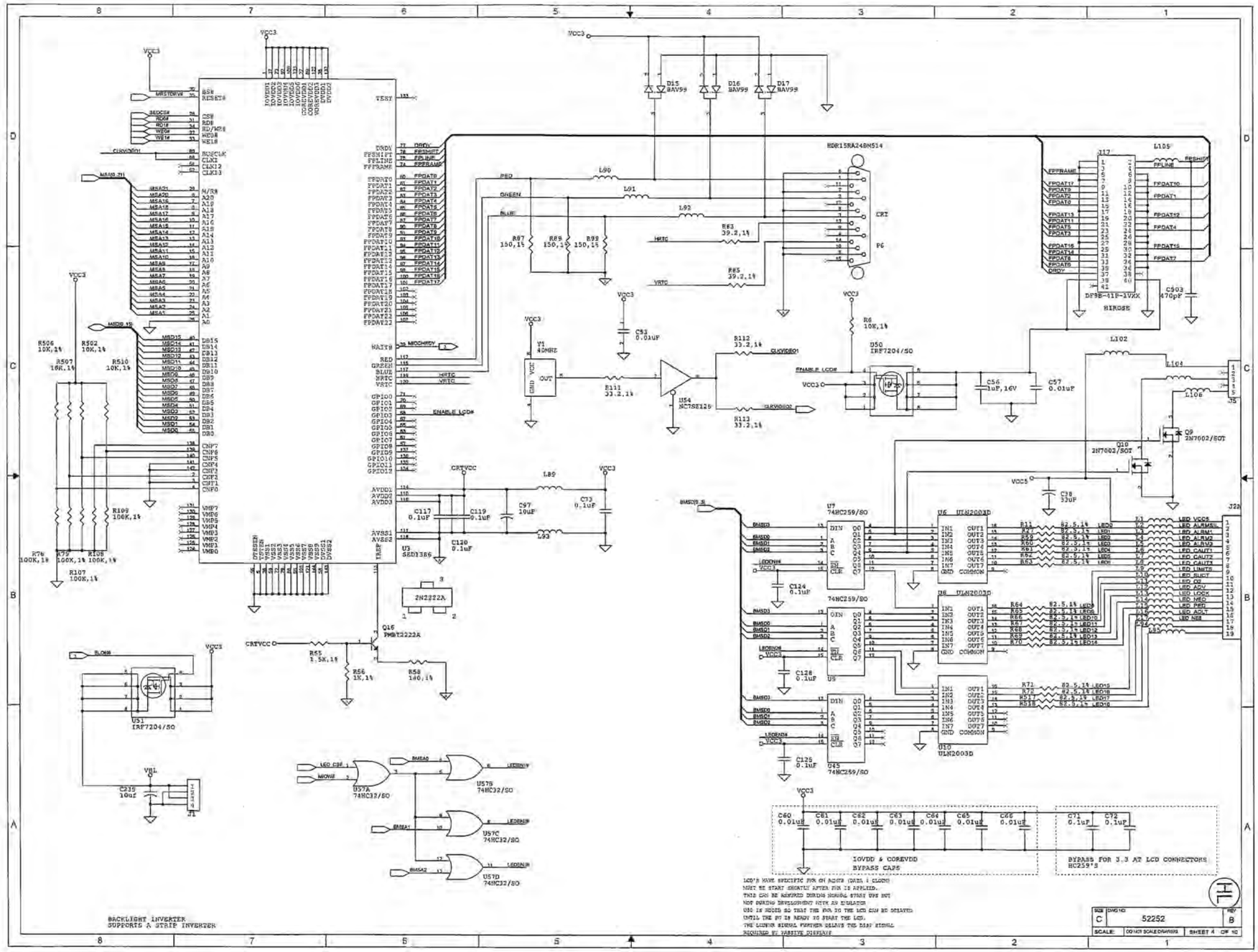
Control, PCBA, 32 Bit

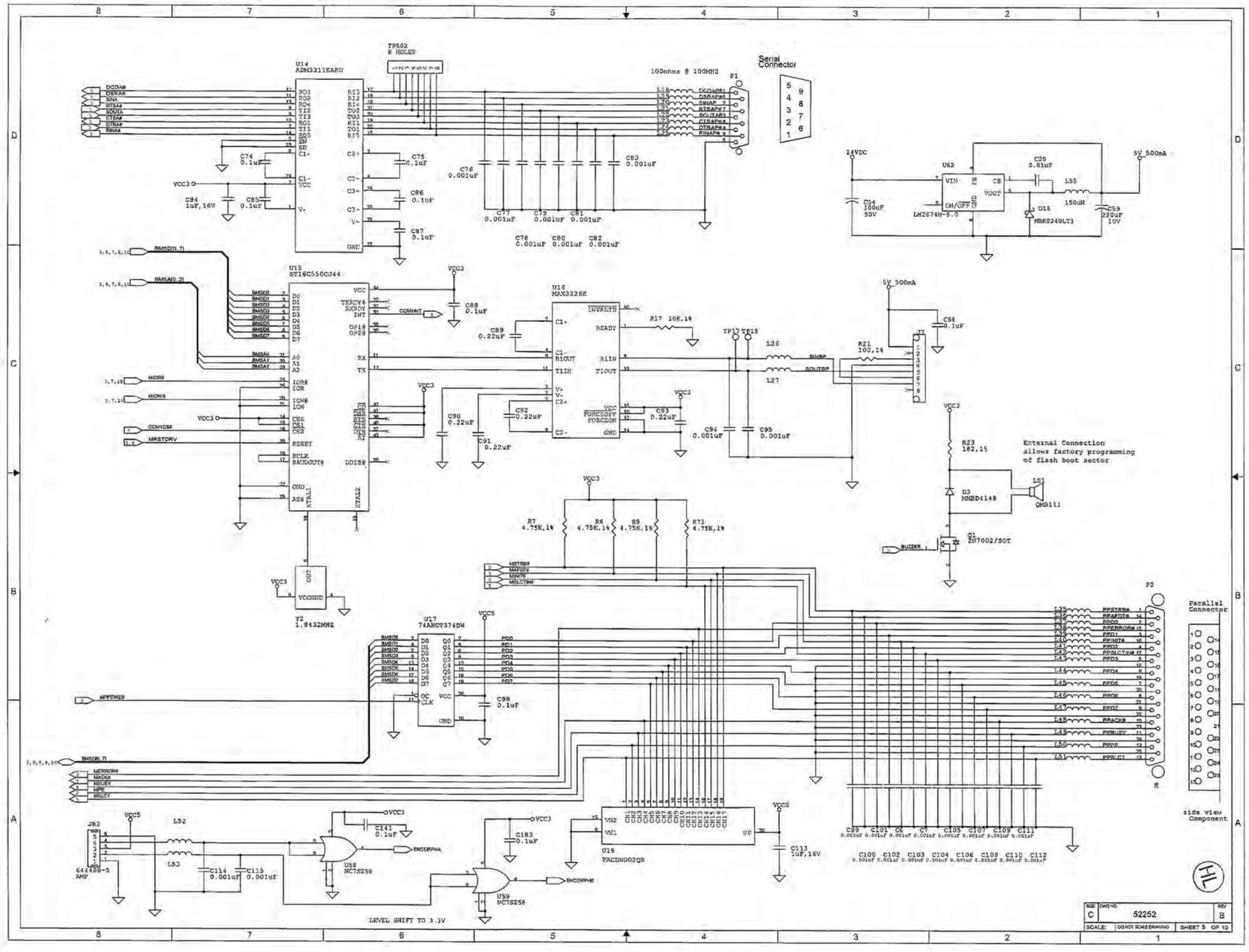
REVISION HISTORY					
REV	ECO NO.	DESCRIPTION	DRAFTING	APPROVED	DATE
X1	58673	PILOT RELEASE PER ECO	RJ HALES	MG	5.28.03
A	59190	PRODUCTION RELEASE PER ECO	RJH	MG	9.17.03
B	59475	REVISE PER ECO	RJH	MG	1/28/04

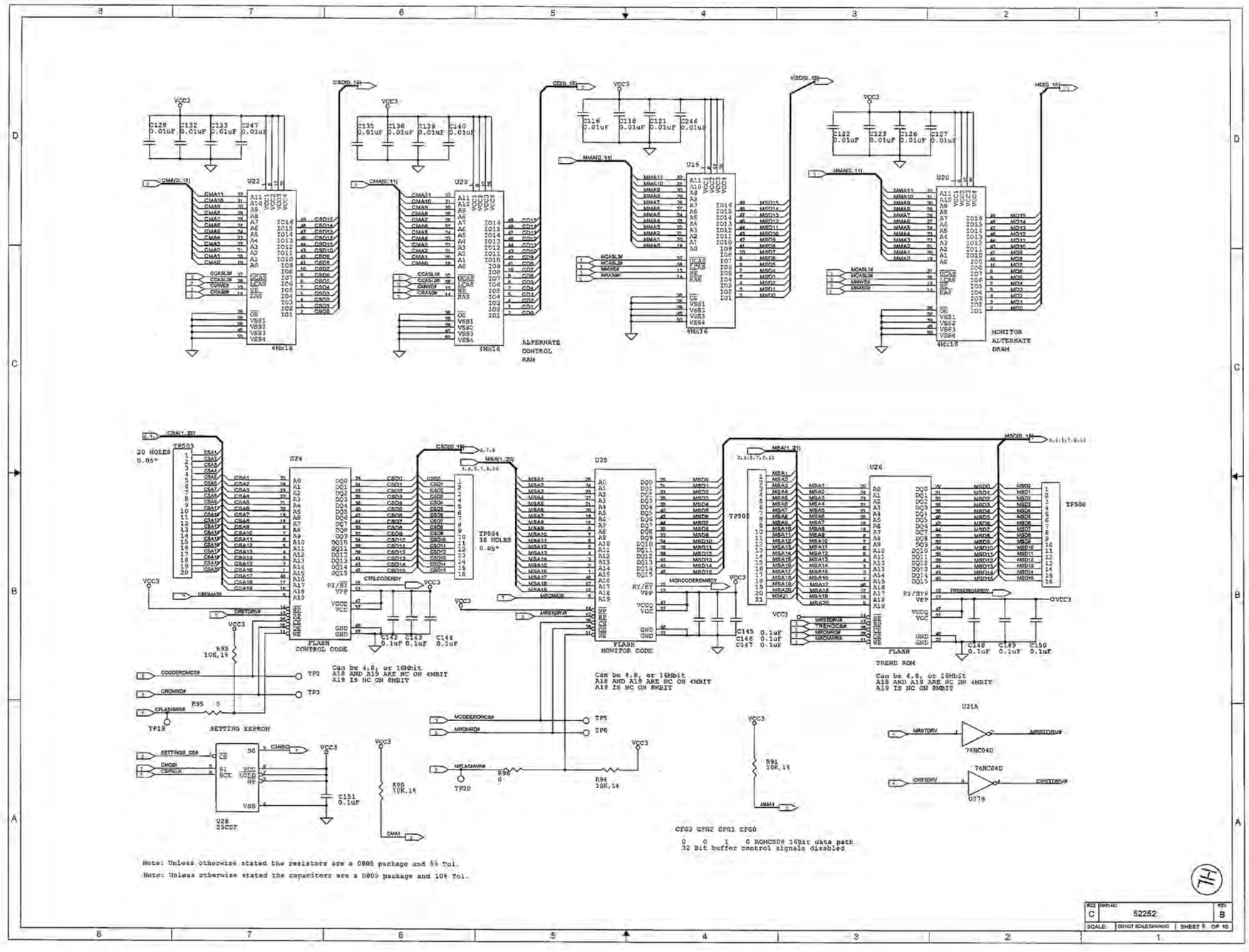


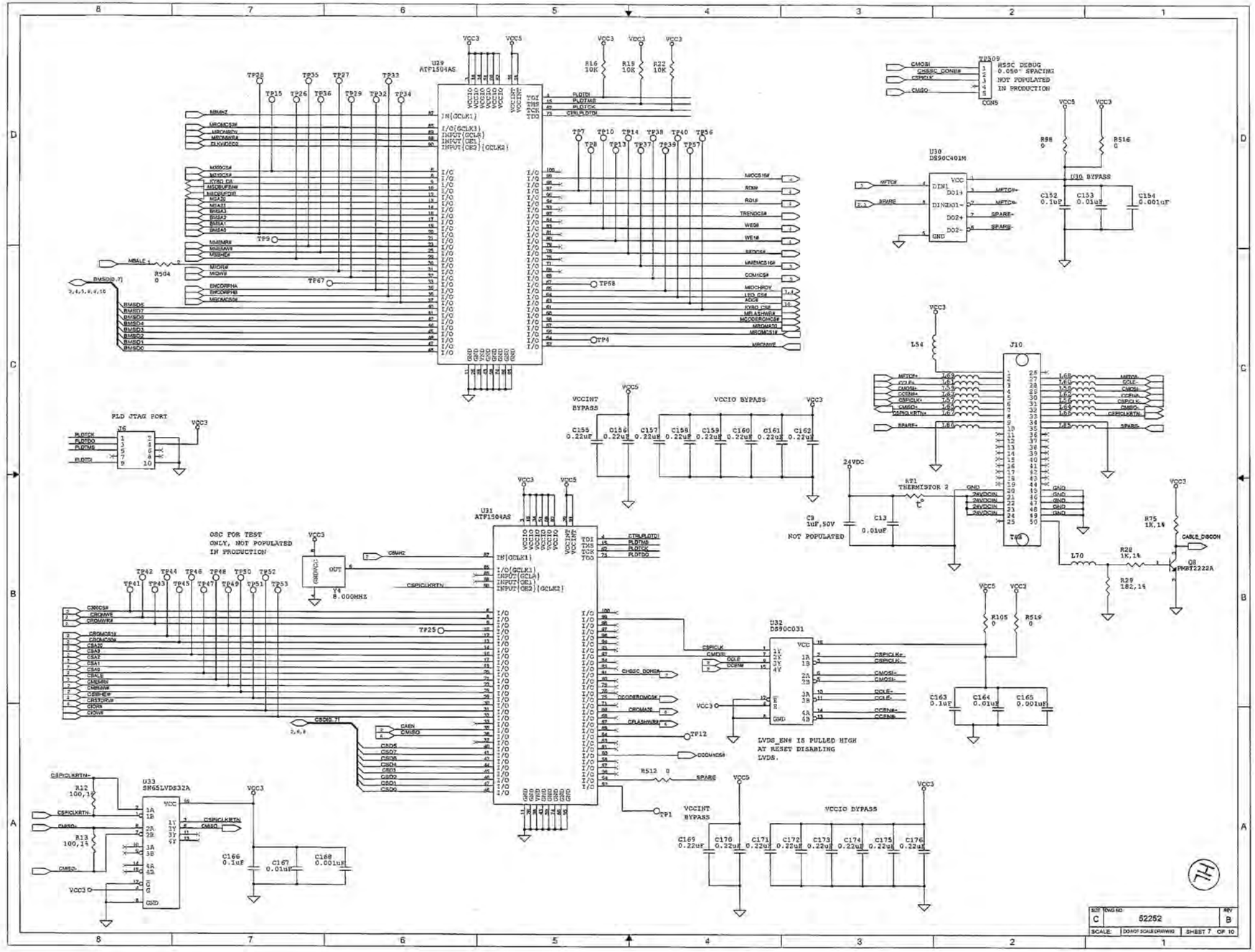

CONTROL
ELAN 410
32.768 KHz CRYSTAL
ECLIPTEK ECPSM29T
0.050" SPACING
NOT POPULATED
IN PRODUCTION
CONTROL
CPU
JTAG
Note: Unless otherwise stated the resistors are a 0805 package and 5% Tol.
Note: Unless otherwise stated the capacitors are a 0805 package and 10% Tol.
52252
SHEET 2 OF 10

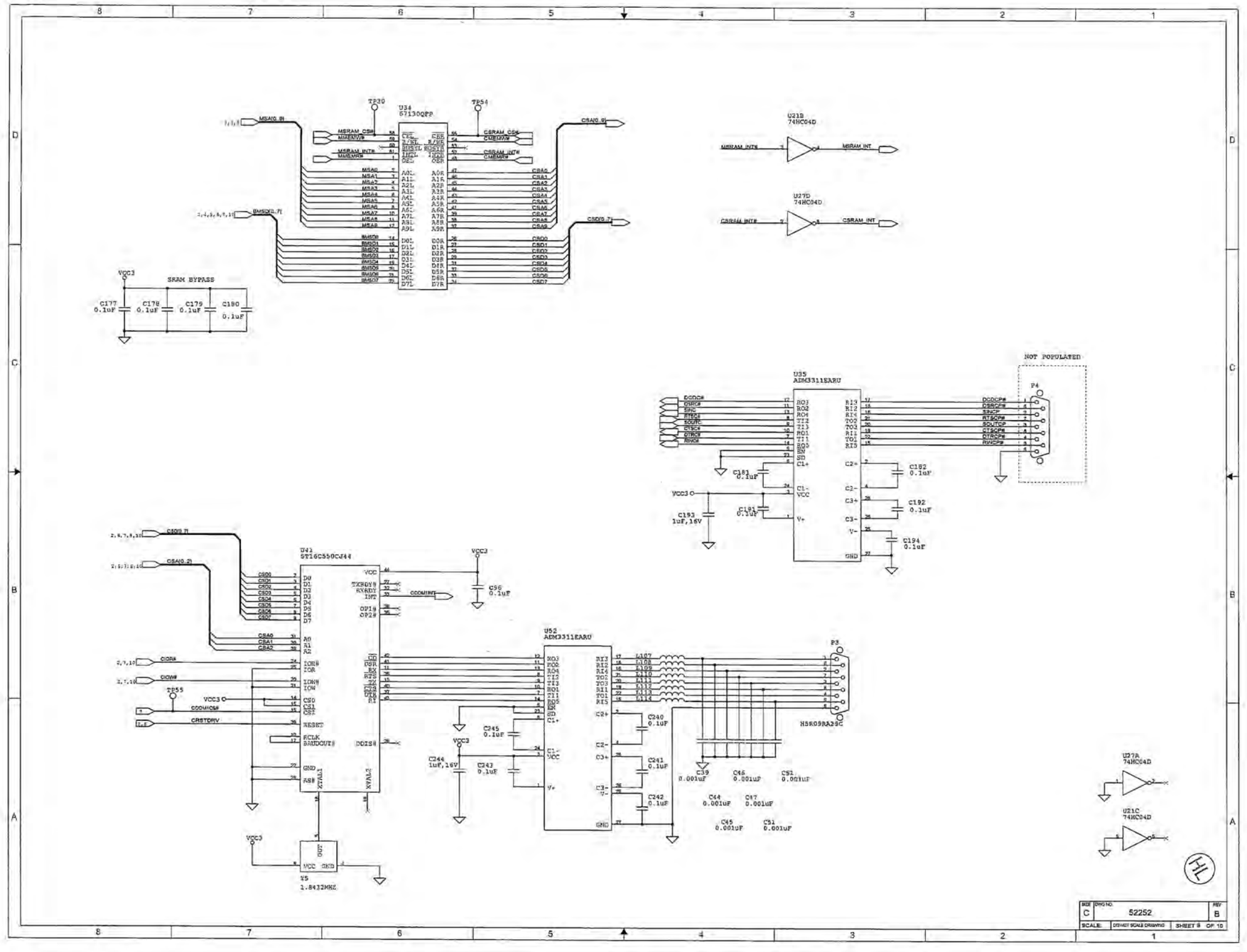

MONITOR
ELAN 410
U2
U42
74LVT245MSA
U4
74LVT245MSA
CPU JTAG
32.768 KHz CRYSTAL
MEDBUFDIR = L
IS B -> A
Note: Unless otherwise stated the resistors are a 0805 package and 5% Tol.
Note: Unless otherwise stated the capacitors are a 0805 package and 10% Tol.
52252
SHEET 3 OF 10

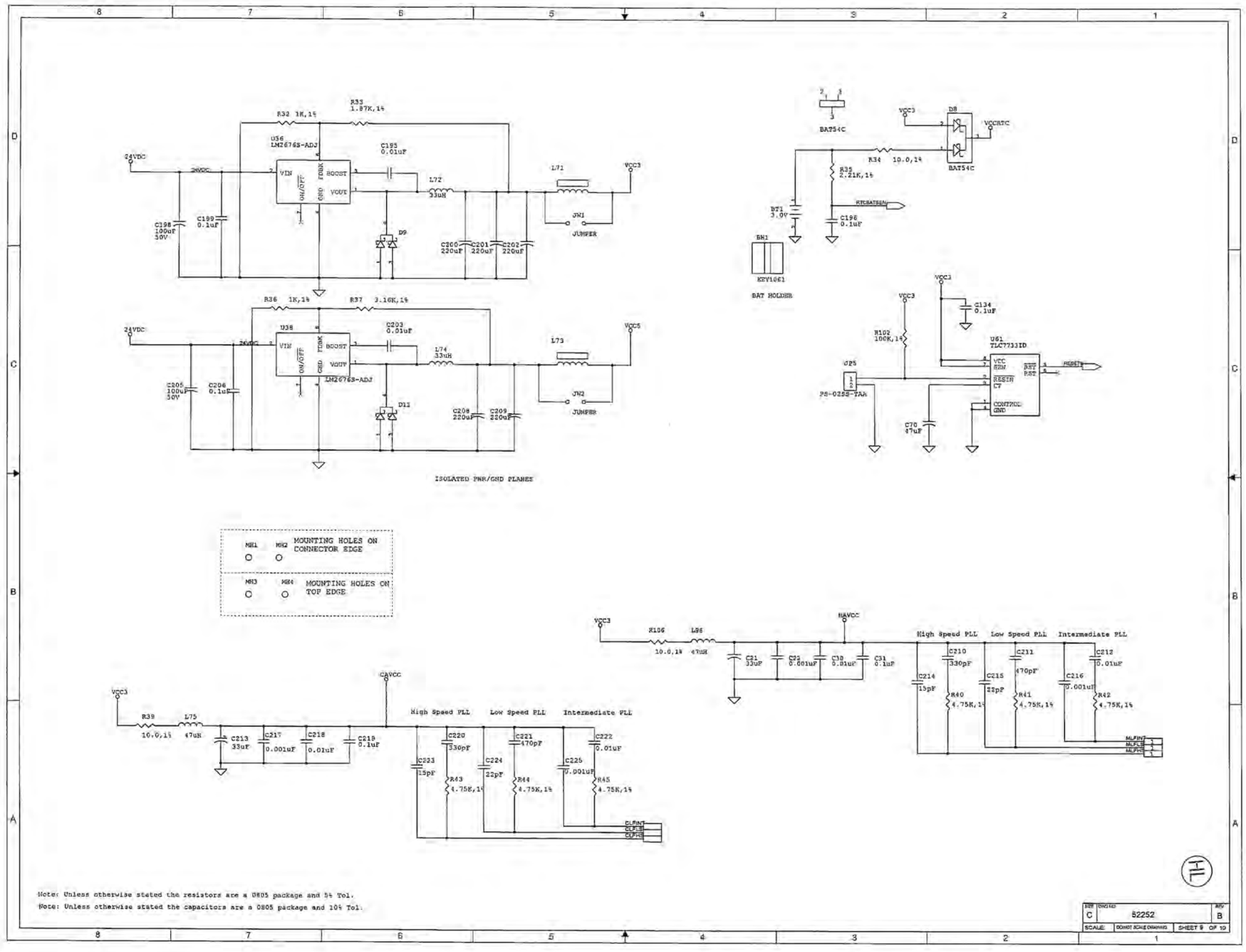

BACKLIGHT INVERTER
SUPPORTS A STRIP INVERTER
IOVDD & COREVDD
BYPASS CAPS
BYPASS FOR 3.3 AT LCD CONNECTORS
HC259'S
52252
SHEET 4 OF 10

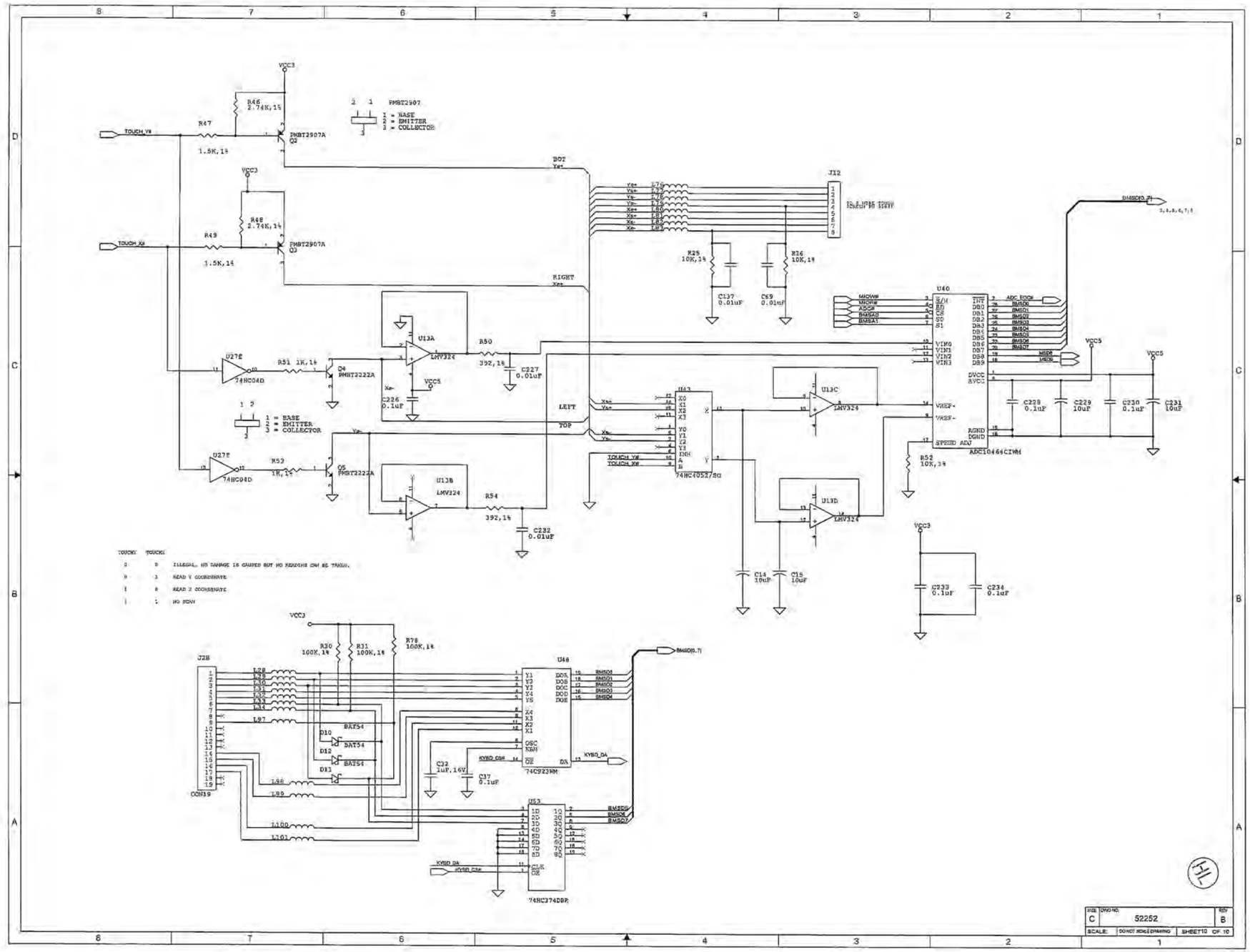

U14
ADM3311EARU
TP502
8 HOLES
160ohms @ 100MHZ
Serial Connector
P1
24VDC
5V 500mA
U62
LM2674M-5.0
L55
150uH
D16
MBRS240LT3
U15
ST16C550CJ44
U16
MAX3226E
R17 10K,1%
R21 100,1%
L26
L27
SINBP
SOUTBP
External Connection
allows factory programming
of flash boot sector
D3
MMBD4148
LS1
Q1
2N7002/SOT
U17
74AHCT374DW
Y2
1.8432MHZ
P2
Parallel Connector
side view
Component
JP2
64448B-5
AMP
L52
L53
U58
MC78258
U59
MC78256
LEVEL SHIFT TO 3.3V
U19
FACDND02QB
52252
SHEET 5 OF 10


ALTERNATE CONTROL RAM
MONITOR ALTERNATE DRAM
20 HOLES 0.05"
TP503
TP504 16 HOLES 0.05"
TP505
TP506
FLASH CONTROL CODE
FLASH MONITOR CODE
FLASH TREND ROM
SETTING EEPROM
Can be 4,8, or 16Mbit A18 AND A19 ARE NC ON 4MBIT A19 IS NC ON 8MBIT
CFG3 CFG2 CFG1 CFG0
0 0 1 0 ROMCSON 16bit data path 32 Bit buffer control signals disabled
Note: Unless otherwise stated the resistors are a 0805 package and 5% Tol.
Note: Unless otherwise stated the capacitors are a 0805 package and 10% Tol.
52252
SHEET 5 OF 10

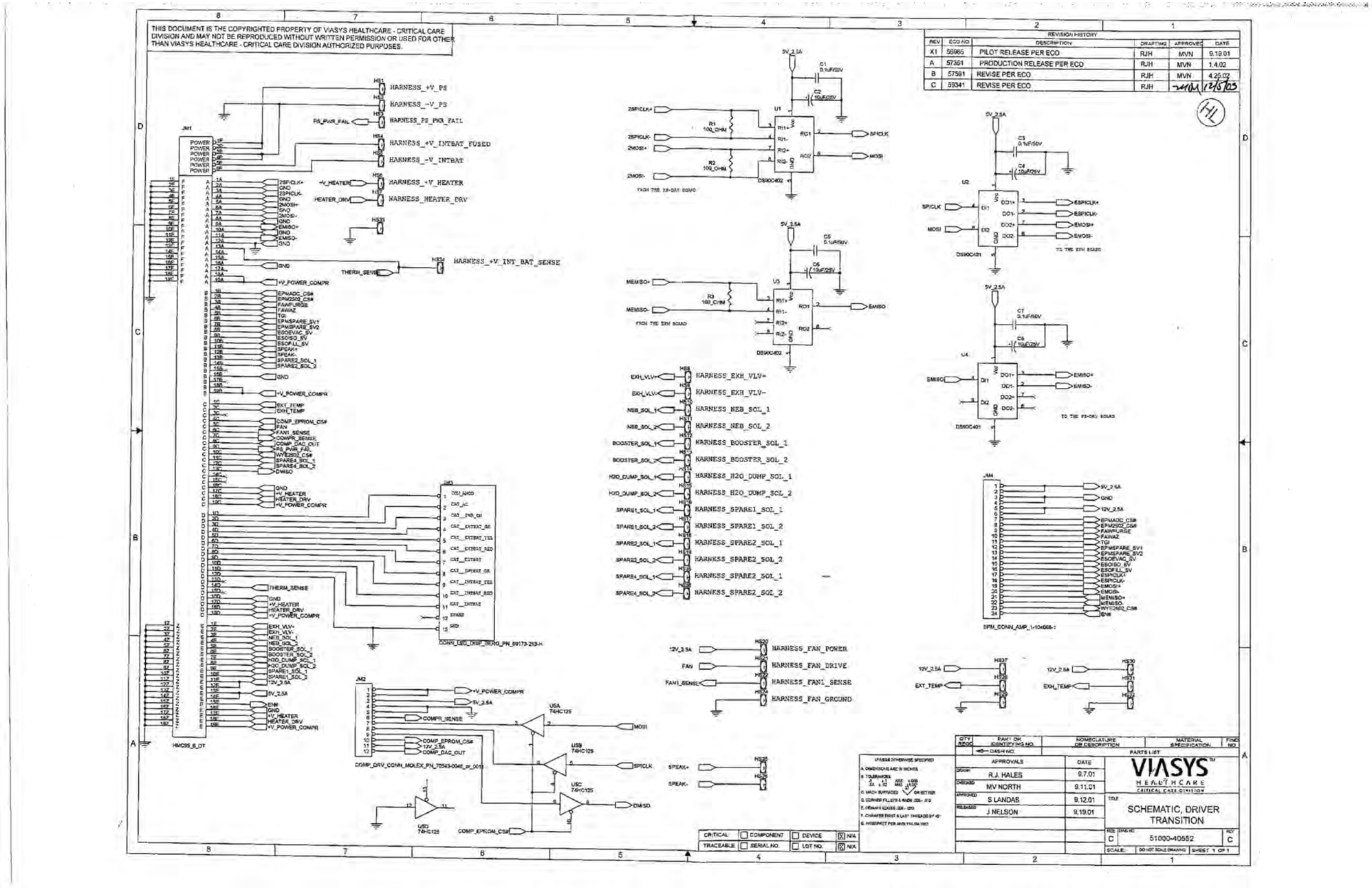

U29
ATF1504AS
U30
DS90C401M
U31
ATF1504AS
U32
DS90C031
U33
SN65LVDS32A
J6
PLD JTAG PORT
J10
TP309
HSSC DEBUG
0.050" SPACING
NOT POPULATED
IN PRODUCTION
CON5
J10 BYPASS
VCCINT BYPASS
VCCIO BYPASS
OSC FOR TEST
ONLY, NOT POPULATED
IN PRODUCTION
Y4
8.000MHZ
LVDS_EN# IS PULLED HIGH
AT RESET DISABLING
LVDS.
THERMISTOR 2
NOT POPULATED
CABLE_DISCON
Q8
PMBT2222A
SIZE
C
DWG NO.
52252
REV
B
SCALE:
DO NOT SCALE DRAWING
SHEET 7 OF 10


TP30
U34
67130QFP
TP54
MSA0..8
MSRAM_CS#
MUXEN7/8
MSRAM_INT#
MUXEN/8
CSA0..8
CSRAM_CS#
CSRAM_INT#
MSD0..7
CSD0..7
U21B
74HC04D
MSRAM_INT#
MSRAM_INT
U27D
74HC04D
CSRAM_INT#
CSRAM_INT
VCC3
SRAM BYPASS
C177 0.1uF
C178 0.1uF
C179 0.1uF
C180 0.1uF
U35
ADM3311EARU
DCDCP#
DSRCP#
SRCP
RTSCP#
SOUTCP
CTSCP#
DTRCP#
RINCP#
C183 0.1uF
C182 0.1uF
C181 0.1uF
C192 0.1uF
C193 1uF,16V
C194 0.1uF
NOT POPULATED
P4
U42
ST16C550CJ44
CSD0..7
CSA0..2
VCC3
C96 0.1uF
CCOMRINT
CIOR#
CIOW#
TP55
CCOMRCS#
CRSTDRV
XTAL1
XTAL2
Y5
1.8432MHZ
U52
ADM3311EARU
C245 0.1uF
C244 1uF,16V
C243 0.1uF
C240 0.1uF
C241 0.1uF
C242 0.1uF
C39 0.001uF
C46 0.001uF
C52 0.001uF
C44 0.001uF
C47 0.001uF
C45 0.001uF
C51 0.001uF
P3
H5R09RA29C
U27A
74HC04D
U21C
74HC04D
SIZE C
DWG NO. 52252
REV B
SCALE: DO NOT SCALE DRAWING
SHEET 8 OF 10


R32 1K,1%
R33 1.87K,1%
U36 LM2676S-ADJ
C195 0.01uF
24VDC
24VDC
VIN
ON/OFF
GND
FDBK
BOOST
VOUT
L72 33uH
L71
VCC3
C198 100uF 50V
C199 0.1uF
D9
C200 220uF
C201 220uF
C202 220uF
JW1 JUMPER
R36 1K,1%
R37 3.16K,1%
U38 LM2676S-ADJ
C203 0.01uF
L74 33uH
L73
VCC5
C205 100uF 50V
C206 0.1uF
D11
C208 220uF
C209 220uF
JW2 JUMPER
ISOLATED PWR/GND PLANES
MH1 MH2 MOUNTING HOLES ON CONNECTOR EDGE
MH3 MH4 MOUNTING HOLES ON TOP EDGE
BAT54C
VCC3
D8
VCC5TC
BAT54C
R34 10.0,1%
R35 2.21K,1%
BT1 3.0V
RTCBATSEN
C196 0.1uF
BH1
KEY1061
BAT HOLDER
VCC3
C134 0.1uF
R102 100K,1%
U61 TLC7733ID
VCC
SENS
RESIN
CT
CONTROL
GND
RST
RST
RESET#
JP5
PS-02SS-TAA
C70 47uF
VCC3
R106 10.0,1%
L96 47uH
NAVCC
C21 33uF
C22 0.001uF
C30 0.01uF
C31 0.1uF
High Speed PLL
Low Speed PLL
Intermediate PLL
C210 330pF
C214 15pF
R40 4.75K,1%
C211 470pF
C215 22pF
R41 4.75K,1%
C212 0.01uF
C216 0.001uF
R42 4.75K,1%
MLFINT
MLFLS
MLFHS
CAVCC
VCC3
R39 10.0,1%
L75 47uH
C213 33uF
C217 0.001uF
C218 0.01uF
C219 0.1uF
High Speed PLL
Low Speed PLL
Intermediate PLL
C220 330pF
C223 15pF
R43 4.75K,1%
C221 470pF
C224 22pF
R44 4.75K,1%
C222 0.01uF
C225 0.001uF
R45 4.75K,1%
CLFINT
CLFLS
CLFHS
Note: Unless otherwise stated the resistors are a 0805 package and 5% Tol.
Note: Unless otherwise stated the capacitors are a 0805 package and 10% Tol.
SIZE C
DWG NO 52252
REV B
SCALE: DONOT SCALE DRAWING
SHEET 9 OF 10


VCC3
R46 2.74K,1%
R47 1.5K,1%
TOUCH_YN
PMBT2907A Q2
PMBT2907
1 = BASE
2 = EMITTER
3 = COLLECTOR
BOT
Y+
R48 2.74K,1%
R49 1.5K,1%
TOUCH_XP
PMBT2907A Q3
RIGHT
X+
J12
R25 10K,1%
R26 10K,1%
C137 0.01uF
C69 0.01uF
U40
ADC1044CIWM
U27E
74HC04D
R51 1K,1%
Q4 PMBT2222A
U13A LMV324
R50 392,1%
C227 0.01uF
C226 0.1uF
LEFT
TOP
U27F
R53 1K,1%
Q5 PMBT2222A
U13B LMV324
R54 392,1%
C232 0.01uF
U43
74HC4052/SO
U13C LMV324
U13D LMV324
R52 10K,1%
C228 0.1uF
C229 10uF
C230 0.1uF
C231 10uF
C14 10uF
C15 10uF
C233 0.1uF
C234 0.1uF
TOUCH1 TOUCH0
0 0 ILLEGAL, NO DAMAGE IS CAUSED BUT NO RESULTS CAN BE TAKEN.
0 1 READ Y COORDINATE
1 0 READ X COORDINATE
1 1 NO SCAN
R30 100K,1%
R31 100K,1%
R78 100K,1%
J28
CON19
L96
L97
L98
L99
L100
L101
D10 BAT54
D12 BAT54
D13 BAT54
C32 1uF,16V
C37 0.1uF
U48
74C923WM
KYBD_CS#
KYBD_DA
U53
74HC374DBR
BMSD(0..7)
BMSD0
BMSD1
BMSD2
BMSD3
BMSD4
BMSD5
BMSD6
BMSD7
SIZE C
DWG NO: 52252
REV B
SCALE: DO NOT SCALE DRAWING
SHEET 10 OF 10

PCBA, Driver Transition



PCBA, Power Driver Board

REVISION HISTORY

REV	ECO NO.	DESCRIPTION	DRAFTING	APPROVED	DATE
X1	59162	PILOT RELEASE PER ECO	RJH	MG	9.18.03
A	59204	PRODUCTION RELEASE PER ECO	RJH	MG	10.8.03
B	59379	REVISE PER ECO	RJH	MVN	12.8.03
C	59636	REVISE PER ECO	RJH	MVN	3.17.04
D	59669	REVISE PER ECO	RJH	MVN	6.11.04
E	59866	REVISE PER ECO	RJH	MVN	2.16.05
F	60216	REVISE PER ECO	WKP	MVN	2/24/05

HL

QTY REQD	PART OR IDENTIFYING NO. / ← DASH NO.	NOMECLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	FIND NO.
		PARTS LIST		

UNLESS OTHERWISE SPECIFIED
A. DIMENSIONS ARE IN INCHES.
B. TOLERANCES
.X ±.1 .XXX ±.005
.XX ±.02 ANG ±1.00°
C. MACH SURFACES 32 OR BETTER
D. CORNER FILLETS & RADII .005 - .010
E. DEBURR EDGES .005 - .020
F. CHAMFER FIRST & LAST THREADS BY 45°
G. INTERPRET PER ANSI Y14.5M-1982

	APPROVALS	DATE
DRAWN	RJ HALES	9.9.03
CHECKED	M. GREEN	9.18.03
APPROVED	S. LANDAS	9.18.03
RELEASED	H. LACY	9.19.03

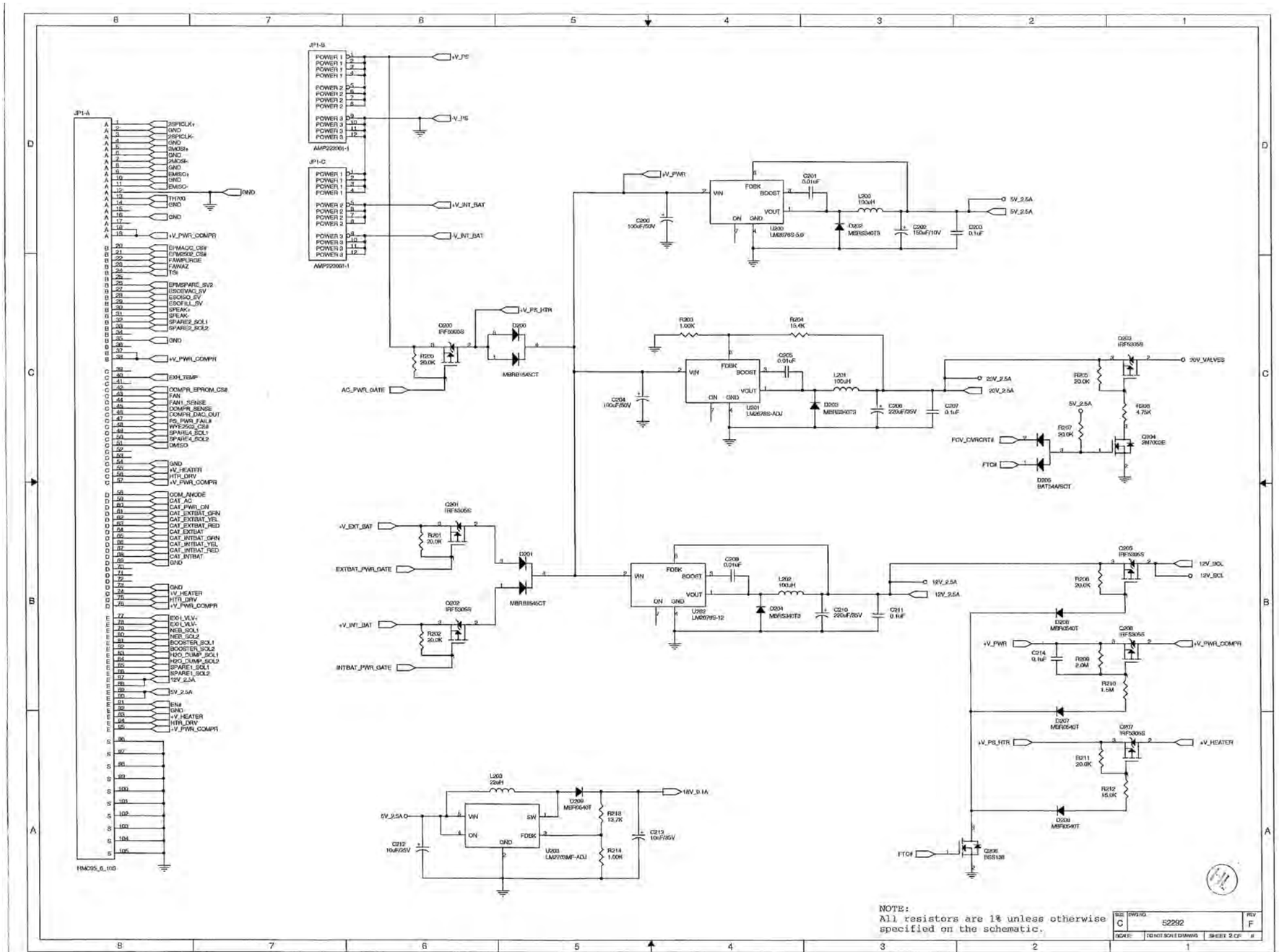
VIASYS™ HEALTHCARE CRITICAL CARE DIVISION

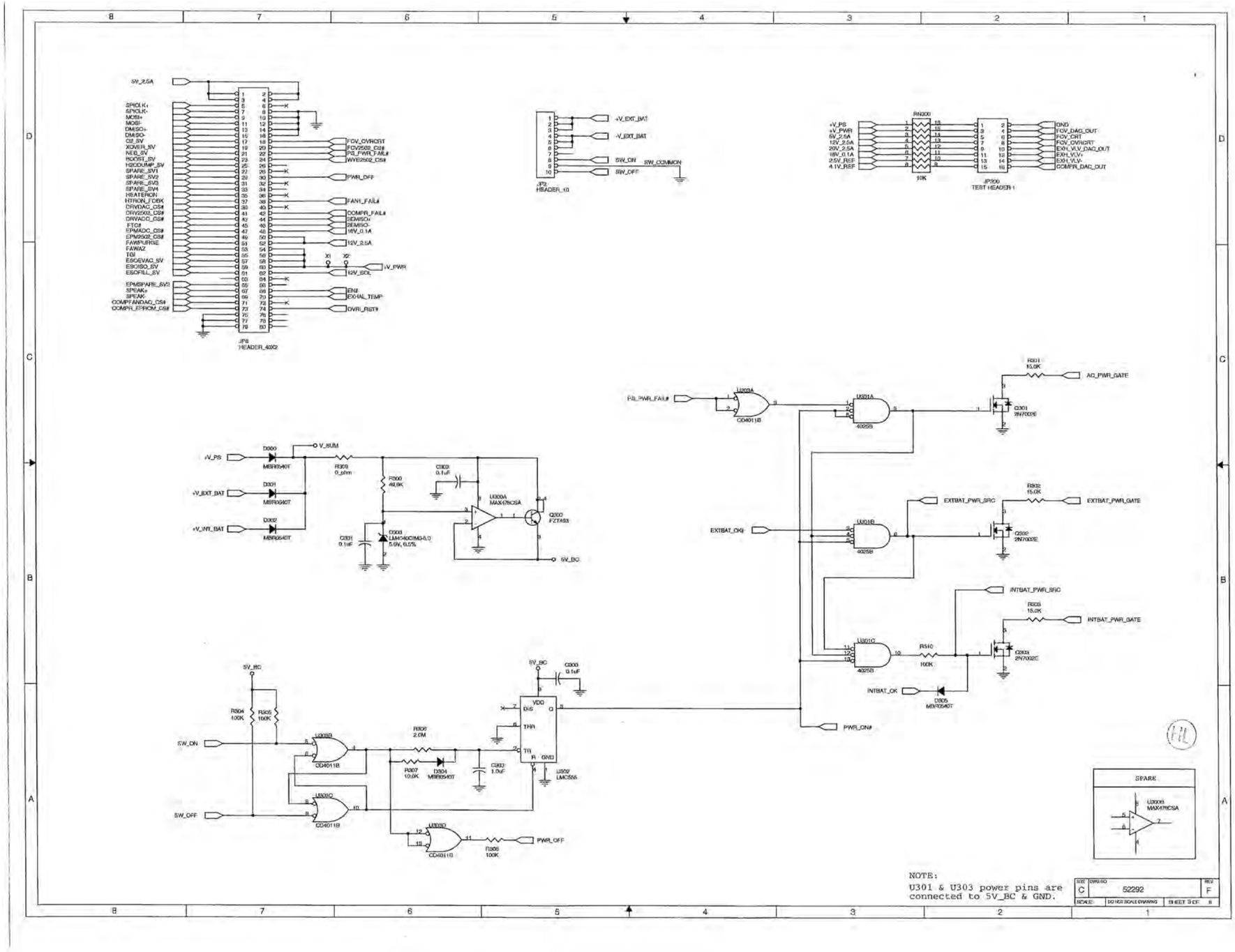
TITLE: SCHEMATIC, POWER DRIVER

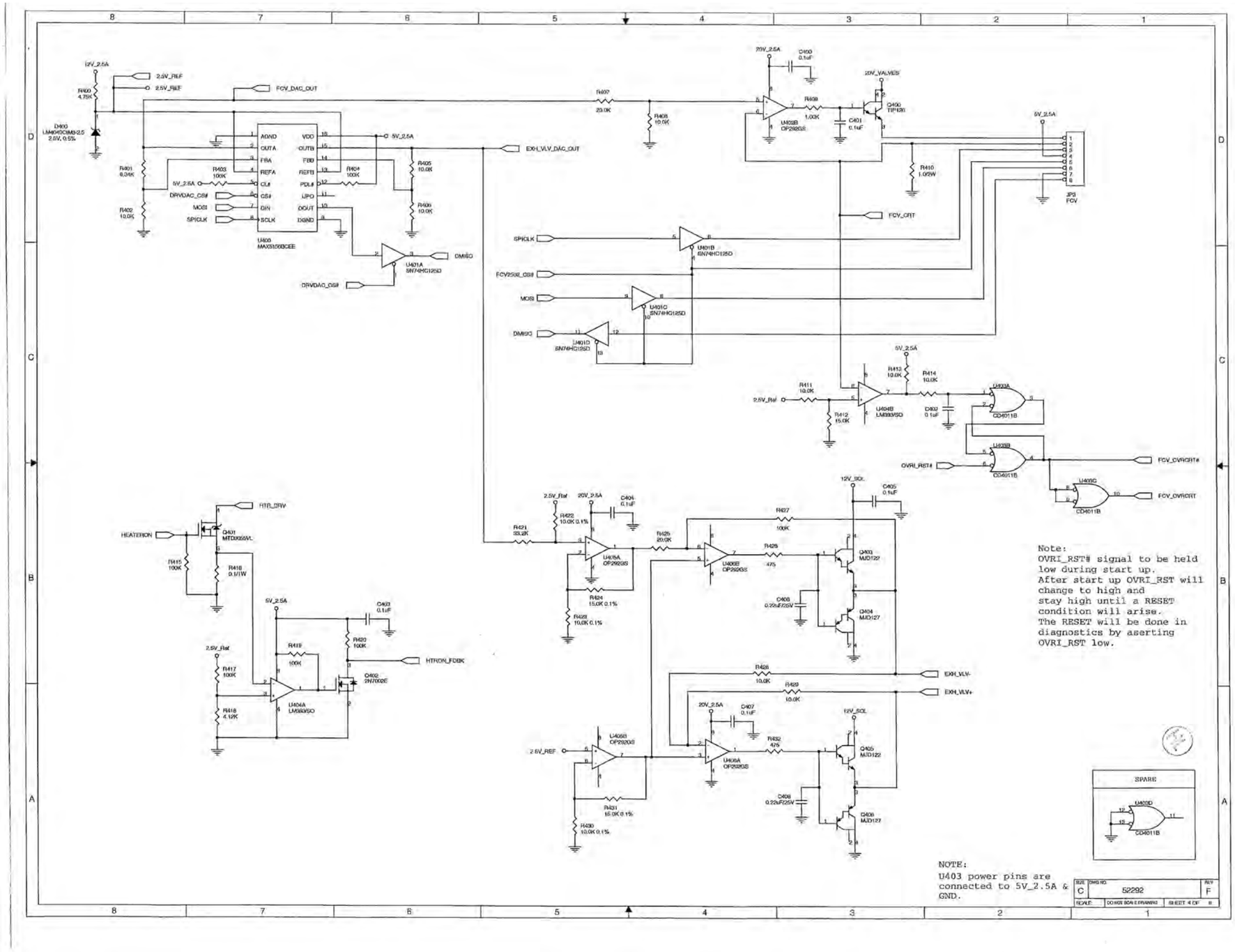
SIZE	DWG NO.	REV
C	52292	F

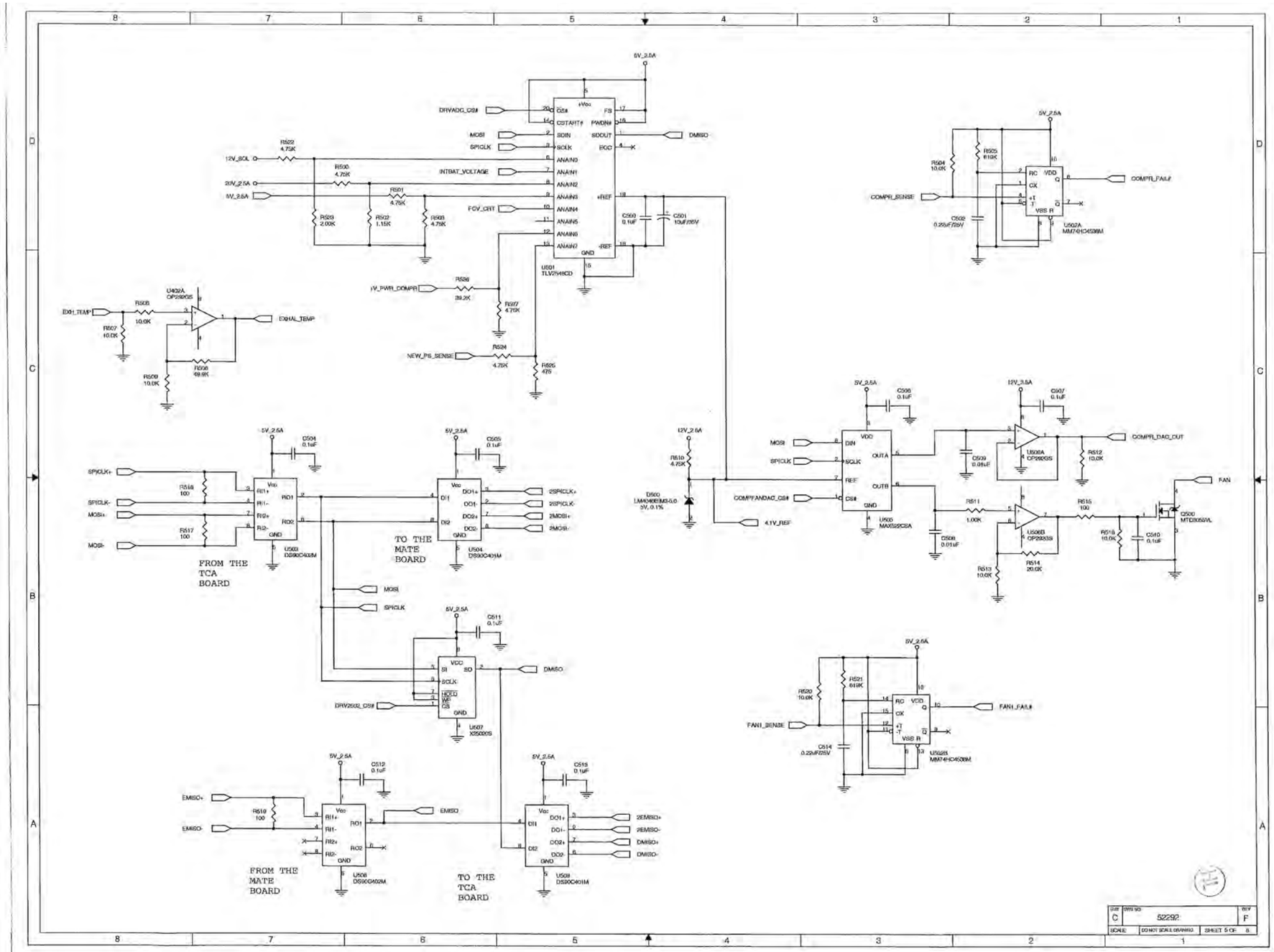
SCALE: | DO NOT SCALE DRAWING | SHEET 1 OF 8

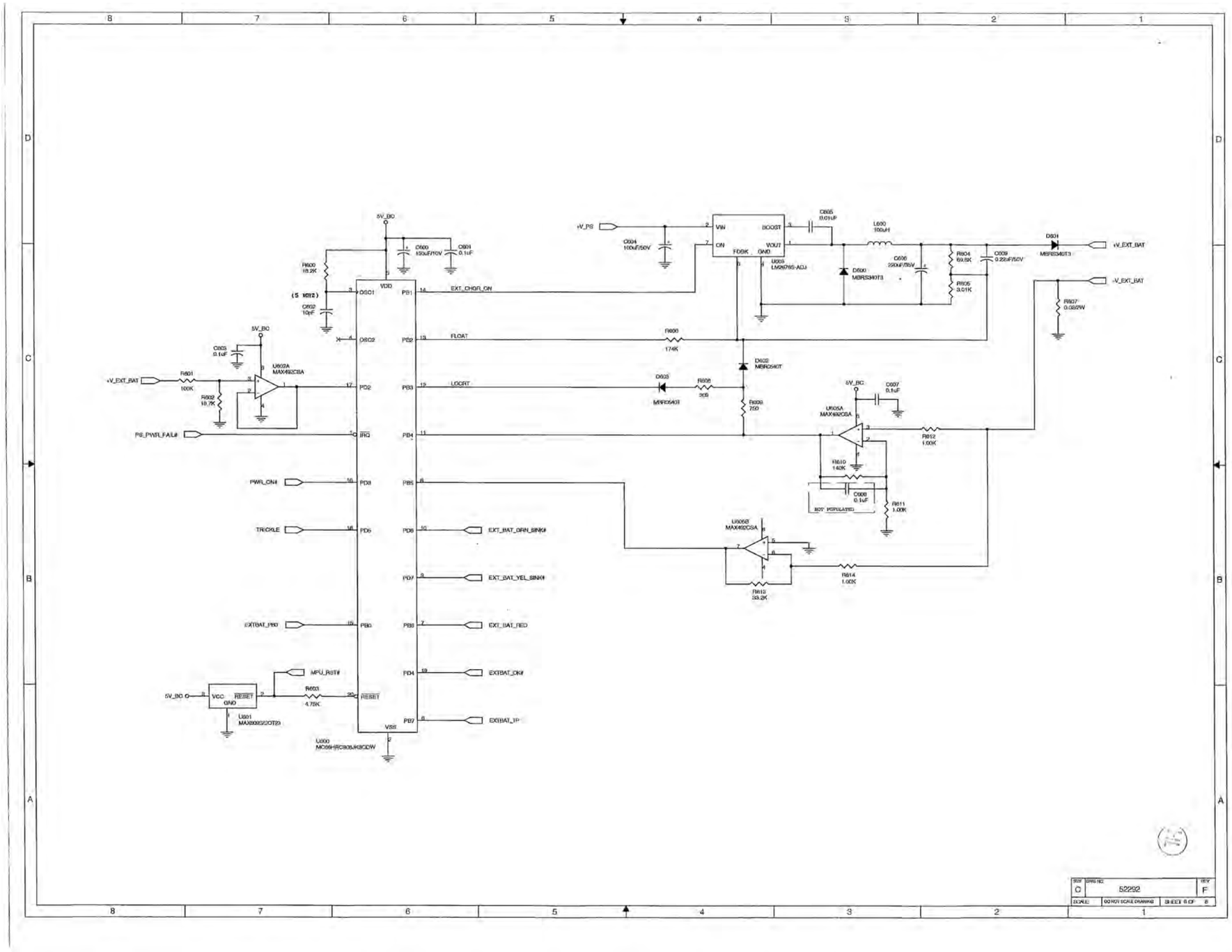
CRITICAL	☐ COMPONENT	☐ DEVICE	☒ N/A
TRACEABLE	☐ SERIAL NO.	☐ LOT NO.	☒ N/A

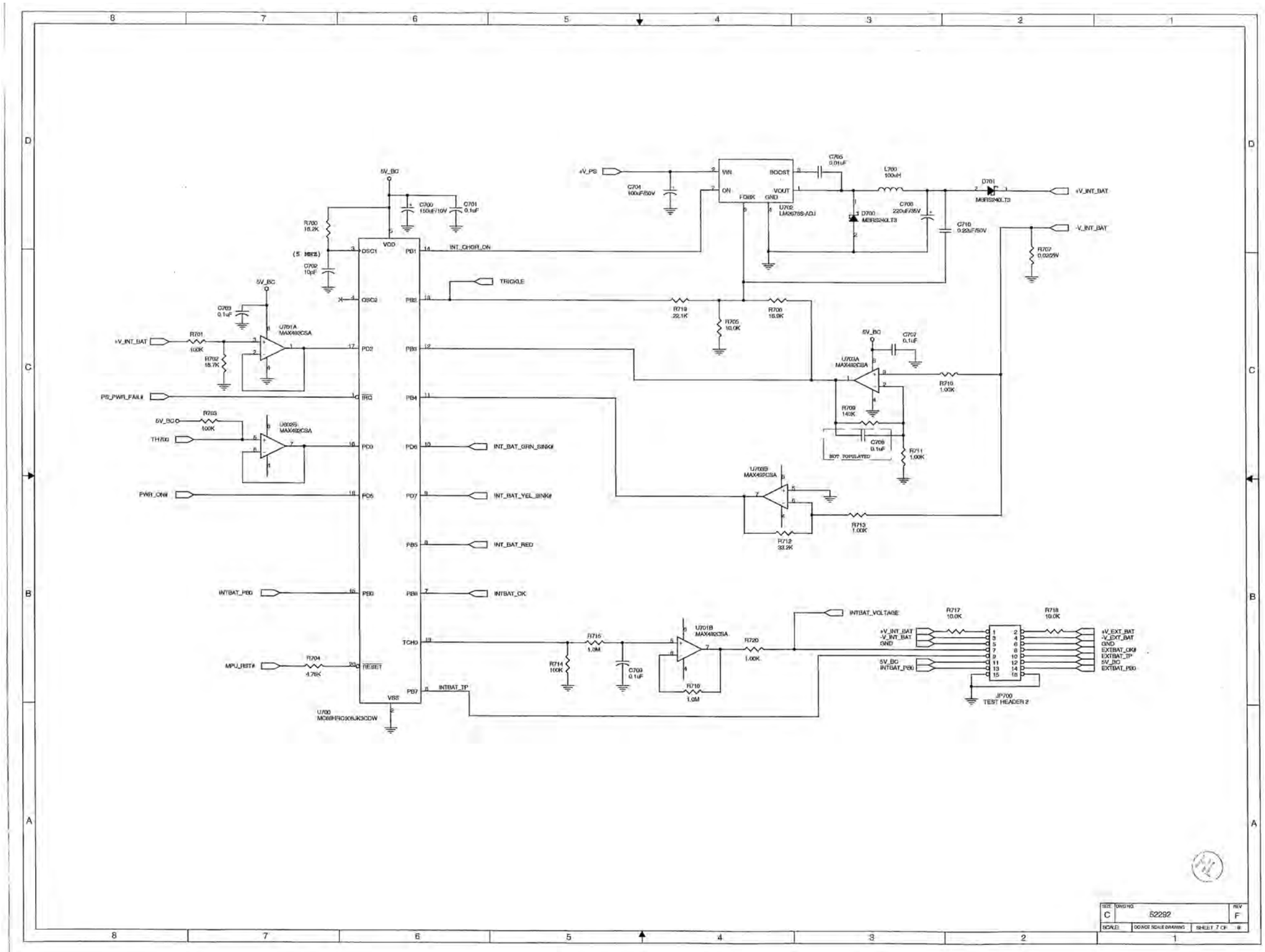

JP1-A
JP1-B
JP1-C
AMP222061-1
+V_PWR_COMPR
+V_PS_HTR
+V_INT_BAT
+V_EXT_BAT
AC_PWR_GATE
EXTBAT_PWR_GATE
INTBAT_PWR_GATE
LM2678S-5.0
LM2678S-ADJ
LM2733MF-ADJ
LM2595-12
MBRB1545CT
MBRS340T3
MBR0540T
IRF5305S
IRF530S
BAT54AWSDT
BSS138
5V_2.5A
12V_2.5A
18V_0.1A
20V_VALVES
12V_SOL
FTC#
FCV_CMRORT#
NOTE:
All resistors are 1% unless otherwise specified on the schematic.
52292
SHEET 2 OF 8

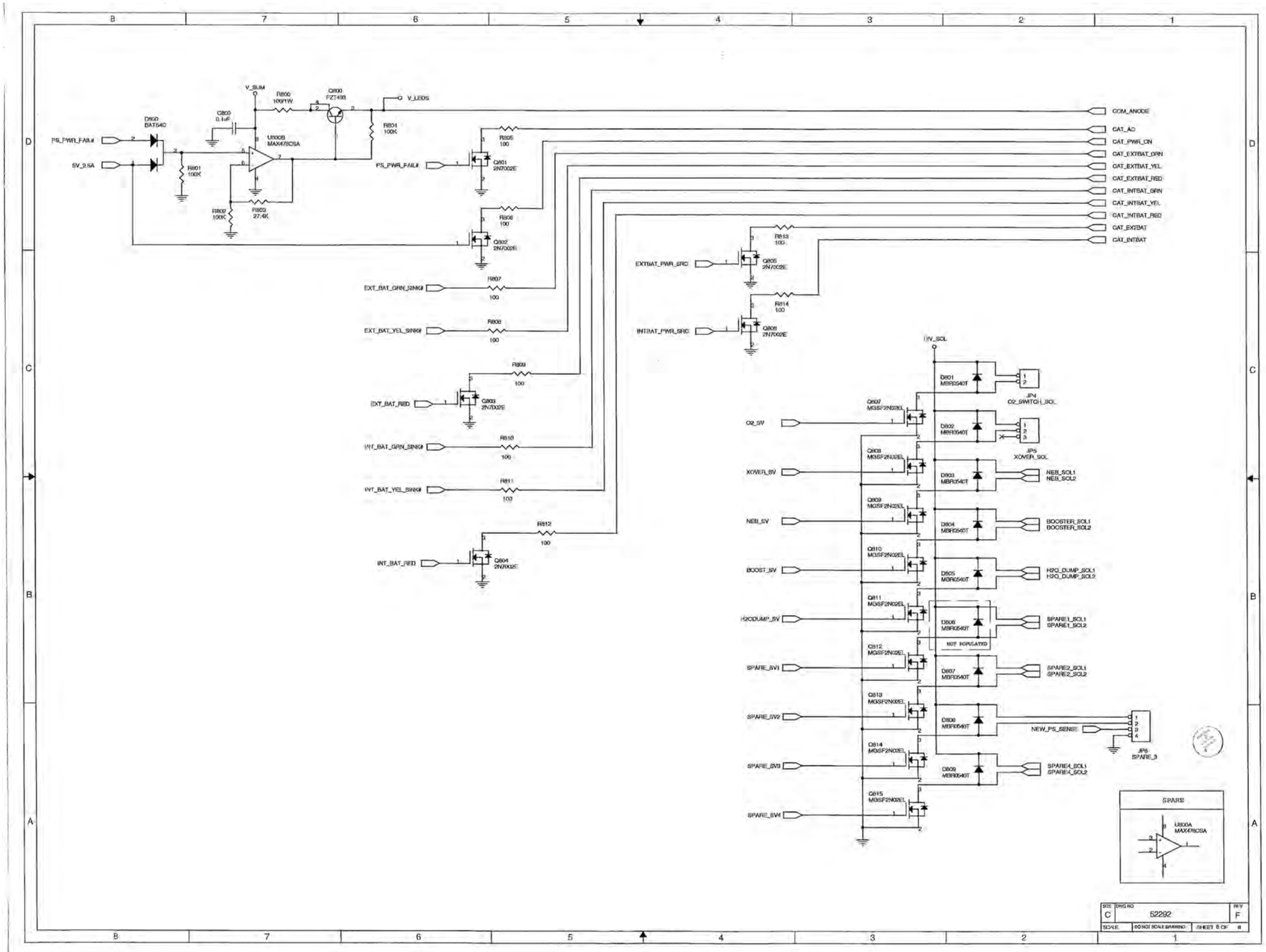

5V_2.5A
SPICLK+
SPICLK-
MOSI+
MOSI-
DMISO+
DMISO-
O2_5V
XOVER_5V
NEB_5V
ROAST_5V
HICDUMP_5V
SPARE_5V1
SPARE_5V2
SPARE_5V3
SPARE_5V4
HEATERON
HTRON_FDBK
DRVDAC_CS#
DRV2502_CS#
DRVACC_CS#
FTC#
EPMADC_CS#
EPM502E_CS#
FAWPURGE
FAWAZ
TdI
ESOEVAC_5V
ESOISO_5V
ESOFILL_5V
EPMSPARE_5V2
SPEAK+
SPEAK-
COMPFANDAC_CS#
COMPR_EPROM_CS#
FOV_OVRCRT
FOV2502_CS#
PS_PWR_FAIL#
WYE2502_CS#
PWR_OFF
FAN1_FAIL#
COMPR_FAIL#
SEMISO+
SEMISO-
16V_0.1A
12V_2.5A
+V_PWR
12V_SOL
EN#
EXHAL_TEMP
OVRI_RST#
JP8
HEADER_40X2
+V_EXT_BAT
-V_EXT_BAT
SW_ON
SW_COMMON
SW_OFF
JP2
HEADER_10
RN300
10K
+V_PS
+V_PWR
5V_2.5A
12V_2.5A
20V_2.5A
18V_0.1A
2.5V_REF
4.1V_REF
GND
FOV_DAC_OUT
FOV_CRT
FOV_OVRCRT
EXH_V_V_DAC_OUT
EXH_V_V+
EXH_V_V-
COMPR_DAC_OUT
JP300
TEST HEADER 1
PS_PWR_FAIL#
U302A
CD4011B
U301A
4025B
R301
15.0K
AC_PWR_GATE
Q301
2N7002E
EXTBAT_OK#
EXTBAT_PWR_SRC
R302
15.0K
EXTBAT_PWR_GATE
Q302
2N7002E
U301B
INTBAT_PWR_SRC
R303
15.0K
INTBAT_PWR_GATE
Q303
2N7002E
U301C
R310
100K
INTBAT_OK
D305
MBR0540T
PWR_ON#
+V_PS
D300
MBR0540T
V_SUM
R309
0_ohm
+V_EXT_BAT
D301
MBR0540T
+V_INT_BAT
D302
MBR0540T
R300
49.9K
C302
0.1uF
C301
0.1uF
D303
LM4040D3MG-5.0
5.0V, 0.5%
U300A
MAX476CSA
Q300
FZT493
5V_BC
5V_ON
R304
100K
R305
100K
U303B
CD4011B
R306
2.0M
R307
10.0K
D304
MBR0540T
C303
1.0uF
U302
LMC555
C300
0.1uF
5V_OFF
U303C
CD4011B
U303D
CD4011B
R308
100K
PWR_OFF
SPARE
U300B
MAX476CSA
NOTE:
U301 & U303 power pins are connected to 5V_BC & GND.
SIZE C
DWG NO 52292
REV F
SCALE: DO NOT SCALE DRAWING
SHEET 3 OF 8


12V_2.5A
2.5V_REF
2.5V_REF
FCV_DAC_OUT
R400 4.75K
D400 LM4040CIM3-2.5 2.5V, 0.5%
R401 8.34K
R402 10.0K
R403 100K
5V_2.5A
DRVDAC_CS#
MOSI
SPICLK
U405 MAX5160CEE
AGND
OUTA
FBA
REFA
CLR#
CS#
DIN
SCLK
VDD
OUTB
FBB
REFB
PDL#
LPO
DOUT
DGND
5V_2.5A
R404 100K
R405 10.0K
R406 10.0K
EXH_VLV_DAC_OUT
DMISO
U401A SN74HC125D
DRVDAC_CS#
R407 29.0K
R408 10.0K
20V_2.5A
C400 0.1uF
20V_VALVES
R409 1.00K
U403B OP282GS
Q400 TIP120
C401 0.1uF
5V_2.5A
R410 1.02W
FCV_CRT
JP3 FCV
SPICLK
U401B SN74HC125D
FCV2502_CS#
MOSI
U401C SN74HC125D
DMISO
U401D SN74HC125D
5V_2.5A
R411 10.0K
2.5V_Ref
R412 10.0K
R412 15.0K
U404B LM393/SO
R414 10.0K
C402 0.1uF
U403A
CD4011B
U403B
CD4011B
OVRI_RST#
FCV_OVRIGHT#
U403C
CD4011B
FCV_OVRCRT
HTR_DRV
HEATERON
Q401 MTD20555VL
R415 100K
R416 0.1/1W
5V_2.5A
C403 0.1uF
2.5V_Ref
R417 100K
R418 4.12K
R419 100K
R420 100K
U404A LM393/SO
Q402 2N7002E
HTRON_FDBK
2.5V_Ref
20V_2.5A
C404 0.1uF
R422 10.0K 0.1%
R421 33.2K
R425 20.0K
U405A OP282GS
R424 15.0K 0.1%
R423 10.0K 0.1%
U406B OP282GS
12V_SOL
C405 0.1uF
R427 100K
R426 475
Q403 MJD122
Q404 MJD127
C406 0.22uF/25V
R428 10.0K
R429 10.0K
EXH_VLV-
EXH_VLV+
20V_2.5A
C407 0.1uF
2.5V_REF
U406D OP282GS
U406A OP282GS
R432 475
Q405 MJD122
Q406 MJD127
C408 0.22uF/25V
R431 15.0K 0.1%
R430 10.0K 0.1%
Note:
OVRI_RST# signal to be held low during start up.
After start up OVRI_RST will change to high and stay high until a RESET condition will arise.
The RESET will be done in diagnostics by asserting OVRI_RST low.
SPARE
U403D
CD4011B
NOTE:
U403 power pins are connected to 5V_2.5A & GND.
SIZE C
DWG NO. 52292
REV F
SCALE
DO NOT SCALE DRAWING
SHEET 4 OF
8
7
6
5
4
3
2
1
A
B
C
D

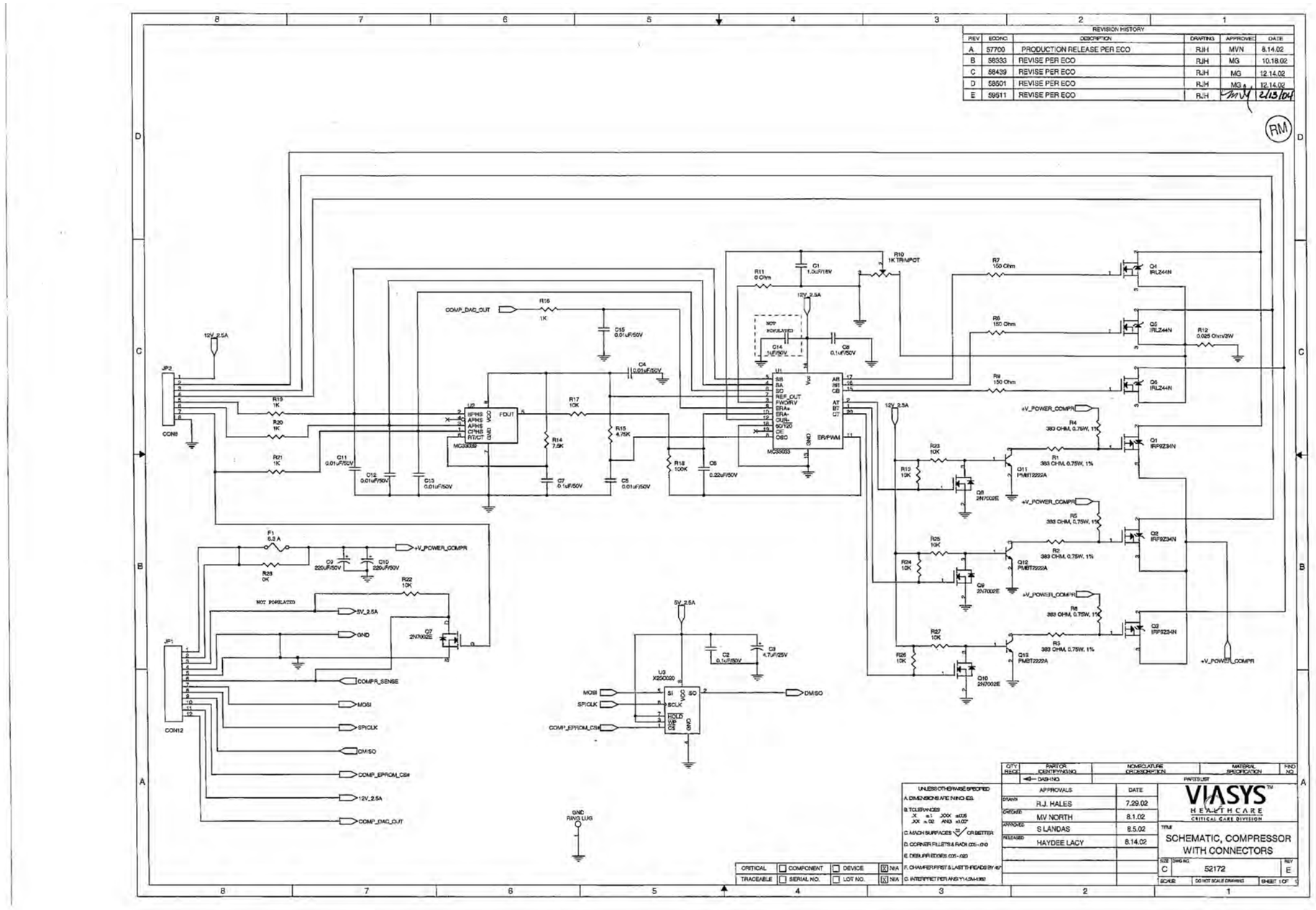

5V_2.5A
DRVADC_CS#
MOSI
SPICLK
DMISO
12V_SOL
2V5_2.5A
5V_2.5A
INTBAT_VOLTAGE
FCV_CRT
+V_PWR_COMPR
NEW_PS_SENSE
EXH_TEMP
EXHAL_TEMP
COMPR_SENSE
COMPR_FAIL#
FAN1_SENSE
FAN1_FAIL#
COMPR_DAC_OUT
FAN
4.1V_REF
SPICLK+
SPICLK-
MOSI+
MOSI-
2SPICLK+
2SPICLK-
2MOSI+
2MOSI-
FROM THE TCA BOARD
TO THE MATE BOARD
EMISO+
EMISO-
2EMISO+
2EMISO-
DMISO+
DMISO-
FROM THE MATE BOARD
TO THE TCA BOARD
52292
F
SHEET 5 OF 8


5V_BC
C600 150uF/10V
C601 0.1uF
R600 18.2K
(5 Volt)
C602 10pF
VDD
OSC1
OSC2
+V_PS
C604 100uF/50V
VIN
ON
FDBK
BOOST
VOUT
GND
U603 LM2675S-ADJ
C605 0.01uF
L600 100uH
D600 MBRS340T3
C606 220uF/35V
R604 69.8K
R605 3.01K
C609 0.22uF/50V
D601 MBRS340T3
+V_EXT_BAT
-V_EXT_BAT
R607 0.082W
EXT_CHG/I_ON
FLOAT
LOCRT
R600 174K
D602 MBR2540T
D603 MBR0540T
R606 309
R608 750
C603 0.1uF
U602A MAX462CSA
+V_EXT_BAT
R601 100K
R602 18.7K
PS_PWR_FAIL#
PWR_ON#
TRICKLE
EXTBAT_PRS
MPU_RST#
R603 4.75K
U601 MAX809S/20T29
RESET
VCC
GND
U600 MC68HRC908JK8CDW
PB0
PB1
PB2
PB3
PB4
PB5
PB6
PB7
PD0
PD1
PD2
PD3
PD4
PD5
PD6
PD7
IRQ
VSS
EXT_BAT_GRN_SINK#
EXT_BAT_YEL_SINK#
EXT_BAT_RED
EXTBAT_CK#
EXTBAT_1P
U605A MAX462CSA
C607 0.1uF
R612 1.00K
R610 140K
C608 0.1uF
NOT POPULATED
R611 1.00K
U605B MAX462CSA
R614 1.00K
R613 33.2K
Size C
DWG NO 52292
REV F
SCALE DO NOT SCALE DRAWING
SHEET 8 OF 8

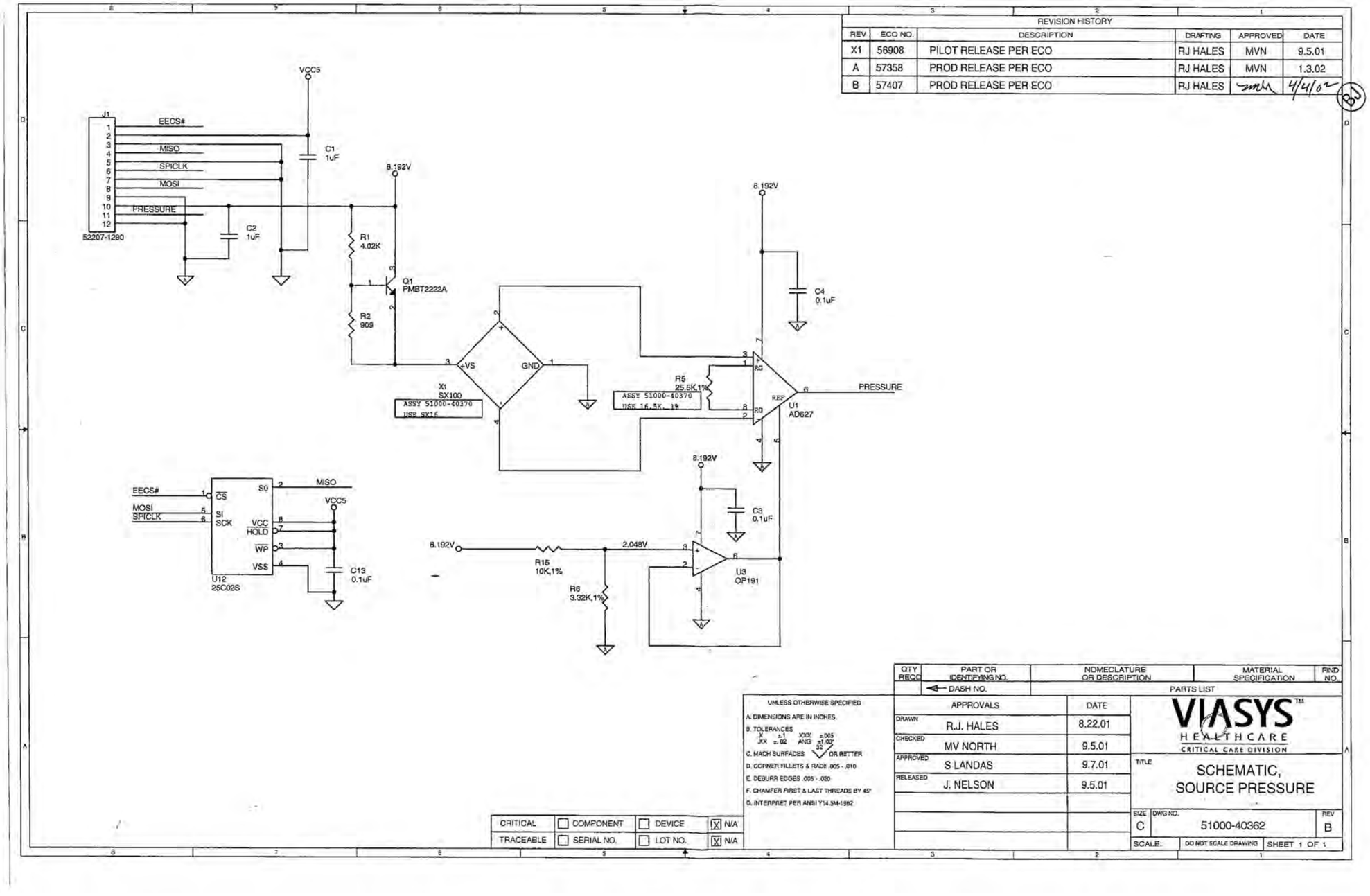

+V_PS
VIN
BOOST
ON
FDBK
VOUT
GND
U702
LM2678S-ADJ
C704
100uF/50V
C705
0.01uF
L700
100uH
D701
MBRS340LT3
+V_INT_BAT
D700
MBRS340LT3
C706
220uF/35V
C710
0.22uF/50V
-V_INT_BAT
R707
0.025W
5V_BC
C700
150uF/10V
C701
0.1uF
R700
18.2K
(5 MHz)
C702
10pF
VDD
OSC1
OSC2
INT_CHGR_ON
TRICKLE
R719
22.1K
R705
10.0K
R706
18.2K
C703
0.1uF
U701A
MAX492CSA
+V_INT_BAT
R701
100K
R702
18.7K
PS_PWR_FAIL#
IRQ
5V_BC
R703
100K
TH700
U702B
MAX492CSA
PWR_ON#
INT_BAT_GRN_SINK#
INT_BAT_YEL_SINK#
INT_BAT_RED
INTBAT_P00
P00
P01
P02
P03
P04
P05
P06
P07
P10
P11
P12
P13
P14
P15
P16
P17
INTBAT_OK
TCH0
RESET
MPU_RST#
R704
4.75K
VSS
INTBAT_TP
U700
MC68HC908JK3CDW
R715
1.0M
R714
100K
C709
0.1uF
U701B
MAX492CSA
R716
1.0M
R720
1.00K
INTBAT_VOLTAGE
R717
10.0K
R718
10.0K
+V_INT_BAT
-V_INT_BAT
GND
5V_BC
INTBAT_P00
+V_EXT_BAT
-V_EXT_BAT
GND
EXTBAT_OK#
EXTBAT_TP
5V_BC
EXTBAT_P00
JP700
TEST HEADER 2
U703A
MAX492CSA
C702
0.1uF
R710
1.00K
R709
1.00K
C708
0.1uF
DO7 POPULATED
R711
1.00K
U703B
MAX492CSA
R713
1.00K
R712
33.2K
SIZE
C
DWG NO.
52292
REV
F
SCALE:
DO NOT SCALE DRAWING
SHEET 7 OF 18


V_SUM
R800 100/1W
Q800 FZT493
V_LEDS
C800 0.1uF
D800 BAT54C
U800B MAX478CSA
PS_PWR_FAIL#
5V_2.5A
R801 100K
R802 100K
R803 27.4K
RB01 100K
Q801 2N7002E
R805 100
R806 100
Q802 2N7002E
R807 100
R808 100
R809 100
Q803 2N7002E
R810 100
R811 100
R812 100
Q804 2N7002E
EXT_BAT_GRN_SINK#
EXT_BAT_YEL_SINK#
EXT_BAT_RED
INT_BAT_GRN_SINK#
INT_BAT_YEL_SINK#
INT_BAT_RED
R813 100
Q805 2N7002E
R814 100
Q806 2N7002E
EXTBAT_PWR_SRC
INTBAT_PWR_SRC
COM_ANODE
CAT_AC
CAT_PWR_ON
CAT_EXTBAT_GRN
CAT_EXTBAT_YEL
CAT_EXTBAT_RED
CAT_INTBAT_GRN
CAT_INTBAT_YEL
CAT_INTBAT_RED
CAT_EXTBAT
CAT_INTBAT
V_SOL
D801 MBRB540T
JP4 O2_SWITCH_SOL
Q807 MGSF2N02EL
O2_SV
D802 MBRB540T
Q808 MGSF2N02EL
XOVER_SV
JP5 XOVER_SOL
D803 MBRB540T
NEB_SOL1
NEB_SOL2
Q809 MGSF2N02EL
NEB_SV
D804 MBRB540T
BOOSTER_SOL1
BOOSTER_SOL2
Q810 MGSF2N02EL
BOOST_SV
D805 MBRB540T
H2O_DUMP_SOL1
H2O_DUMP_SOL2
Q811 MGSF2N02EL
H2ODUMP_SV
D806 MBRB540T
SPARE1_SOL1
SPARE1_SOL2
NOT POPULATED
Q812 MGSF2N02EL
SPARE_SV1
D807 MBRB540T
SPARE2_SOL1
SPARE2_SOL2
Q813 MGSF2N02EL
SPARE_SV2
D808 MBRB540T
NEW_PS_SENSE
JP6 SPARE_3
Q814 MGSF2N02EL
SPARE_SV3
D809 MBRB540T
SPARE4_SOL1
SPARE4_SOL2
Q815 MGSF2N02EL
SPARE_SV4
SPARE
U800A MAX478CSA
SIZE C
DWG NO 52292
REV F
SCALE: DO NOT SCALE DRAWING
SHEET 8 OF 8

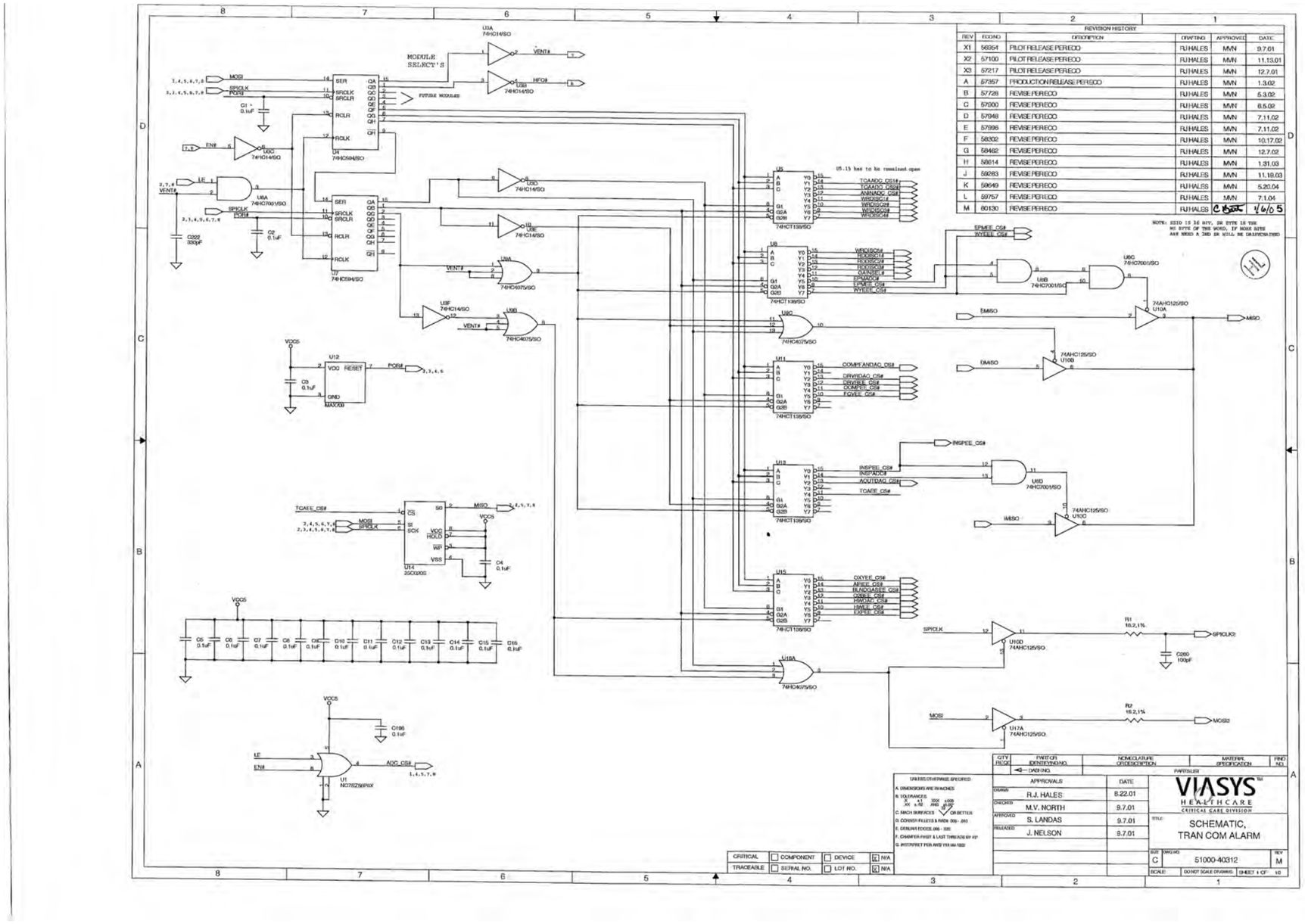
PCB Compressor with Connectors

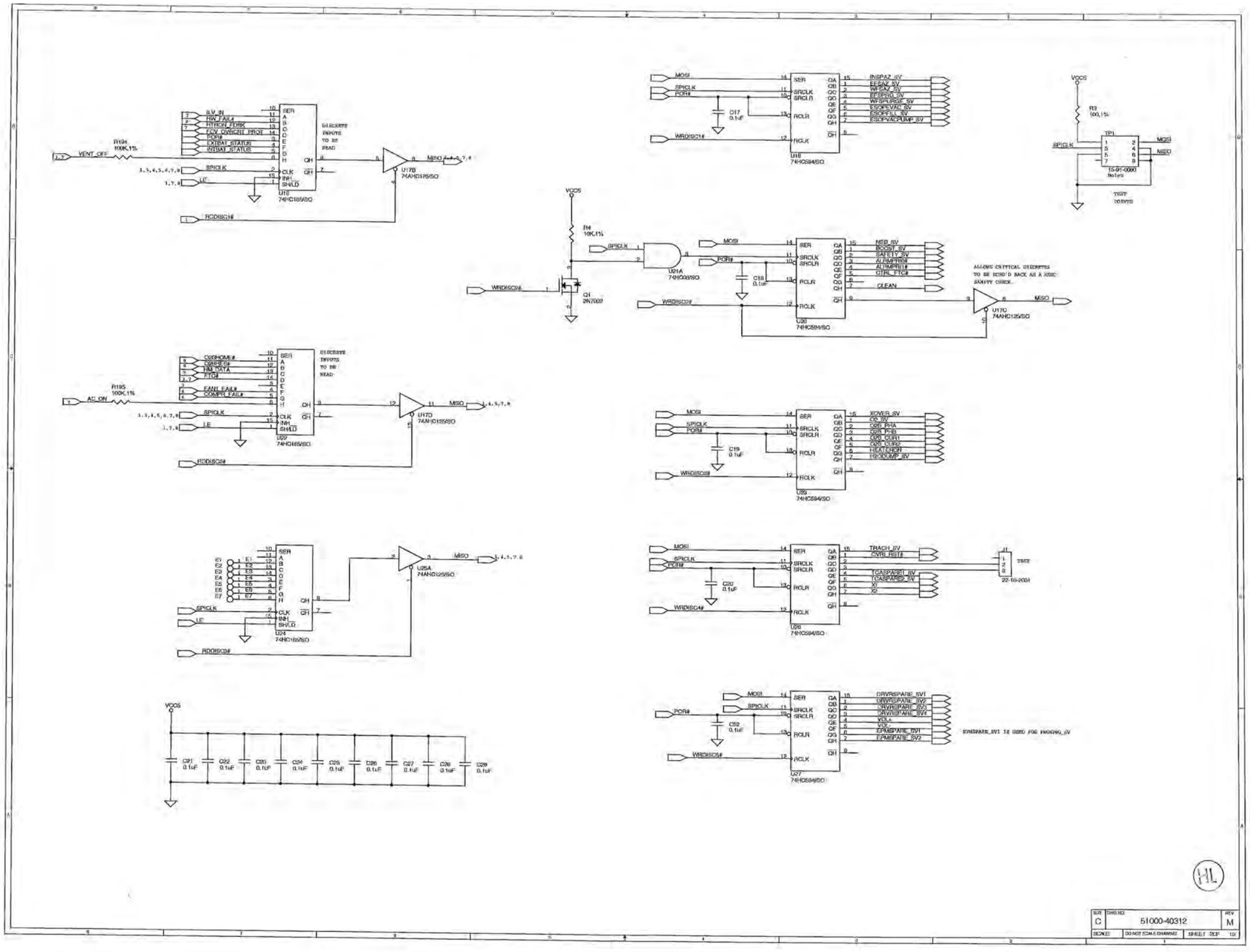


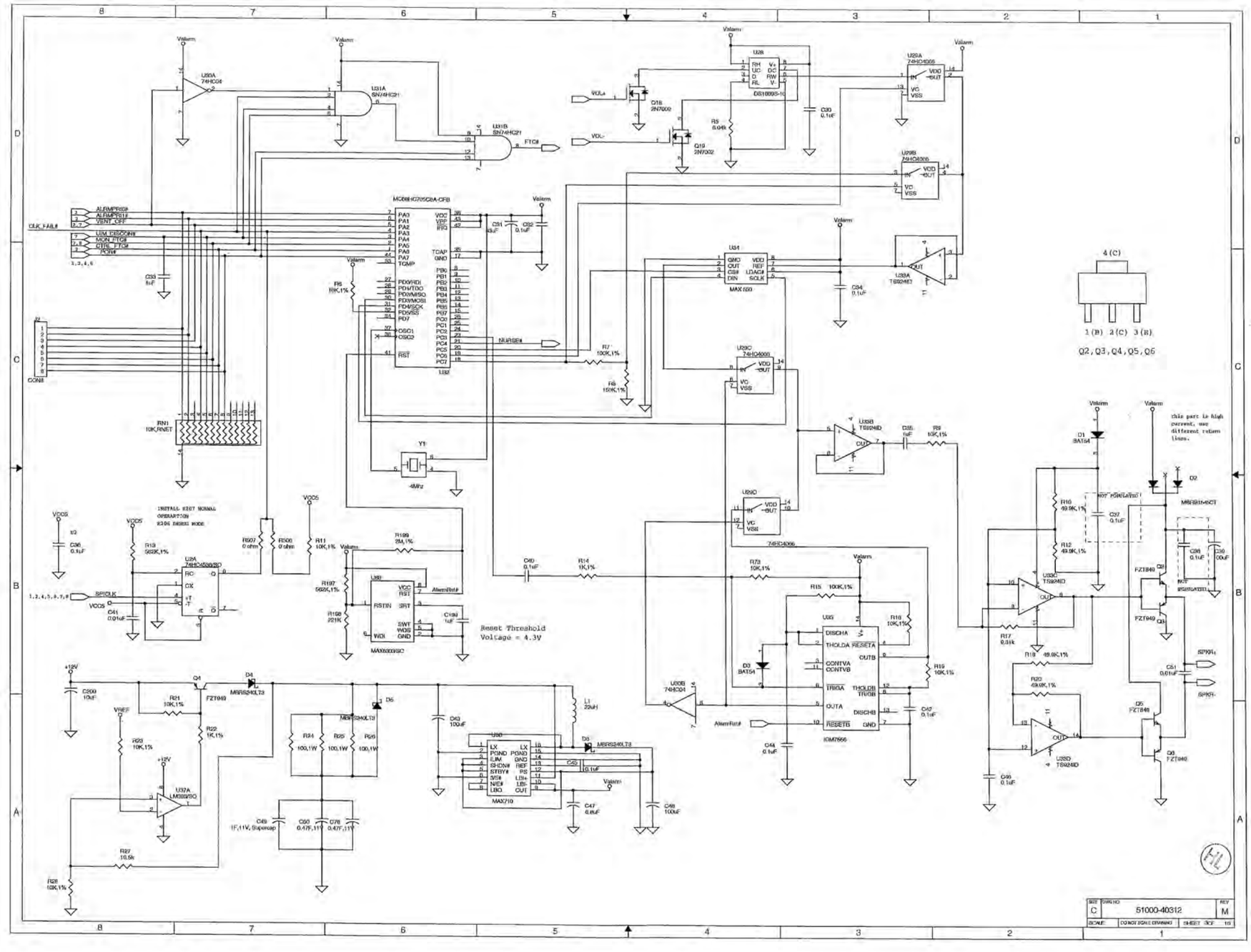
PCBA, Supply Pressure

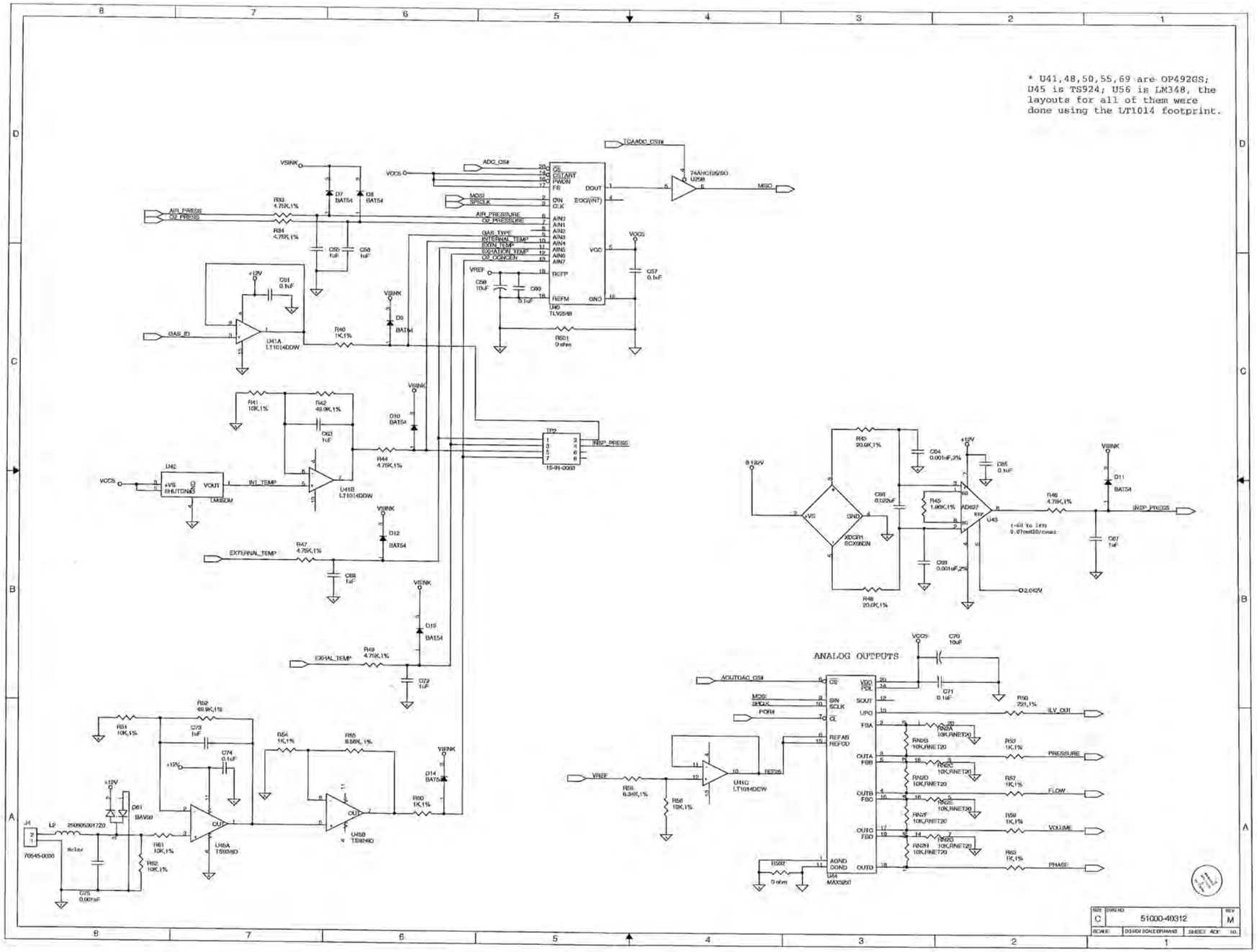


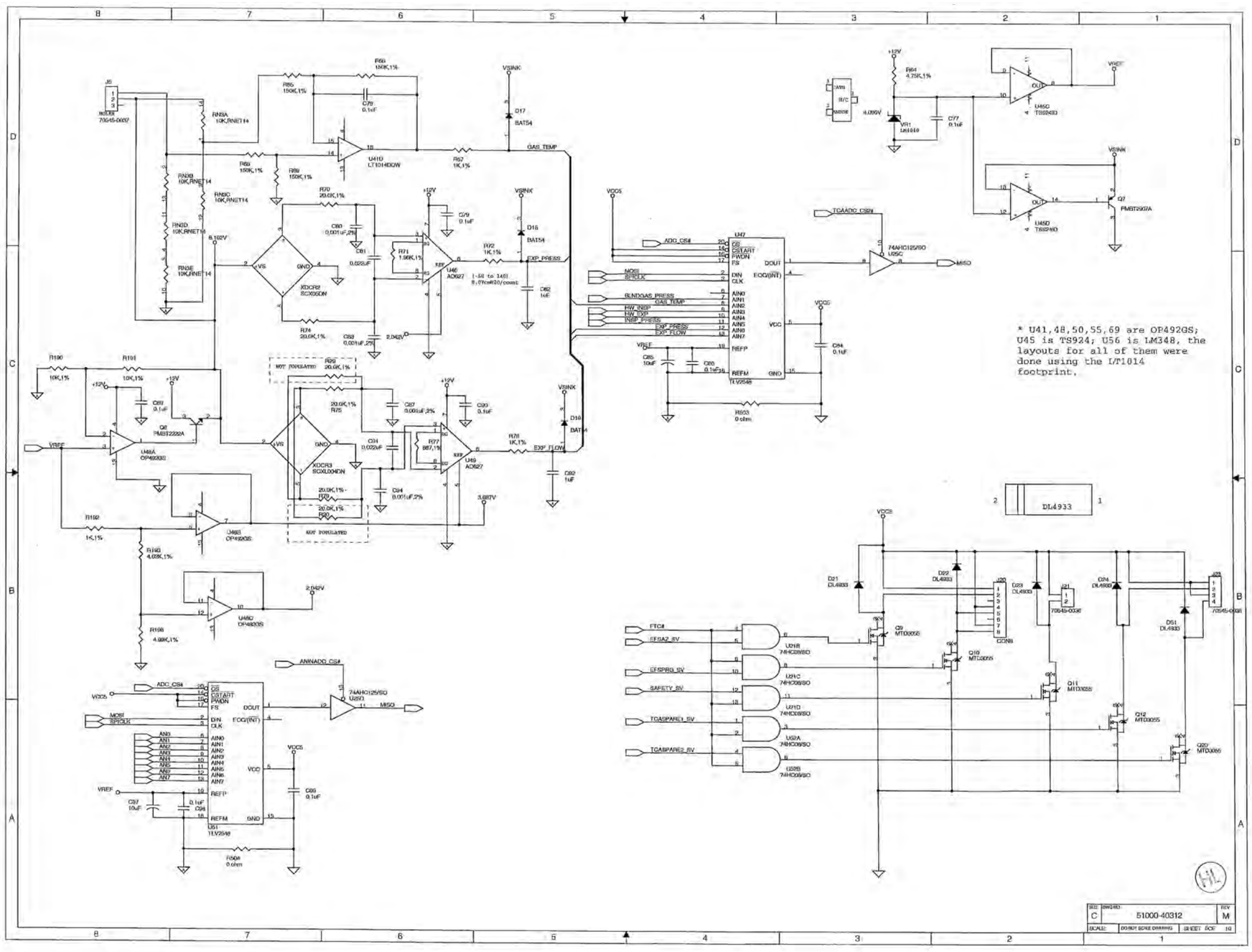
Trans Com Alarm

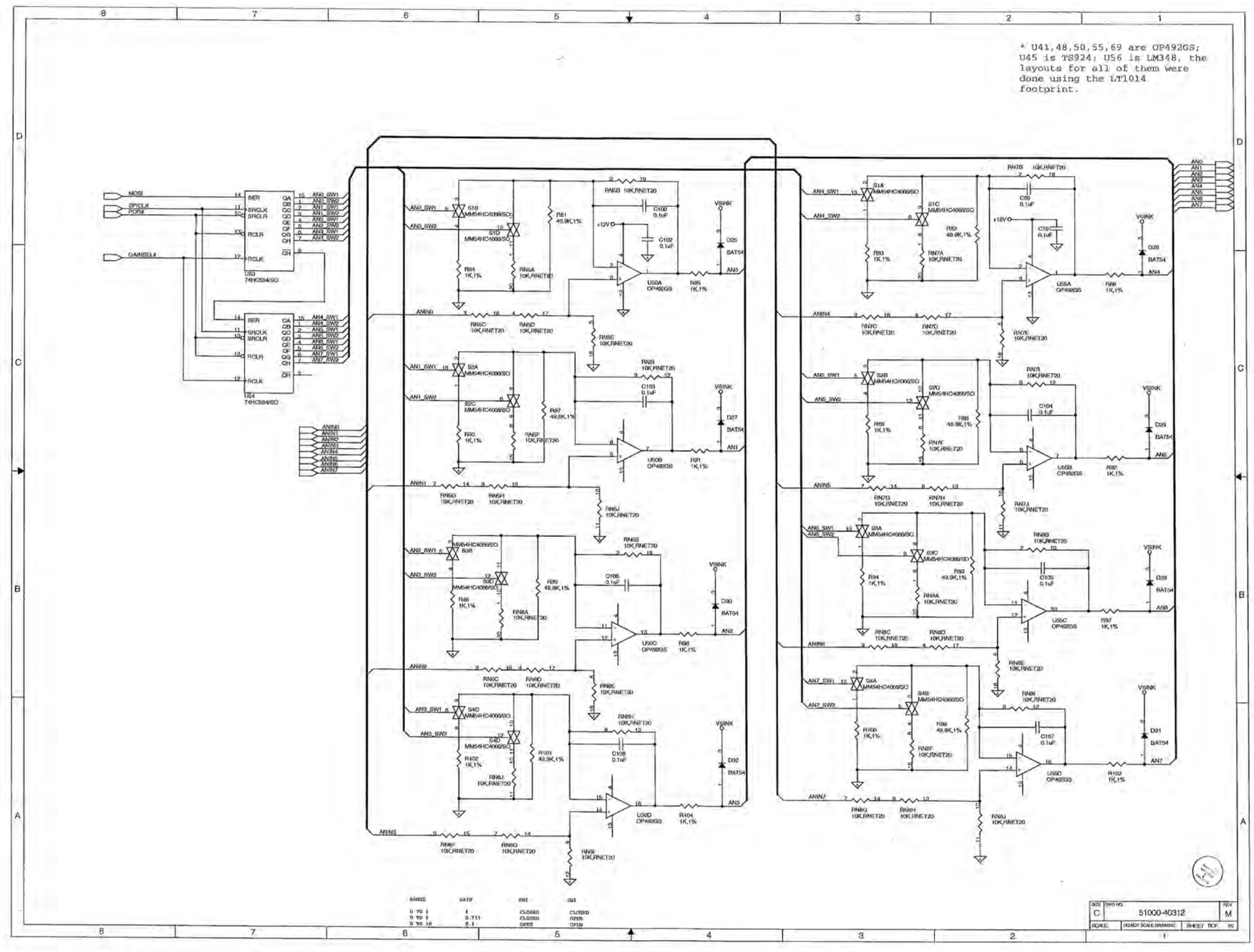


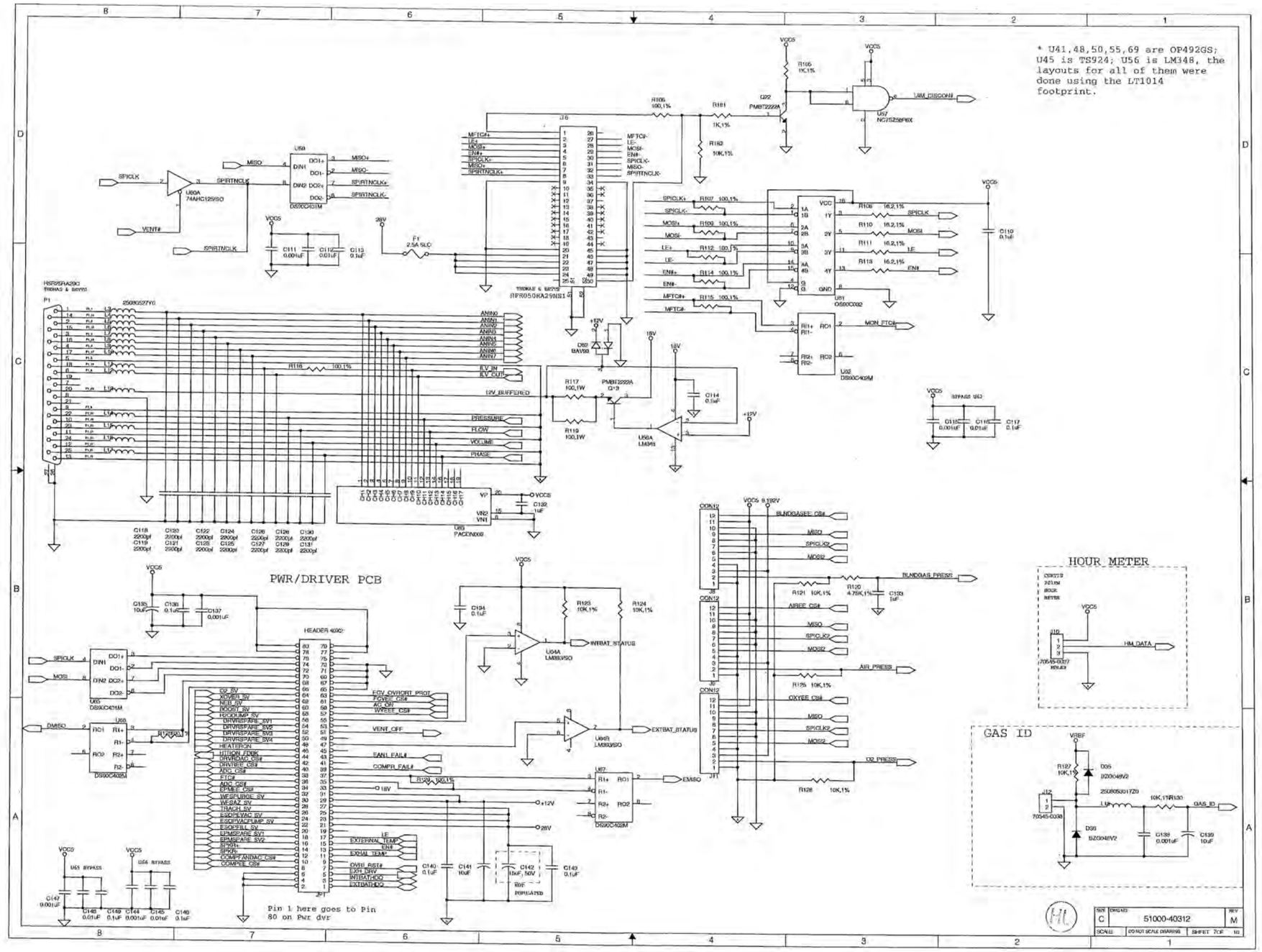

MOSI
SPICLK
PORT#
WRDISC1#
C17 0.1uF
U16 74HCS594/SO
INSPAZ_5V
EESAV_5V
WFSAZ_5V
EFSPROX_5V
WFSPURGE_5V
ESOPEVAC_5V
ESOPFILL_5V
ESOPVAC-PUMP_5V
VCC5
R3 100,1%
SPICLK
TP1
MOSI
MISO
15-91-0060
TEST POINTS
R194 100K,1%
VENT_OFF
BLV_IN
HW_FAIL#
HYPOX_FDBK
FDV_OVRCRT_PROT
PORT#
INTBAT_STATUS
INTBAT_STATUS
SPICLK
LE
U17B 74AHC125/SO
RDDISC1#
R14 10K,1%
Q1 2N7002
U21A 74HC08/SO
WRDISC2#
C18 0.1uF
U30 74HCS594/SO
NEB_5V
BOOST_5V
BATFLTV_5V
ALMPRI#
ALMPRI1#
CTRL_FTG#
CLEAN
ALLOWS CRITICAL DISCRETES TO BE READ'D BACK AS A MISC. SANITY CHECK.
U17C 74AHC125/SO
MISO
R195 100K,1%
AC_ON
COMPHOME#
COMPSTS#
HM_DATA
PITCH
FANIL FAIL#
COMPR_FAIL#
SPICLK
LE
U29 74HCH165/SO
RDDISC2#
U17D 74AHC125/SO
MISO
C19 0.1uF
U28 74HCS594/SO
XOVER_5V
CC_5V
CCS_PHA
CCS_PHB
CCS_CUR1
CCS_CUR2
HEATHDRV
HEADDUMP_5V
E1
E2
E3
E4
E5
E6
E7
U24 74HC165/SO
U25A 74AHC125/SO
MISO
RDDISC3#
C20 0.1uF
U26 74HCS594/SO
TRACH_5V
OVRL_RST#
TCASPARE1_5V
TCASPARE2_5V
X1
X2
J1
TEST
22-10-2031
VCC5
C21 0.1uF
C22 0.1uF
C23 0.1uF
C24 0.1uF
C25 0.1uF
C26 0.1uF
C27 0.1uF
C28 0.1uF
C29 0.1uF
C52 0.1uF
U27 74HCS594/SO
DRVRSPARE_5V1
DRVRSPARE_5V2
DRVRSPARE_5V3
DRVRSPARE_5V4
VOUT
VCC
EPMSPARE_5V1
EPMSPARE_5V2
EPMSPARE_5V1 IS USED FOR PHOENIX_5V
51000-40312
C
M
DO NOT SCALE DRAWING

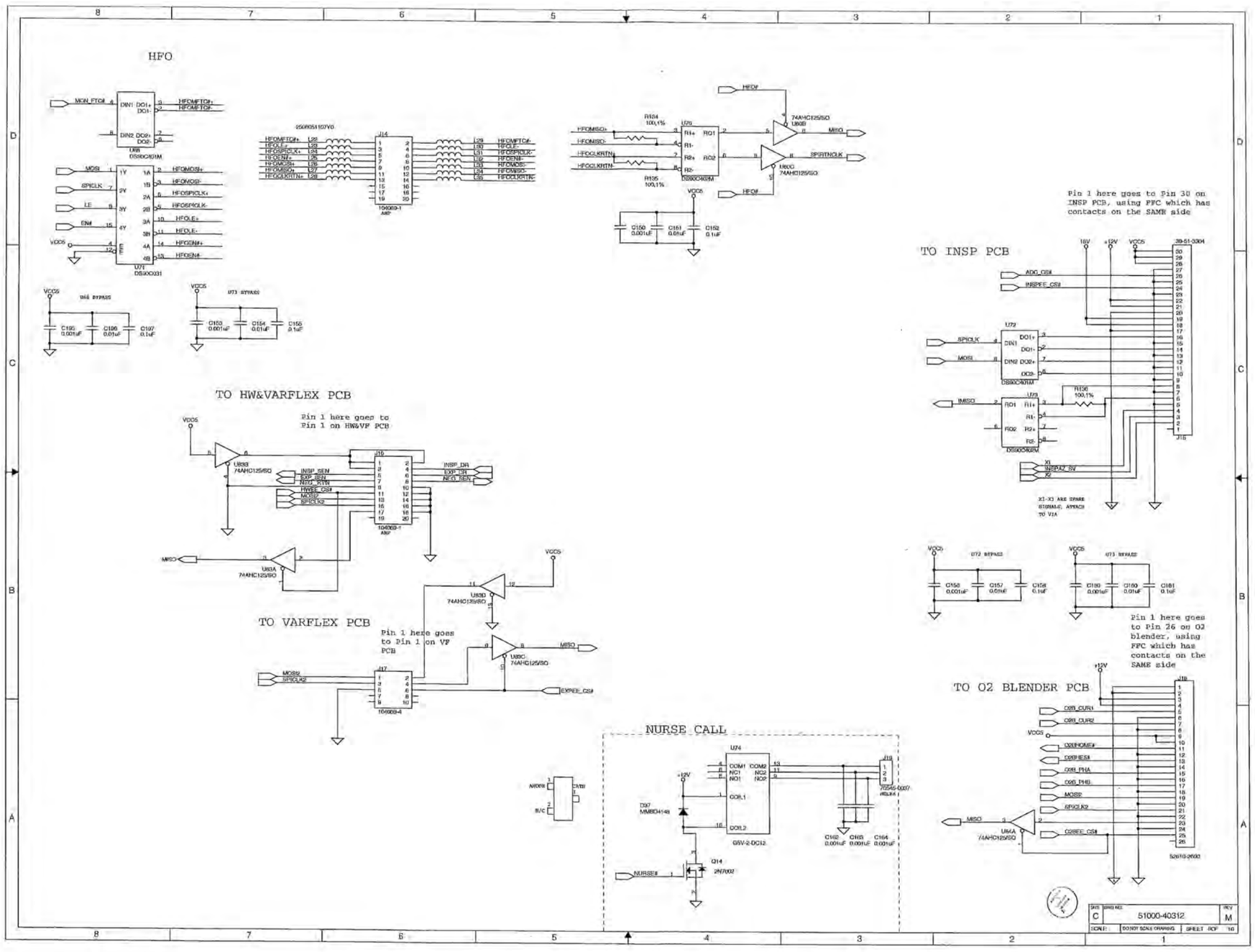

Reset Threshold Voltage = 4.3V
4 (C)
1 (B) 2 (C) 3 (B)
Q2, Q3, Q4, Q5, Q6
this part is high current, use different return lines.
51000-40312

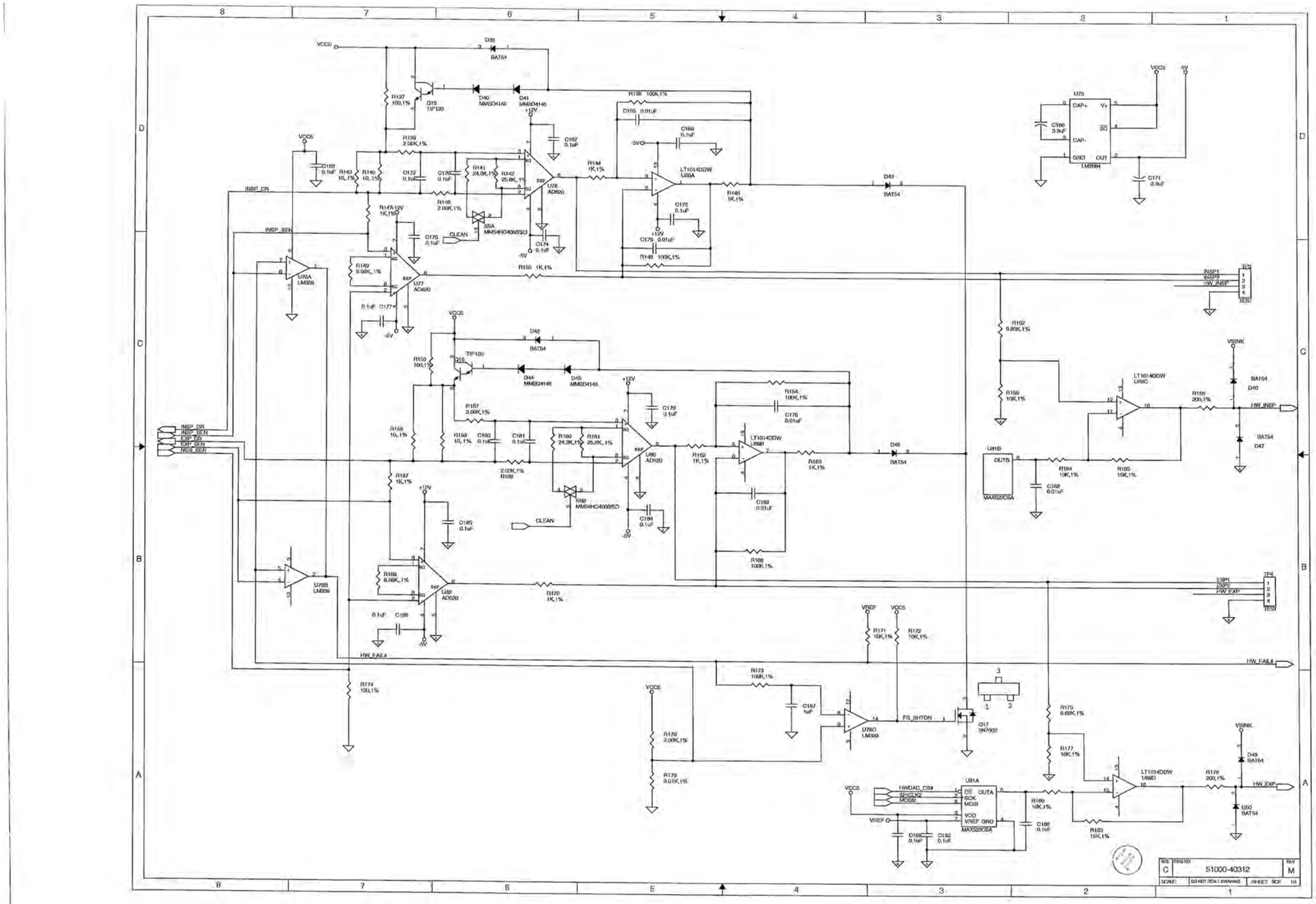

* U41,48,50,55,69 are OP492GS; U45 is TS924; U56 is LM348, the layouts for all of them were done using the LT1014 footprint.
ANALOG OUTPUTS
51000-40312

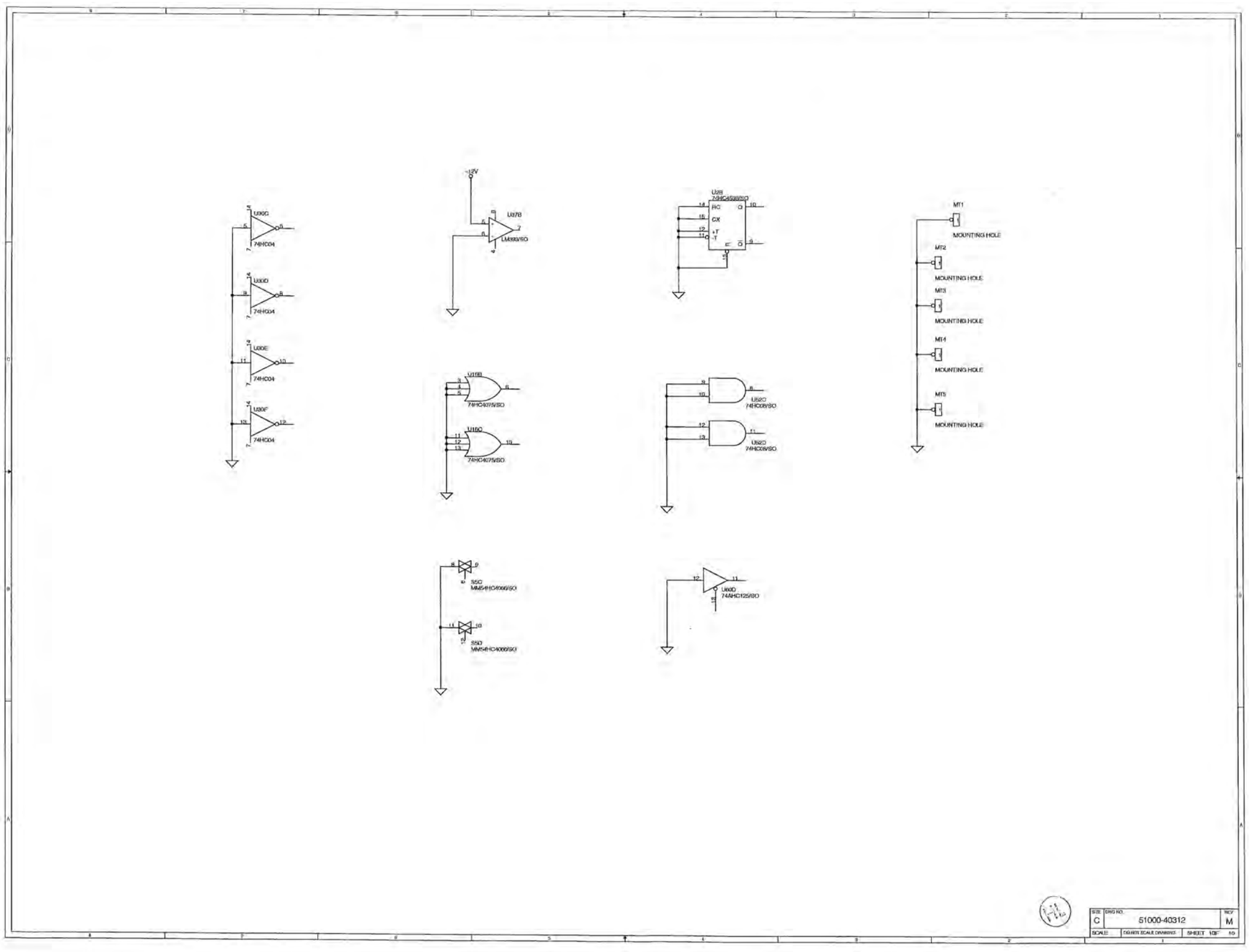

* U41,48,50,55,69 are OP492GS; U45 is TS924; U56 is LM348, the layouts for all of them were done using the LT1014 footprint.
51000-40312
C
M
SCALE: DO NOT SCALE DRAWING
SHEET 8OF 10


* U41,48,50,55,69 are OP492GS; U45 is TS924; U56 is LM348, the layouts for all of them were done using the LT1014 footprint.
MOSI
SPICLK
PCR#
GAINSEL#
74HCS594/SO
VSINK
BAT54
+12V
AN0_SW1
AN0_SW2
AN1_SW1
AN1_SW2
AN2_SW1
AN2_SW2
AN3_SW1
AN3_SW2
AN4_SW1
AN4_SW2
AN5_SW1
AN5_SW2
AN6_SW1
AN6_SW2
AN7_SW1
AN7_SW2
MM54HC4066/SO
OP492GS
OP493GS
OP483GS
51000-40312
C
M


* U41,48,50,55,69 are OP492GS; U45 is TS924; U56 is LM348, the layouts for all of them were done using the LT1014 footprint.
PWR/DRIVER PCB
HOUR METER
GAS ID
Pin 1 here goes to Pin 80 on Pwr dvr
51000-40312


HFO
TO INSP PCB
Pin 1 here goes to Pin 30 on INSP PCB, using FFC which has contacts on the SAME side
TO HW&VARFLEX PCB
Pin 1 here goes to Pin 1 on HW&VF PCB
TO VARFLEX PCB
Pin 1 here goes to Pin 1 on VF PCB
TO O2 BLENDER PCB
Pin 1 here goes to Pin 26 on O2 blender, using FFC which has contacts on the SAME side
NURSE CALL
51000-40312

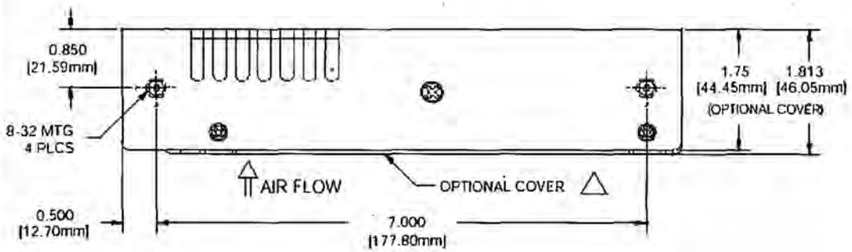

VCC5
D38 BAT54
R137 100,1%
Q15 TIP120
D40 MMBD4148
D41 MMBD4148
+12V
R138 100K,1%
C165 0.01uF
C167 0.1uF
C168 0.1uF
-5V
R139 2.00K,1%
C169 0.1uF
R143 10,1%
R140 10,1%
C172 0.1uF
C170 0.1uF
R141 24.9K,1%
R142 25.6K,1%
U78 AD620
R144 1K,1%
LT1014DDW U68A
D42 BAT54
R145 1K,1%
C173 0.1uF
C179 0.01uF
R146 100K,1%
R147 12V 1K,1%
R148 2.00K,1%
35A MMSHC40005SO
CLEAN
C175 0.1uF
C174 0.1uF
INSP_DIR
INSP_SEN
R149 8.66K,1%
U77 AD620
R150 1K,1%
U78A LM339
0.1uF C177
U75 CAP+ V+ SD CAP- GND OUT LM2664
C166 3.3uF
C171 3.3uF
INSP1
INSP2
HW_INSP
TEST
R152 8.66K,1%
R155 10K,1%
VSINK
LT1014DDW U68C
R156 200,1%
D46 BAT54
HW_INSP
D47 BAT54
U81B MAX528CSA
R184 10K,1%
C182 0.01uF
R185 15K,1%
D43 BAT54
7IP120
Q16
D44 MMBD4148
D45 MMBD4148
R153 100,1%
R157 2.00K,1%
R158 10,1%
R159 10,1%
C180 0.1uF
C181 0.1uF
R160 24.9K,1%
R161 25.6K,1%
U80 AD620
R162 1K,1%
R163 1K,1%
R154 100K,1%
C178 0.01uF
LT1014DDW U68B
D48 BAT54
C183 0.01uF
R108 100K,1%
R167 1K,1%
C185 0.1uF
35B MMSHC40005SO
C194 0.1uF
R168 8.66K,1%
U82 AD620
R170 1K,1%
0.1uF C186
HW_FAIL#
R174 10,1%
R171 10K,1%
R172 10K,1%
R173 100K,1%
C197 1nF
U78C LM339
FS_SHTDN
Q17 2N7002
R175 8.66K,1%
R177 10K,1%
R176 2.00K,1%
R179 3.01K,1%
U81A MAX528CSA
HWDAC_CS#
SPI/CLK2
MOSI2
OUTA
SCK
MOSI
VDD
VREF GND
R180 10K,1%
C188 0.1uF
R183 15K,1%
C187 0.1uF
C190 0.1uF
LT1014DDW U68D
R178 200,1%
D49 BAT54
HW_EXP
D50 BAT54
TP4
EXP1
EXP2
HW_EXP
TEST
SIZE C
DRWG NO 51000-40312
REV M
SCALE
DO NOT SCALE DRAWING
SHEET 9OF 16


U30C
74HC04
U30D
74HC04
U30E
74HC04
U30F
74HC04
+12V
U37B
LM393/SO
U28
74HC4538/SO
MT1
MOUNTING HOLE
MT2
MOUNTING HOLE
MT3
MOUNTING HOLE
MT4
MOUNTING HOLE
MT5
MOUNTING HOLE
U19B
74HC4075/SO
U19D
74HC4075/SO
U52C
74HC08/SO
U52D
74HC08/SO
SSD
MM54HC4066/SO
SSD
MM54HC4066/SO
U40D
74AHC125/SO
SIZE C
DWG NO. 51000-40312
REV M
SCALE DO NOT SCALE DRAWING
SHEET 10F 10

Power Supply

REVISIONS				
SYM	DESCRIPTION	DRFTG	APPROVED	DATE
A	PRODUCTION RELEASE PER ECO 56843.	FS	MS	8/6/01
B	REVISED PER ECO 58036	TRD		9/18/02

HL



ALSO SEE PAGE 2

SPECIFICATIONS:

TEMP RANGE: 0 TO 50°C
SUPPLY VOLTAGE: 85 TO 264 VAL

DRAWN	R. VALDEZ	12/18/00
CHECKED	M. SANELL	8/6/01
APPROVED	S. LANDAS	8/6/01
RELEASED	J. NELSON	8/17/01

VIASYS™ HEALTHCARE CRITICAL CARE DIVISION

SOURCE CONTROL

Purchase only from Approved Manufacturer List

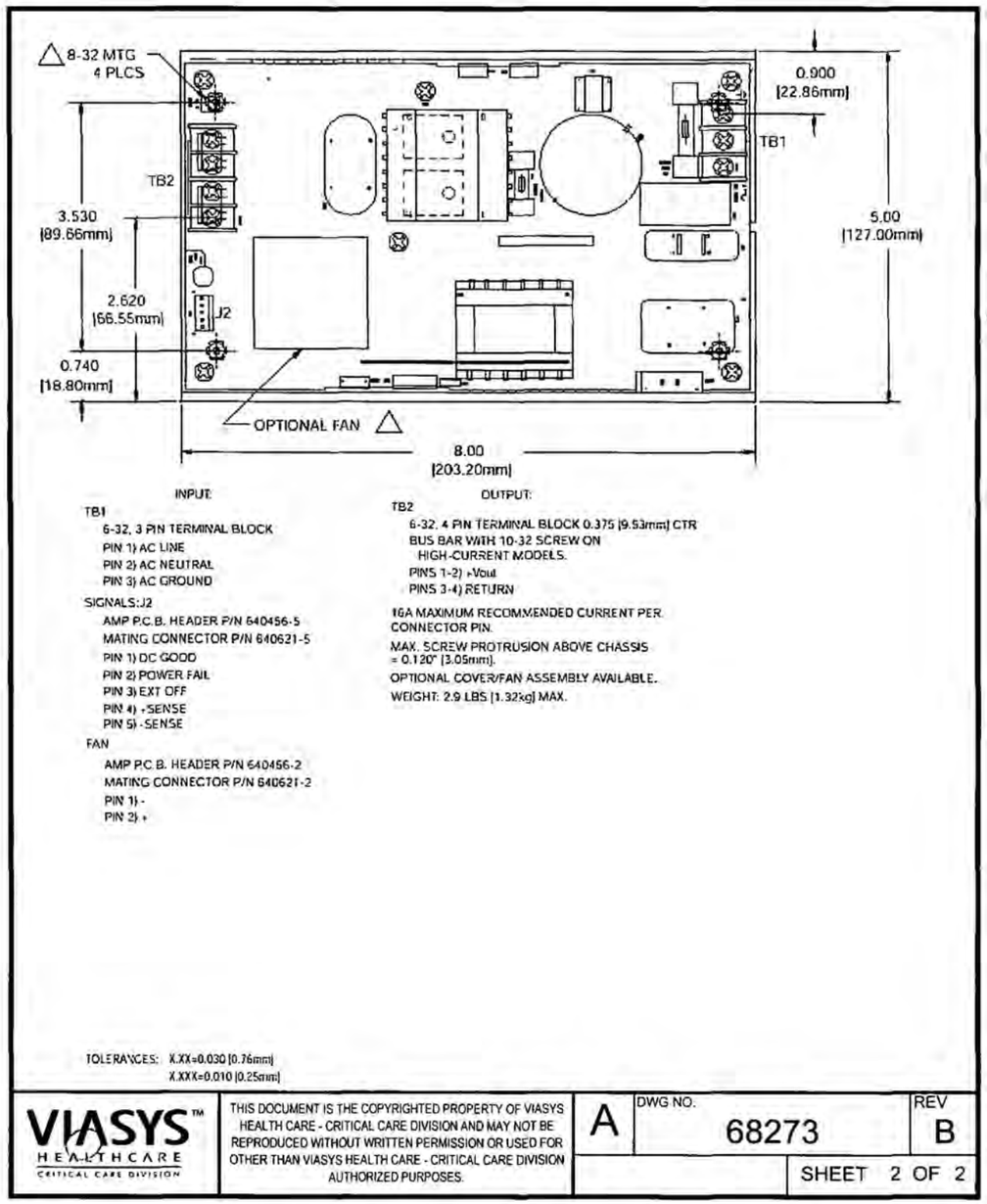
- Located in the MMS data base
- Same part number & revision level

The information contained in this document was taken in part from the manufacturer's catalog and should be used for reference only. Dimensions are in inches unless otherwise noted.

TITLE: POWER SUPPLY, 32.5V, 7.7AMP

SIZE	DWG NO.	REV.
A	68273	B

SCALE NONE SHEET 1 OF 2


8-32 MTG
4 PLCS
0.900
[22.86mm]
TB1
TB2
3.530
[89.66mm]
5.00
[127.00mm]
2.620
[66.55mm]
J2
0.740
[18.80mm]
OPTIONAL FAN
8.00
[203.20mm]
INPUT:
TB1
6-32, 3 PIN TERMINAL BLOCK
PIN 1) AC LINE
PIN 2) AC NEUTRAL
PIN 3) AC GROUND
SIGNALS:J2
AMP P.C.B. HEADER P/N 640456-5
MATING CONNECTOR P/N 640621-5
PIN 1) DC GOOD
PIN 2) POWER FAIL
PIN 3) EXT OFF
PIN 4) +SENSE
PIN 5) -SENSE
FAN
AMP P.C.B. HEADER P/N 640456-2
MATING CONNECTOR P/N 640621-2
PIN 1) -
PIN 2) +
OUTPUT:
TB2
6-32, 4 PIN TERMINAL BLOCK 0.375 [9.53mm] CTR
BUS BAR WITH 10-32 SCREW ON
HIGH-CURRENT MODELS.
PINS 1-2) +Vout
PINS 3-4) RETURN
16A MAXIMUM RECOMMENDED CURRENT PER
CONNECTOR PIN.
MAX. SCREW PROTRUSION ABOVE CHASSIS
= 0.120" [3.05mm].
OPTIONAL COVER/FAN ASSEMBLY AVAILABLE.
WEIGHT: 2.9 LBS [1.32kg] MAX.
TOLERANCES: X.XX=0.030 [0.76mm]
X.XXX=0.010 [0.25mm]
VIASYS™ HEALTHCARE
CRITICAL CARE DIVISION
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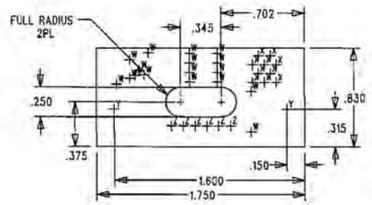
A
DWG NO.
68273
REV
B
SHEET 2 OF 2

PCBA, Exhalation Flow Transition

REVISION HISTORY					
REV	ECO NO.	DESCRIPTION	DRAFTING	APPROVED	DATE
X1	56689	PILOT RELEASE PER ECO	RJH	MVN	7.23.01
A	57362	PROD RELEASE PER ECO	RJH	[illegible]	1.3.02

UNLESS OTHERWISE SPECIFIED

1. FABRICATE BOARD USING ARTWORK 51000-40433 REV A.
2. BOARD VIEWED FROM PRIMARY SIDE.
3. MATERIAL: BOARD TO BE COMPOSED OF 4 CIRCUIT LAYERS OF COPPER CLAD/PLATED (HTE PER IPC-C-150) "GFN" GLASS-EPOXY LAMINATES PER M-S-13949 (POLYFUNCTIONAL WITH LOW RESIN CONTENT PREPREG PREFERRED) OVERALL BOARD THICKNESS TO BE 0.062 +/- 0.005
4. DIELECTRIC THICKNESS BETWEEN CIRCUIT LAYERS SHALL BE AS FOLLOWS:
   BETWEEN LAYERS 1 AND 2 ---- NO LESS THAN 0.018
   BETWEEN LAYERS 2 AND 3 ---- NO LESS THAN 0.018
   BETWEEN LAYERS 3 AND 4 ---- NO LESS THAN 0.018
5. ALL HOLES TO BE PLATED THRU TO HAVE 0.0002 – 0.0007 POSITIVE ETCHBACK ON HOLES PRIOR TO PLATING. ELONGATION PROPERTY OF 10% ON ALL PLATED COPPER. HOLE DIAMETER TOLERANCE TO BE +/- 0.003 AFTER PLATING.
6. NON-PLATED HOLES MAY BE USED AS TOOLING POINTS.
7. BOARD SUPPLIER'S NAME, TRADEMARK, U.L. RECOGNITION CODE AND TYPE DESIGNATION TO BE ETCHED ONTO SECONDARY SIDE OF BOARD.
8. MINIMUM CONDUCTOR WIDTH 0.006
   MINIMUM CONDUCTOR SPACING 0.006
9. COPPER CIRCUITRY THICKNESS SHALL BE PLATED UP TO THE FOLLOWING DIMENSIONS:
   OUTER LAYERS ---------- 0.0014 MIN
   INNER LAYERS (ETCHED) ---------- 0.0014 MIN
   PLATED THRU HOLES ---------- 0.0014 MIN
10. WARP OR TWIST OF BOARD SHALL NOT EXCEED 0.010 PER INCH.
11. APPLY GREEN LPI SOLDER MASK CONFORMING TO IPC-SM-840, CLASS 2, OVER BARE COPPER, ONTO BOTH SIDES OF BOARD USING APPROPRIATE ARTWORK.
12. EXPOSED CIRCUITRY TO BE SOLDER COATED AND HOT-AIR SOLDER LEVELED.
13. SILKSCREEN LEGEND ONTO PRIMARY SIDE OF BOARD USING WHITE, EPOXY BASED PAINT OR INK AND APPROPRIATE ARTWORK.
14. BOARD TO BE FREE OF FRAYED OR SHARP EDGES AND ALL TRIM LINES ARE TO BE REMOVED.
15. ACCEPTANCE CRITERIA SHALL BE AS DEFINED IN IPC-A-600, CLASS 2, FOR TYPE 3 PRINTED BOARDS.
16. THE FINISHED BOARD SHALL COMPLY WITH U.L. STANDARD 796 AND HAVE A FLAMMABILITY RATING OF 94V-0 OR BETTER.
17. REVISION STATUS CHANGES TO THIS DRAWING MUST BE REFLECTED ON DRAWING 51000-40430.



SIZE	QTY	SYM	PLTD
15	17	W	PLTD
31	10	X	PLTD
145	2	Y	PLTD
35	6	Z	PLTD

QLT REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	FIND NO.
	← DASH NO.	PART LIST		

UNLESS OTHERWISE SPECIFIED
A. DIMENSIONS ARE IN INCHES.
B. TOLERANCES:
.X ± .1 .XXX ± .005
.XX ± .02 ANG ± 1.00°
C. MACH SURFACES 63 OR BETTER.
D. CORNER FILLETS & RADII .005-.010.
E. DEBURR EDGES .005-.020.
F. CHAMFER FIRST & LAST THREAD 45°
G. INTERPRET PER ANSI Y14.5M-1982

APPROVALS		DATE
DRAWN	R.J. HALES	6.13.01
CHECKED	MV NORTH	6.15.01
APPROVED	S LANDAS	7.13.01
RELEASED	H LACY	7.23.01

VIASYS HEALTHCARE CRITICAL CARE DIVISION

TITLE: PCB, EXHALATION FLOW TRANSITION

SIZE B | DRW NO. 51000-40431 | REV. A

SCALE: 1 : 1 | DO NOT SCALE DRAWING | SHEET 1 OF 1

CRITICAL	☐ COMPONENT	☐ DEVICE	☒ N/A
TRACEABLE	☐ SERIAL NO.	☐ LOT NO.	☒ N/A

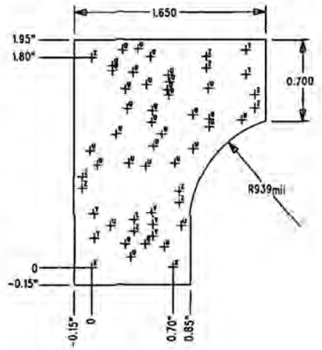
PCBA, Backup Alarm

REVISION HISTORY					
REV	ECO NO.	DESCRIPTION	DRAFTING	APPROVED	DATE
X1	59760	PILOT RELEASE PER ECO	RJ HALES	MG	5.27.04
X2	59785	REVISED PER ECO	RJ HALES	MG	6.17.04
A	59844	PRODUCTION RELEASE PER ECO	RJ HALES	MM	7/23/04

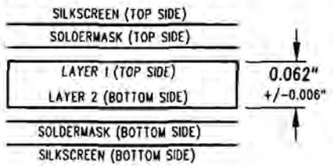
UNLESS OTHERWISE SPECIFIED

1. FABRICATE BOARD USING ARTWORK 52333 REV A.
2. BOARD VIEWED FROM PRIMARY SIDE.
3. MATERIAL: BOARD TO BE COMPOSED OF 2 CIRCUIT LAYERS OF COPPER CLAD/PLATED (HTE PER IPC-C-150) "GFN" GLASS-EPOXY LAMINATES PER M-S-13949 (POLYFUNCTIONAL WITH LOW RESIN CONTENT PREPREG PREFERRED) OVERALL BOARD THICKNESS TO BE 0.062 +/- 0.006
4. DIELECTRIC THICKNESS BETWEEN CIRCUIT LAYERS SHALL BE AS FOLLOWS:
   BETWEEN LAYERS 1 AND 2 ---- NO LESS THAN 0.054
5. ELONGATION PROPERTY OF 10% ON ALL PLATED COPPER. HOLE DIAMETER TOLERANCE TO BE +/- 0.003 AFTER PLATING.
6. NON-PLATED HOLES MAY BE USED AS TOOLING POINTS.
7. BOARD SUPPLIER'S NAME, TRADEMARK, U.L. RECOGNITION CODE AND TYPE DESIGNATION TO BE ETCHED ONTO SECONDARY SIDE OF BOARD.
8. MINIMUM CONDUCTOR WIDTH 0.007
   MINIMUM CONDUCTOR SPACING 0.010
9. COPPER CIRCUITRY THICKNESS SHALL BE PLATED UP TO THE FOLLOWING DIMENSIONS:
   OUTER LAYERS ---------- 0.0014 MIN
   PLATED THRU HOLES ---------- 0.0014 MIN
10. APPLY GREEN LPI SOLDER MASK CONFORMING TO IPC-SM-840, CLASS 3, OVER BARE COPPER, ONTO BOTH SIDES OF BOARD USING APPROPRIATE ARTWORK.
11. EXPOSED CIRCUITRY TO BE SOLDER COATED AND HOT-AIR SOLDER LEVELED.
12. SILKSCREEN LEGEND ONTO PRIMARY AND SECONDARY SIDE OF BOARD USING WHITE, EPOXY BASED PAINT OR INK AND APPROPRIATE ARTWORK.
13. BOARD TO BE FREE OF FRAYED OR SHARP EDGES AND ALL TRIM LINES ARE TO BE REMOVED.
14. ACCEPTANCE CRITERIA SHALL BE AS DEFINED IN IPC-A-600, CLASS 3, FOR TYPE 3 PRINTED BOARDS.
15. THE FINISHED BOARD SHALL COMPLY WITH U.L. STANDARD 796 AND HAVE A FLAMMABILITY RATING OF 94V-0 OR BETTER.
16. REVISION STATUS CHANGES TO THIS DRAWING MUST BE REFLECTED ON DRAWING 52330.

SIZE	QTY	SYM	PLTD
11	33	U	PLTD
35	3	V	PLTD
73	2	W	PLTD
136	3	X	PLTD
134	4	Y	NPLTD
40	10	Z	PLTD



LAYER STACKUP – 2 LAYER



QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION	FIND NO.
	← DASH NO.	PART LIST		

UNLESS OTHERWISE SPECIFIED
A. DIMENSIONS ARE IN INCHES.
B. TOLERANCES:
.X ± .1 .XXX ± .005
.XX ± .02 ANG ± 1.00°
C. MACH SURFACES 63 OR BETTER.
D. CORNER FILLETS & RADII .005-.010.
E. DEBURR EDGES .005-.020.
F. CHAMFER FIRST & LAST THREAD 45°
G. INTERPRET PER ANSI Y14.5M-1982

	APPROVALS	DATE
DRAWN	R.J. HALES	5.19.04
CHECKED	M GREEN	5.26.04
APPROVED	M BERRYHILL	5.27.04
RELEASED	R MILLETARY	5.27.04

VIASYS HEALTHCARE CRITICAL CARE DIVISION

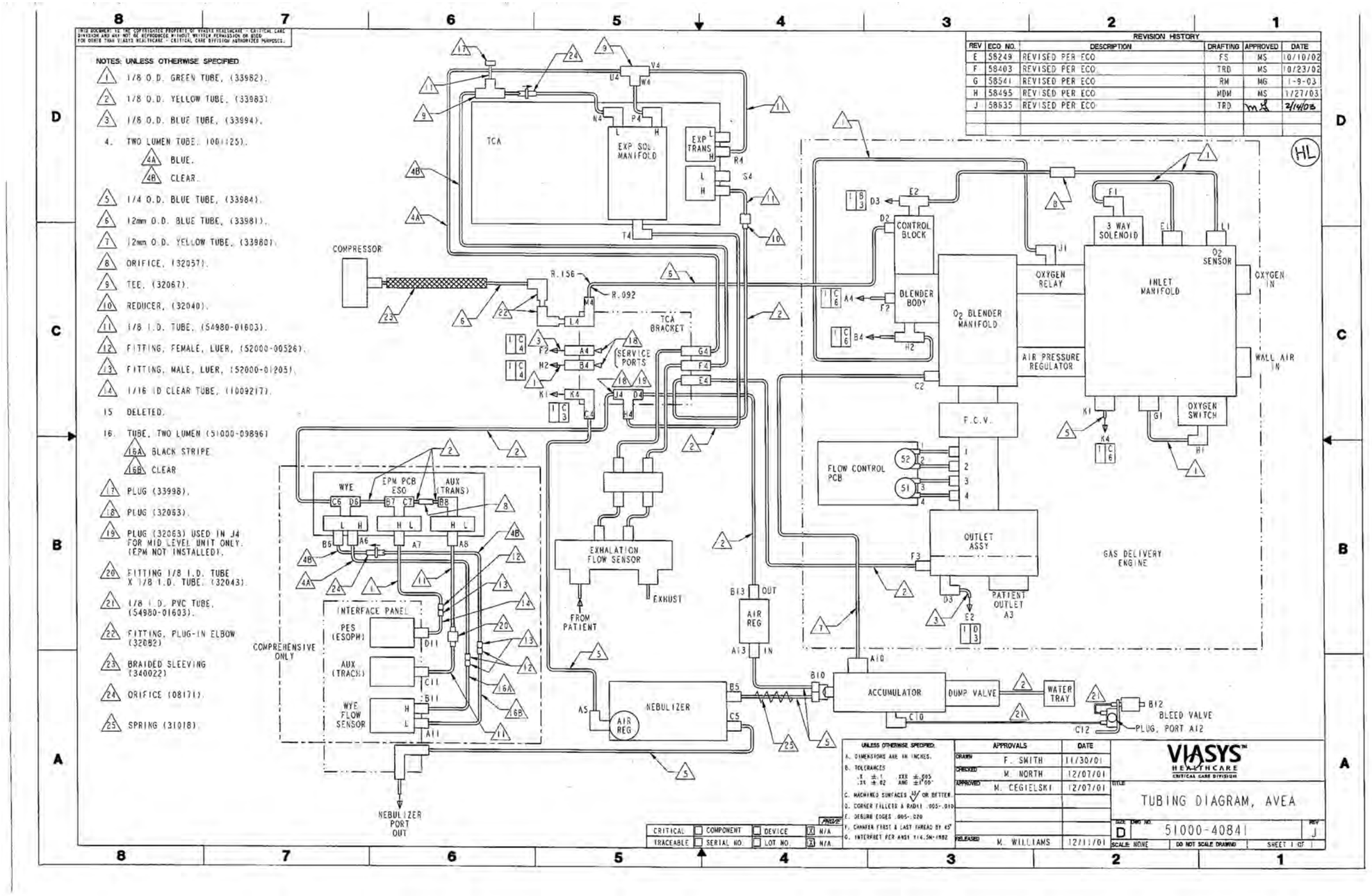
TITLE: PCB, BACKUP ALARM

SIZE B | DRW NO. 52331 | REV. A

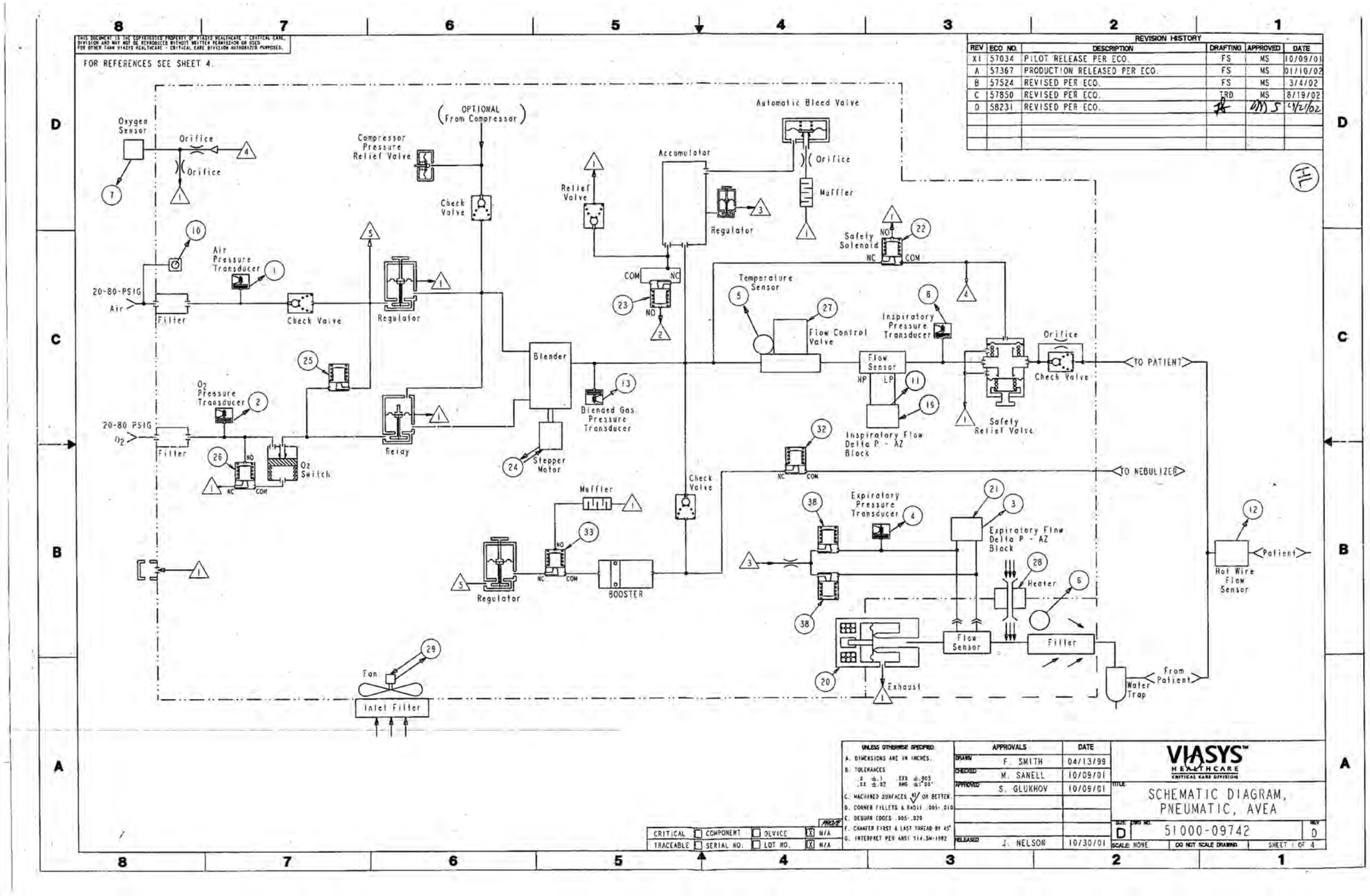
SCALE: 1:1 | DO NOT SCALE DRAWING | SHEET 1 OF 1

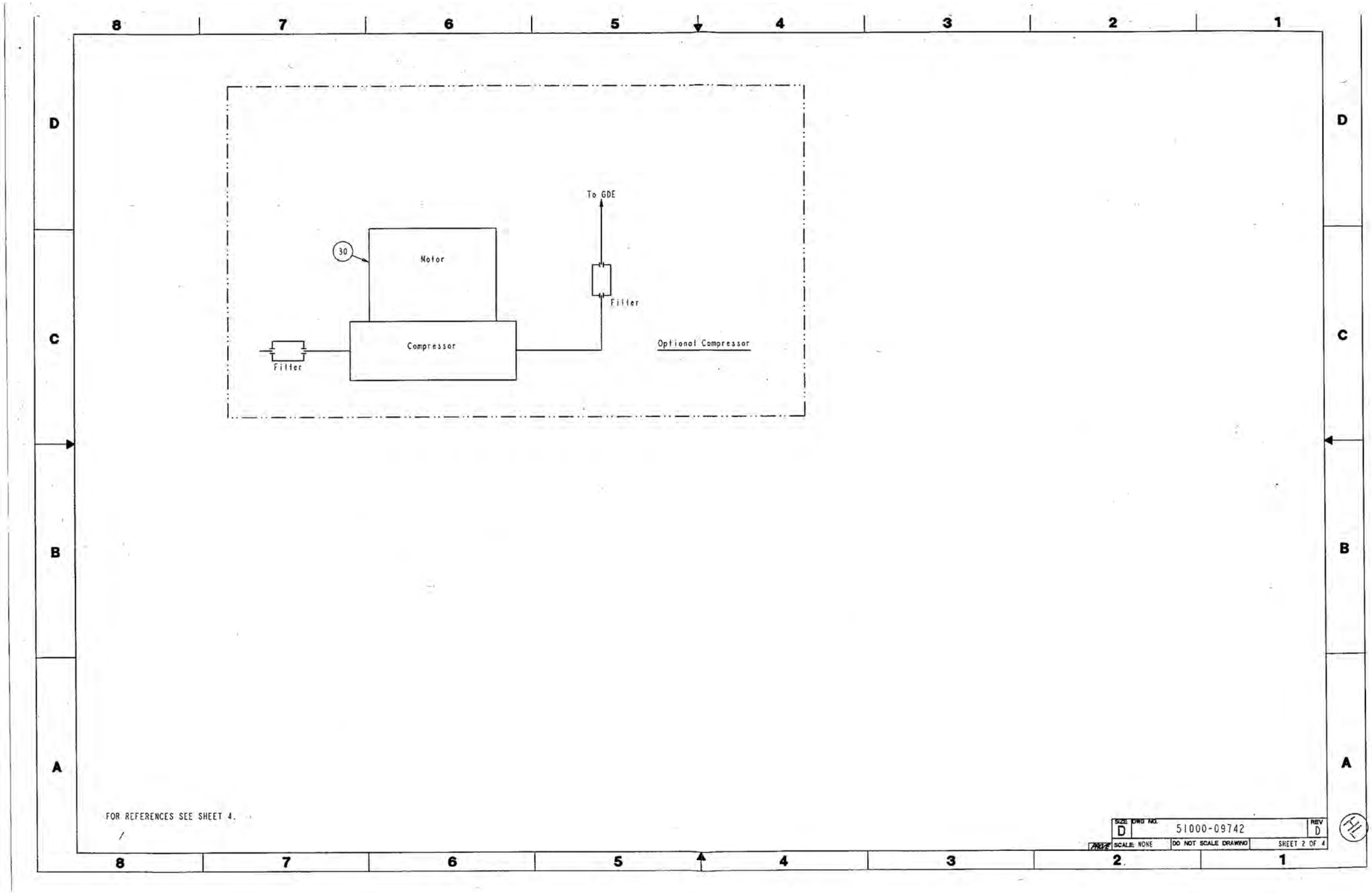
CRITICAL	☐ COMPONENT	☐ DEVICE	☒ N/A
TRACEABLE	☐ SERIAL NO.	☐ LOT NO.	☒ N/A

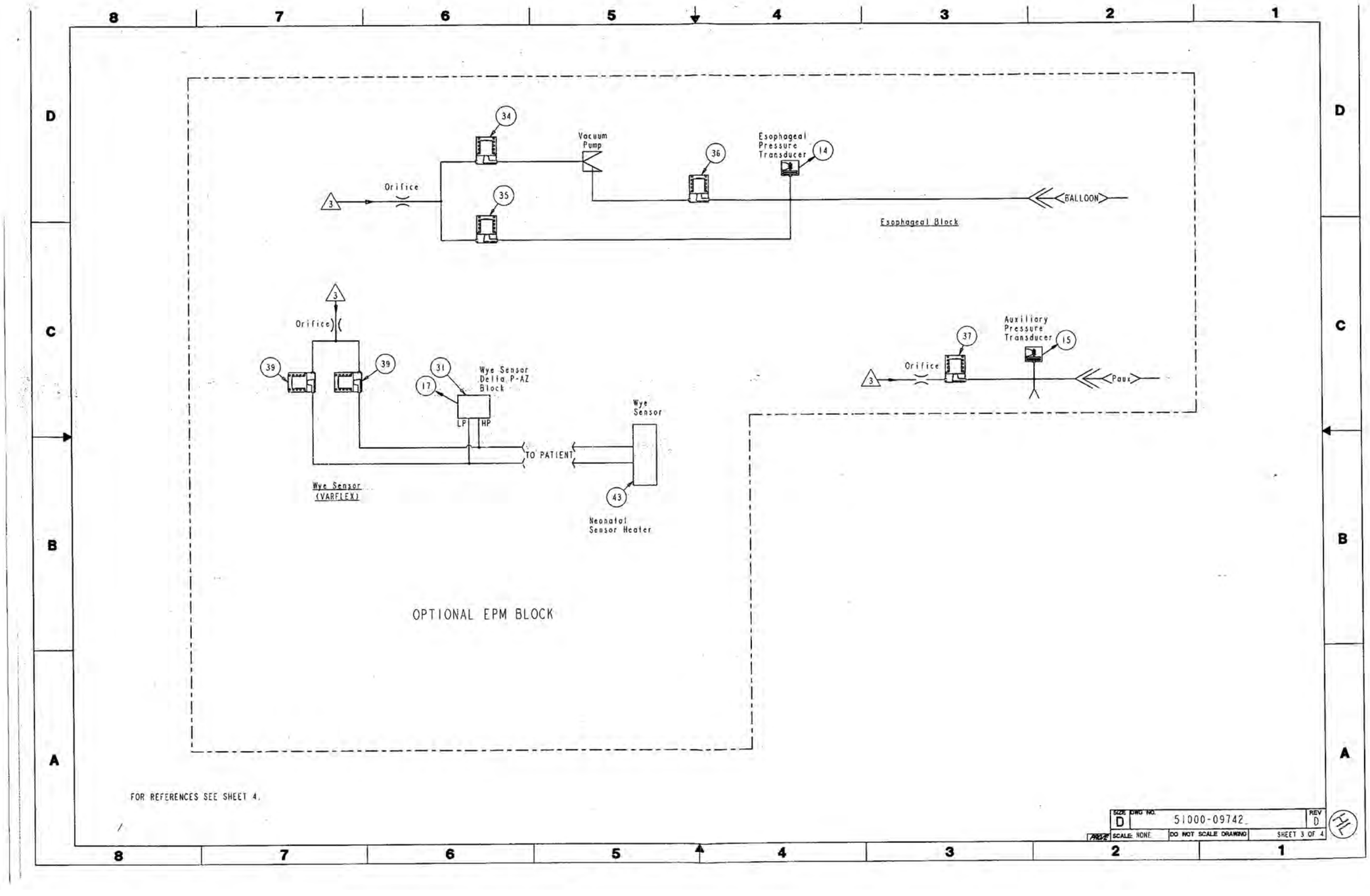
Tubing Diagram



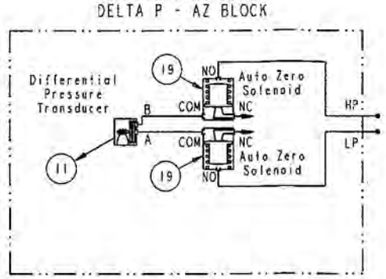
Pneumatic Diagram



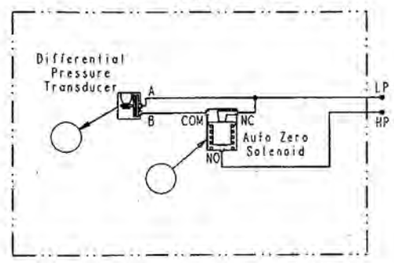

8
7
6
5
4
3
2
1
D
C
B
A
To GDE
30
Motor
Filter
Compressor
Filter
Optional Compressor
FOR REFERENCES SEE SHEET 4.
SIZE D
DWG NO. 51000-09742
REV D
SCALE: NONE
DO NOT SCALE DRAWING
SHEET 2 OF 4


8
7
6
5
4
3
2
1
D
C
B
A
34
Vacuum Pump
36
Esophageal Pressure Transducer
14
Orifice
3
35
BALLOON
Esophageal Block
3
Orifice
39
39
31
Wye Sensor Delta P-AZ Block
17
LP
HP
TO PATIENT
Wye Sensor
Wye Sensor (VARFLEX)
43
Neonatal Sensor Heater
37
Auxiliary Pressure Transducer
15
Orifice
3
Paux
OPTIONAL EPM BLOCK
FOR REFERENCES SEE SHEET 4.
SIZE D
DWG NO. 51000-09742
REV D
SCALE: NONE
DO NOT SCALE DRAWING
SHEET 3 OF 4

INSPIRATORY FLOW
DELTA P - AZ BLOCK



TYPICAL DELTA P-AZ BLOCK



COMMUNICATION BETWEEN BLOCKS

1. OVERBOARD EXHAUST.
2. ACCUMULATOR FLUSH/WATER DUMP EXHAUST.
3. BLENDED GAS FROM LOW PRESSURE REGULATOR.
4. BLENDED GAS FROM SAFETY SV.
5. AIR FROM WALL SOURCE.

TRANSDUCER SIGNALS

1. AIR XDUCER
2. OXYGEN XDUCER
3. EXP FLOW DIF. XDUCER
4. EXP. XDUCER
5. INSP. TEMP. SENSOR
6. EXH SYSTEM TEMP. SENSOR
7. OXYGEN SENSOR.
8. INSP XDUCER
9. NOT USED
10. GAS TYPE ID
11. INSP FLOW DIF. XDUCER
12. HOT WIRE SENSOR
13. BLENDED GAS XDUCER
14. PES XDUCER
15. AUXILIARY XDUCER
16. NOT USED
17. FAW DIF. XDUCER
18. NOT USED

CONTROL SIGNALS

19. INSP AZ SV
20. ACTIVE EXHALATION VALVE
21. EFS AZ SV
22. SAFETY SV
23. WATER DUMP SV
24. BLENDER STEPPER MOTOR
25. CROSSOVER SV
26. OXYGEN SWITCH SV
27. GAS CV
28. HEATER
29. FAN MOTOR
30. COMPRESSOR MOTOR
31. FAW AZ SV
32. NEBULIZER SV
33. BOOSTER DRIVE SV
34. VACUUM PUMP SV
35. ESOP FILL SV
36. ESOP EVACUATION SV
37. PROX PURGE SV
38. EFS PURGE SV
39. WFS PURGE SV
40. DELETED
41. DELETED
42. DELETED
43. NEONATOL SENSOR HEATER

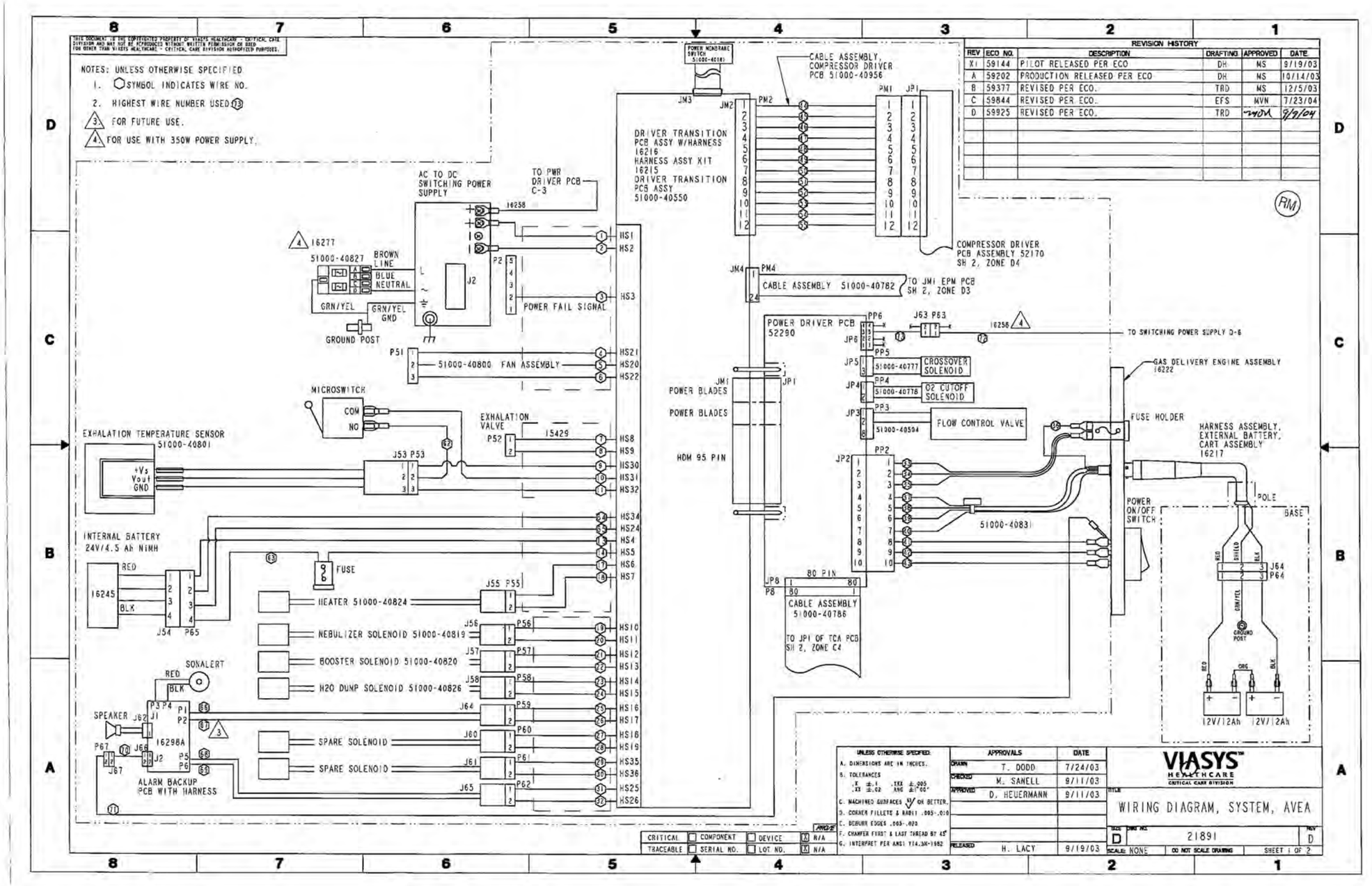
ABBREVIATIONS

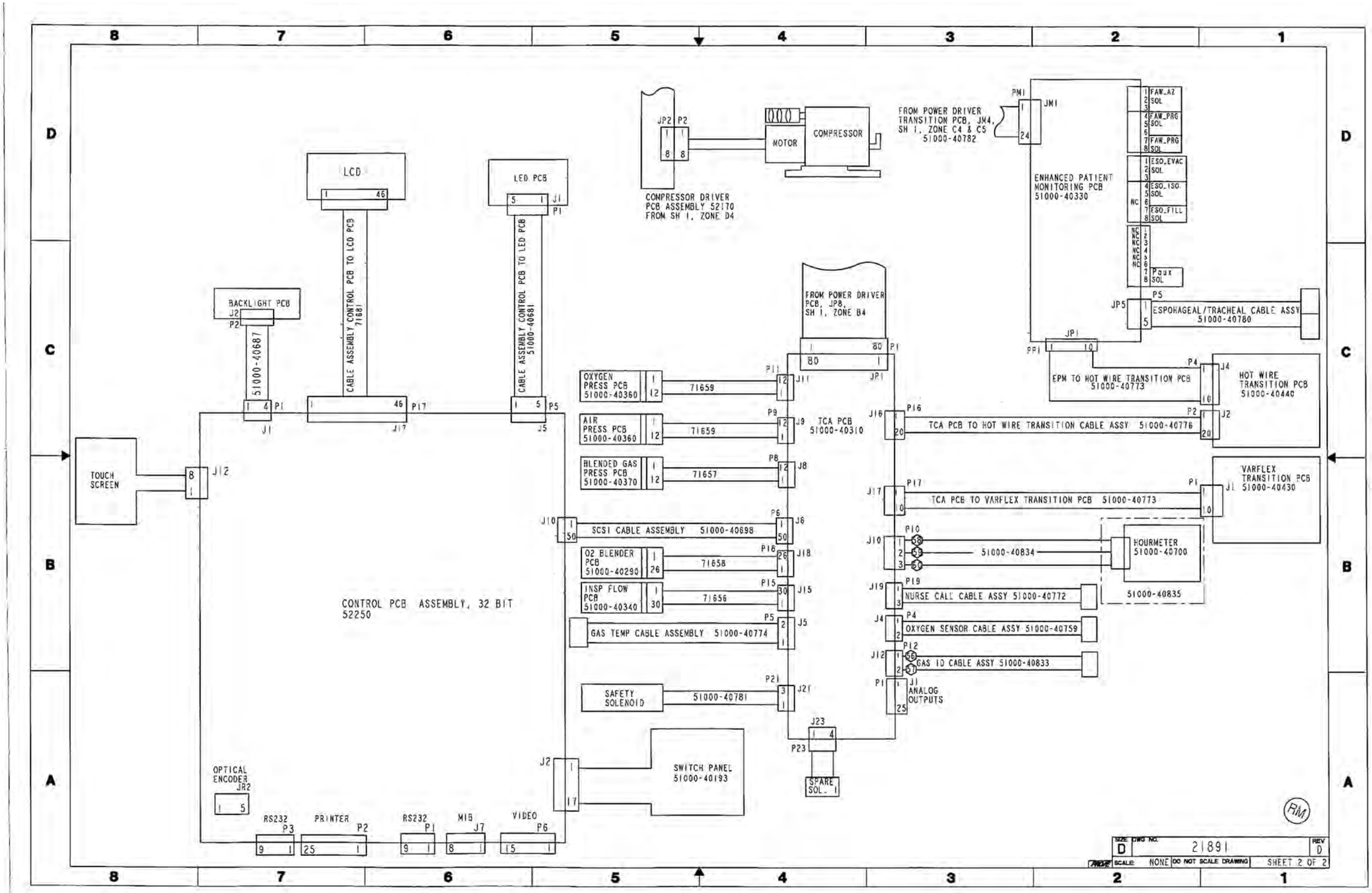
AZ - AUTO ZERO.
CV - CONTROL VALVE.
DIF XDUCER - DIFFERENTIAL PRESSURE TRANSDUCER.
EFS - EXHALED FLOW SENSOR
EPM - ENHANCED PATIENT MONITORS
ESOP - ESOPHAGEAL.
EXH - EXHALATION
EXP - EXPIRATORY.
FAW - AIRWAY FLOW
GDE - GAS DELIVERY ENGINE.
HP - HIGH PRESSURE.
ID - IDENTIFIER.
INSP - INSPIRATORY.
LP - LOW PRESSURE.
PAUX - AUXILIARY PRESSURE
PAW - PROXIMAL (AIRWAY) PRESSURE.
PES - ESOPHAGEAL PRESSURE.
PR - PRESSURE RELIEF
PROX - PROXIMAL
SR - SAFETY / RELIEF VALVE.
SV - SOLENOID VALVE.
TEMP - TEMPERATURE.
WFS - WYE FLOW SENSOR
XDUCER - TRANSDUCER.

NOTE: SYSTEM IS SHOWN IN DE-ENERGIZED STATE.

SIZE	DWG NO.	REV
D	51000-09742	D
A3/A2 SCALE: NONE	DO NOT SCALE DRAWING	SHEET 4 OF 4

Wiring Diagram




LCD
LED PCB
COMPRESSOR DRIVER PCB ASSEMBLY 52170 FROM SH 1, ZONE D4
MOTOR
COMPRESSOR
FROM POWER DRIVER TRANSITION PCB, JM4, SH 1, ZONE C4 & C5 51000-40782
ENHANCED PATIENT MONITORING PCB 51000-40330
FAW_AZ SOL
FAW_PRG SOL
FAW_PRG SOL
ESO_EVAC SOL
ESO_ISO SOL
ESO_FILL SOL
Paux SOL
ESOPHAGEAL/TRACHEAL CABLE ASSY 51000-40780
BACKLIGHT PCB
51000-40687
CABLE ASSEMBLY CONTROL PCB TO LCD PCB 71681
CABLE ASSEMBLY CONTROL PCB TO LED PCB 51000-40681
FROM POWER DRIVER PCB, JP8, SH 1, ZONE B4
EPM TO HOT WIRE TRANSITION PCB 51000-40773
HOT WIRE TRANSITION PCB 51000-40440
OXYGEN PRESS PCB 51000-40360
AIR PRESS PCB 51000-40360
BLENDED GAS PRESS PCB 51000-40370
71659
71659
71657
TCA PCB 51000-40310
TCA PCB TO HOT WIRE TRANSITION CABLE ASSY 51000-40776
TCA PCB TO VARFLEX TRANSITION PCB 51000-40773
VARFLEX TRANSITION PCB 51000-40430
TOUCH SCREEN
SCSI CABLE ASSEMBLY 51000-40698
O2 BLENDER PCB 51000-40290
71658
INSP FLOW PCB 51000-40340
71656
GAS TEMP CABLE ASSEMBLY 51000-40774
51000-40834
HOURMETER 51000-40700
51000-40835
NURSE CALL CABLE ASSY 51000-40772
OXYGEN SENSOR CABLE ASSY 51000-40759
GAS ID CABLE ASSY 51000-40833
ANALOG OUTPUTS
SAFETY SOLENOID
51000-40781
SPARE SOL. 1
SWITCH PANEL 51000-40193
CONTROL PCB ASSEMBLY, 32 BIT 52250
OPTICAL ENCODER
RS232
PRINTER
RS232
MIB
VIDEO
SIZE D
DWG NO. 21891
REV D
SCALE NONE
DO NOT SCALE DRAWING
SHEET 2 OF 2

Specifications

Pneumatic Supply

Air or Heliox Supply

Pressure Range:	20 to 80 psig (Supply Air)
	20 to 80 psig (Supply Heliox)
	3 to 10 psig (Compressor Air)
Temperature:	10 to 62 °C (50 to 143.6 °F)
Humidity:	Dew Point of gas should be 1.7 °C (3 °F) below the ambient temperature (minimum)
Minimum Flow:	80 L/MIN at 20 psig
Inlet Fitting:	CGA DISS-type body, No. 1160 (Air)
	CGA DISS-type body, No. 1180 (Heliox)

The 1180 fitting is available from most medical specialty gas suppliers. One such company is Superior Products in Cleveland, Ohio, (216) 651-9400 (P/N MA692).

Oxygen Supply

Pressure Range:	20 to 80 psig (Supply Oxygen)
Temperature:	10 to 40 °C (50 to 104 °F)
Humidity:	Dew Point of gas should be 1.7 °C (3 °F) below the ambient temperature (minimum)
Minimum Flow:	80 L/MIN at 20 psig
Inlet Fitting:	CGA DISS-type body, No. 1240

Electrical Supply

AC Power Supply

The ventilator operates within specification when connected to the following AC power supplies:

Nominal	Voltage Range	Frequency Range
100 VAC	(85 to 110 VAC)	47 to 65 Hz
120 VAC	(102 to 132 VAC)	55 to 65 Hz
230 VAC	(196 TO 253 VAC)	47 to 65 Hz
240 VAC	(204 TO 264 VAC)	47 to 65 Hz

DC Power Supply

The ventilator can also operate from a 24 VDC power source (internal or external battery).

Internal Battery:

The ventilator operates for 30 minutes when operated on the internal battery with a compressor and one hour on a 50 PSI air source. The maximum charge time to achieve a full charge is 8 to 12 hours.

External Battery:

With an external battery supplying 22.0 to 26.4 VDC, the ventilator will operate for two hours with a compressor and four hours on a 50 PSI air source.

Data Input / Output

Analog Inputs

The ventilator provides up to 8 programmable channels for analog signal inputs. Each channel shall be scalable for the input ranges specified.

Ranges:	0 to 1 VDC
	0 to 5 VDC
	0 to 10 VDC
Resolution:	0.25 mV (for 0 to 1 VDC)
	1.37 mV (for 0 to 5 VDC)
	2.5 mV (for 0 to 10 VDC)

Analog Outputs

The ventilator provides 4 signals to the analog output connector:

1. Airway Pressure, PAW:

Connection	DB25 connector, pin 22. Ground pins 9-13
Range:	-60 to 140 cmH_2O
Scale:	1 cmH_2O/25 mV
Accuracy:	± 50 mV or ± 5% of reading, whichever is greater
Zero Offset:	1.5 VDC at 0 cmH_2O

2. Flow

Connection DB25 connector, pin 23. Ground pins 9-13

Inspiratory/Expiratory flow:

When selected, the ventilator provides a continuous analog voltage representative of inspiratory flow minus expiratory flow.

Range:	-300 to 200 L/MIN (Adult)
	-120 to 80 L/MIN (Pediatric)
	-60 to 40 L/MIN (Neonate)
Scale Factor:	1 L/MIN / 10 mV (Adult)
	1 L/MIN / 25 mV (Pediatric)
	1 L/MIN / 50 mV (Neonate)
Accuracy:	± 10% of reading or ± 30 mV, whichever is greater
Zero Offset:	3.0 VDC at 0 L/MIN

Machine:

When selected the ventilator provides a continuous analog voltage representative of machine delivered flow.

Range:	0 to 200 L/MIN (Adult)
	0 to 100 L/MIN (Pediatric)
	0 to 50 L/MIN (Neonate)
Scale Factor:	1 L/MIN / 25 mV (Adult)
	1 L/MIN / 50 mV (Pediatric)
	1 L/MIN / 100 mV (Neonate)
Accuracy:	± 10% of reading or ± 30 mV, whichever is greater
Zero Offset:	None

3. Volume:

Connection	DB25 connector, pin 24. Ground pins 9-13
Range:	-1.00 to 4.00 L (Adult)
	-200 to 800 mL (Pediatric)
	-100 to 400 mL (Neonate)
Scale Factor:	1 L / V (Adult)
	1 mL / 5 mV (Pediatric)
	1 mL / 10 mV (Neonate)
Accuracy:	± 10% of reading or ± 30 mV, whichever is greater
Zero Offset:	1.000 VDC

4. Breath Phase

Connection DB25 connector, pin 25. Ground pins 9-13.

The ventilator provides a continuous analog voltage representative of breath phase (Inspiration = 5 VDC, Expiration = 0 VDC).

Digital Communication

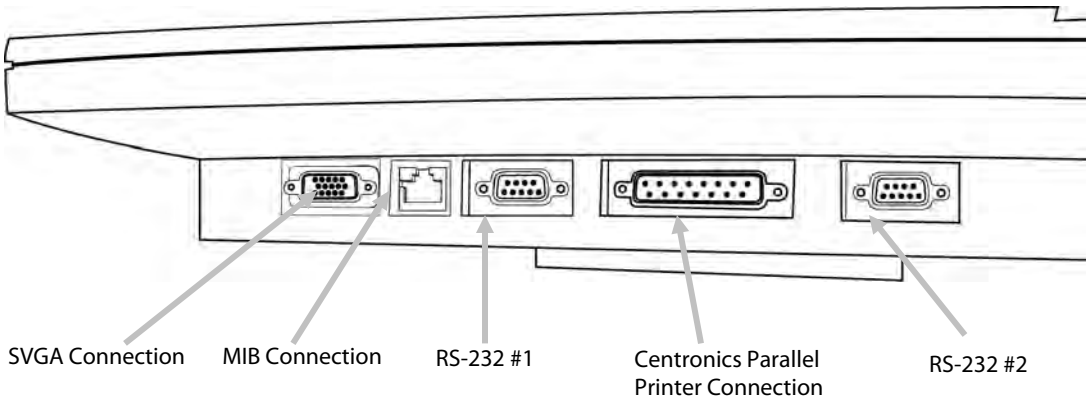


Figure 11.1 Connections beneath the ELAN UIM screen

The ventilator has two RS-232 ports on the ELAN UIM for bi-directional communication of data: RS-232 Ch1 and RS-232 Ch2. RS232-1 DB9-F connector is active for software upgrades and the Avea communication protocol, recommended to connect only to CareFusion applications.

RS-232-Channel 2 DB9-F is reserved for future applications.

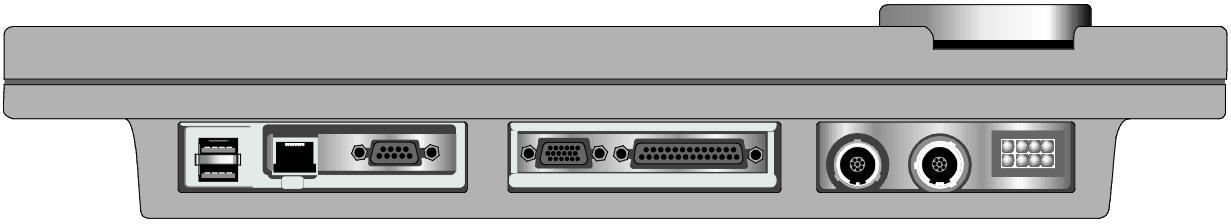


Figure 11.2 Connections beneath the Coldfire UIM screen

Printer

The ventilator UIM has a standard 25-pin female Centronics parallel printer port, DB25-F, active on all models for use with HP color deskjet printers with parallel interface.

Printing from the Avea:

1. The print screen is compatible with Hewlett Packard 300 and 900 series printers.
2. The port is on the underside of the UIM fairly in the middle. A “printer” symbol has been placed on the UIM directly above the port itself.
3. It is a parallel printer port.
4. After connecting the appropriate printer you may print a screen at any time.

5. Press “FREEZE” to capture the screen data.
6. Press “PRINT” and the screen will be printed.

Video Output (SVGA Connection)

The ventilator UIM provides a video output connector which allows for interfacing to an externally located 256-color, 800 x 600, SVGA monitor.

MIB Connection

Configuration of the Avea to communicate with interfaces always requires setting the baud rate and communication parameter to match the host device.

From the Main Screen:

1. Press SCREENS UTILITIES INPUT/OUTPUT RS 232 Output.
2. Rotate the DATA DIAL until the applicable selection appears.
3. Press the “ACCEPT” button.
4. In the same manner, set the baud rate and communication parameter to match the host device.

The Avea will then be configured to communicate with the interface selected.

When properly connected, the communication ICON in the Avea INPUT/OUTPUT screen will be present.

GSP (Generic Serial Protocol)

This interface is available in Avea software versions 3.3 and greater. The Avea GSP Interface Kit is P/N 16375 and includes a CAT-5 Cable and a 9 pin adapter.

Phillips Vue Link

Avea software versions 3.1 and greater may be interfaced with the Phillips Vue Link system. The P/N for the Vue-Link CAT 5 serial cable and adapter is 16337.

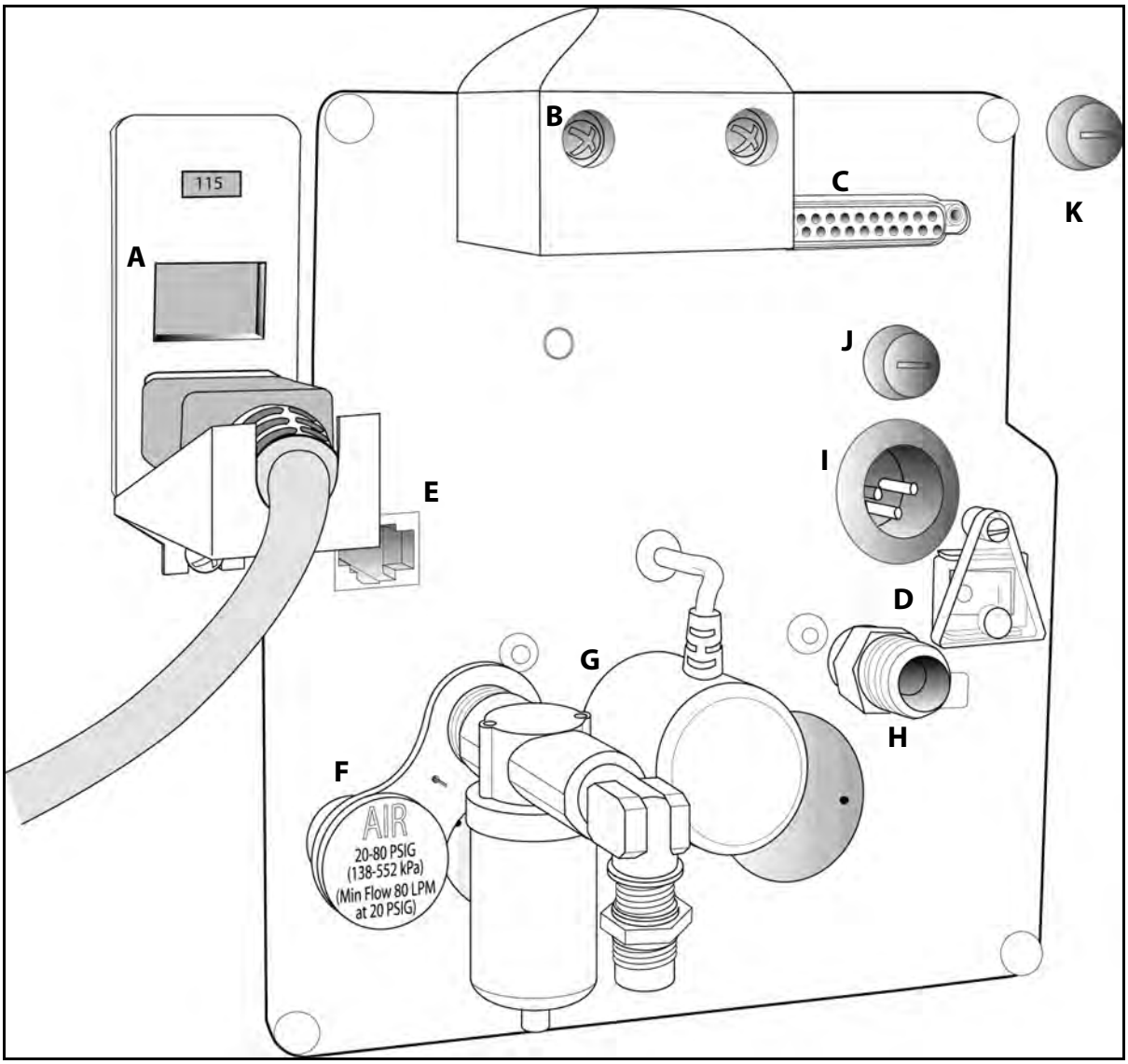


Figure 11.3 Rear Panel

A – AC power module	G – Oxygen sensor
B – UIM connection	H – Oxygen hose connection
C – Analog input/output/ILV	I – External battery connector
D – Power ON/OFF Switch	J – External battery fuse
E – Nurse call system connection	K – Internal battery fuse
F – Air smart connector	

Remote Nurse Call

The ventilator has a modular jack configured to interface with external systems that are either wired for normally open (N.O., close on alarm) or normally closed (N.C., open on alarm) signals.

In the active state, the remote alarm can sink 1.0 A.

The Remote Nurse Call cable may be permanently affixed to the Avea ventilator.

1. Remove paper backing from the cable bridge P/N 08231 and attach the bridge sticky side to the location as show in the photo provided.
2. Insert the Remote Nurse Call cable into the receptacle until it clicks and locks into the position.
3. Insert the cable tie P/N 07803 provided through the cable bridge, bend the Remote Nurse Call cable as show in the photo against the top of the cable bridge.
4. Insert the pointed end of the cable tie through the opposite locking end of the cable tie and pull it finger tight only against the Remote Nurse Call cable.
5. Ensure that the Remote Nurse Call Cable has a slight looping bend to it and not a sharp 90-degree bend. This will ensure there is not undo stress applied to the Remote Nurse Call cable.

   Cut off the excess cable tie flush with the locking portion of the cable tie.

Independent Lung Ventilation (ILV)

The ventilator provides an output (master) and an input (slave) for synchronization of ventilators. The output supplies a 5 VDC logic signal synchronized to the breath phase of the master. ILV CABLE P/N 16124 ILV CABLE KIT P/N 16246

Atmospheric and Environmental Specifications

Temperature and Humidity

Storage

Temperature: −20 to 60 °C (−4 to 140 °F)

Humidity: 0 to 95% RH non-condensing

Operating

Temperature: 5 to 40 °C (41 to 104 °F)

Humidity: 0 to 95% RH non-condensing

Barometric Pressure

760 to 545 mmHg

Blender Bleed

The bleed rate from the relay is 2.3 SLPM (O_2).

The bleed to the O_2 sensor is approximately 0.1 SLPM (blended gas).

The bleed specification is 7.5 +/- 0.5 LPM at 9 +/- 0.5 PSI at the accumulator. When there is sufficient minute ventilation to keep the pressure below that value, the bleed is shut off.

Sound Levels

Measured at three meters in front of the Avea ventilator:

Lowest Alarm Level – 55dBA.

Highest Alarm Level – 75 dBA.

Physical Dimensions

Overall Size

Ventilator: 17″ W x 16″ D x 10.5″ H

UIM: 16.25″ W x 2.5″ D x 13.75″ H

Weight

Ventilator w/ UIM: $\leq$ 73 lbs.

Compressor: $\leq$ 7 lbs.

Accessories

Pall Microbial Filter

Resistance:

The exhalation filter supplied with your Avea ventilator is manufactured by Pall Medical of Ann Arbor, MI, USA. The published maximum resistance of this filter is 4 cmH_2O at 20 L/min for the Intervene 255 Filter (small) and 4cm H_2O at 100 L/min for the 725 (large) filter.

Compliance:

The compliance for the small filter is < 0.5 mL/cmH_2O and for the large filter is < 0.4 mL/cmH_2O

Materials:

Materials used in the construction of both filters have passed USP Class VI 121° C Plastic and Cytoxicity test.

For further information please contact Pall Medical.

Water Trap

Resistance:

The resistance of the small water trap assembly including the collection bottle is < than 0.25 cmH2O at 20 L/min.

Compliance:

The compliance of both water trap assemblies including the collection bottle is < 0.2 mL/cmH_2O.

Exchange Protocol

The following describes several typical transaction sequences for this protocol. Others are possible, but are analogous to or extensions of those presented.

Figure 11.4

Default

The default transmission mode for all data types is "By Request".

Disabled State

All data transmission may be disabled under certain circumstances, for example, if an alternate data channel (MIB) is selected for communication. In this case, all Service

Requests will be replied with a failure message.

Avea Message Bar Text

Avea MESSAGE BAR TEXT	CAUSE
"Confirm Apnea Settings."	Selection of CPAP/PSV or APRV on Mode Select popup when active.
"Proximal Flow Sensor required."	Acceptance of Volume Limit setting when Size is NEO, Volume Limit is active, and no Wye Flow Sensor connected (Varflex or Hotwire).
"Bias Flow insufficient to allow Flow Trigger."	Acceptance of Bias Flow setting or Flow Trigger setting when Flow Trigger < (Bias Flow + 0.5 lpm).
"Heliox concentration will change."	Acceptance of $\%O_2$ setting when Heliox is being used.
"Nebulizer not available."	Acceptance of Peak Flow setting < 15 lpm when Nebulizer is active or on pressing of Nebulizer membrane key when Peak Flow setting < 15 lpm
"Confirm inspiratory pressure settings."	Selection of Volume Limit control when Volume Limit active (i. e., not at default / highest value for patient size).
"Settings restored to defaults."	Patient Accept when New Patient selected.
"Compliance Compensation not active for NEO."	Size Accept when Size is NEO, and Circ Comp setting is non-zero.
"Minimum 0.2 sec Inspiratory Time."	Acceptance of any combination of settings that will produce an I-Time of less than 0.2 seconds.
"Maximum 4:1 I:E Ratio."	Acceptance of any combination of settings that will produce an I:E Ratio of 4:1 or greater.
"Maximum 3 sec Inspiratory Time."	Acceptance of any combination of settings when size is NEO that will produce an I-Time of greater than 3 seconds.
"Maximum 5 sec Inspiratory Time."	Acceptance of any combination of settings when size is PED or ADULT that will produce an I-Time of greater than 5 seconds.
"Invalid Calibration"	**Service State Only:** Validation failure, while calibration dialog box is active for selected device.
"Error saving Serial/Model Number"	**Service State Only:** On accept of Serial Number or Model Number Change.
Clear Messages	**Service State Only:** Validation success, while calibration dialog box is active for selected device.
"FCV Characterization in progress."	**Service State Only:** On start of Flow Control Valve characterization procedure.
"FCV Characterization complete."	**Service State Only:** On successful completion of Flow Control Valve characterization procedure.
"FCV Characterization failed."	**Service State Only:** Unsuccessful completion of Flow Control Valve characterization procedure. Validation failure characterization and tuning data.
Installed Software Version	Power Up
Current Time, Date, and Runtime Hours	Main key pressed.
“DPRAM Comm. Error, Ctrl"	Loss of Communication with Control microprocessor
"Printing."	Print Screen button was pressed; commenced sending screen data to printer.
"Printer Out of Paper."	Print Screen button was pressed, printer reported it is out of paper.
"Printer Offline."	Print Screen button was pressed; printer is not available.

Avea MESSAGE BAR TEXT	CAUSE
"Printer Error."	Print Screen button was pressed; printer reported an error condition.
"Printer Ready."	Sending screen data to printer has completed.
"Printer Busy."	Print Screen button was pressed, device has not completed sending data from previous activation.
"Volume Limit disabled."	On disconnect of WFS (Neo or Hotwire) when Size is NEO and Volume Limit is active.
"Proximal Flow Sensor disconnected."	On disconnect of WFS, any type.
"Flow sensor is not Heliox-compatible."	On connect of Hotwire WFS when Heliox is active.
"Proximal Airway Line disconnected."	On disconnect of Proximal Pressure connection.
"Proximal Flow Sensor conflict.	On simultaneous connect of Hotwire and VarFlex WFS.
"Esophageal monitoring not available."	On connect of Esophageal Balloon when size is NEO.
"Tracheal monitoring not available."	On connect of Tracheal Catheter when size is NEO.
"Flow Sensor Error."	On power up, failure to validate any internal flow sensor.
"Wye Sensor Error."	On connect and failure to validate any proximal flow sensor.
"Device Error."	On detection of a fault classified as “Device Error” (see Fault Section)
"Esophageal Balloon Leak Test Failed."	On failure of Esophageal Balloon leak test.
“Stopped: Patient Effort Detected”	Upon detecting Patient effort in maneuvers which require a passive patient
“Proximal Flow Sensor Ready”	

Adjusting Barometric Pressure for Altitude

For ELAN UIMs, the default setting for barometric pressure on Avea is 760 mm Hg. For institutions at altitudes of 1000 feet or greater, barometric pressure can be set by the operator (see Table 11.1 Altitude to Barometric Pressure Conversion).

Open the screens menu by pressing the screen indicator on the touch screen or the “SCREENS” membrane button located to the left of the touch screen.

Select utility from the screens menu. Press the touch screen button for barometric pressure and use the data dial to change the setting. Once you have reached the desired barometric pressure setting, press the “ACCEPT” membrane button adjacent to the data dial.

To close the utilities screen and return to the main screen, press the screen indicator again and select MAIN from the menu or press the membrane button to the left of the touch screen labeled “MAIN”.

For Coldfire UIMs, the barometric pressure is measured by an onboard pressure transducer and cannot be adjusted.

Below is a chart of approximate Barometric Pressure at varying altitude:

Table 11.1 Altitude to Barometric Pressure Conversion[1]

Altitude (ft)	Barometric Pressure (mm Hg)
0	760
1000	733
2000	707
3000	681
4000	656
5000	632
6000	609
7000	588
8000	567
9000	545

[1] CRC Handbook of Chemistry and Physics 61st Edition,1980-1981, CRC Press, Inc. Boca Raton, Florida

Monitor Ranges and Accuracies

DISPLAY	DESCRIPTION	RANGE	ACCURACY
VOLUME MONITORS			
The volume measured during the inspiratory phase of the breath is accumulated as the inspired tidal volume, and the volume measured during the exhalation phase is accumulated as the exhaled tidal volume. This volume does not include the volume delivered by the Circuit Compliance Compensation function for volume breaths.			
Vte	Exhaled tidal volume.	0 to 4 L	(± 20mL + 10% of reading)- Adult machine sensor (± 1 mL + 10% of reading)- Neonate wye sensor
Vte/kg	Exhaled tidal volume adjusted for patient weight	0 to 4 mL/kg	
Vti	Inspired tidal volume.	0 to 4 L	(± 20mL + 10% of reading)- Adult machine sensor (± 1 mL + 10% of reading)- Neonate wye sensor
Vti/kg	Inspired tidal volume adjusted for patient weight	0 to 4 mL/kg	
Spon Vt	Spontaneous tidal volume.	0 to 4 L	(± 20mL + 10% of reading)- Adult machine sensor (± 1 mL + 10% of reading)- Neonate wye sensor
Spon Vt/kg	Spontaneous tidal volume adjusted for patient weight	0 to 4 mL/kg	
Mand Vt	Mandatory tidal volume. Displayed as a rolling average of either 8 breaths or one minute, whichever occurs first.	0 to 4 L	(± 20mL + 10% of reading)- Adult machine sensor (± 1 mL + 10% of reading)- Neonate wye sensor
Mand Vt/kg	Mandatory tidal volume adjusted for patient weight	0 to 4 mL/kg	Derived
Vdel	Delivered machine volume measured by the ventilator's inspiratory flow sensor.	0 to 4L	(± 20mL + 10% of reading)-
% Leak	Percent leakage. The difference between the inspired and exhaled tidal volumes in terms of % difference.	Derived	Derived
Ve	Minute Volume. Volume of gas exhaled by the patient during the last minute.	0 to 99.9 L	Derived
Ve/kg	Minute volume adjusted for patient weight	0 to 999 mL/kg	Derived
Spon Ve	Spontaneous minute volume.	0 to 99.9L	Derived
Spon Ve/kg	Spontaneous minute volume adjusted for patient weight	0 to 999mL/kg	Derived

DISPLAY	DESCRIPTION	RANGE	ACCURACY
RATE/TIME MONITORS			
Rate	Breath Rate.	0 to 200 bpm	± 3% or ± 2 bpm whichever is greater
Spon Rate	Spontaneous breath rate.	0 to 200 bpm	± 3% or ± 2 bpm whichever is greater
Ti	Inspiratory time.	0.00 to 99.99 sec	± 0.03 sec
Te	Exhalation Time.	0.00 to 99.99 sec	± 0.03 sec
I:E	Inspiratory/expiratory ratio *Note: Not active for demand breaths.*	1:99.9 to 99.9:1	Derived from accuracies for monitored Ti and Te
f/Vt	Rapid shallow breathing index.	0 to 500 b^2/min/L	Derived from accuracies for spontaneous breath rate and spontaneous minute volume
PRESSURE MONITORS			
Ppeak	Peak inspiratory pressure. Not active with spontaneous breaths	0 to 120 cmH_2O	± 3.5% of reading or ± 2 cmH_2O, whichever is greater
Pmean	Mean airway pressure.	0 to 120 cmH_2O	± 3.5% of reading or ± 2 cmH_2O, whichever is greater
Pplat	Plateau pressure. If no plateau occurs, then the monitor displays * * *	0 to 120 cmH_2O	± 3.5% of reading or ± 2 cmH_2O, whichever is greater
PEEP	Positive end expiratory pressure.	0 to 60 cmH_2O	± 3.5% of reading or ± 2 cmH_2O, whichever is greater
Air Inlet	Air inlet gas supply pressure.	0 to 80 psig	± 5 psig (1.4 – 5.5 bar)
O2 Inlet	Oxygen inlet gas supply pressure.	0 to 80 psig	± 5 psig (1.4 - 5.5 bar)
GAS COMPOSITION MONITORS			
FiO2	Delivered percent O_2.	0 to 100%	± 3%
MECHANICS			
Cdyn	Dynamic Compliance (C_{DYN} and C_{DYN} / Kg), absolute and normalized to patient weight.	0 to 300 mL/cmH_2O	Derived
Cdyn/Kg		0.00 to 5.00 $mL/cmH_2O \cdot kg$	
Cstat	Respiratory System Compliance (C_{RS}), (a.k.a. Static Compliance C_{STAT}), absolute and normalized to patient weight. *Note:This requires an Inspiratory Hold maneuver.*	0 to 300 mL/cmH_2O	Derived
Cstat/Kg		0.00 to 5.00 $mL/cmH_2O \cdot kg$	
Rrs	Respiratory system resistance. *Note: Calculation is performed during an Inspiratory Hold maneuver.*	0 to 100 cmH_2O/L/sec	Derived
PIFR	Peak Inspiratory flow rate.	0 to 300 L/min (All patients)	± 10% of setting or ± (0.2 L/min + 10% of setting), whichever is greater

DISPLAY	DESCRIPTION	RANGE	ACCURACY
PEFR	Peak Expiratory flow rate.	0 to 300 L/min (All patients)	± 10% of setting or ± (0.2 L/min + 10% of setting), whichever is greater
Ccw	The ratio of the tidal volume (exhaled) to the Delta Esophageal Pressure (dP_{ES}). Requires an esophageal balloon.	0 to 300 mL/cmH_2O	± 10%
C_{LUNG}	The ratio of the tidal volume (exhaled) to the delta transpulmonary pressure. The delta transpulmonary pressure is the difference between the airway plateau pressure (during an inspiratory pause) and esophageal pressure (at the time the airway plateau pressure is measured) minus the difference between the airway and esophageal baseline pressures. Requires an inspiratory hold and esophageal balloon.	0 to 300 mL/cmH_2O	± 10%
C_{20} / C	The ratio of the dynamic compliance during the last 20% of inspiration (C_{20}) to the total dynamic compliance (C).	0.00 to 5.00	± 10%
R_{RS}	The total resistance during the inspiratory phase of a breath. Respiratory System Resistance is the ratio of the airway pressure differential (peak – plateau) to the inspiratory flow 12 ms prior to the end of inspiration. Requires an inspiratory hold.	0 to 100 cmH_2O/L/sec	± 10%
R_{PEAK}	The Peak Expiratory Resistance (R_{PEAK}), is defined as the resistance at the time of the Peak Expiratory Flow (PEFR).	0.0 to 100.0 cmH_2O/L/sec	± 10%
R_{IMP}	The airway resistance between the wye of the patient circuit and the tracheal sensor. Requires an inspiratory hold and tracheal catheter.	0.0 to 100.0 cmH_2O/L/sec	± 10%
R_{LUNG}	The ratio of the tracheal pressure differential (peak – plateau) to the inspiratory flow 12 ms prior to the end of inspiration. Requires an inspiratory hold and tracheal catheter.	0.0 to 100.0 cmH_2O/L/sec	± 10%
dP_{AW}	The difference between peak airway pressure ($P_{PEAK\,AW}$) and baseline airway pressure ($PEEP_{AW}$).	–120 to 120 cmH_2O	± 2 cm H_2O or ± 5% whichever is greater

DISPLAY	DESCRIPTION	RANGE	ACCURACY
dP_{ES}	The difference between peak esophageal pressure ($P_{PEAK\ ES}$) and baseline esophageal pressure ($PEEP_{ES}$).	–120 to 120 cmH_2O	± 2 cm H_2O or ± 5% whichever is greater
AutoPEEP	The airway pressure at the end of an expiratory hold maneuver. Requires a passive patient.	0 to 50 cmH_2O	± 2 cm H_2O or ± 5% whichever is greater
dAutoPEEP	The difference between airway pressure at the end of an expiratory hold maneuver and the airway pressure at the start of the next scheduled breath after the expiratory hold maneuver. Requires a passive patient.	0 to 50 cmH_2O	± 2 cm H_2O or ± 5% whichever is greater
$AutoPEEP_{ES}$	The difference between esophageal pressure measured at the end of exhalation ($PEEP_{ES}$) minus the esophageal pressure measured at the start of a patient-initiated breath ($P_{ES\ start}$) and the sensitivity of the ventilator's demand system. The sensitivity of the ventilator's demand system is the difference between the baseline airway pressure ($PEEP_{AW}$) and the airway pressure when the patient initiates a breath ($P_{AW\ start}$). Requires an esophageal balloon.	0 to 50 cmH_2O	± 2 cm H_2O or ± 5% whichever is greater
Ptp Plat	Transpulmonary pressure during an inspiratory hold, which is the difference between the airway plateau pressure ($P_{PLAT\ AW}$) and the corresponding esophageal pressure. Requires an inspiratory hold and esophageal balloon.	–60 to 120 cmH_2O	± 2 cm H_2O or ± 5% whichever is greater
P_{tp} PEEP	The difference between the corresponding airway and esophageal pressures at the end of the expiratory hold during an AutoPEEP maneuver. Requires an inspiratory hold and esophageal catheter.	–60 to 120 cmH_2O	± 2 cmH_2O or ± 5%, whichever is greater
MIP	The maximum negative airway pressure that is achieved by the patient, during an expiratory hold maneuver.	–60 to 120 cmH_2O	± 2 cmH_2O or ± 5%, whichever is greater
P_{100}	The negative pressure that occurs 100 ms after an inspiratory effort has been detected.	–60 to 120 cmH_2O	± 2 cmH_2O or ± 5%, whichever is greater

DISPLAY	DESCRIPTION	RANGE	ACCURACY
WOB_V	The summation of airway pressure (P_{AW}) minus the baseline airway pressure ($PEEP_{AW}$) times the change in tidal volume to the patient (ΔV) during inspiration, and normalized to the total inspiratory tidal volume (V_{ti}).	0.00 to 20.00 Joules/L	$\pm$ 10%
WOB_P	Patient Work of Breathing (WOB_P), normalized to the total inspiratory tidal volume. Patient work of breathing is defined as the summation of two work components: work of the lung and work of the chest wall. Requires an esophageal balloon.	0.00 to 20.00 Joules/L	$\pm$ 10%
WOB_I	The work performed by the patient to breathe spontaneously through the breathing apparatus, i.e. the E.T. tube, the breathing circuit, and the demand flow system. Requires a tracheal catheter.	0.00 to 20.00 Joules/L	$\pm$ 10%

Note:

Monitored values are displayed as BTPS

Monitored Values

End Tidal CO_2 ($EtCO_2$)

The patient's peak expired CO_2 as measured and reported by the CO_2 sensor in the airway. $EtCO_2$ is measured for each breath. The display is either a breath-by-breath measurement or an averaged measurement.

Range:

0 – 150 mmHg (0 – 20.0 kPa)

Resolution:

0.1 mmHg (0.01 kPa) or three significant digits (whichever is greater)

Accuracy:

± 2 mmHg for 0 – 40 mmHg

± 5% of reading for 41 – 70 mmHg

± 8% of reading for 71 – 100 mmHg

± 10% of reading for 101 – 150 mmHg

Note:

The minimum differential between inspired and expired CO_2 must be 5 mmHg (0.7kPa) or greater.

Warning!

Do not use $EtCO_2$ as basis for changing ventilation parameters without reference to clinical condition and independent monitors such as blood gas.

CO_2 Elimination (VCO_2)

The amount of CO2 eliminated every minute. This is calculated over each minute, and then averaged over the set VCO2 averaging time.

Range:

0 – 999 mL/min

Resolution:

0.1 mL or three significant digits (whichever is greater)

CO_2 ($VtCO_2$)

The amount of CO2 exhaled per breath. VtCO2 is measured for each breath and then averaged over the set VCO2 Averaging time.

Range:

0 – 299 mL

Resolution:

0.1 mL or three significant digits (whichever is greater)

Anatomical Dead Space (Vd ana)

The volume of dead space in the patient's airway. Anatomical dead space is measured for each breath. This value is averaged over the set VCO2 averaging time.

Range:

0 – 999 mL

Resolution:

0.1 mL or three significant digits (whichever is greater)

Anatomical Dead Space / Tidal Volume Ratio (Vd / Vt ana)

Vd / Vt ana is averaged over the set VCO2 averaging time.

Range:

0 – 99%

Resolution:

1%

Note:

VCO_2, $VtCO_2$, Vd ana and Vd/Vt ana require flow to be measured by a proximal flow sensor at the wye, or circuit compliance compensation to be active. If a proximal flow sensor or circuit compliance compensation are not used, the Avea displays *** in those fields.

Note:

An arterial blood gas sample is required to calculate VA, Vd phy, Vd/Vt phy, Vd alv, OI, and P/F. These values are available at the Capnography Maneuver screen.

Alveolar Ventilation (VA)

Alveolar Ventilation is the volume of gas participating in gas exchange per minute.

Range:

0 – 99.9 L/min

Resolution:

0.01 L/min or three significant digits (whichever is greater)

Physiologic Dead Space (Vd phy)

Range:

0 – 999 mL

Resolution:

0.1 mL or three significant digits (whichever is greater)

Physiologic Dead Space / Tidal Volume Ratio (Vd / Vt phy)

Range:

0 – 99%

Resolution:

1%

Alveolar Dead Space (Vd alv)

Range:

0 – 999 mL

Resolution:

0.1 mL or three significant digits (whichever is greater)

Oxygenation Index (OI)

Oxygenation index is a dimensionless number often used to assess the “pressure cost” of oxygenation.

Range:

0 – 200 (PaO2 entered in mmHg) 0 – 1500 (PaO2 entered in kPa)

Resolution:

0.1 or three significant digits (whichever is greater)

PaO_2 / FIO_2 Ratio (P/F)

The PaO2 / FIO2 ratio is a simple assessment of gas exchange.

Range:

0 – 800 (PaO2 entered in mmHg) 0 – 106 (PaO2 entered in kPa)

Resolution:

0.1 or three significant digits (whichever is greater)

Sensor Specifications and Circuit Resistance

Table 11.2 Varflex® Flow Sensor

Sensor	Infant 15 mm	Adult 15 mm
Part Number	7002500	7002300
Type	Single Use	Single Use
Circuit Location	Wye	Wye
Performance Specifications		
Flow Range	0.024 to 30 L/min	1.2 to 180 L/min
Diff Pres Range	± 5.72 cmH_2O	± 5.72 cmH_2O
Accuracy*	± (0.012 L/min + 5% or reading	± (0.1 L/min + 5% or reading
Resistance	4.5 cmH_2O at 30 L/min	2.4 cmH_2O at 60 L/min
Dead Space	0.7 mL installed	9.6 mL installed
Freq. Response**	17 Hz	26 Hz
Airway Pres Range	-140 to 140 cmH_2O	-140 to 140 cmH_2O
Calibration (EEPROM)	29 Point Curve	29 Point Curve
Linearity	< 1% between points	< 1% between points
Operating Temperature	5° to 40° C 41° to 104° F	5° to 40° C 41° to 104° F
Physical Specifications		
Sensor Length	1.36 in (3.5 cm)	2.45 in (6.2 cm)
Diameter Insp (Vent Side)	15 mm OD	15 mm OD
Diameter Exp (Patient)	15 mm OD	15 mm OD
Tube Length	48 in (121.9 cm)	73 in (185.4 cm)
Connector	Bicore Proprietary	Bicore Proprietary
Weight	22 g (0.7 oz)	31 g (1.0 oz)
Service Life	Single Patient Use	Single Patient Use
Sterilization	NA	NA
Material	Sensor – Lexan Flap – Mylar Tubing – PVC Connector - ABS	Sensor – Lexan Flap – Mylar Tubing – PVC Connector - ABS

L/min: Dry air at 77° F (25° C) and 14.7 psig barometric pressure.

* Includes ± 1% for linearity and hysteresis with no zero drift for the pressure transducer and ± 2 % for temperature and humidity variations.

The sensor must be corrected for barometric pressure, and oxygen concentration.

** Frequency Response is signal attenuation to 0.707 input and assumes 100 Hz sample rate.

Hot Wire Flow Sensor Specifications

Table 11.3 Hot Wire Flow Sensor

Part Number	51000-40081
Type:	Multiple use heated wire
Circuit Location:	Wye
Performance Specifications	
Flow Range:	0 (+/- 0.002) to 30 L/min
Vol. Accuracy:	+/-10%
Flow Resistance:	15 cmH_2O at 20 L/min
Dead Space:	0.8 mL
Freq. Response*:	16 Hz
Calibration:	36 point curve
Linearity:	< 2%
Operating Temperature:	5 to 40°C
Physical Specifications	
Sensor length	1.68"
Diameter Insp (Vent Side)	15 mm OD
Diameter Exp (Patient Side)	15 mm OD
Tube length	NA
Connector	Pin and Socket type
Weight	< 10g (not including wire)
Service Life	25 cycles
Sterilization	Steam Autoclave
Materials	Sensor - Delrin Wire – Platinum Screen – Stainless Steel 304 or 316 Pin – PhBz, gold over nickel plated Spacer - Delrin

Circuit Resistance (per EN794 –1)

It is important to check the inspiratory and expiratory resistance specification of patient circuits used with the Avea to ensure they do not exceed the following limits when adding attachments or other components or subassemblies to the breathing circuit.

Note:

Refer to product labeling supplied with any accessory to be added to the breathing circuit for this information.

- 0.6 KPA (6cmH_2O) at 60 L/min for adult patients
- 0.6 KPA (6cmH_2O) at 30 L/min for pediatric patients
- 0.6 KPA (6cmH_2O) at 5 L/min for neonatal patients

Warning!

Total resistance of the inspiratory and expiratory limbs of the breathing circuit with accessories should not exceed 4cmH_2O at 5 L/min if inspiratory flows $\geq$ 15 liters per minute are used in TCPL ventilation modes.

Circuit Resistance Test

To measure the resistance of the inspiratory and expiratory limbs of the breathing circuit with accessories connect the patient breathing circuit as described in Chapter 2.

1. Select TCPL SIMV with settings:

Rate	1
Inspiratory Pressure	15 cmH_2O
Peak Flow	8.0 L/min
Inspiratory Time	0.35 sec
PEEP	0 cmH_2O
Flow Trigger	20 Lmin
% O_2	21 %
Bias Flow	5 L/min
Pressure trigger	20 cmH_2O

2. Select waveform Pinsp
3. With the patient wye blocked, allow the baseline pressure (PEEP) to stabilize for 10 seconds and press the FREEZE key.
4. Use the data dial to read the pressure from the Pinsp waveform. The pressure must not exceed 4cmH_2O at 5 L/min if inspiratory flows > 15 liters per minute are used in TCPL ventilation modes.

Advanced Pulmonary Mechanics Monitored Parameters

Rapid Shallow Breathing Index (f / V_t)

The ventilator is capable of displaying the calculated value for Rapid Shallow Breathing Index (f / V_t), which is the spontaneous breath rate per tidal volume, and is based on the following formula:

$f / V_t = f^2 / V_e$, where f = spontaneous breath rate (BPM) and Ve = spontaneous minute ventilation in LPM

Range: 0 to 500 b^2/min/L

Resolution: 1 b^2/min/L

Chest wall Compliance (C_{CW})

Chest wall Compliance (C_{CW}), is the ratio of the tidal volume (exhaled) to the Delta Esophageal Pressure (dP_{ES}).

$$C_{CW} = \frac{V\text{te}}{d\text{P}_{ES}}$$

Range: 0 to 300 mL/cmH_2O

Resolution: 1 mL/cmH_2O

Note: Requires an esophageal balloon catheter.

Accuracy: ± 10%

Lung Compliance (C_{LUNG})

Lung Compliance (C_{LUNG}), is the ratio of the tidal volume (exhaled) to the delta transpulmonary pressure. The delta transpulmonary pressure is the difference between the airway plateau pressure (during an inspiratory pause) and esophageal pressure (at the time the airway plateau pressure is measured) minus the difference between the airway and esophageal baseline pressures.

$C_{LUNG} = \frac{V\text{te}}{\text{dP}_{\text{PLAT TP}}}$, where $dP_{PLAT\,TP} = (P_{PLAT\,AW} - P_{ES}) - (PEEP_{AW} - PEEP_{ES})$

Range: 0 to 300 mL/cmH_2O

Resolution: 1 mL/cmH_2O

Note: Requires an Inspiratory Hold maneuver and an esophageal balloon catheter.

Accuracy: ±10%

Compliance Ratio (C_{20} / C)

Compliance Ratio (C_{20} / C), is the ratio of the dynamic compliance during the last 20% of inspiration (C_{20}) to the total dynamic compliance (C).

Range: 0.00 to 5.00

Resolution: 0.01

Accuracy: ± 10%

Respiratory System Resistance (R_{RS})

Respiratory System Resistance (R_{RS}), is the total resistance during the inspiratory phase of a breath. Respiratory System Resistance is the ratio of the airway pressure differential (peak – plateau) to the inspiratory flow 12 ms prior to the end of inspiration.

Range: 0 to 100 $cmH_2O/L/sec$

Resolution: 0.1 $cmH_2O/L/sec$

Limitation: Active for volume breaths only.

Note: Requires an Inspiratory Hold maneuver.

Accuracy: ± 10%

Peak Expiratory Resistance (R_{PEAK})

The ventilator shall be capable of calculating and displaying the Peak Expiratory Resistance (R_{PEAK}), which is defined as the resistance at the time of the Peak Expiratory Flow (PEFR).

$$R_{PEAK} = \frac{P_{PEFR}}{PEFR}$$

Range: 0.0 to 100.0 $cmH_2O/L/sec$

Resolution: 0.1 $cmH_2O/L/sec$

Accuracy: ± 10%

Imposed Resistance (R_{IMP})

Imposed Resistance (R_{IMP}), is the airway resistance between the wye of the patient circuit and the tracheal sensor.

Range: 0.0 to 100.0 $cmH_2O/L/sec$

Resolution: 0.1 $cmH_2O/L/sec$

Note: Requires an Inspiratory Hold maneuver and a tracheal catheter.

Accuracy: ± 10%

Lung Resistance (R_{LUNG})

Lung Resistance (R_{LUNG}), is the ratio of the tracheal pressure differential (peak – plateau) to the inspiratory flow 12 ms prior to the end of inspiration.

Range: 0.0 to 100.0 $cmH_2O/L/sec$

Resolution: 0.1 $cmH_2O/L/sec$

Note: Requires an Inspiratory Hold maneuver and a tracheal catheter.

Accuracy: ± 10%

Peak Inspiratory Flow Rate (PIFR)

The ventilator is capable of monitoring and displaying the actual peak inspiratory flow rate for the inspiratory phase of a breath.

Range: 0 to 300 LPM (All patients)

Resolution: 1 LPM (Adult/Pediatric)
0.1 LPM (Neonate)

Accuracy: ± 10%

Peak Expiratory Flow Rate (PEFR)

The ventilator is capable of monitoring and displaying the actual peak expiratory flow rate for the expiratory phase of a breath.

Range: 0 to 300 LPM (All patients)

Resolution: 1 LPM (Adult/Pediatric)

0.1 LPM (Neonate)

Accuracy: ± 10%

Delta Airway Pressure (dP_{AW})

Delta Airway Pressure (dP_{AW}), which is the difference between peak airway pressure ($P_{PEAK\,AW}$) and baseline airway pressure ($PEEP_{AW}$).

$dP_{AW} = P_{PEAK\,AW} - PEEP_{AW}$

Range: −120 to 120 cmH_2O

Resolution: 1 cmH_2O

Accuracy: ± 2cmH_2O or ± 5%, whichever is greater

Delta Esophageal Pressure (dP_{ES})

Delta Esophageal Pressure (dP_{ES}), is the difference between peak esophageal pressure ($P_{PEAK\,ES}$) and baseline esophageal pressure ($PEEP_{ES}$).

$dP_{ES} = P_{PEAK\,ES} - PEEP_{ES}$

Range: −120 to 120 cmH_2O

Resolution: 1 cmH_2O

Accuracy: ± 2cmH_2O or ± 5%, whichever is greater

AutoPEEP$_{AW}$

AutoPEEPaw, is the airway pressure at the end of an expiratory hold maneuver.

Range: 0 to 50 cmH_2O

Resolution: 1 cmH_2O

Accuracy: ± 2cmH_2O or ± 5%, whichever is greater

Note:

Requires a passive patient.

Delta AutoPEEP$_{AW}$ (dAutoPEEP$_{AW}$)

Delta AutoPEEP$_{AW}$ (dAutoPEEP$_{AW}$), is the difference between airway pressure at the end of an expiratory hold maneuver and the airway pressure at the start of the next scheduled breath after the expiratory hold maneuver.

Range: 0 to 50 cmH_2O

Resolution: 1 cmH_2O

Note: Requires a passive patient.

Accuracy: ± 2cmH_2O or ± 5%, whichever is greater

AutoPEEP$_{ES}$

AutoPEEP$_{ES}$ is defined as the difference between esophageal pressure measured at the end of exhalation (PEEP$_{ES}$) minus the esophageal pressure measured at the start of a patient-initiated breath ($P_{ES\ start}$) and the sensitivity of the ventilator's demand system. The sensitivity of the ventilator's demand system is the difference between the baseline airway pressure (PEEP$_{AW}$) and the airway pressure when the patient initiates a breath ($P_{AW\ start}$).

AutoPEEP$_{ES}$ = (PEEP$_{ES}$ − $P_{ES\ start}$) − (PEEP$_{AW}$ − $P_{AW\ start}$)

Range: 0 to 50 cmH_2O

Resolution: 1 cmH_2O

Note: Requires an esophageal balloon catheter.

Accuracy: ± 2cmH_2O or ± 5%, whichever is greater

Transpulmonary Pressure, Plateau (P_{tp} Plat)

The ventilator is capable of calculating and displaying the Transpulmonary pressure during an inspiratory hold, which is the difference between the airway plateau pressure ($P_{PLAT\ AW}$) and the corresponding esophageal pressure.

P_{tp}Plat = $P_{PLAT\ AW}$ − P_{ES}

Range: −60 to 120 cmH_2O

Resolution: 1 cmH_2O

Accuracy: ± 2cmH_2O or ± 5%, whichever is greater

Note:

This requires an inspiratory hold and an esophageal catheter.

Transpulmonary Pressure, AutoPEEP (P_{tp} PEEP)

Transpulmonary pressure, AutoPEEP (P_{tp}PEEP) is the difference between the corresponding airway and esophageal pressures at the end of the expiratory hold during an AutoPEEP maneuver.

P_{tp}PEEP = P_{AW} − P_{ES} (at the end of an expiratory hold)

Range: −60 to 120 cmH_2O

Resolution: 1 cmH_2O

Accuracy: ± 2 cmH_2O or ± 5%, whichever is greater

Note: Requires an inspiratory hold and an esophageal catheter.

Maximum Inspiratory Pressure (MIP)

Maximum Inspiratory Pressure (MIP), is the maximum negative airway pressure that is achieved by the patient, during an expiratory hold maneuver.

Range: −60 to 120 cmH_2O

Resolution: 1 cmH_2O

Accuracy: ± 2cmH_2O or ± 5%, whichever is greater

Respiratory Drive (P_{100})

Respiratory Drive (P_{100}), is the negative pressure that occurs 100 ms after an inspiratory effort has been detected.

$P_{100} = P_{end\ 100} - PEEP_{AW}$

Range: −60 to 120 cmH_2O

Resolution: 1 cmH_2O

Accuracy: ± 2cmH_2O or ± 5%, whichever is greater

Ventilator Work of Breathing (WOB_V)

Ventilator Work of Breathing (WOB_V), is defined as the summation of airway pressure (P_{AW}) minus the baseline airway pressure ($PEEP_{AW}$) times the change in tidal volume to the patient (ΔV) during inspiration, and normalized to the total inspiratory tidal volume (V_{ti}).

If $P_{AW} > PEEP_{AW}$,

$$WOB_V = \frac{\sum_{Insp}(P_{AW} - PEEP_{AW})\Delta V}{V_{ti}}$$

Range: 0.00 to 20.00 Joules/L

Resolution: 0.01 Joules/L

Accuracy: ± 10%

Patient Work of Breathing (WOB_P) (Normalized to Delivered Tidal Volume)

Patient Work of Breathing (WOB_P), normalized to the total inspiratory tidal volume. Patient work of breathing is defined as the summation of two work components: work of the lung and work of the chest wall.

$WOB_P = WOB_{LUNG} + WOB_{CW}$

where $WOB_{LUNG} = \sum_{Testart}^{Tiend}(PEEP_{ES} - P_{ES})\Delta V$ (if $PEEP_{ES} > P_{ES}$ and V > 0)

and $WOBCW = \frac{V_P{}^2}{2C_{CW}}$ (if $PEEP_{ES} > P_{ES}$)

Work of the lung (WOB_{LUNG}) is calculated using esophageal pressure when the baseline esophageal pressure ($PEEP_{ES}$) is greater than the esophageal pressure (P_{ES}), indicating patient effort.

Work of the chest wall (WOB_{CW}) for a spontaneously breathing patient is calculated using only the portion of the total tidal volume delivered due to a patient effort (V_P) and the chest wall compliance (C_{CW}).

Range: 0.00 to 20.00 Joules/L

Resolution: 0.01 Joules/L

Accuracy: ± 10%

Note:

Requires an esophageal balloon catheter.

Imposed Work of Breathing (WOB_I)

Imposed Work of Breathing (WOB_I), is defined as the work performed by the patient to breathe spontaneously through the breathing apparatus, i.e. the E.T. tube, the breathing circuit, and the demand flow system.

Imposed work is assessed by integrating the change in tracheal pressure and tidal volume, and normalizing the integrated value to the total inspiratory tidal volume (V_{ti}). (Requires the use of an optional tracheal catheter.) Based on the following formula:

$$WOBI = \int_0^{V_{ti}} \left(PEEP_{AW} - P_{TR}\right) * \frac{dV}{dt},$$

where $PEEP_{AW}$ = airway baseline pressure
P_{TR} = tracheal pressure
V_{ti} = inspired tidal volume
Range: 0.00 to 20.00 Joules/L
Resolution: 0.01 Joules/L
Accuracy: ± 10%

Note:

Requires a tracheal catheter.

Glossary

AC	Alternating Current (mains electricity).
ATPD	Ambient Temperature, Ambient Pressure, Dry.
Bias Flow	A continuous flow through the patient breathing circuit. The level of Bias Flow can be set from .4 to 5 L/min
Bpm	Breaths per minute.
Breath Interval	Elapsed time from the start of one breath to the start of the next.
Breath Period	The length of time between machine-initiated breaths. Depends on the Breath Rate setting and is computed by dividing 60 seconds by the Breath Rate setting. When the Breath Rate setting is 15 bpm, for example, the breath period is four seconds (i.e., 60 / 15). In this example, the ventilator initiates a breath every four seconds.
Breath Rate	The number of breaths delivered in a minute.
BTPD	Body Temperature at Ambient Pressure, Dry
BTPS	Body Temperature at Ambient Pressure, Saturated.
Button	A push button switch used to toggle a function on or off.
cmH_2O	Centimeters of water pressure.
Controls	Any button, switch, or knob that allows you to modify the ventilator's behavior.
Demand Flow	The flow generated by the ventilator to meet the patient's flow demand in order to maintain PEEP at the preset level.
DVM	Digital Volt Meter
EPM	Enhanced Patient Monitoring
$ETCO_2$	End Tidal CO_2
Event	An anomalous condition that occurs during ventilator operation.
Flow	The rate at which gas is delivered. Measured in liters per minute (L/min).
GDE	Gas Delivery Engine
Indicators	A visual element showing operational status.
L	Liters. A unit of volume.
L/min	Liters per minute. A unit of flow.
LED	Light Emitting Diode
Mode	An operating state of the ventilator that determines the allowable breath types.
Monitored Parameter	A measured value displayed in the monitor window.
O_2	Oxygen
OVP	Operational Verification Procedure
Patient Breathing Circuit	The tubing that provides the ventilatory interface between the patient and ventilator.
Paw	Airway Pressure. Measured in cmH_2O at the exhalation valve.

PEEP	Positive End Expiratory Pressure.
PEEP	See Positive End Expiratory Pressure.
PIP	Peak Inspiratory Pressure . Shows the highest circuit pressure to occur during inspiration as measured at the exhalation valve. The display is updated at the end of inspiration. PIP is not updated for spontaneous breaths.
Pplat	Plateau Pressure. Measured during an Inspiratory Hold maneuver. Used to calculate Static Compliance. (Cst).
Preset	An operator set ventilator parameter.
PSIG	Pounds per square inch gauge. 1 PSIG = .07bar
Sigh Breath	A Volume Controlled machine breath having a tidal volume equal to one-and-a-half times (150%) of the current tidal volume setting.
Trigger	Value at which the ventilator initiates delivery of a breath as a result of measured patient effort.
User Verification Tests (UVT)	A group of tests to check ventilator performance prior to connecting the ventilator to a patient.
WOB	Patient Work of Breathing i.e. a measure of Patient Effort.


Avea

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