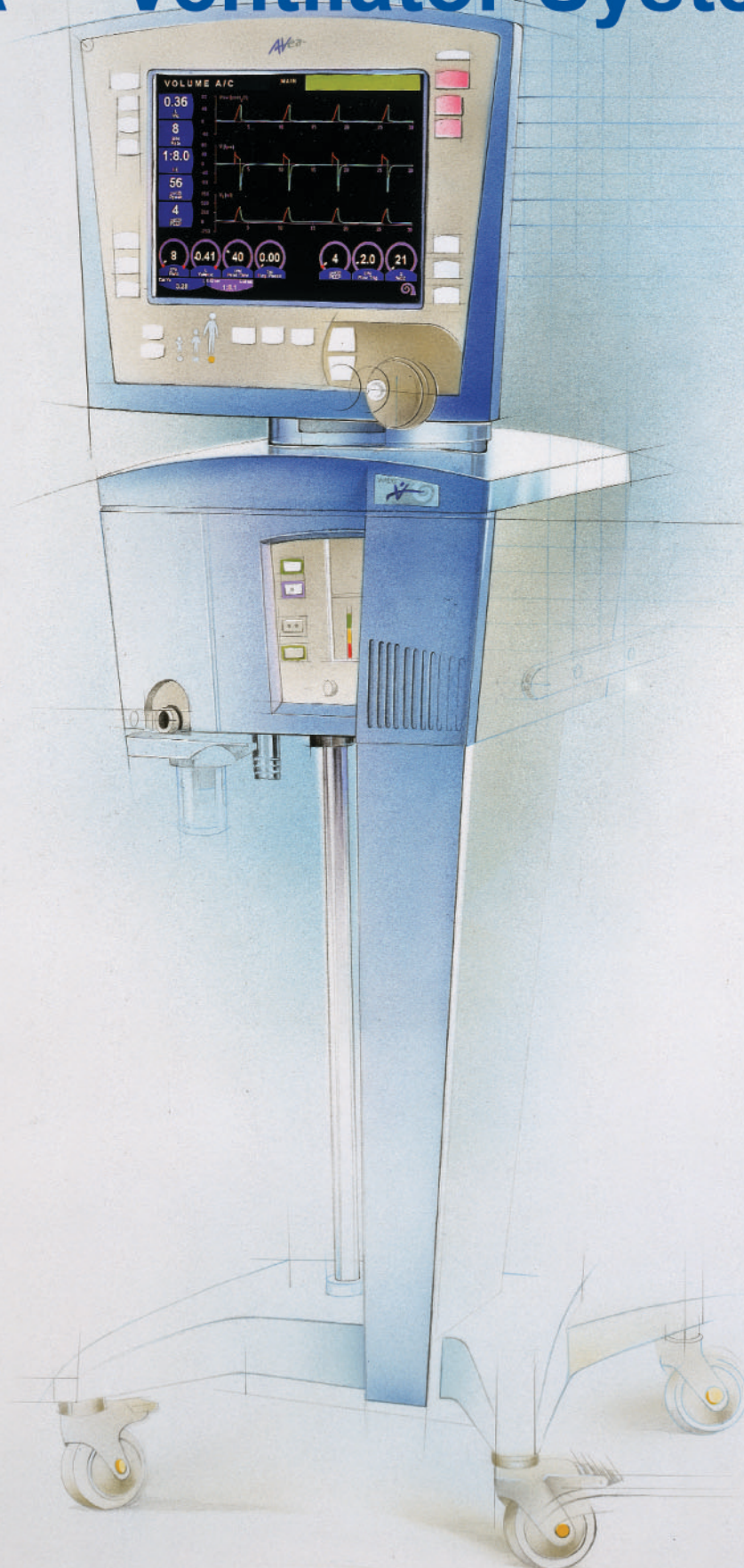


# Service Manual

## AVEA™ Ventilator System



L1524 Rev. C

# **Service Manual**

## ***AVEA Ventilator Systems***

*Aivea*

## Revision History

| Date        | Revision | Pages | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------|----------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| August 2002 | Rev. A   | All   | Released Engineering Document Control ECO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| July 2003   | Rev. B   | All   | <p>Add Exception button and Exception screen to Error Log screen. Add list of error codes. Add OVP kits &amp; 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 &amp; Exp transducer Cal instructions. Add ref to Communications Protocol. Add unpacking &amp; setup instructions.</p> <p>Reorganize chapters, add chapter 3, add chapter 5 (OVP), add software upgrade info (chapter 6), add chapter 9, add chapter 10, add appendix D.</p> |



|              |        |             |                                                                                    |
|--------------|--------|-------------|------------------------------------------------------------------------------------|
| January 2006 | Rev. C | Throughout  | Updated the company name.                                                          |
|              |        | vi          | Added external batteries to the Limitation of Liability.                           |
|              |        | 1-7         | Added symbols for the battery and for HeOx.                                        |
|              |        | 2-1         | Updated the General Description.                                                   |
|              |        | 2-2         | Changed the references of the Tracheal Catheter and the Esophageal Balloon.        |
|              |        | 2-3         | Changed "O <sub>2</sub> bottle" to "O <sub>2</sub> tank."                          |
|              |        | 2-6         | Changed the Monitor MCU description.                                               |
|              |        | 2-9         | Updated the description of the power supply system and the Transducer / Alarm PCB. |
|              |        | 2-12        | Updated the description of the heated expiratory system.                           |
|              |        | 3-1         | Updated the standard-stand carton contents table.                                  |
|              |        | 3-8         | Updated the procedure for setting up the Customer Transport Cart kit.              |
|              |        | 3-11 – 3-12 | Updated figures.                                                                   |
|              |        | 3-14        | Added part number references to "E Cylinder Bracket Assembly Instructions."        |
|              |        | 4-1         | Added Pediatric Patient Circuit to the list of equipment.                          |
|              |        | 4-2         | Removed the note regarding the UIM.                                                |
|              |        | 4-3         | Replaced the word "arm" with "neck." Removed the note regarding the UIM.           |
|              |        | 4-4         | Added a note regarding the screws to the Metal Top Cover section.                  |
|              |        | 4-4 – 4-7   | Updated the Gas Delivery Engine Removal procedure.                                 |
|              |        | 4-11 – 4-12 | Updated the fuse specifications.                                                   |
|              |        | 4-15 – 4-16 | Updated the Compressor /Scroll Pump section.                                       |

|  |             |                                                                          |
|--|-------------|--------------------------------------------------------------------------|
|  | 4-16        | Changed the part number of the Enhanced Patient Monitor board.           |
|  | 4-18 – 4-19 | Added the fan assembly and power supply part numbers.                    |
|  | 4-22        | Added part numbers to step 1 of the removal procedure.                   |
|  | 4-23        | Changed step 5 of the Installation procedure to include the part number. |
|  | 5-1         | Added references to PSI to the Setup procedure.                          |
|  | 5-4 – 5-7   | Updated the Manual Alarms Testing section.                               |
|  | 5-10        | Added two steps to the Testing Guidelines section.                       |
|  | 5-11        | Added step 22 to the Membrane Switch test.                               |
|  | 5-12 – 5-13 | Op. Verification Checklist                                               |
|  | 5-16        | Updated the Checkout Sheet.                                              |
|  | A-58        | Replaced figure A-1                                                      |
|  | A-59 – A-60 | Updated the MIB Connection section.                                      |
|  | A-61        | Added the Blender Bleed section.                                         |
|  | A-62        | Added the Sound Levels section.                                          |
|  | A-63 – A-64 | Updated the Water Trap section.                                          |
|  | A-66        | Updated the Message Bar Text table.                                      |
|  | A-69 – A-74 | Added the Monitor Ranges and Accuracies table.                           |
|  | A-75        | Added the Sensor Specifications and Circuit Resistance table.            |
|  | A-76        | Added the Hot Wire Flow Sensor Specifications table.                     |
|  | A-77        | Added the Circuit Resistance section.                                    |

# Notices

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## Trademark Notices

AVEA<sup>®</sup> is a registered trademark of VIASYS Respiratory Care Inc. in the U.S. and some other countries. All other brand names and product names mentioned in this manual are trademarks, registered trademarks, or trade names of their respective holders.

## 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

EU Notified Body:

BSI (Reg. No. 0086)

Trade names:

AVEA Ventilator



0086

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



## Warranty

THE AVEA<sup>®</sup> 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 VIASYS Respiratory Care Inc., (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:

1. Components for monitoring of physical variables such as temperature, pressure, or flow are warranted for ninety (90) days from date of receipt.
2. Elastomeric components and other parts or components subject to deterioration, over which the Company has no control, are warranted for sixty (60) days from date of receipt.
3. Internal batteries are warranted for ninety (90) days from the date of receipt.
4. 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.

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# 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 & 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/cm<sup>2</sup>). 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 VIASYS Respiratory Care or a VIASYS Respiratory Care authorized service facility or a VIASYS Respiratory Care trained hospital service technician.



## *Cautions*

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

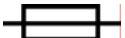
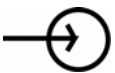
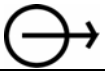
- Ensure that the voltage selection and installed fuses are set to match the voltage of the wall outlet, or damage may result.
- A battery that is fully drained (i.e. void of any charge) may cause damage to the ventilator and should be replaced.
- All accessory equipment that is connected to the ventilator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

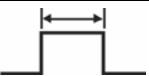
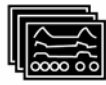
The following cautions apply when cleaning the ventilator or when sterilizing ventilator accessories.

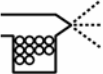
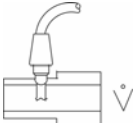
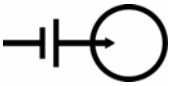
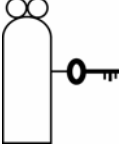
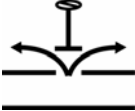
- Do not sterilize the ventilator. The internal components are not compatible with sterilization techniques.
- Do not gas sterilize or steam autoclave tubing adapters or connectors in place. The tubing will, over time, cause poor connection and possible leaks.
- DO NOT submerge the ventilator or pour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

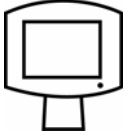
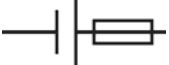
# Equipment Symbols

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<br>Symbol #01-36 IEC 60878  | This symbol indicates INPUT.                                                                                                                                                                                                                         |
|    | Symbol #5035 IEC 60417<br>Symbol #01-37 IEC 60878  | This symbol indicates OUTPUT                                                                                                                                                                                                                         |
|    | Symbol #5019 IEC 60417<br>Symbol #01-20 IEC 60878  | This symbol indicates protective EARTH (ground).                                                                                                                                                                                                     |
|    | Symbol #5021 IEC 60417<br>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<br>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<br>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<br>Symbol #01-01 IEC 60878  | Indicates ON (Power)                                                                                                                                                                                                                                 |
|  | Symbol #5008 IEC 60417<br>Symbol #01-02 IEC 60878  | Indicates OFF (Power)                                                                                                                                                                                                                                |
|  | Symbol #0651 ISO 7000                              | Horizontal return with line feed. Indicates ACCEPT entered values for a specific field.                                                                                                                                                              |
|  | VIASYS Respiratory Care Symbol                     | Indicates PATIENT EFFORT                                                                                                                                                                                                                             |
|  | VIASYS Respiratory Care symbol                     | Indicates MANUAL BREATH                                                                                                                                                                                                                              |
|  | VIASYS Respiratory Care Symbol                     | MAIN SCREEN                                                                                                                                                                                                                                          |
|  | Symbol #417 IEC 5102                               | EVENT READY                                                                                                                                                                                                                                          |

|                                                                                     |                                                              |                                       |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------|---------------------------------------|
|    | VIASYS Respiratory Care Symbol                               | MODE                                  |
|    | VIASYS Respiratory Care Symbol                               | ADVANCED SETTINGS                     |
|    | VIASYS Respiratory Care Symbol                               | SET-UP for patient Data               |
|    | VIASYS Respiratory Care Symbol                               | SiPAP Duration                        |
|    | MDD Directive 93/42/EEC                                      | CE Mark                               |
|    | Symbol #5307 IEC 60417                                       | ALARM RESET                           |
|    | Symbol #5319 IEC 60417                                       | ALARM SILENCE                         |
|   | VIASYS Respiratory Care symbol                               | ADULT patient                         |
|  | VIASYS Respiratory Care symbol                               | PEDIATRIC patient                     |
|  | VIASYS Respiratory Care symbol                               | NEONATAL (Infant) patient             |
|  | Graphical Symbol in general use internationally for "DO NOT" | CANCEL, do not accept entered values. |
|  | VIASYS Respiratory Care symbol                               | Select DISPLAYED SCREEN function.     |
|  | Symbol 5467 IEC 60417                                        | FREEZE the current display.           |
|  | VIASYS Respiratory Care symbol                               | Enable the ALARM LIMITS screen        |
|  | VIASYS Respiratory Care symbol                               | This symbol indicates a CONTROL LOCK. |

|                                                                                     |                                |                                         |
|-------------------------------------------------------------------------------------|--------------------------------|-----------------------------------------|
|    | VIASYS Respiratory Care symbol | NEBULIZER port                          |
|    | VIASYS Respiratory Care symbol | Increase OXYGEN                         |
|    | VIASYS Respiratory Care symbol | PRINT SCREEN                            |
|    | VIASYS Respiratory Care symbol | SUCTION port                            |
|    | VIASYS Respiratory Care symbol | VARIABLE ORIFICE FLOW SENSOR connection |
|    | VIASYS Respiratory Care symbol | HOT WIRE FLOW SENSOR connection         |
|    | VIASYS Respiratory Care symbol | ANALOG IN/OUT connection                |
|   | VIASYS Respiratory Care symbol | Display the MAIN SCREEN                 |
|  | VIASYS Respiratory Care symbol | DO NOT BLOCK PORT                       |
|  | VIASYS Respiratory Care symbol | EXTERNAL BATTERY connection             |
|  | VIASYS Respiratory Care symbol | Indicates GAS ID port                   |
|  | VIASYS Respiratory Care symbol | OXYGEN SENSOR connection                |
|  | VIASYS Respiratory Care symbol | OVERPRESSURE relief                     |
|  | VIASYS Respiratory Care symbol | REMOTE NURSE CALL connection            |

|                                                                                    |                                |                                                 |
|------------------------------------------------------------------------------------|--------------------------------|-------------------------------------------------|
|   | VIASYS Respiratory Care symbol | UNIVERSAL INTERFACE MONITOR connection          |
|   | VIASYS Respiratory Care Symbol | This symbol indicates an EXTERNAL BATTERY INPUT |
|   | VIASYS Respiratory Care Symbol | This symbol indicates an INTERNAL BATTERY FUSE  |
|   | VIASYS Respiratory Care Symbol | This symbol indicates ALARM LOUDNESS            |
|   | VIASYS Respiratory Care Symbol | Operating on Battery Indicator                  |
|  | VIASYS Respiratory Care Symbol | Operating on Heliox                             |

*Aivea*

# 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.

| Functions & Accessories                | Standard                            | Plus                                | Comprehensive                       |
|----------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Modes                                  | All                                 | All                                 | All                                 |
| Proximal Hot Wire Flow Sensing         | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Synchronized Nebulizer                 | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 24 Hour Trending                       | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Internal Battery                       | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Full Color Graphics Display            | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Loops and Waveforms                    | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Standard Cart                          | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |                                     |
| Proximal Variable Orifice flow sensing |                                     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Proximal Airway Pressure Monitoring    |                                     | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Tracheal Pressure Monitoring           |                                     |                                     | <input checked="" type="checkbox"/> |
| Esophageal Pressure Balloon            |                                     |                                     | <input checked="" type="checkbox"/> |
| Internal Compressor                    |                                     |                                     | <input checked="" type="checkbox"/> |
| Heliox Delivery                        |                                     |                                     | <input checked="" type="checkbox"/> |
| Optional Functions & 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                            |



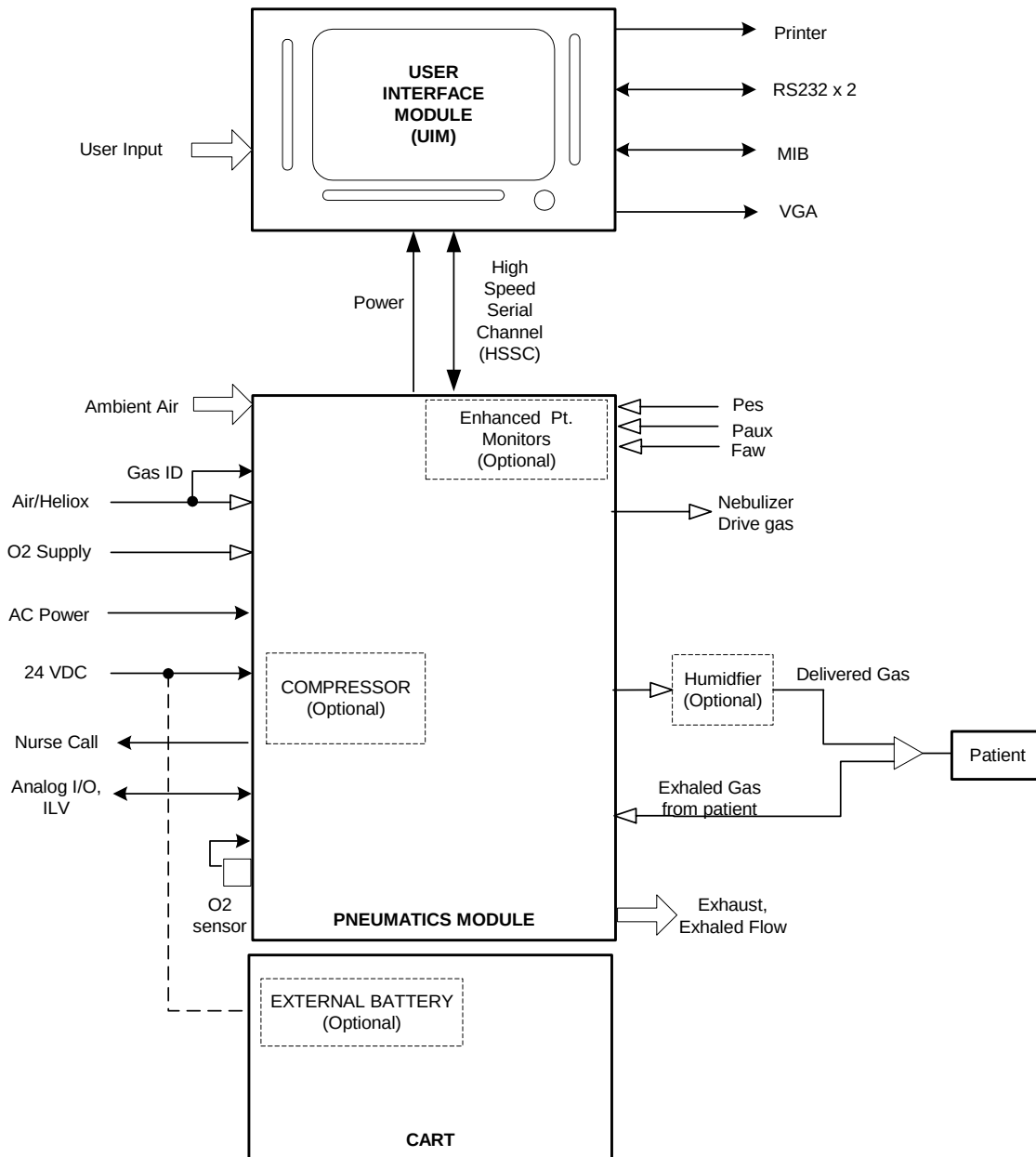
## High Level Design

AVEA has been designed with three basic modules, the user interface module (UIM), the pneumatics module (PM), and the stand (see Figure 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  $\text{FiO}_2$  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 VIASYS (Bear/Bird) 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  $\text{O}_2$  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.

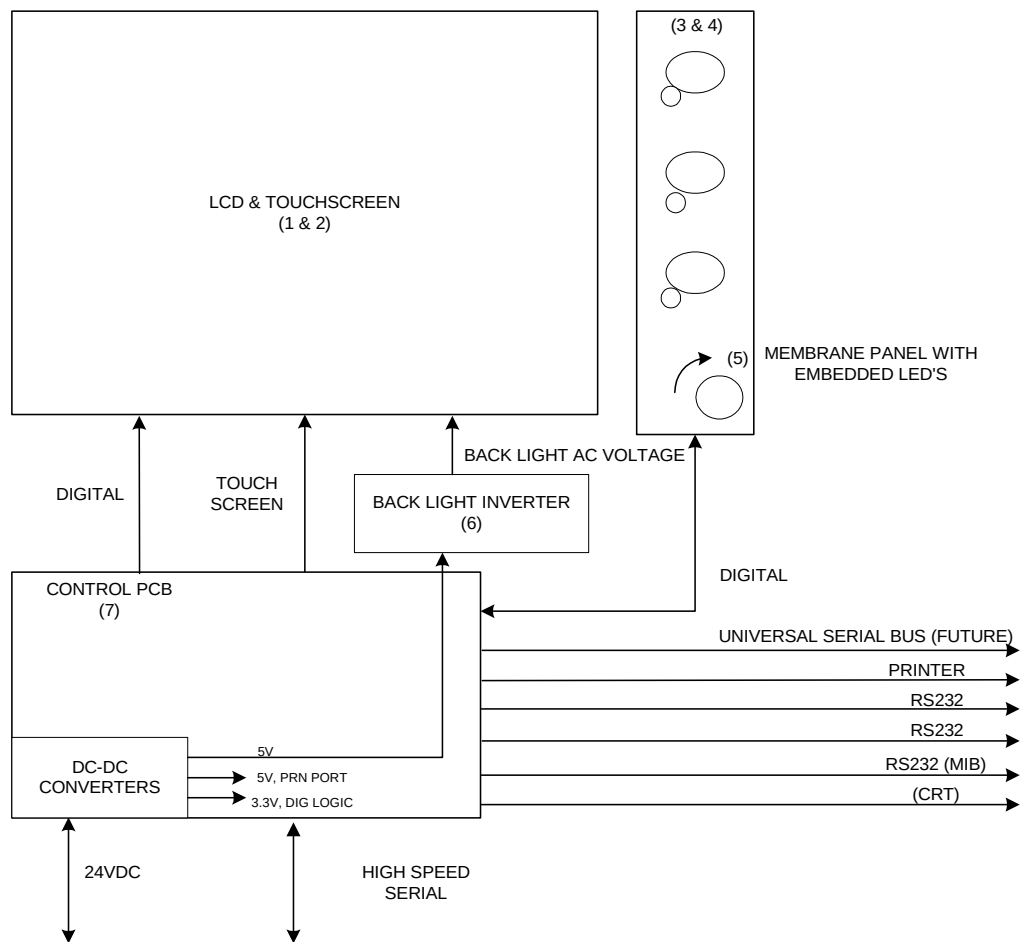


**Figure 2-3 High End Device Modular Diagram**

## 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 2-4 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.

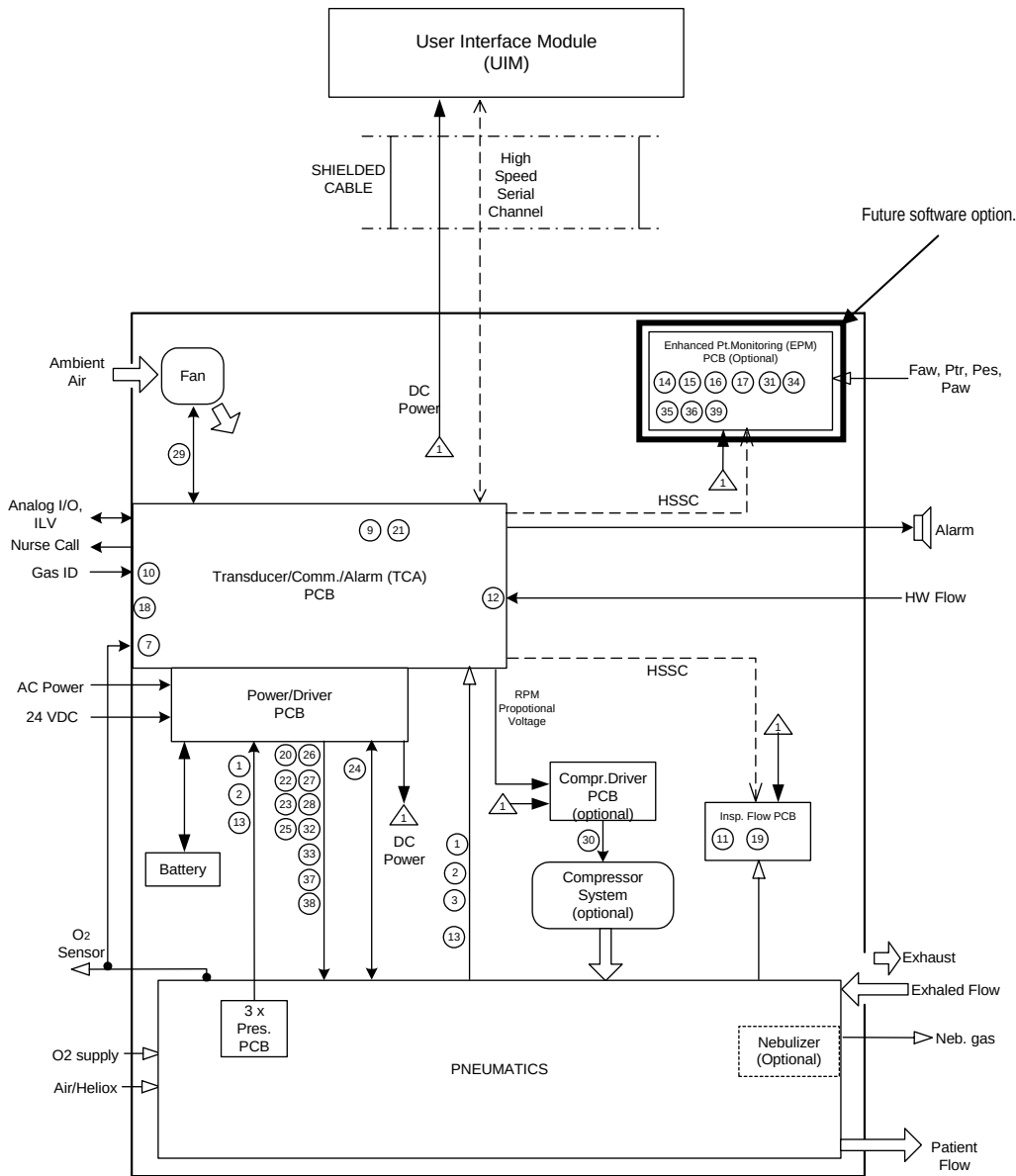
## Control PCB

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 2-5 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 connected in series. 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 2 hours without the compressor. With the external 17 Ah lead acid batteries combined with the internal battery powers the entire system, including compressor, will run for 2 hours on batteries, and greater than 8 hours without 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 FiO2 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 of 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.

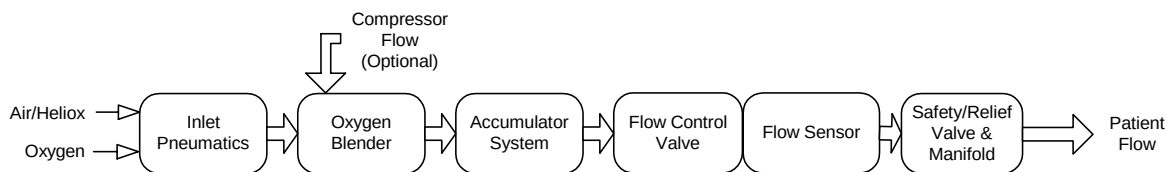
There are four 10-bit analog output channels on the TCA for pressure, flow, volume, and breath phase respectively. They have a full scale of 0 to 5 VDC with 10-bit resolution. In addition, there are 8 programmable analog inputs that can be used to display external signals. They are digitized with a 10 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<sub>2</sub>, Air, or Air alternate external gas; it provides extra filtration and regulates air and O<sub>2</sub> 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 2-6 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<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> pressure to pilot the O<sub>2</sub> Relay. In addition, the Oxygen Blender simultaneously moves to the 100% O<sub>2</sub> 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<sub>2</sub>, and the regulated air pressure provides 100% 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. 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 contaminants 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 0.3 $\mu$ m 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.

*Aivea*

## Chapter 3 Installation Instructions

This chapter provides instructions for installing the AVEA ventilator systems.

### Stand Assembly

#### *Standard Cart Assembly Instructions (P/N 15986)*

##### Standard stand carton contents

| QUANTITY | DESCRIPTION                             |
|----------|-----------------------------------------|
| 10 each  | 5/16" screws                            |
| 10 each  | 5/16 " lock washers                     |
| 2 each   | 5/16-18" hex nuts                       |
| 1 each   | Drag chain and modified washer          |
| 2 each   | Flat washers for pole                   |
| 1 each   | 7/16 tube bracelet                      |
| 1 each   | Top plate assembly                      |
| 2 pieces | Stand Posts                             |
| 1 each   | Pedestal base                           |
| 4 each   | End caps                                |
| 4 each   | Casters (2 with brake, 2 without brake) |

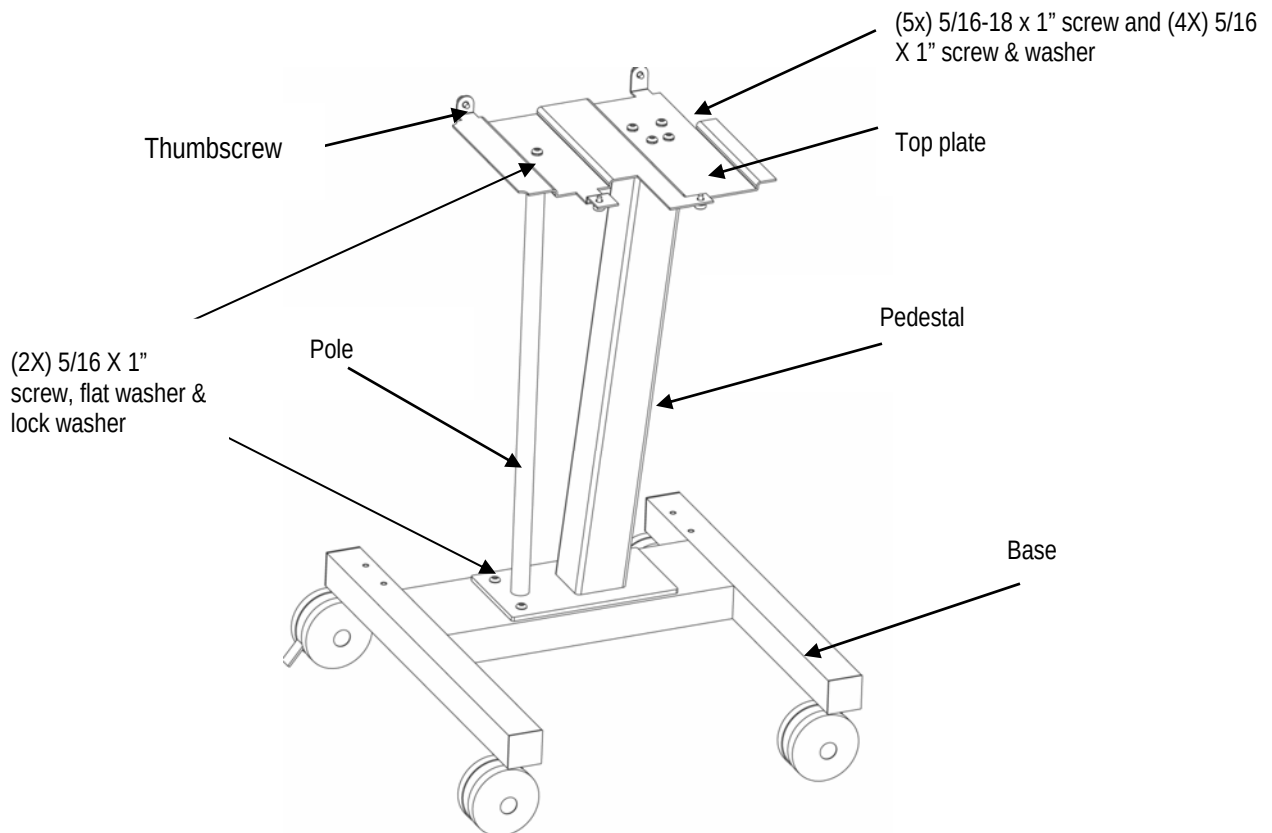
##### Tools required

1/2" open end socket

3/16" Allen wrench or driver

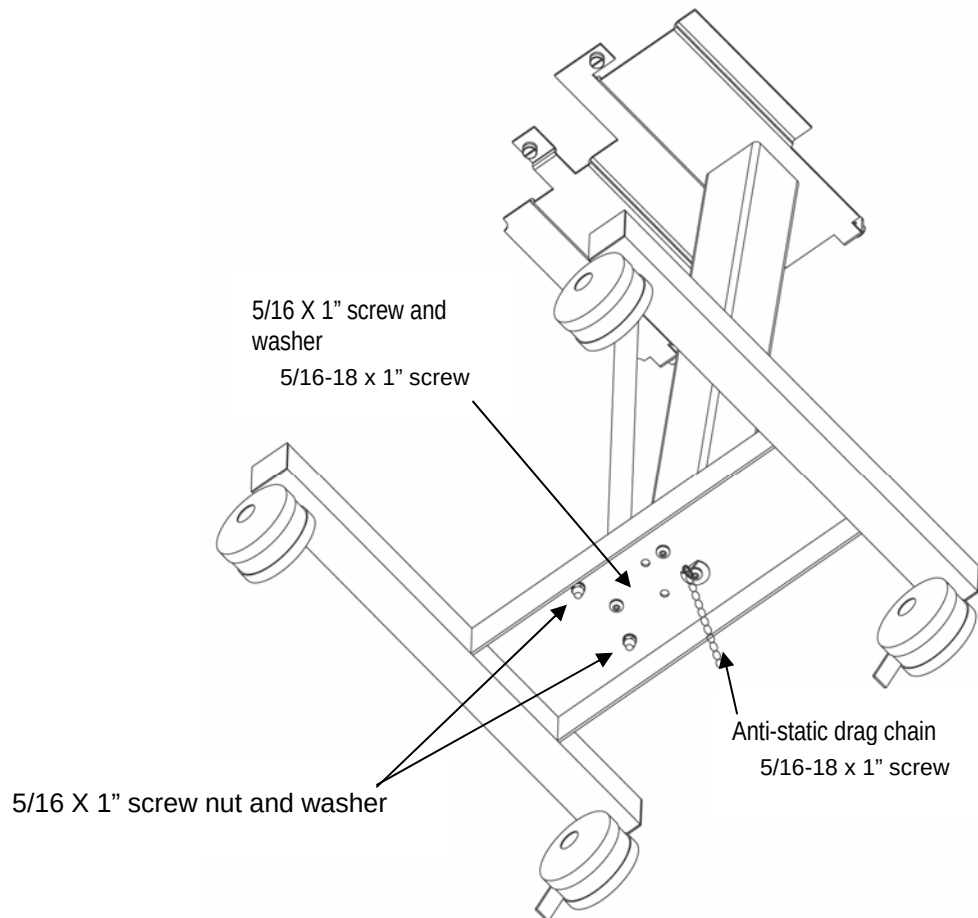
1. Remove the contents of carton.
2. Attach the base to the pedestal using the 5/16" screws, washers and nuts as shown in Figure 3.1. The anti-static drag chain may be attached to either screw.
3. Attach the pole to the assembly using the 5/16" screws and washers (refer to Figure 3.1).

4. Attach the top plate to the pedestal using the 5/16" screws and washers (refer to Figure 3.1).



**Figure 3-1 Assembling the Stand**

5. Place AVEA Ventilator on top plate, align thumbscrews (4) and lightly start all thumbscrews to locate AVEA Ventilator (refer to figure 3.2). Fully tighten (4) thumbscrews to secure AVEA Ventilator.

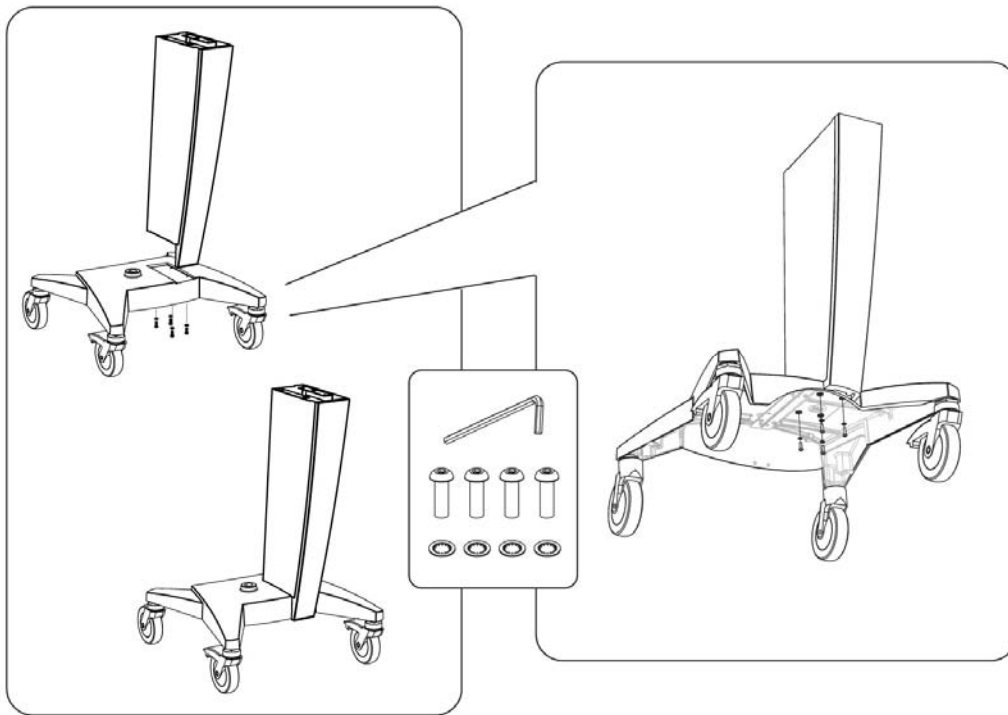


**Figure 3-2 Bottom of stand**

# Comprehensive 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 as shown in Figure 3-3. Place pedestal onto the base assembly as show in Figure 3-3.

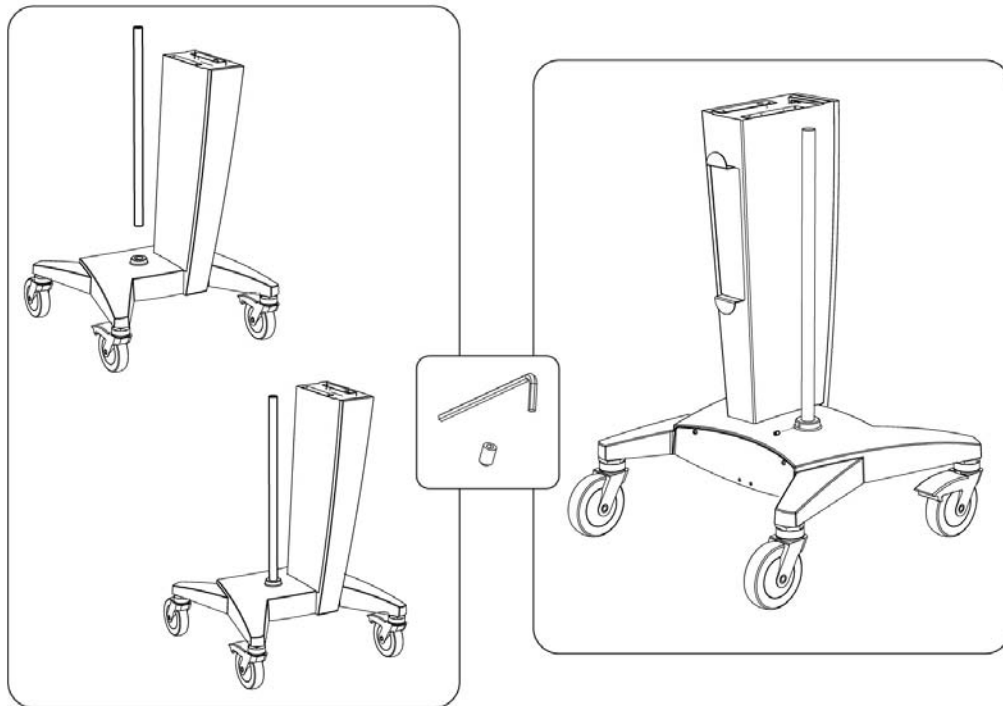


**Figure 3-3**

5. Using the 1/8" Allen wrench provided install and secure the 4 10/24" x 3/4" screws along with the 4 star washers.

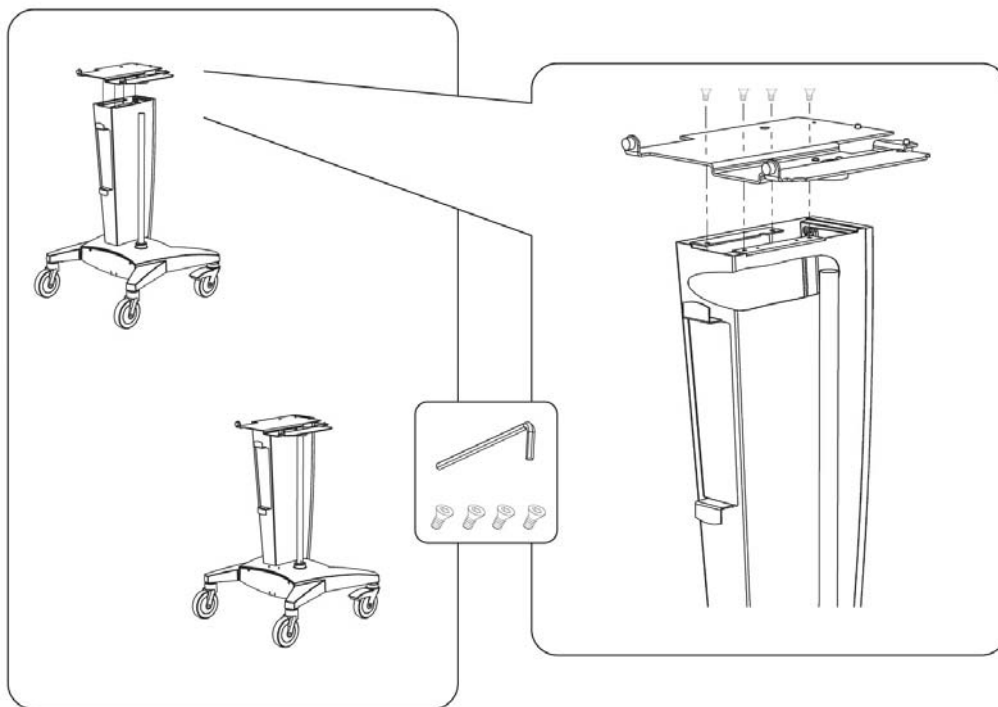


6. Install collar set screw using the 1/8" Allen as shown in Figure 3-4. Next remove pole from Top Plate carton install and secure the 1" pole using the collar set screw as shown in Figure 3-4.



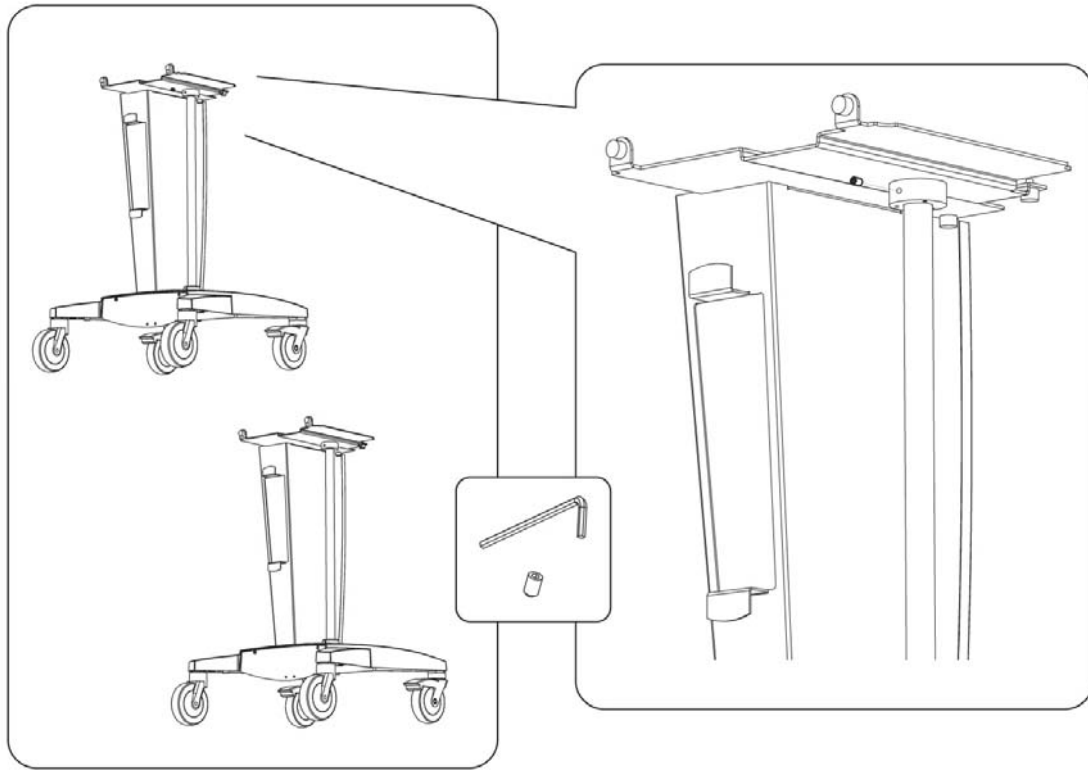
**Figure 3-4**

7. Remove Top Plate and set Top Plate onto the pedestal and pole as shown in Figure 3-5. Using the 3/32" Allen wrench provided install and secure the 4 counter sink screws as shown in Figure 3-5.



**Figure 3-5**

8. Using the 1/8" Allen secure the setscrew of the upper collar into the 1" pole as shown in Figure 3-6.



**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.

## Customer Transport Cart Kit P/N 11372

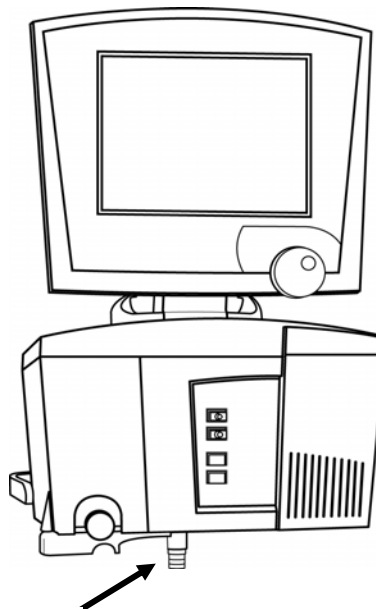
Note: Before installation, verify that the following parts are in your kit:

| Description                                                            | Quantity | Part Number |
|------------------------------------------------------------------------|----------|-------------|
| 12V lead acid battery                                                  | 2        | 16179       |
| Battery tray, screw (10/32 x 5/16) X2, washer #10 X 2 & nut 10/32 KEPS |          | 33977       |
| Wire harness                                                           | 1        | 16217       |
| Literature                                                             | 1        | L2285       |
| Rack Tank Cart Assembly                                                | 1        | 33978       |

If any parts are missing contact VIASYS AVEA Customer Service at 800-325-0082 or 760-883-7185.

### External Battery Installation

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 note on following page).
3. If attached, remove the Gas Tank holder from the base.

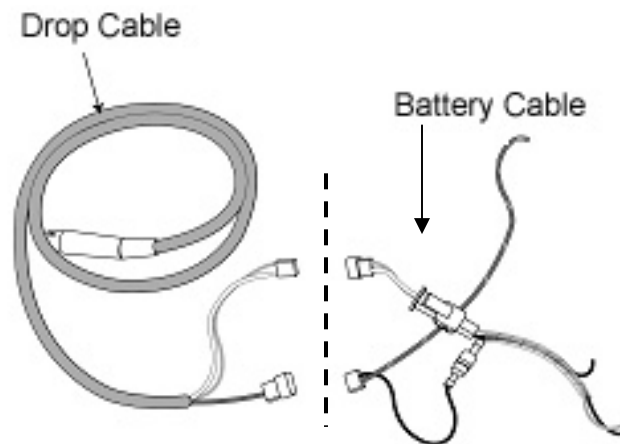


Patient Breathing  
Gas Outlet

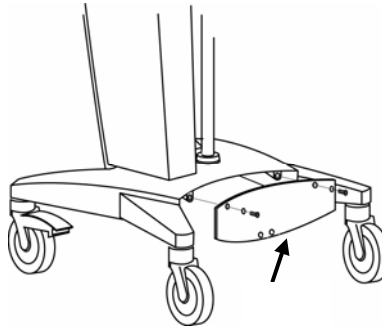
## Note

*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.*

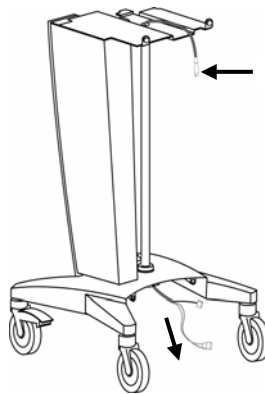
4. Detach the drop-cable portion from the main battery harness as shown.



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



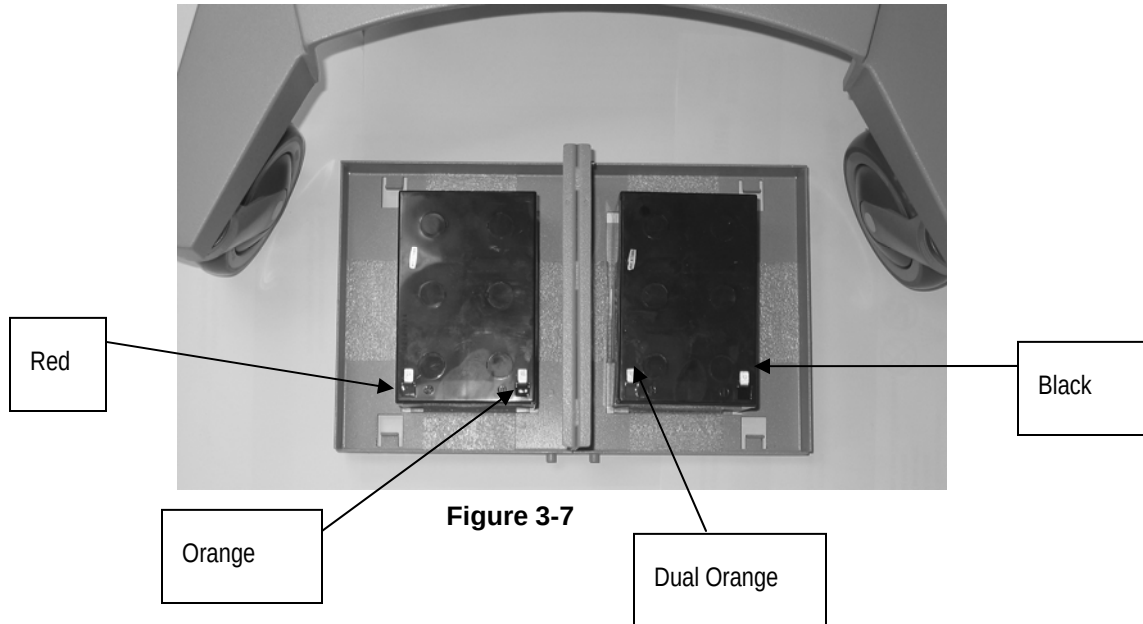
6. Thread cable harness through the cart pole.



### CAUTION

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

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



8. Attach harness (P/N 16217) to batteries:

- Connect black wire to negative post (black) on the outer right hand side battery
- Connect the dual orange wire to positive post (red) on the inner right hand side battery
- Feed the single orange and single red wires through the center battery support bracket opening to the left hand side battery area
- Connect the single orange wire to the negative post (black) on the left hand side battery
- Connect the single red wire (positive) to the positive post (red) on left hand side battery

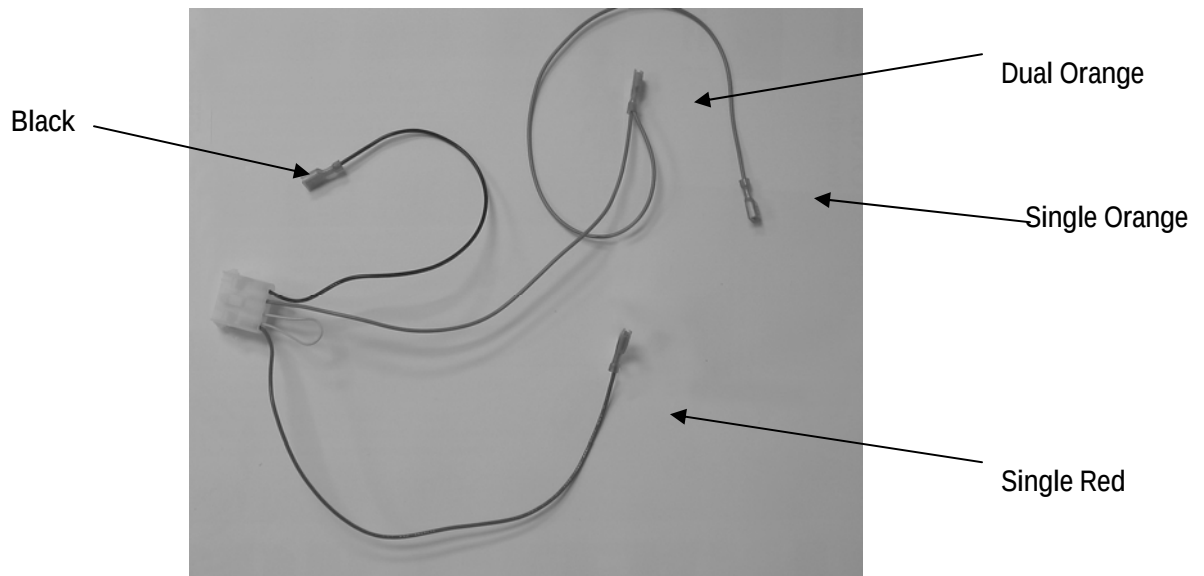


Figure 3-8

9. Attach monitor PC board (P/N 16105) and wiring:

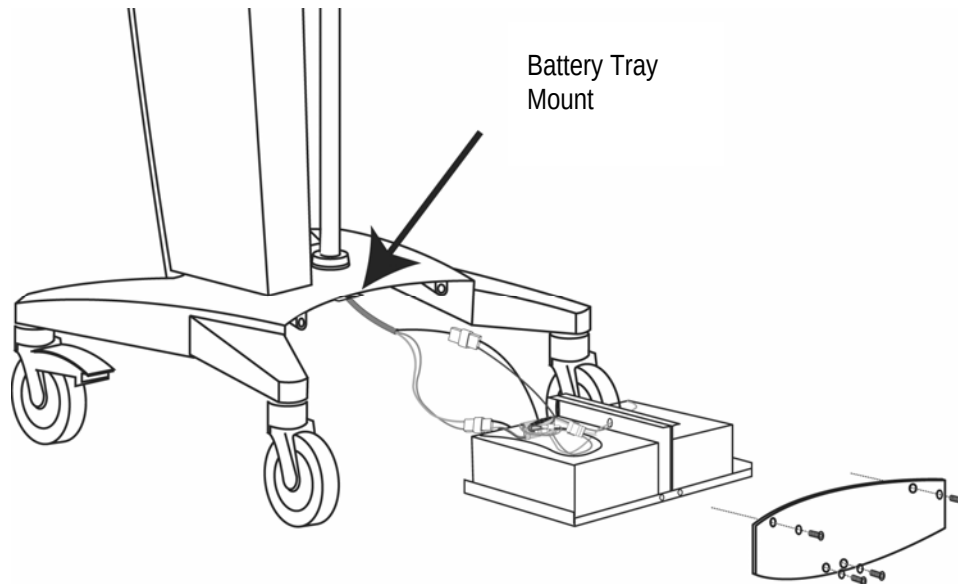
- Connect 4 pin male Molex™ to the 4 pin female Molex from the battery harness



**Figure 3-9**

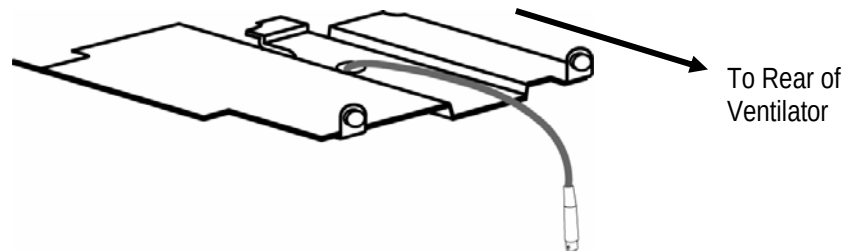


10. Slowly slide the completed battery and tray assembly onto the mount beneath the AVEA stand making sure that no wires are kinked or scuffed during assembly. Maintain tension on drop cable from top of cart to prevent kinking at battery tray. Sufficient cable slack must be available at top of cart to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

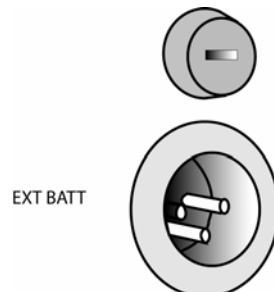


11. Attach the faceplate removed earlier in the instructions to the bottom of the battery tray with the hardware supplied.

12. 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.



13. Connect the external battery cable to the connection labeled EXT BATT on the rear panel of the AVEA.



- 14 Plug the AVEA into a grounded AC outlet and apply power to the ventilator.
15. 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.*

---

## “E” Cylinder Bracket Assembly Instructions

This assembly (P/N 33978) is part of kit, P/N 11372.

| Quantity | Description                             |
|----------|-----------------------------------------|
| 1 each   | Saddle                                  |
| 1 each   | Center post with Velcro cylinder straps |
| 2 each   | 1/4"-20 counter-sink allen-head screws  |
| 4 each   | 1/4"-20 round-head allen screws         |
| 4 each   | Lock washers                            |

### Tools Required for Assembly

- 1 each 5/32" hex wrench/driver
- 1 each drill with 17/64" bit
- 1 each ruler
- 1 each center punch

## Standard Stand Tank Rack Bracket Installation

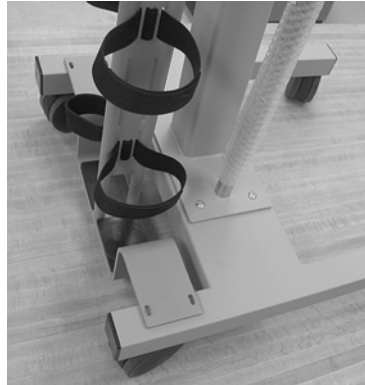
### Basic Stand Tank Rack Bracket Installation

1. Install the center post in the tank bracket using two flathead 1/4"-20 thread screws to secure. (Figure 3.10)



**Figure 3-10 Basic Stand Assembly**

Place assembled tank bracket on short side of "H" stand legs. (Figure 3.11)



**Figure 3-11 Tank brackets**

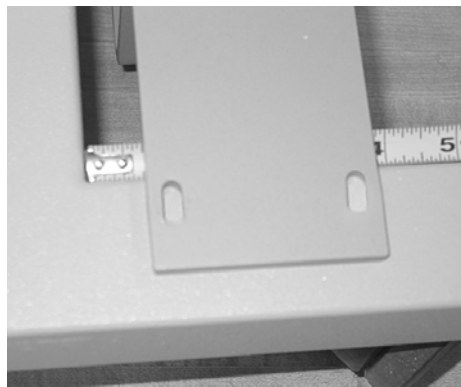
### NOTE

---

*If there are pre-drilled holes on the "H" stand, skip to Step 8.*

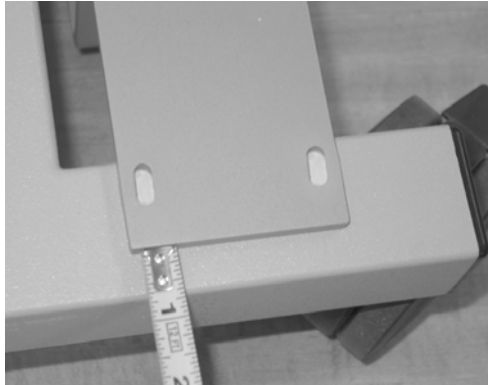
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2. Place tape measure under bracket. Slide bracket back 3/4" from the edge of the "H" cross piece. (Figure 3.12)



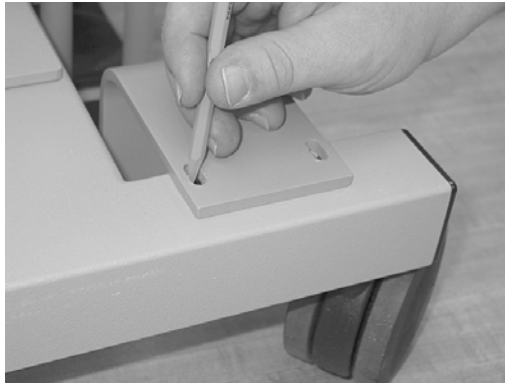
**Figure 3-12 Plate**

3. Center the bracket on the two legs of the "H". The bracket should be positioned approximately  $11/16$ " from the outside edge of each leg. Recheck the initial  $3/4$ " dimension measurement (refer to Figure 3.13).



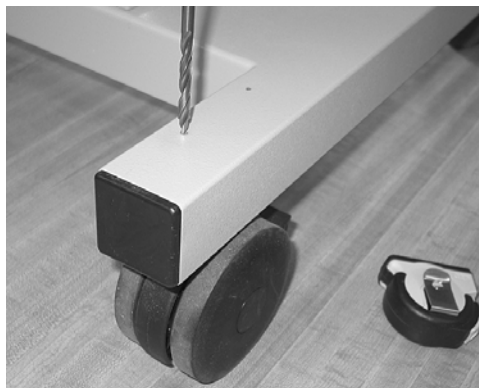
**Figure 3-13 Plate Placement**

4. Using a pencil, mark location of tank bracket in center of slotted holes on the bracket. (Figure 3.14).



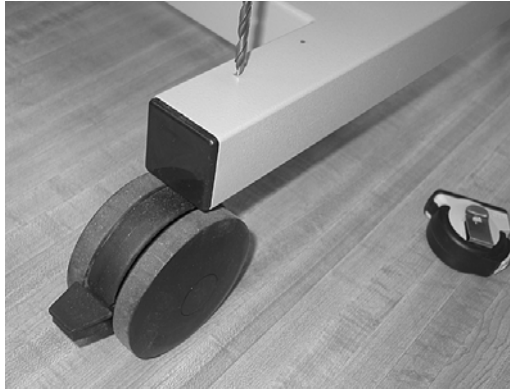
**Figure 3-14 Hole pattern**

5. Center punch-marked locations. Before drilling, move rear wheels out of the way to prevent damage. (Figure 3.15).



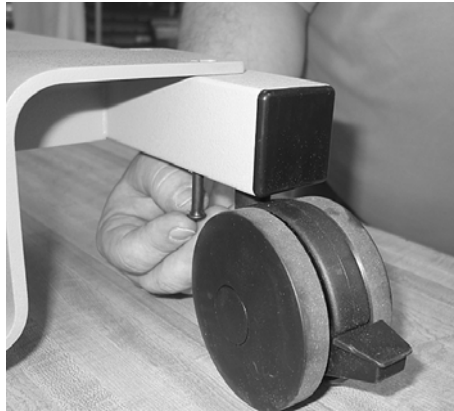
**Figure 3-15 Wheel alignment**

6. Using  $17/64"$  (.265) drill bit, drill through both bracket walls. (Figure 3.16)



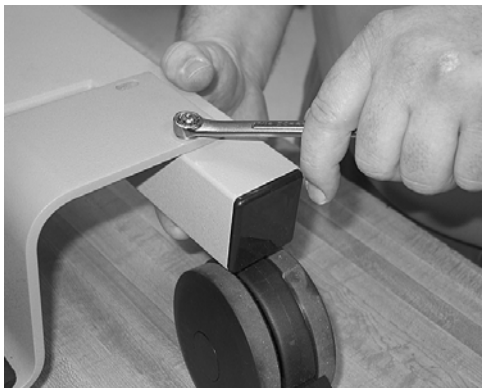
**Figure 3-16 Drill position**

7. Remove burrs from drilled holes and insert screw from bottom, guiding through both holes in tubing and tank bracket. (Figure 3.17)



**Figure 3-17 Deburring**

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



**Figure 3-18 Tighten**

## Assembly Instructions for Comprehensive Cart Tank Rack Bracket

Place the comprehensive stand on a flat surface with the rear of the stand facing up.

Align the saddle with the 4 stand mounting holes as shown in the photos below (Photo 1 and 2).



**Figure 3-19 Photo 1**



**Figure 3-20 Photo 2**

With the 5/32 Allen wrench, install and secure the 4 screws and lock washers to attach the saddle to the stand.

### 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 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 3.21)



**Figure 3-21 Box Opening**

3. Remove the AVEA accessory box. Place it on a secure surface. (Figure 3.22)



**Figure 3-22 Accessory box removal**

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. (Fig. 3.23)



**Figure 3-23 Protective packaging**



6. Apply the brakes on the cart that has been previously assembled by pressing down on the foot pedals. (Fig. 3.24)



**Figure 3-24 Brakes**

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 3.25)



**Figure 3-25 Thumbscrew Positions**

## Note

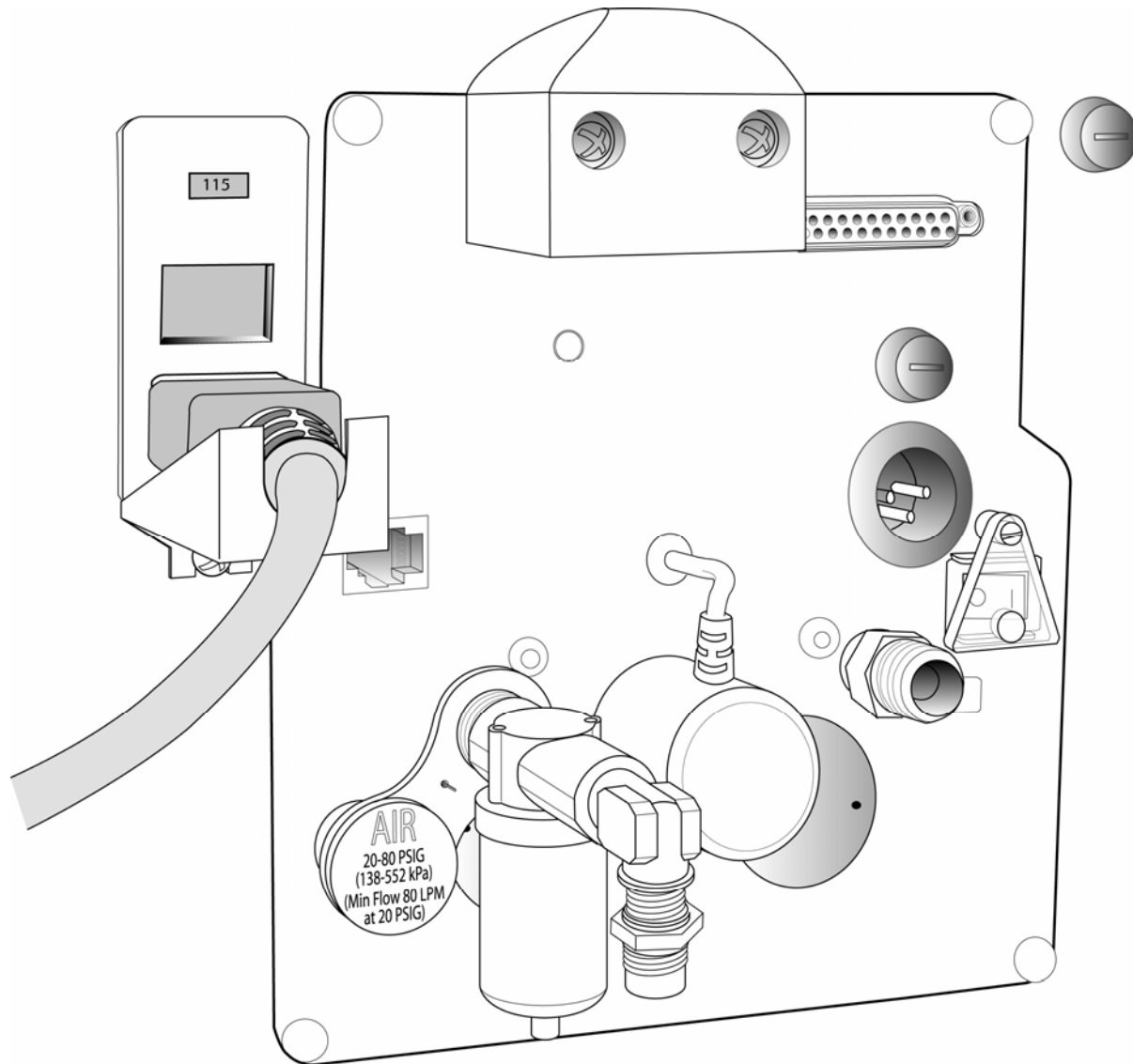
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*Make sure the external battery cable lays untwisted in the cable slot and emerges at the rear of the ventilator (if applicable)*

---

8. Loosely secure the 2 thumbscrews in the back of the ventilator, followed by the 2 thumbscrews on the bottom front of the unit. Tighten all 4 screws.

## SETTING UP THE REAR OF THE VENTILATOR



### Medical Gas Connector Kit Installation Instructions

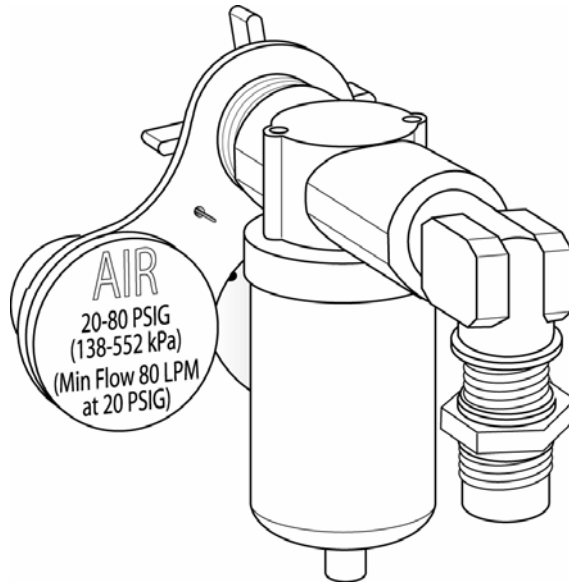
#### *Air “Smart” Connector Installation Instructions (P/N 51000-40897 DISS)*

##### **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 connector comes pre-assembled with the integral water trap/filter as shown in figure 1. It attaches to the fitting located to the left of the Oxygen cell on the rear panel of the AVEA.*

**CAUTION**

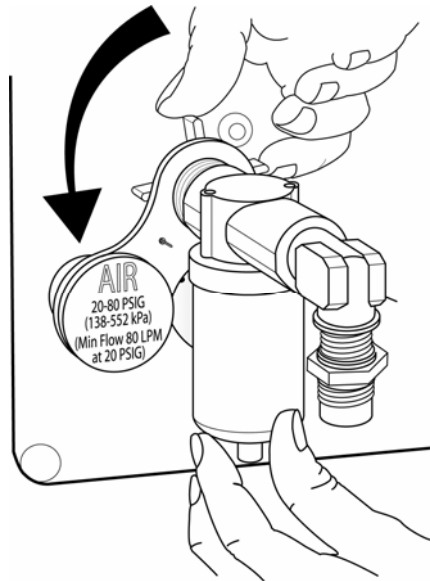
Always consult your Operators Manual for instructions and clinical recommendations concerning the use of AVEA accessories.



**Figure 3-26**

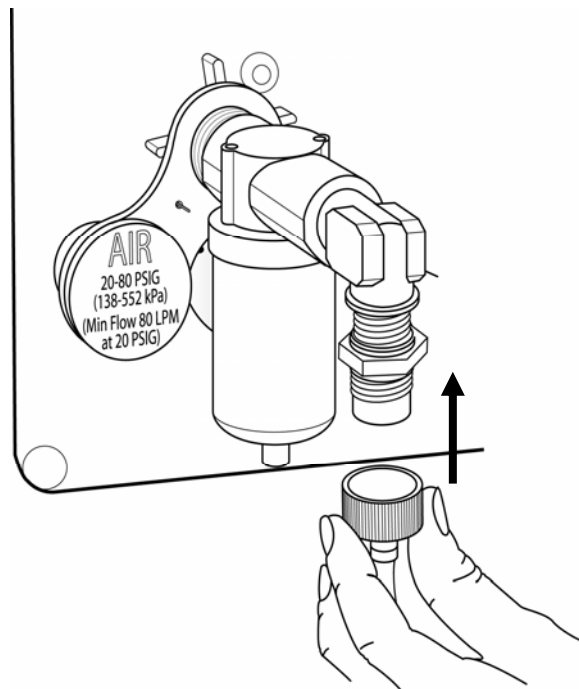
1. Carefully align and seat the 'smart' connector pin and the gas fitting.

2. Tighten the threaded collar on the AVEA onto the male gas fitting of the "smart" connector assembly. (Fig. 3.27)



**Figure 3-27**

Attach the Air hose appropriate for your gas configuration. (Fig. 3.28) (Female DISS fitting is shown here).



**Figure 3-28**

# Air and Heliox Tethered “Smart” Connector Installation Instructions

(Domestic/ DISS P/N 16131 / International / NIST P/N 16132)

## WARNING

Connection of a gas supply at the Helium-Oxygen mixture inlet that does not contain 20% oxygen can cause hypoxia or death.

Although an 80/20 mixture of Helium and Oxygen is marketed as medical grade gas, the Helium/Oxygen gas mixture is not labeled for any specific medical use.

## Note

*The Heliox “smart” connector comes already tethered to the Air assembly and the “smart” connector attachment bracket as shown in figure 3.29.*

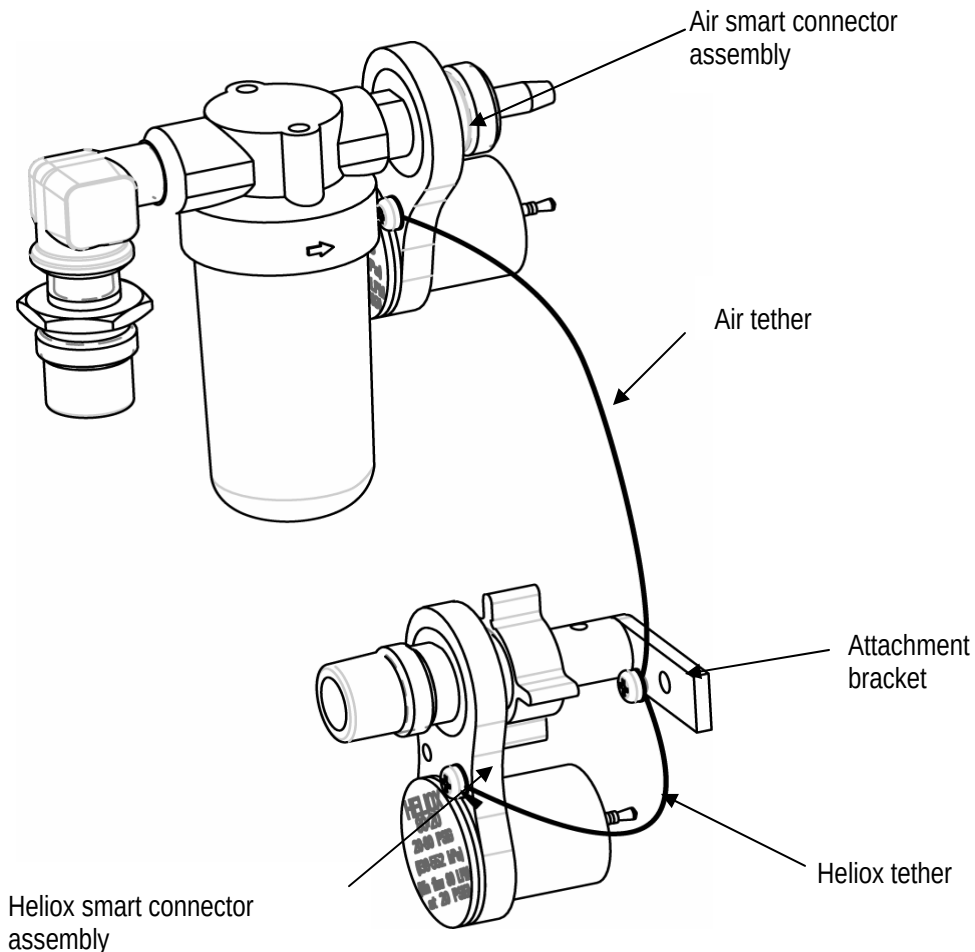
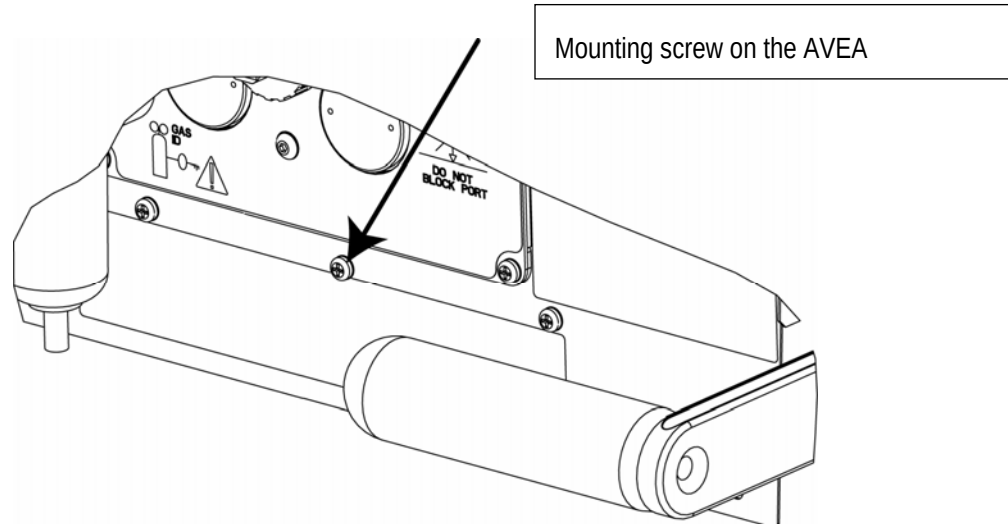


Figure 3-29

## Note

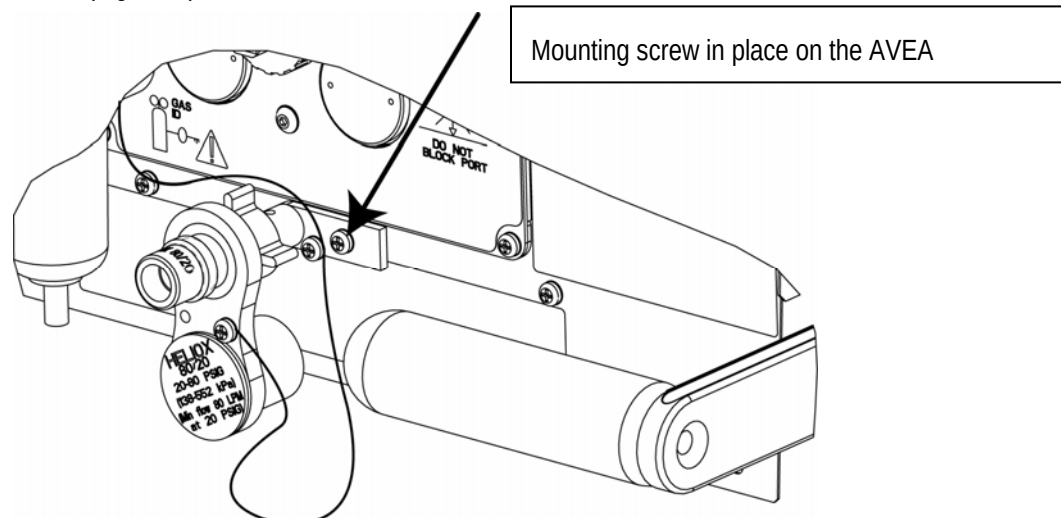
*The Heliox "smart" connector is designed for use with an 80/20 Heliox tank only. Only a mixture of 20% oxygen and 80% Helium can be used as the Heliox gas supply.*

1. To assemble the Air/Heliox assembly, first attach the Air "smart" connector/water trap assembly to the AVEA rear panel fitting as described in the "Air connector only installation instructions" section.
2. After attaching the Air connector, remove the Philips screw from the rear of the AVEA. (Figure 3.30)



**Figure 3-30**

3. Insert the screw provided in the kit through the mount on the tethered Heliox Smart connector holder. (Fig. 3.31)



**Figure 3-31**

## Heliox “Smart” Connector Installation Instructions (DISS P/N 51000-40918)

### Note

*The Heliox “smart” connector is designed for use with an 80/20 Heliox tank only. Only a mixture of 20% oxygen and 80% Helium can be used as the Heliox gas supply. To use the Heliox “smart” connector you must turn off the air gas supply and unscrew and detach the Air hose from the air smart connector.*

### CAUTION

The air “smart” connector and water trap are removed as one unit. Do not attempt to separate them as you may damage the assembly.

### Note

*Heliox 15' hose is P/N 50000-40042.*

1. To remove the Air “smart connector and water trap, support the assembly with one hand and loosen the attachment collar. (Figure 3.32)

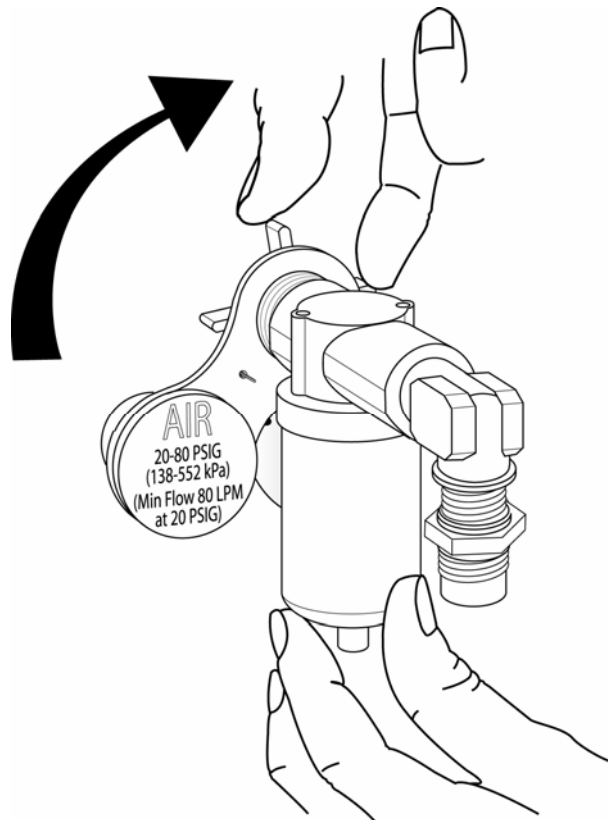
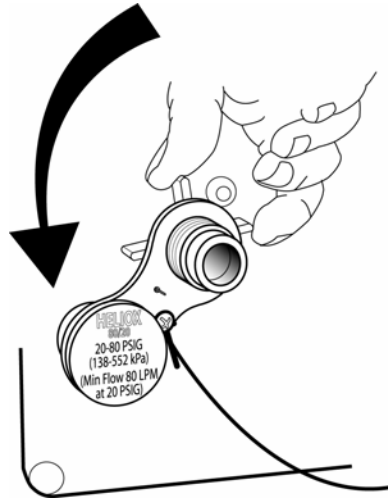


Figure 3-32

2. While still supporting the air connector, loosen the collar of the tethered Heliox Connector and detach it from its storage bracket. (Figure 3.33)



**Figure 3-33**

3. Position the Air connector onto the same support bracket and tighten down the collar until the air connector and water trap are **fully** secured to the storage bracket.

### CAUTION

Make sure that neither the air nor the Heliox tether gets caught in the support collar while you are tightening it down. If either tether fouls the threads of the collar, the Air connector assembly may not be adequately secured to the bracket.

### Note

*Please note that a DISS fitting may be required in addition to those included. These may be obtained from Superior Products in Cleveland, Ohio (216) 651-9400 P/N MA692 or your gas fittings supplier of choice.*

4. Align the Heliox smart connector with the Smart connector receptacle on the left side of the AVEA back panel from which you removed the Air connector. Tighten down the collar of the gas port onto the Heliox fitting. (Figure 3.34)



5. The HeO<sub>2</sub> cylinder symbol should appear in the lower right hand corner of the user interface screen.

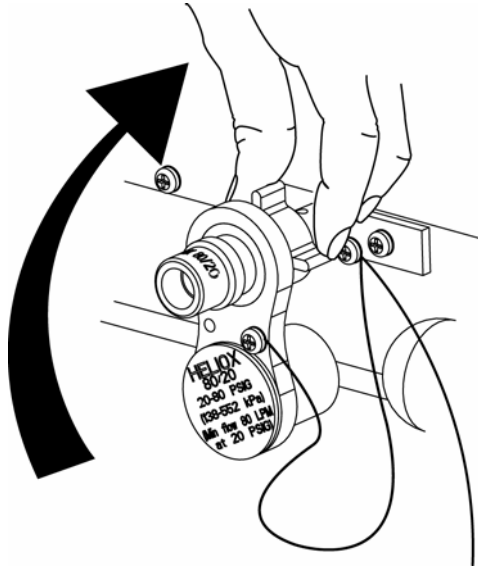
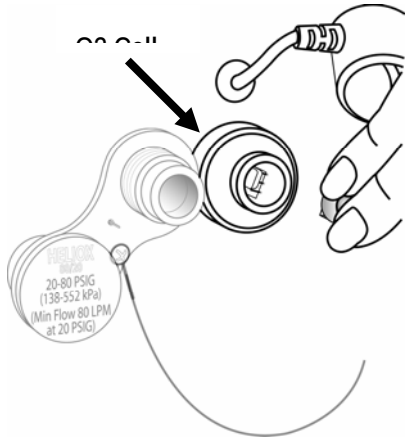


Figure 3-34

## Connecting the Oxygen Sensor P/N 68289



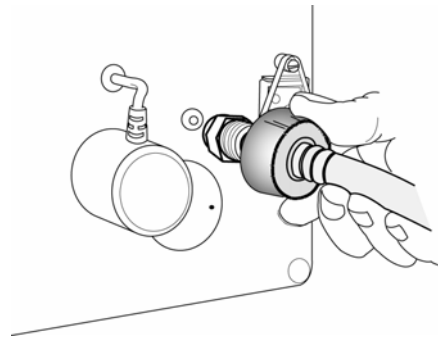
The oxygen sensor cell is located on the rear panel, between the two gas fittings. The oxygen sensor cable emerges from the rear panel directly above the sensor. Carefully align and then gently push the connector onto the oxygen sensor until it seats. When a good connection has been made, slide the protective cover down and push over the sensor.

**Figure 3-35 Connecting the O2 Sensor**

## Attaching the Gas Hoses

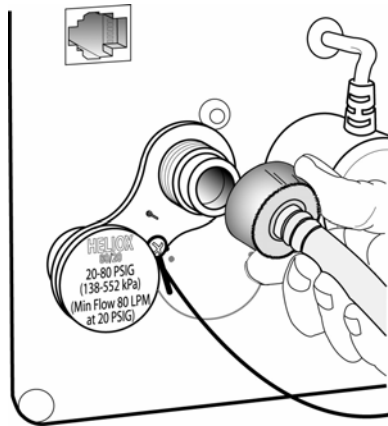
### Oxygen Connection

Attach the Oxygen hose to the fitting on the right of the back panel (see figure 3-36).



**Figure 3-36 Connecting the O2 Hose**

### Heliox Connection



If you have the upgrade for Heliox delivery, attach the Heliox hose to the tethered "Smart" connector fitting on the left of the back panel as shown in figure 3-37.

The air hose will not attach to the fitting designed for Heliox and vice versa.

**Figure 3-37 Connecting the Heliox Hose**

## WARNING

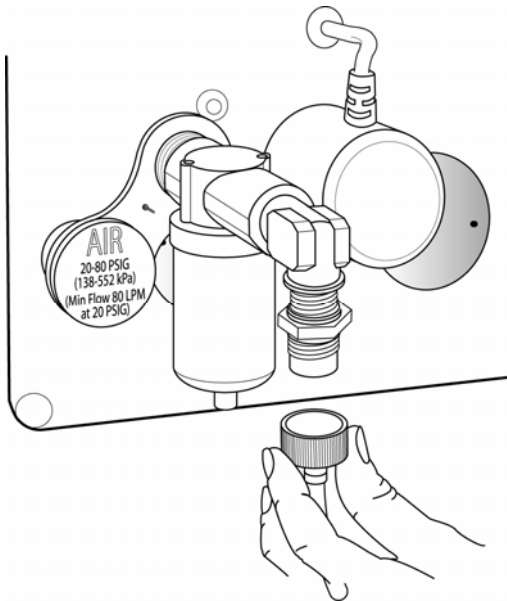
Allow 90 seconds for the accumulator to purge before initiating patient ventilation with Heliox gas.

## WARNING

Connection of a gas supply at the Helium-Oxygen mixture inlet that does not contain 20% oxygen can cause hypoxia or death.

Although an 80/20 mixture of Helium and Oxygen is marketed as medical grade gas, the Helium/Oxygen gas mixture is not labeled for any specific medical use.

### Attaching the Air Hose



Attach the Air supply hose to the “Smart” connector fitting with the integral water trap/filter on the left of the back panel as shown in figure 3-38.

The fitting shown here is a DISS fitting. Fittings which accept NIST and Air Liquide hoses are also available from VIASYS.

The air hose will not attach to the fitting designed for Heliox and vice versa.

**Figure 3-38 Attaching the Air Hose to the water trap/filter**

## Note

*The fitting for Air will not accept a Heliox connection and vice versa.*

*Aivea*

# Chapter 4 Assembly and Disassembly

## General Instructions and Warnings

The removal and installation of major subassemblies requires OVP and possibly calibration. 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 VIASYS Healthcare, Critical Care Division, 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.

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 (see figure 3.1) 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 & Equipment

### Note

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

Long & short Philips screwdrivers

Flat bladed screwdriver

7/8" Nut Driver

11/32" Nut Driver

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. Remove (1) Phillips screw from the 'front arm cover' located below the UIM. 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 exhalation filter from the filter well. Using a long Phillips screwdriver, remove the (1) Phillips screw located at the top of the exhalation filter assembly well.
5. Remove the (1) Phillips screw located at the exhalation port marked EXH.
6. Remove the (4) 11/32 KEP nuts that secure the 'plastic top cover' opening onto the chassis.
7. Remove (2) Phillips screws that secure the 'plastic top cover' to the rear chassis.
8. Slide the top 'plastic top cover' forward and upward away from the chassis.
9. Remove the (2) Phillips screws and washers that secure the 'UIM interface cable connector' on the rear chassis. Unplug the 'UIM interface cable connector'.
10. Carefully pull the 'UIM interface cable connector' through the 'plastic top cover' opening.
11. While continuously supporting the UIM, remove (4) nuts that fasten the UIM onto the 'support arm'.

## ***User Interface Module (UIM)***

### **Installation**

1. 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) nuts.
2. Feed the 'UIM interface cable connector' into the 'plastic top cover' opening, towards the rear of the chassis.
3. Slide the 'plastic top cover' back in place.
4. Install (2) Phillips screws and washers into the 'UIM interface cable connector' and secure it to the rear chassis.
5. Install (2) Phillips screws to secure the 'plastic top cover' to the rear chassis.
6. Install (1) Phillips screw located at the exhalation port marked EXH.
7. Use (4) 11/32 KEP nuts to secure the 'plastic top cover' opening onto the chassis.
8. Using a long Phillips screwdriver, install (1) Phillips screw at the top of the exhalation filter assembly well. Install the exhalation filter back into the filter well,
9. Tilt the UIM down and install the 'back arm cover'. Install two mounting screws inside the 'back arm cover' and tighten them.
10. Install the 'front arm cover'. Install (1) Phillips screw into the 'front arm cover' and tighten it.
11. 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 Filter Assembly/UIM

### Removal

1. If installed, remove the exhalation filter assembly.
2. 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 pulling straight down.
3. Remove the rubber collar by grasping one of the two rubber tabs at the bottom. Pull firmly in an “arcing” motion.
4. Remove the (1) Phillips screw on the front neck cover below the monitor and remove the front arm cover.
5. Remove the two mounting screws now visible inside the back neck cover.
6. Tilt down the UIM and remove the back neck cover. Remove the (2) Phillips screws and washers on the molded gray cover connector attached to the rear panel and unplug the UIM interface cable.
7. Using a long Phillips screwdriver, remove the (1) Phillips screw located at the top of the exhalation filter assembly well.
8. Remove the (1) Phillips screw located at the exhalation port marked EXH.
9. Remove the (4) 11/32 KEP nuts on the rounded portion of the molded plastic top cover.
10. While supporting the UIM continuously, remove (4) 3/8 KEP nuts holding the UIM in place on the aluminum ring.
11. Remove the 2 Phillip head screws from the back of the unit that attaches the plastic top cover to the pneumatic module.
12. Remove the UIM, then the plastic top cover.

## Metal Top Cover

### Removal

1. With the Plastic Top Cover removed, continue by removing the 19 SEMS screws, (3) on the left side (5) on the right side and (11) on top.

### Note

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

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### Note

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

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

### Warning

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*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.*

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## Gas Delivery Engine P/N 16222A

### Gas Delivery Engine Removal

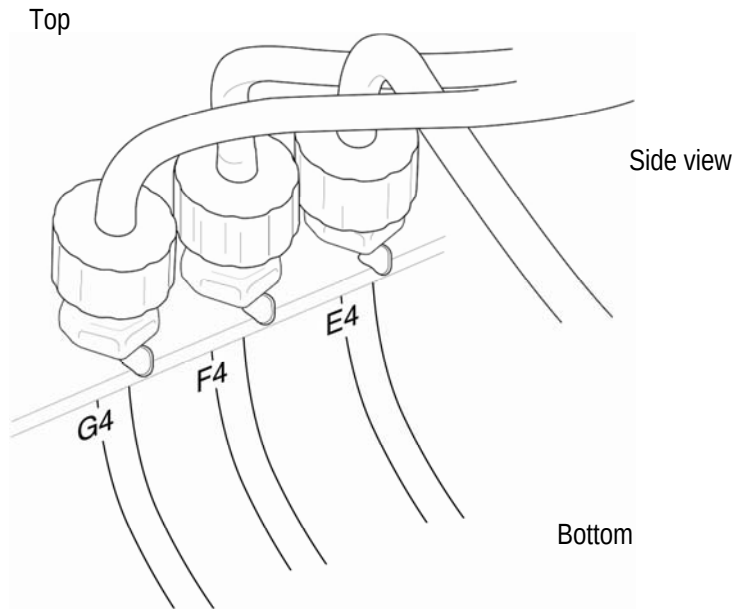
1. Referring to the instructions above, remove the UIM and molded metal top covers
2. Disconnect internal battery.
3. Disconnect the 4-pin connector from the battery monitor board to the gas delivery engine (51000-40022 Only).
4. Remove the (4) SEMS screws located at each corner of the rear panel.
5. Remove A/C power cord bracket.
6. Cut the tie wrap and remove the metal tubing support bracket and disconnect the tube from the accumulator outlet by releasing the compression fitting.
7. Completely remove the hose between the gas delivery engine assembly and the scroll pump/compressor filter.
8. 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.

9. Unscrew the luer-lock fittings (the clear yellow 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

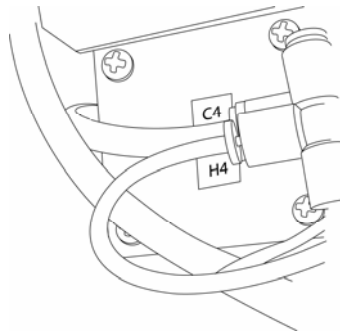
**E4**

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)

10. Disconnect the yellow bleed tubing from C4 by releasing the compression fitting.
11. 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.

**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)

12. Disconnect the yellow tubing from (D4) that feeds the EPM board.
13. Loosen the 11/32 nut securing the assembly to the base at the bottom front left.
14. 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.
15. Remove the power cord support bracket.

## Note

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*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.*

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*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.*

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16. Locate the internal battery pack and cut the 2 purple wires located at the battery pack to 1.5” (inches).
17. Fold back onto itself, 1 of the wires that has been cut ¼” (inch).
18. Cut the wire that was not folded even with the wire that was folded, so that they are now even in length.
19. Cut a piece of heat shrink tube that has been supplied to 1” (inch) in length.
20. Slide both purple wires that have been folded and cut into the heat shrink tube.
21. Ensure that both wires are inside the heat shrink tube and that neither wire is showing through the end of the heat shrink tube.
22. 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.
23. Locate the Compressor power board located next to the compressor pump.
24. Remove the one 11/32” nut securing the ground wire from the compressor power board.
25. Remove the 2 11/32” nuts securing the compressor power board to the unit case.
26. Raise the compressor board up and away from the unit enough to allow disconnection of the 2 wire harnesses.
27. Cut the ground wire 1”(inch) from the compressor power board.
28. Fold back onto itself, the cut wire ¼” (inch) that is attached to the Compressor Board.
29. Cut a piece of heat shrink tube that has been supplied to 1” (inch) in length.
30. Slide the wire that has been folded and cut into the heat shrink tube.
31. 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.
32. Reconnect the 2 wire connectors to the Compressor Power Board.
33. Re-install the Compressor Power Board to the unit case using the 2 11/32” (inch) nuts.
34. Cut all tie straps securing Battery Monitor Board P/N 16105.
35. Disconnect the 2 pin connector of the battery monitor board from the 2 pin connector containing wires #12 and #13.

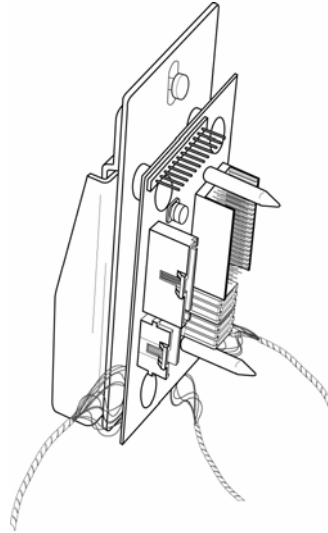
36. Disconnect the 4 pin connector from the battery monitor board to the battery.
37. Disconnect wire #14 from the black wire of the battery monitor board.
38. Disconnect the 2 wires from the fuse holder. The battery monitor board will now be free to remove from the unit.
39. Connect wire # 14 to the straight terminal of the fuse holder.
40. 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.
41. Connect the black wire from cable harness P/N 16243 to the right-angle terminal connector of the fuse holder.
42. 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 tubing from the EPM board into C4 by inserting into the compression fitting.
4. Connect the yellow bleed tubing from the sensor assembly; the clear yellow tubing to F4, and the blue tubing to G4. To connect into the luer lock fittings, twist and push.
5. Connect the clear tubing from the sensor assembly to F4 luer lock fitting, and the black striped tubing to G4 luer lock fitting.
6. 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).
7. Connect the 4-pin battery monitor board to the gas delivery engine.
8. 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 (see diagram) 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.

9. Attach and secure the (4) SEMS screws on the four corners of the rear panel.
10. Replace the yellow hose from the gas delivery engine to the compressor filter.
11. Connect yellow hose from the accumulator into the compression fitting. Replace the metal safety bracket, and secure with a new tie wrap.
12. Tighten the 11/32 nut at bottom right of the Gas Delivery engine and tighten down.
13. Attach the User Monitor Interface and cable.

### Note

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*Perform the Calibration and Operational Verification Procedure located in the AVEA service manual.*

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14. Once all tests are preformed, remove the User Interface Module and install the metal cover and all associated screws.
15. Install plastic top cover and User Interface Module (UIM).

### Note

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

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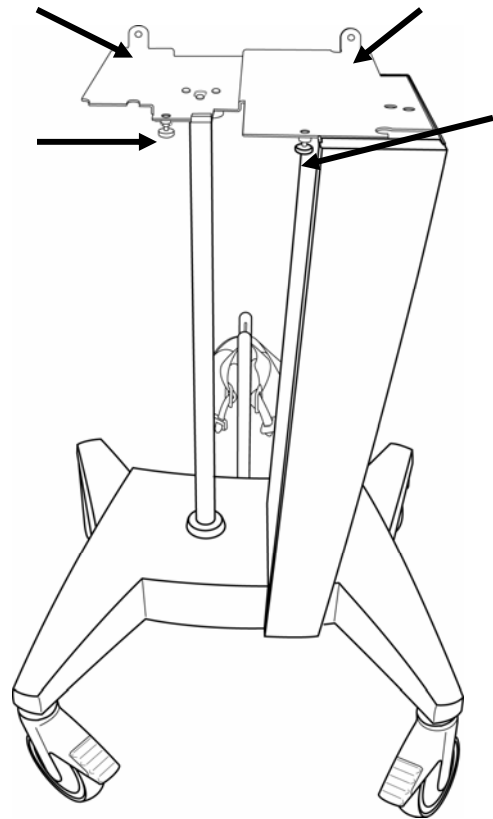
## Ventilator wheeled base

### Removal

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

### Installation

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



**Figure 4-4 Wheeled base showing attachment points**

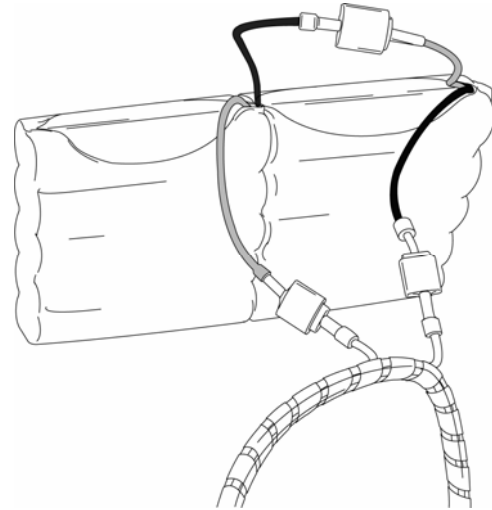
## Internal Batteries P/N 68339A

### Removal

1. Referring to the instructions in this chapter, remove the following components:  
UIM and the top cover
2. Internal battery fuse holder
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.

**Figure 4-5 Battery fuse holder & Bracket**

7. Disconnect the positive and negative leads from the wire harness that connects to the driver transition board.
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.



**Figure 4-6 Battery Assembly**

## 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 wrongly 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:  
UIM and the top cover.

## 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<br>(Viasys P/N 71692)   | 1.5 amp<br>(Viasys P/N 71698)  |
| 230/240VAC   | (2) 250 V 6.35 X 31.75mm | 6.3 amp<br>(Viasys P/N 03490)    | 3.15 amp<br>(Viasys P/N 71692) |

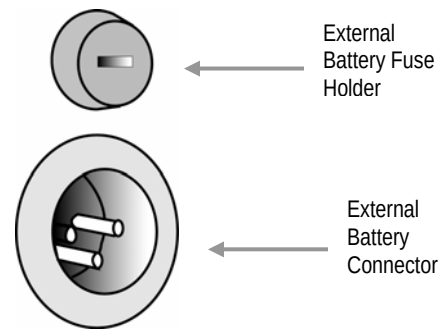
**WARNING**

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.

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.



**Figure 4-7 External Battery Connector & Fuse**

**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.

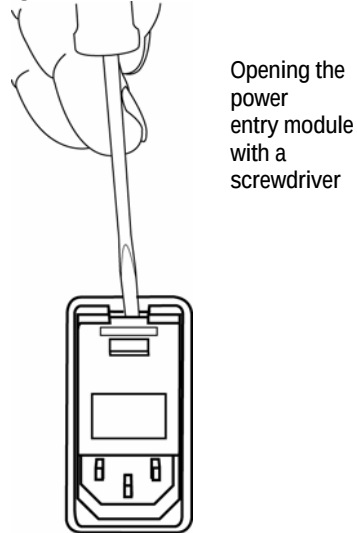
To replace mains electrical fuses, refer to figures 4-8 through 4-12 and do the following:



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.
3. Carefully ease the red fuse holder out of the power entry module.
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 6.1.
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.
7. Close the power entry module cover and check to make sure that the correct voltage is displayed through the window.

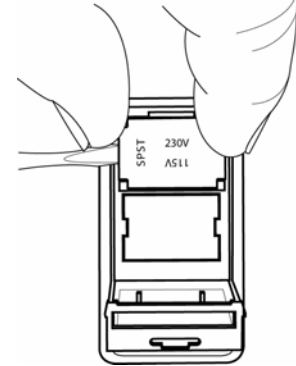
## Changing the AC Fuses:

**Figure 4-8**

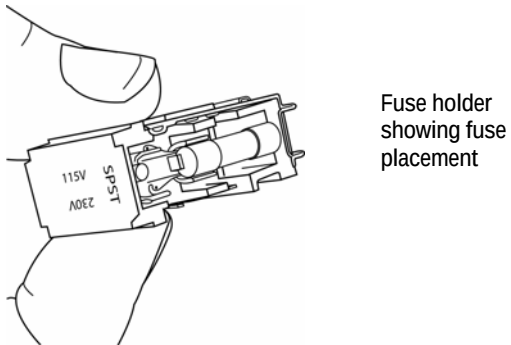


**Figure 4-9**

Removing the fuse holder

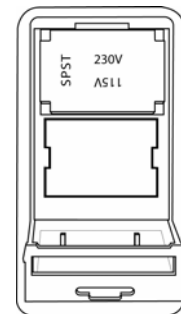


**Figure 4-10**

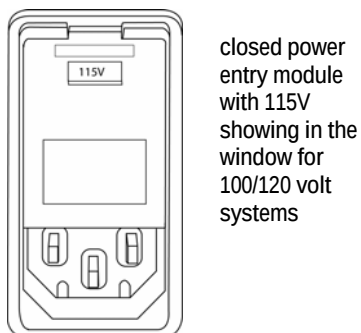


**Figure 4-11**

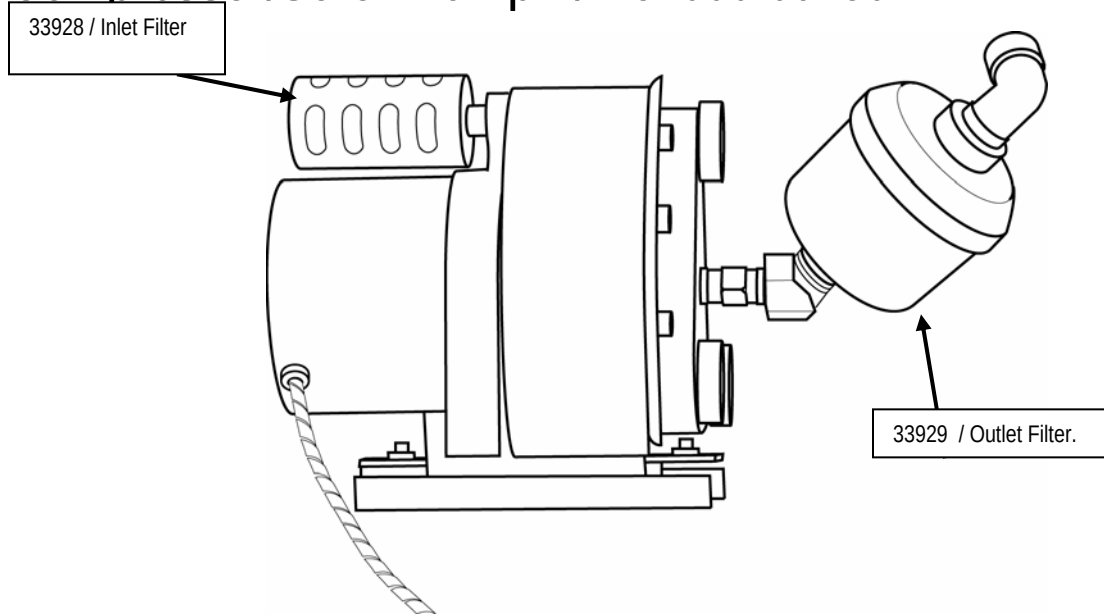
Fuse-holder with 230V label uppermost for 230/240VAC systems.



**Figure 4-12**



## Compressor/Scroll Pump P/N 51000-09750A



**Figure 4-13**      **Compressor/ Scroll Pump**

### Removal

1. Referring to the instructions in this chapter, remove the following components:  
UIM and the top cover.
2. Remove high pressure hose from compressor motor at the filter outlet. Move the high pressure hose out of your working area.
3. Disconnect from A/C power.
4. Disconnect internal battery.
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. Carefully lift compressor pump to clear the power board shield.
8. Access the 12-pin scroll pump connector and disconnect from the driver transition board.
9. Remove the (2) KEPS nuts on the scroll compressor board (1) on the right and (1) on the front, and remove the compressor board.
10. Scroll pump is now completely detached.
11. Remove from the unit and set aside.

### Note

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*Compressor power board should be placed in an antistatic bag.*

---

## 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.

### Note

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*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*

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5. Position the scroll compressor board onto two studs and secure with (2) KEPS nuts; (1) on the right and (1) on the front. Inlet 33928 / & outlet 33929 / Filters (0.3 microns)
6. Reattach the high pressure hose to the filter outlet.
7. Referring to the instructions in this chapter, re-install the following components:
  - UIM and the top cover.

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

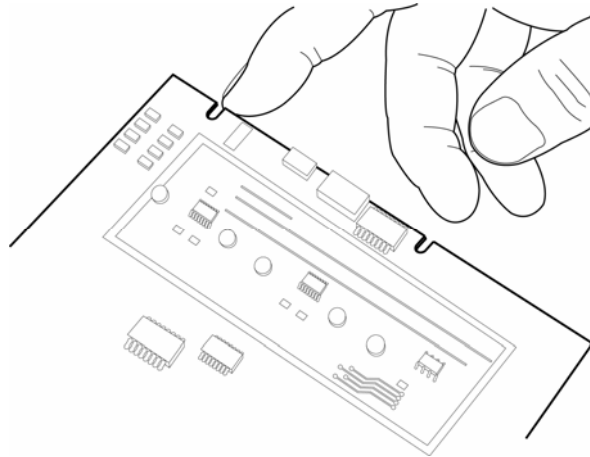
### Removal

1. Referring to the instructions in this chapter, remove the following components:
  - UIM and the top cover
  - 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. Turn the unit on its' side.
6. Remove (7) Phillips screws; 2 from the lower back panel and (5) from the bottom panel.
7. Remove bottom panel.
8. Remove (2) screws from the top of the front panel.
9. Loosen (2) KEPS nuts from the bottom that hold the front panel.
10. Pull off front panel.
11. Loosen (1) KEPS nut from the bottom and (4) screws on the front panel.
12. Remove the blue tubing from the nebulizer to the front panel.
13. 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.

## CAUTION

Never pull on a cable during disconnection.

## Installation



**Figure 4-14** 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.
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 this chapter, install the following components:  
Ventilator assembly onto the base  
UIM and the top cover

## Fan Assembly P/N 51000-40861

(12 VDC, 550mA)

### *Removal*

1. Referring to the instructions in this chapter, remove the following components: UIM and the top cover.
2. Disconnect the fan cable from the wire harness of the TCA board.
3. Pop off the fan filter cover.
4. Remove the filter and the filter cover.
5. 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 TCA 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, install the following components:
  - UIM and the top cover.

## Power Supply P/N 16388

### Tools Required

- Phillips #2 screwdriver with 8" shaft
- 11/32 nut driver
- 3/8 nut driver
- Side cutters
- Needle-nosed pliers

### Removal

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

- UIM and the top cover.

### Note

---

*To gain access to the power supply, the aluminum shield under the plastic top cover must also be removed. There are (19) SEMS screws; (3) on the left, (5) on the right and (11) on top.*

---

- Fan assembly
  - EPM board (It is not necessary to remove this board when gaining access to the power supply. Please see instructions at the end of this procedure).
  - Scroll pump/compressor.
2. Cut and remove all cable ties that secure the wire assemblies to the power shield.
  3. Disconnect the 5-pin connector at J2.

### 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. Part number:

### 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:
  - Scroll Pump / Compressor
  - EPM board. (If not removed, return the EPM to its' position on the (2) mounting studs and secure using the (2) Phillips screws.
  - Fan assembly.
  - Scroll compressor.
  - UIM and the top cover.



Table 4-2 AVEA Power supply specifications

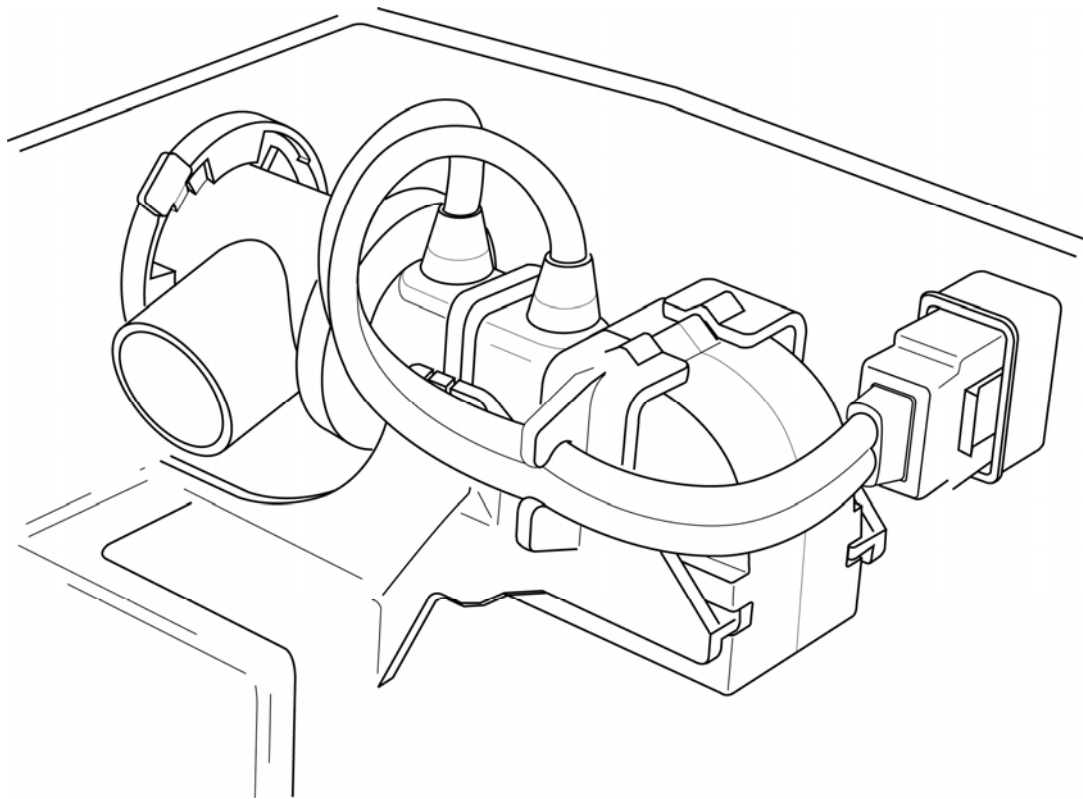
| INPUT                     | OUTPUT                                          |
|---------------------------|-------------------------------------------------|
| TB1                       | TB2                                             |
| 6-32 3 pin terminal block | 6-32 4 pin terminal block 0.375 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:*

1. Remove the (2) 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 a static bag and set out of the way of the compressor and power board.

## Exhalation Valve P/N 16319 and Exhalation Flow Sensor Assembly P/N 51000-40023

Exhalation housing P/N 20030



**Figure 4-15**      **Exhalation Valve and Flow Sensor\***  
**Assembly**

### *Removal*

1. Referring to the instructions in this chapter, remove the following components:
  - UIM and the top cover.
  - Exhalation filter (51000-40640) & watertrap assembly (50000-40035).
2. Remove the third (and last) screw from the exhalation assembly cover of the left hand corner of the AVEA. Remove the cover.
3. Pull the locking shroud of the connector back and disconnect the sensor from the chassis.
4. Grasp the rubber elbow and slide it towards you and remove.

5. Gently remove the exhalation flow sensor by pulling straight towards you.
6. Push in the locking tab on the exhalation valve body and twist the body counterclockwise to remove.
7. Remove the silicon diaphragm from the exhalation valve assembly.
8. Disconnect the two wires from the wiring harness.
9. Carefully cut the cable tie retaining the exhalation valve.
10. 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)
11. Remove the exhalation valve by sliding it out of the brackets and slightly spreading the mount so as not to damage the wires..

#### CAUTION

Ensure that you do not damage the small wires 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 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 blue rubber elbow sensor boot in by lining it up with the grooves.
9. Attach the connector to the chassis by pulling back the plastic sleeve and pushing it into place.
10. Push the locking clip back to secure the sensor.
11. Reinstall the exhalation assembly cover using 2 of the 3 screws (side and bottom front).
12. Referring to the instructions in this chapter, re-install the following components:
  - UIM and the top cover.

## Heater Assembly P/N 51000-40824

### *Removal*

1. Remove the (4) Phillip #1 screws holding the shield.
2. Remove (2) KEP nuts at the base.
3. Disconnect the 3-pin and 2-pin connectors and label.
4. Remove (2) 11/32 KEP nuts on the back of the front panel shielding the flow sensor PCB.
5. Remove (2) Phillips #2 screws from the front panel.
6. Remove corner piece
7. Remove screws (4) Phillip #1 holding shield.
8. Remove heater assembly
9. The top cover.
  - Exhalation Valve and Flow Sensor Assembly
  - Remove the screws holding the shield and remove shield.
  - Remove 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. Referring to the instructions in this chapter, install the following components:
2. Reinstall heater assembly into the shield using (4) Phillips #1 screws.
3. Attach corner to the base assembly using (3) KEPS nuts and (2) Phillips #2 screws.
  - Re-attach heater.
  - Re-attach shield.
  - Exhalation Valve and Flow Sensor Assembly
  - UIM and the top cover.

## Microswitch, Top Cover P/N 68294

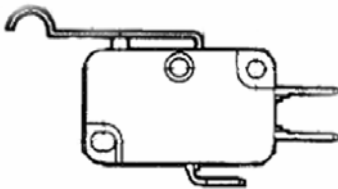


Figure 4-16

Top Cover Micro Switch

## ***Removal***

1. Referring to the instructions in this chapter, remove the following components:
  - UIM and the top cover.
2. Remove attachment screws, disconnect and lift off the micro switch.

## ***Installation***

1. Reattach using screws provided. Re-connect the wiring.
2. Referring to the instructions in this chapter, install the following components:
  - UIM and the top cover.

## **EMI Shield**

### ***Removal***

1. Referring to the instructions in this chapter, remove the following components:
  - 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 following components:
  - UIM and the top cover.

## **Front Interface Panel P/N 51000-40635**

### ***Removal***

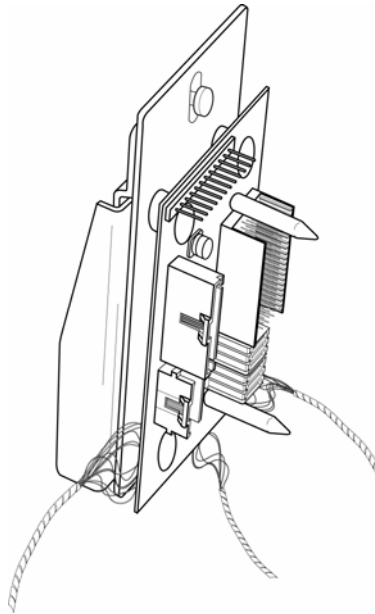
1. Referring to the instructions in this chapter, remove the following components:
  - UIM and the top cover.
  - Ventilator assembly (from the base).
  - Gas delivery engine assembly.
2. Remove the flow sensor cover by removing the (3) SEMS screws.
3. Remove the (2) KEPS nuts, the EMI shield, brass 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.

## Transition board with harness P/N 16216



**Figure 4-17**

**Driver transition board**

### *Removal*

1. Referring to the instructions in this chapter, remove the following:
  - UIM and the top cover.
  - Gas delivery engine assembly.
  - Fan assembly connections
  - Scroll compressor connections.
  - Front interface panel connections.
2. Disconnect the wiring to the power supply board and the battery.
3. Remove the spiral wrap to the alarm connector, and feed the wires out of the hole in the chassis one connector at a time.
4. Remove the (2) Phillips screws and flat washers from the chassis.
5. Remove the Phillips screws on the board bracket and remove the board from the bracket.

### *Installation*

1. Mount the driver transition board into the first half of the bracket; place the board on the three round threaded studs with the cables spread outward, and secure the (3) Phillips screws.
2. Place the flat side of the other half of the bracket on the two mounting pins and slide it down.
3. Install (1) Phillips screw from the front to the rear of the bracket and leave finger tight.
4. Align the bracket over the two threaded holes in the chassis and install (2) Phillips screws using flat washers.

5. Align the driver transition board; slide in the gas delivery engine assembly, carefully connect it to the driver transition board, adjusting the bracket as necessary.
6. Once the alignment is complete, secure the driver transition board and the height adjustment pin on the bracket, and then remove the gas delivery engine assembly.
7. Feed the top wiring harness through the small hole in the front right of the chassis, one connector at a time.
8. Install the spiral wrap, leaving the alarm connector hanging off to the side.
9. Make the appropriate connections to the power supply board and to the battery.
10. Referring to the instructions in this chapter, install the following components:
  - Front interface panel.
  - Scroll compressor.
  - Fan assembly.
  - Gas delivery engine assembly.
  - UIM and the top 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.
2. Turn the unit over and support it on 2x4 pieces of wood to avoid putting the entire weight of the unit on the 4 standoffs.
3. Disconnect the wire to the driver transition board.
4. 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:
  - Bottom cover.
  - Front panel.
  - Ventilator assembly onto the base.
  - UIM and the top cover.



## Nebulizer Assembly P/N 51000-40026

### *Note*

---

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

---

### *Removal*

1. Referring to the instructions in this chapter, remove the following components:
  - UIM and the top cover.
  - Ventilator assembly from base.
  - Bottom cover.
2. Cut tie wraps on the nebulizer booster.
3. Remove wire harness.
4. Disconnect the two solenoid connectors to the driver transition board.
5. Disconnect the tubing from the accumulator.
6. 6 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.
7. Disconnect blue tube just in front of the solenoid.

### *Installation*

1. 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.
2. Position the nebulizer onto the three threaded studs and using ong needle-nosed pliers, secure with (3) 11/32 KEPS nuts; (2) on the left side and (1) on the right.
3. Connect the tubing from the accumulator to the left side of the nebulizer.
4. 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.
5. Connect the two solenoid connectors from the driver transition board.
6. Referring to the instructions in this chapter, install the following components:
  - Bottom cover.
  - Gas delivery engine assembly.
  - UIM and the top cover.

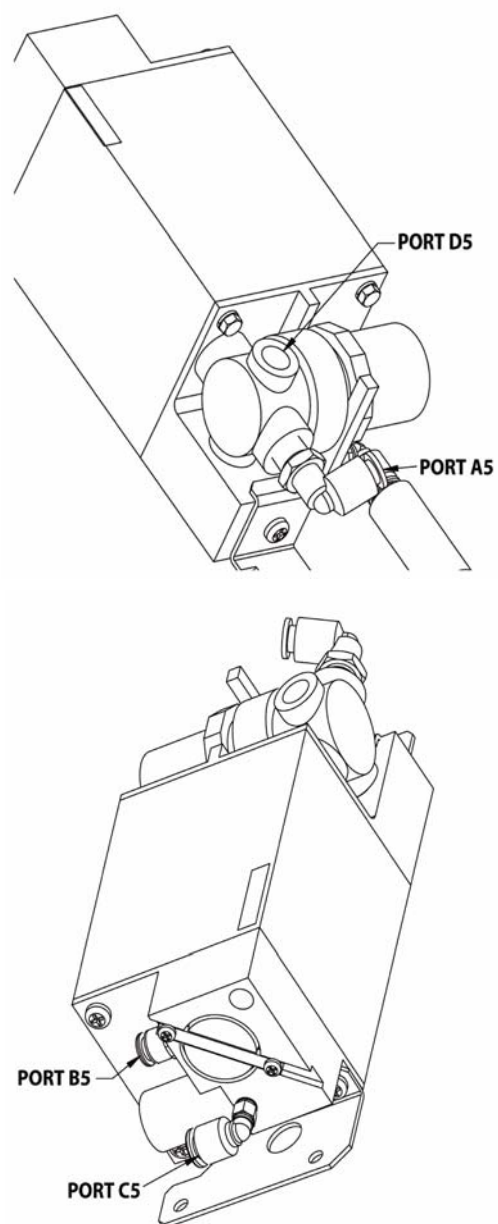


Figure 4-18

Nebulizer Assembly showing ports

## Accumulator P/N 51000-40748

### *Removal*

1. Referring to the instructions in this chapter, remove the following components:
  - UIM and the top cover.
  - Gas delivery engine assembly.
  - Ventilator assembly from base.
  - Bottom cover.
  - Front panel.
  - Speaker.
  - Nebulizer.
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. 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.
2. Rotate the supply tube to the gas delivery engine into the slot on the bottom left of the chassis.
3. Position the accumulator by sliding the two notches over the threaded studs at the bottom and seating the top onto the two mounting studs.
4. Secure the accumulator with (4) 11/32 KEPS nuts, one on each corner.
5. Connect the tubing to the solenoid drain panel.
6. Connect the solenoid cable to the driver transition board.
7. Referring to the instructions in this chapter, install the following components:
  - Speaker.
  - Bottom cover.
  - Front panel.
  - Nebulizer.
  - Ventilator assembly onto the base.
  - Gas delivery engine assembly.
  - UIM and the top cover.

## Secondary Alarm Installation (KitP/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.

## General Instructions and Warnings

The removal and installation of major subassemblies requires OVP and calibration. Refer to Service Manual L1524.

When disassembling or assembling the AVEA, refer to the tubing diagram, P/N 51000-40840, the wiring diagram P/N 51000-40839 and appropriate schematics and assembly drawings located in Appendix B of the Service manual L1524. The illustrations shown here are for reference only, current revisions of these diagrams and schematics are available to qualified personnel from VIASYS Healthcare, Critical Care Division, Technical Support.

### WARNING

ALWAYS TAKE STANDARD ESD PRECAUTIONS WHEN WORKING ON AVEA VENTILATOR SYSTEMS.

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

Ensure the ventilator is disconnected from the AC and DC power supplies 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 & 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 National Institute of Standards Technology (NIST) or equivalent. When variances exist between the indicated and actual values, the calibration curves [provided for each instrument by the testing laboratory] must be used to establish the actual correct values. This certification procedure should be performed at least once every six months. More frequent certification may be required based on usage.*

Long & short Philips screwdrivers  
Flat bladed screwdriver  
Side Cutters  
11/32" Nut Driver (8"shank)  
3/8" Nut Driver  
5/16" Nut Driver  
Thin Needle-nose Pliers

## 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 cart.
8. Carefully lay the unit so that the bottom plate is facing up.
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 maybe 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. Wires #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.

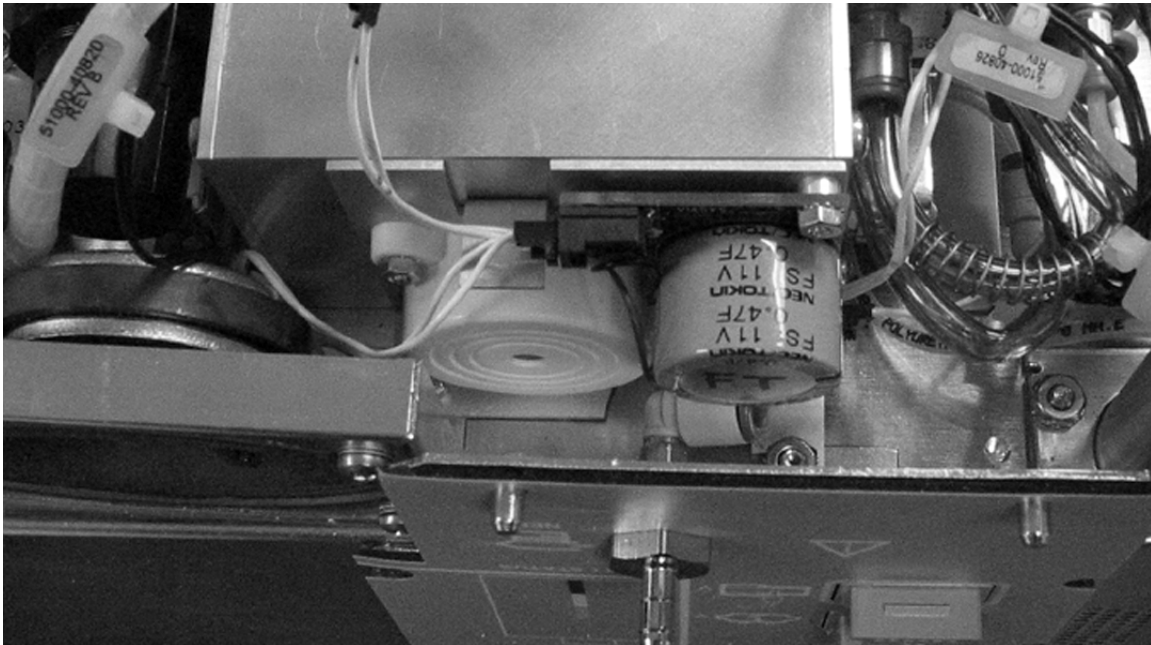


Photo #1

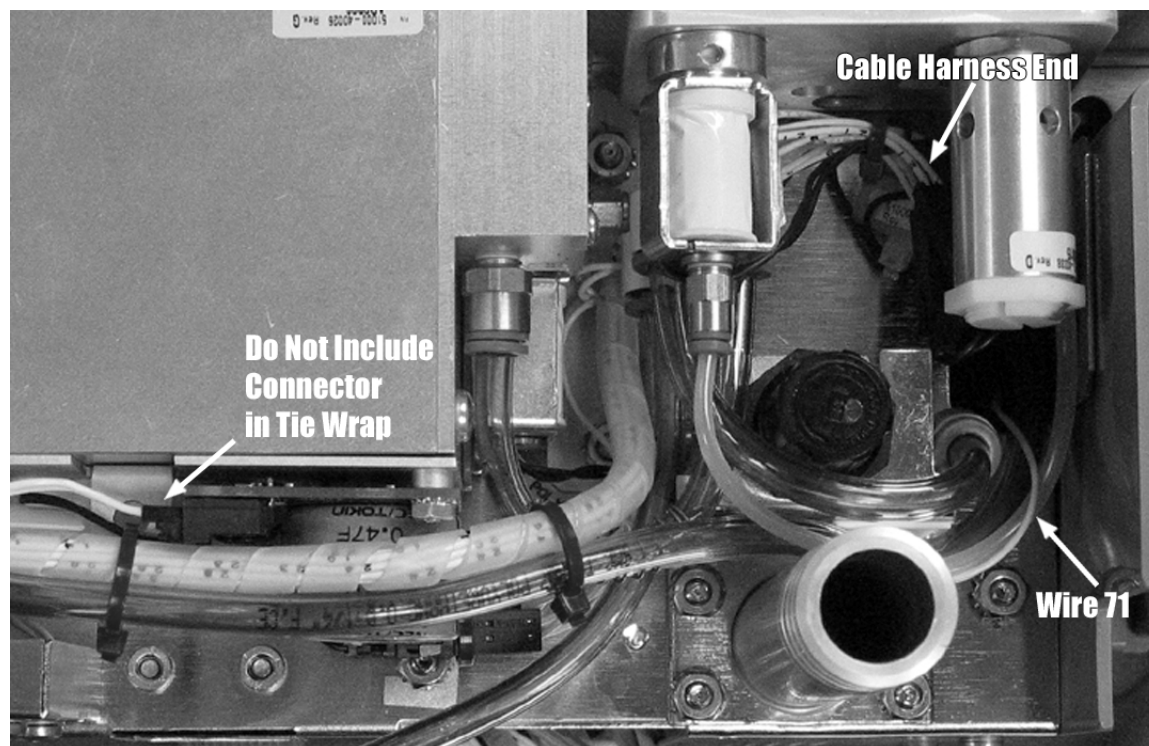


Photo #2

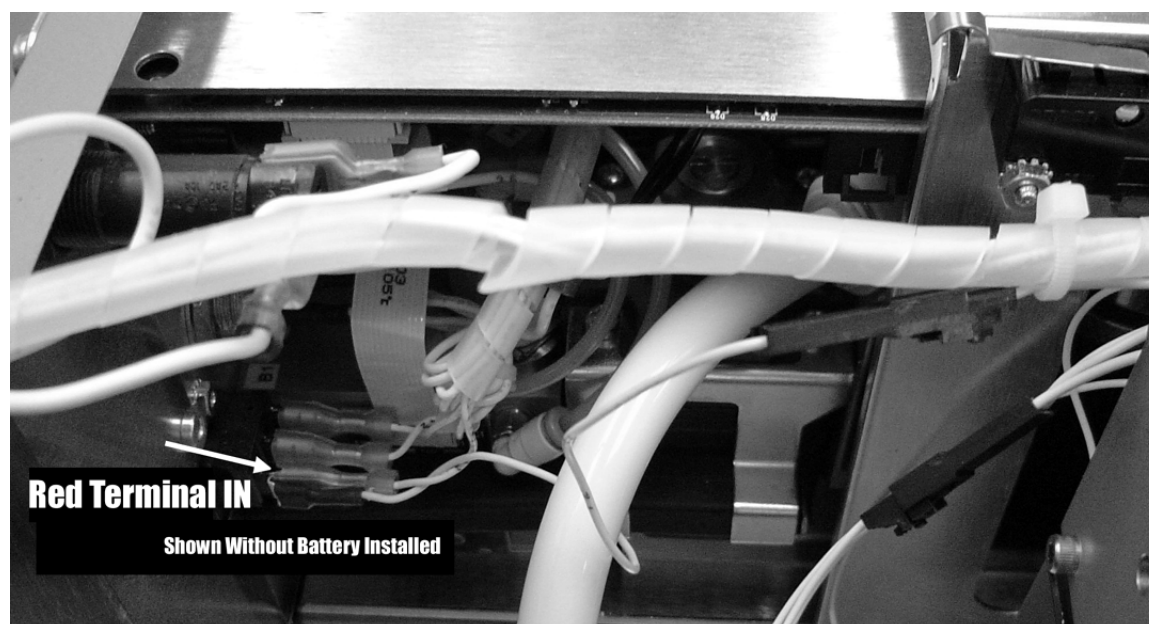
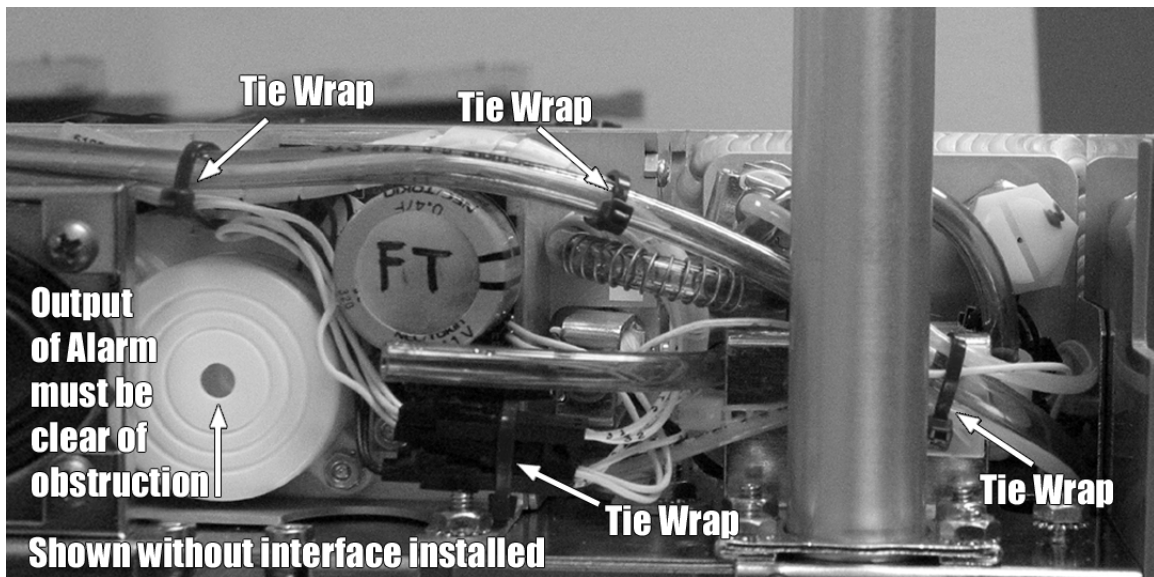


Photo #3





Photo#4

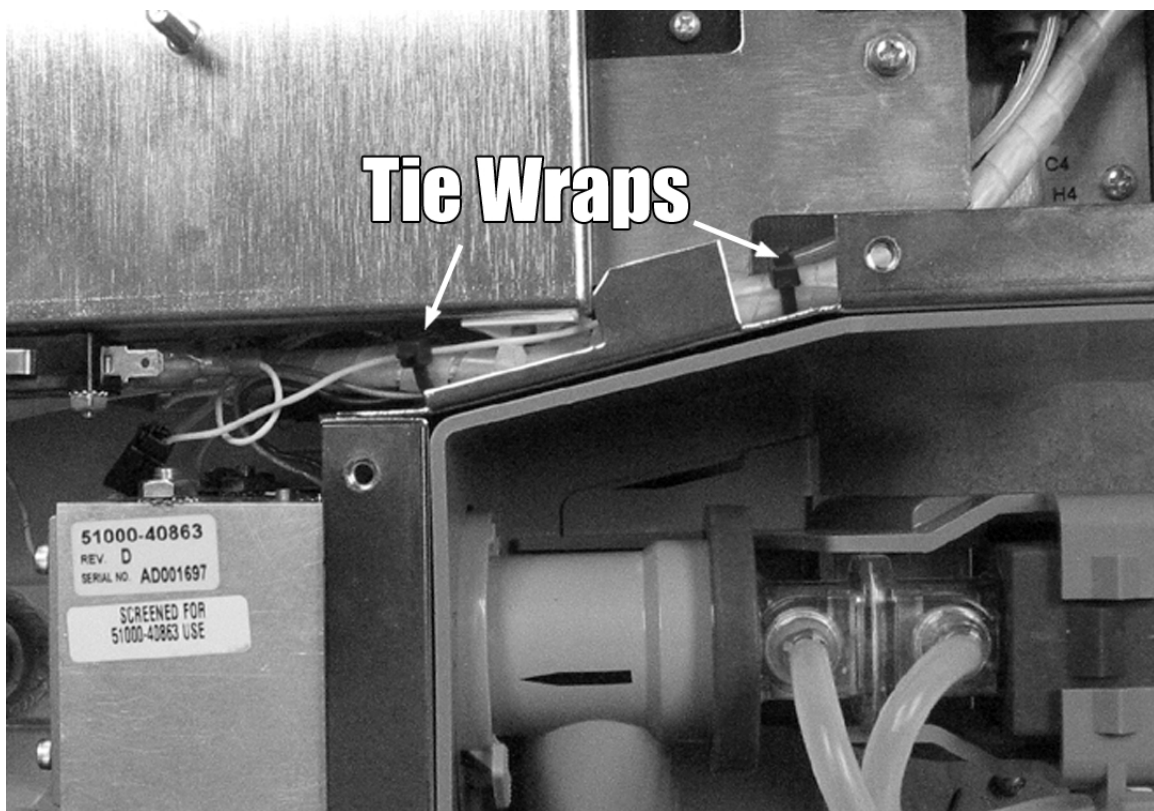


Photo #5

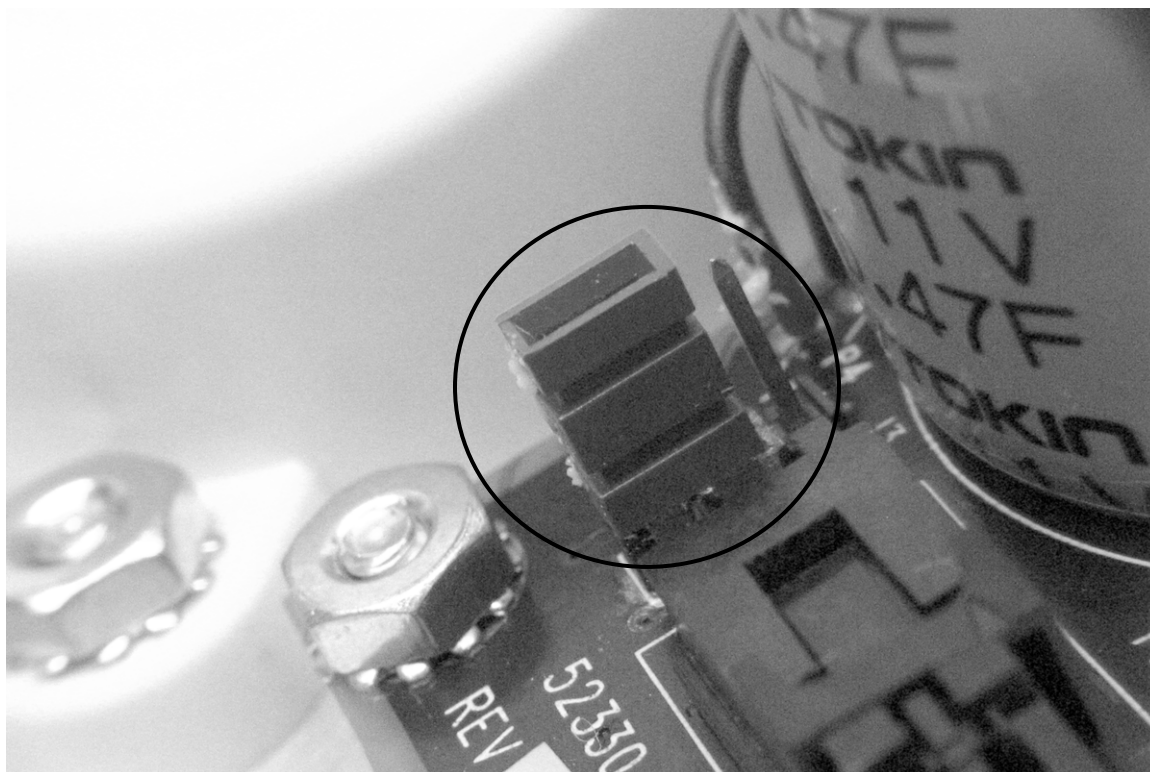


Photo #6a Prior to ventilator serial # ADV03500

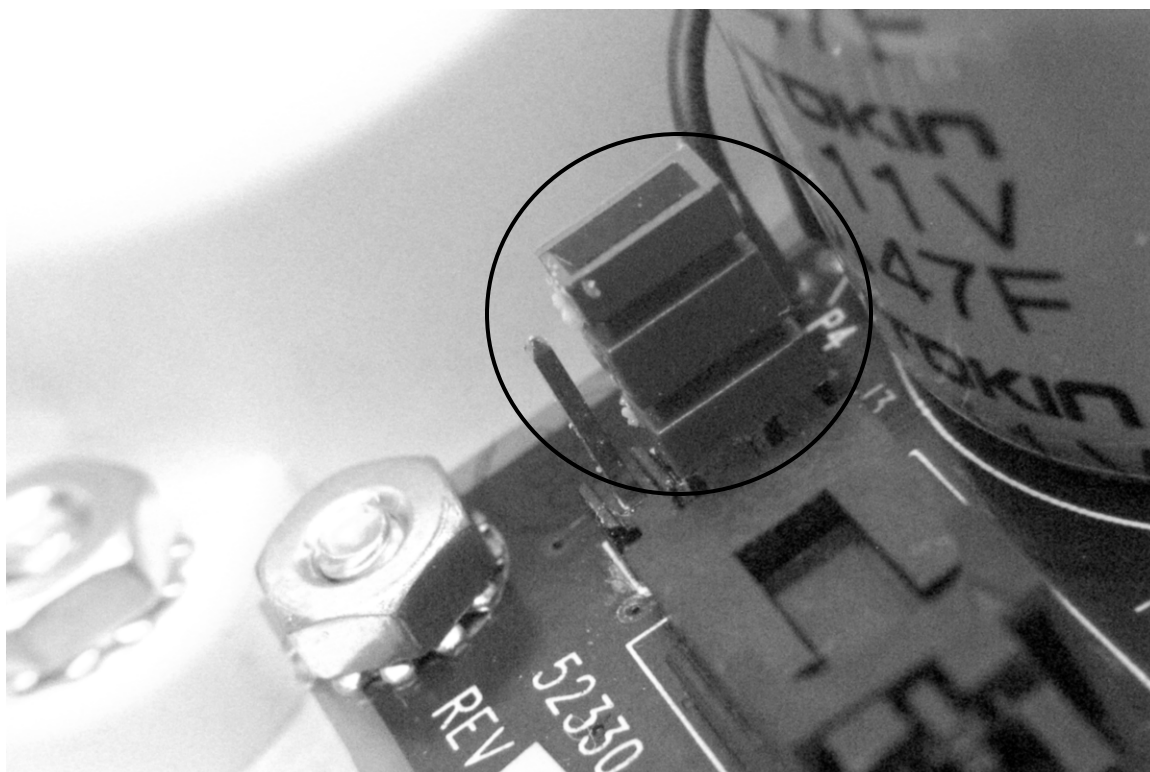


Photo #6b After ventilator serial # ADV03500

# Chapter 5    Operational Verification Procedure (OVP)

## WARNING

Verification Testing should always be done off patient.

## Set up

Plug the AVEA into a suitable AC Power source, 50 PSI oxygen source and 50 PSI medical air source. Initially, connect an adult patient circuit and an adult test lung.

## NOTE

*Manufacturer 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) in testing VIASYS ventilation equipment:.*

- 1      Turn power on.
- 2      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 at the end of this procedure).
- 3      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.
- 4      Ensure that *Leak Comp* and *Humidifier active* are off. Press *Setup Accept*.

## User Verification Tests (UVT)

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

### *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:

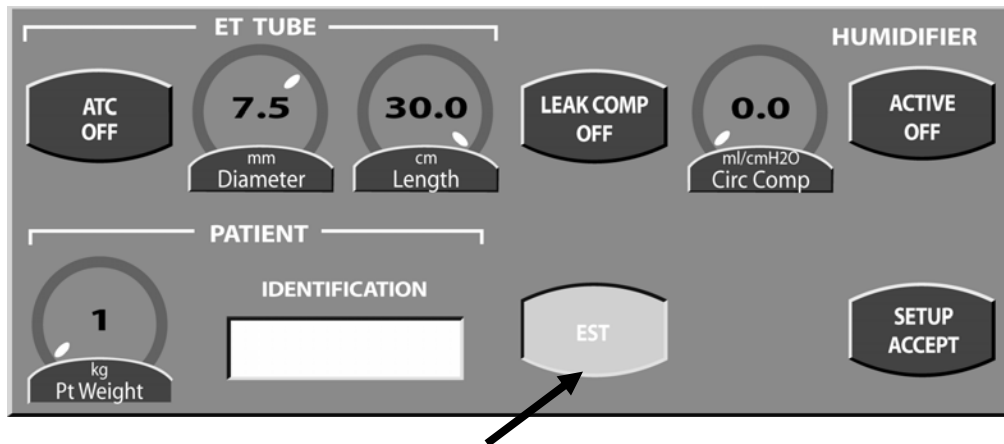
- Processor Self Check
- ROM Check Sum
- RAM Test

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. Normal ventilation commences at the culmination of the POST.

## Extended Systems Test (EST)

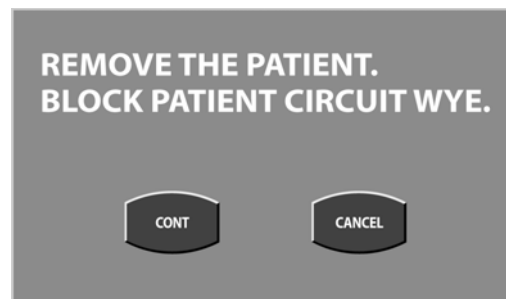
Note: Ensure that the O2 alarm is enabled. The O2 sensor calibration portion of the EST will fail if the O2 alarm is disabled.

- 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.)

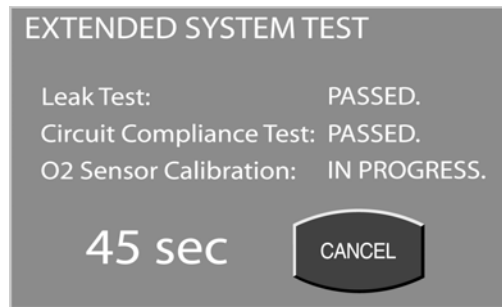


Figure 5-3

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.

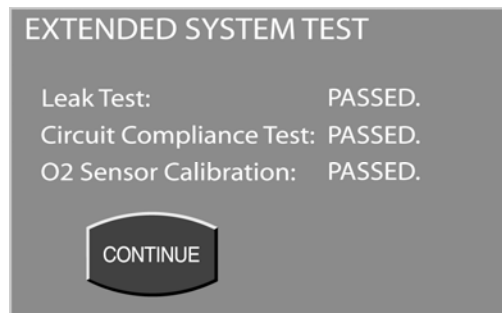


Figure 5.4

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

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 O2 Sensor Calibration will immediately fail.*

---

## Manual Alarms Testing

This testing verifies the following alarms:

|                  |                           |
|------------------|---------------------------|
| Low PEEP alarm   | Low O <sub>2</sub> alarm  |
| High Ppeak alarm | High O <sub>2</sub> alarm |
| High Ppeak,      | EXT High Ppeak alarm      |
| Low Ve alarm     | Low Ve 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            |
| O <sub>2</sub> 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 <sub>2</sub> O   | 20 ml/cmH <sub>2</sub> O   | N/A             |
| Resistance                     | 5 cmH <sub>2</sub> O/L/sec | 5 cmH <sub>2</sub> O/L/sec | N/A             |

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 ones listed in this manual are those for software version 3.4.

**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 <sub>2</sub> O | 0.0 ml/cmH <sub>2</sub> O | 0.0 ml/cmH <sub>2</sub> O<br>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)                   | 8 bpm                 | 12 bpm                | 20 bpm                 |
| Tidal Volume (Volume)                | 500 ml                | 100 ml                | 2.0 ml in volume modes |
| Peak Flow                            | 60 L/min              | 20 L/min              | 8 L/min                |
| Inspiratory Pressure (Insp Pres)     | 15 cmH <sub>2</sub> O | 15 cmH <sub>2</sub> O | 15 cmH <sub>2</sub> O  |
| Inspiratory Pause (Insp Pause)       | 0.0 sec               | 0.0 sec               | 0.0 sec                |
| Inspiratory Time (Insp Time)         | 1.0 sec               | 0.75 sec              | 0.35 sec               |
| PSV                                  | 0 cmH <sub>2</sub> O  | 0 cmH <sub>2</sub> O  | 0 cmH <sub>2</sub> O   |
| PEEP                                 | 6 cmH <sub>2</sub> O  | 6 cmH <sub>2</sub> O  | 3 cmH <sub>2</sub> O   |
| Inspiratory Flow Trigger (Flow Trig) | 1.0 L/min             | 1.0 L/min             | 0.5 L/min              |
| %O <sub>2</sub>                      | 21%                   | 21%                   | 21%                    |

**Table 5-4 Advanced Settings**

| Adv. Settings                            | Adult Setting          | Pediatric Setting      | Neonate Setting        |
|------------------------------------------|------------------------|------------------------|------------------------|
| Vsync                                    | 0 (off)                | 0 (off)                | N/A                    |
| Vsync Rise                               | 5                      | 5                      | N/A                    |
| Sigh                                     | 0 (off)                | 0 (off)                | N/A                    |
| Waveform                                 | 1 (Dec)                | 1 (Dec)                | 1 (Dec)                |
| Bias Flow                                | 2.0 L/min              | 2.0 L/min              | 2.0 L/min              |
| Inspiratory Pressure Trigger (Pres Trig) | 3.0 cmH <sub>2</sub> O | 3.0 cmH <sub>2</sub> O | 3.0 cmH <sub>2</sub> O |
| PSV Rise                                 | 5                      | 5                      | 5                      |
| PSV Cycle                                | 25%                    | 25%                    | 10%                    |
| PSV Tmax                                 | 5 sec                  | 0.5 sec                | 0.35 sec               |
| Machine Volume (Mach Vol)                | 0 L                    | 0 ml                   | 0 ml                   |
| Volume Limit (Vol Limit)                 | 2.50 L                 | 500 ml                 | 300.0 ml               |
| Inspiratory Rise (Insp Rise)             | 5                      | 5                      | 5                      |
| Flow Cycle                               | 0% (off)               | 0% (off)               | 0% (off)               |
| T High PSV                               | Off                    | Off                    | N/A                    |



| Adv. Settings | Adult Setting | Pediatric Setting | Neonate Setting |
|---------------|---------------|-------------------|-----------------|
| T High Sync   | 0%            | 0%                | N/A             |
| T Low Sync    | 0%            | 0%                | N/A             |
| Demand Flow   | On            | On                | On              |

**Table 5-5 Alarm Settings**

|                                               | Adult Setting         | Pediatric Setting     | Neonate Setting       |
|-----------------------------------------------|-----------------------|-----------------------|-----------------------|
| <b>High Rate</b>                              | 75 bpm                | 75 bpm                | 75 bpm                |
| <b>High Tidal Volume (High Vt)</b>            | 3.00 L                | 1000 ml               | 300 ml                |
| <b>Low Tidal Volume (Low Vt)</b>              | 0.0 L                 | 0.0 ml                | 0.0 ml                |
| <b>Low VTe Sensitivity</b>                    | 3 breaths             | 3 breaths             | 3 breaths             |
| <b>Low Exhaled Minute Volume (Low Ve)</b>     | 1.0                   | 0.5                   | 0.05                  |
| <b>High Exhaled Minute Volume (High Ve)</b>   | 30.0 L/min            | 30.0 L/min            | 5.0 L/min             |
| <b>Low Inspiratory Pressure (Low Ppeak)</b>   | 8 cmH <sub>2</sub> O  | 8 cmH <sub>2</sub> O  | 5 cmH <sub>2</sub> O  |
| <b>High Inspiratory Pressure (High Ppeak)</b> | 40 cmH <sub>2</sub> O | 40 cmH <sub>2</sub> O | 30 cmH <sub>2</sub> O |
| <b>Low PEEP</b>                               | 3 cmH <sub>2</sub> O  | 3 cmH <sub>2</sub> O  | 1 cmH <sub>2</sub> O  |
| <b>Apnea Interval</b>                         | 20 sec                | 20 sec                | 20 sec                |

**Table 5-6 Auxiliary Controls**

|                                     | Adult Setting | Pediatric Setting | Neonate Setting |
|-------------------------------------|---------------|-------------------|-----------------|
| Manual Breath                       | ---           | ---               | ---             |
| Suction                             | ---           | ---               | ---             |
| ↑ O <sub>2</sub>                    | <b>79%</b>    | <b>79%</b>        | <b>20%</b>      |
| <b>Nebulizer</b>                    | ---           |                   |                 |
| <b>Inspiratory Hold (Insp Hold)</b> | ---           | ---               | ---             |
| <b>Expiratory Hold (Exp Hold)</b>   | ---           | ---               | ---             |

1. Make the appropriate connections for air and O<sub>2</sub> 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. Accept this selection by pressing "PATIENT ACCEPT". This will enable default settings for the Manual Alarms Test.
3. Select the appropriate patient size for your test (Adult, Pediatric or Neonate) from the Patient Size Select Screen. Accept this selection by pressing "SIZE ACCEPT". Set *Humidifier Active* 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<sub>2</sub> control to 100%. Disconnect the Oxygen sensor from the back panel of the ventilator and verify that the Low O<sub>2</sub> alarm activates. Return the O<sub>2</sub> control setting to 21% with the sensor still disconnected from the rear panel. Remove sensor from back panel. Provide blow-by to the sensor from an external oxygen flow meter. Verify that the High O<sub>2</sub> alarm activates. Return the % O<sub>2</sub> 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 the default setting of 20 seconds for the apnea interval has elapsed. Reconnect the test lung to the circuit clear the alarm by pressing the reset button.
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.
11. Set the control setting for rate to 1 bpm. Verify that Apnea Interval alarm activates after the default setting of 20 seconds. Return the control setting to its default value and clear the alarm by pressing the reset button. Note that nebulizer is inactive with infant patient size selected.
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. 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. 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. 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. Return the alarm setting to its default value and clear the alarm by pressing the reset button.
18. Set the number of consecutive breaths with an exhaled tidal volume below the Low Vte Alarm setting which are required to sound the alarm. Verify that this set number of breaths is at Low Vte prior to alarm sounding. Default is 3 breaths.
19. 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.
20. 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  $((V_{ti}-V_{te})/V_{ti})$  becomes 95% or greater for three consecutive breaths, the alarm should sound. Without a proximal flow sensor, the threshold becomes 90% leak.
21. Verification of Circuit Occlusion Alarm: This alarm occurs due to excessive resistance in the patient circuit. The Circuit Occlusion Alarm will sound if the inspiratory pressure exceeds the expiratory pressure by greater than 6 cmH<sub>2</sub>O for more than 200 msec. This may be tested by creating 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

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

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

VT e: 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 by the clinician.

## Testing Guidelines

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

Refer to table 5.1: Test Setup Requirements and 5.2: Ventilation Setup

Primary Control VT defaults are as follows:

Adult 500 ml.

Pediatric 100 ml.

Change Neonate to Volume A/C and enter a VT of 20 ml.

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 Seimens test lung, the test is to be performed without the proximal sensor.

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

Select ATPD Flow Correction

Do not use a flow sensor.

Accuracy of displayed exhaled volume is + or – 0.2 ml. plus 10% of set VT.

**Table 5-7 VT Tolerance Ranges**

| VT SET | VT EXHALED                  |
|--------|-----------------------------|
| 1000   | 900 to 1100 ml. +/- 0.2 ml. |
| 500    | 450 to 550 ml. +/- 0.2 ml.  |
| 100    | 90 to 110 ml. +/- 0.2 ml.   |
| 20     | 18 to 22 ml. +/- 0.2 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 ( $\pm 1$  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  $\uparrow$  %O<sub>2</sub> LEDs should illuminate, also LOSS, O<sub>2</sub> appears on the screen in the alarm window. Press Suction again, both Suction and  $\uparrow$  %O<sub>2</sub> LEDs should disappear, press Reset to clear visual alarm.
6. Increase O<sub>2</sub> - Press the Increase O<sub>2</sub> button ( $\uparrow$  %O<sub>2</sub>) Verify that the LED illuminates, The LOSS O<sub>2</sub> alarm activates. Press the button again and verify that the LED turns off. Press RESET to clear the visual alarm.
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 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 this soft key & it will plateau at the top of the inspiratory cycle in the adult and pediatric patient modes.
11. Nebulizer - Connect wall air to unit 20 to 80 psi. 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.
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. The manual breath, suction, increase O<sub>2</sub> 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, Press Set up Accept.
16. Advanced Settings - Press the Advanced Settings screen button. Toggle the screen on & 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 wave forms freeze. Measurement bar appears. Press again and ensure normal refresh of the waveform sweep continues in the Main screen.
22. Screens and Main buttons - Press the Screens button and the Screen Select screen should appear. Press Monitor, the Monitor screen should display. Press Main and the screen should go back to Main screen.

# 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 SerialNumber: \_\_\_\_\_

Hours \_\_\_\_\_ Software Revision \_\_\_\_\_ Other \_\_\_\_\_

If any parts are missing contact VIASYS AVEA Customer Service at 800-325-0082 or 760-883-7185.

## Field replacement and test of the AVEA Compressor Assembly

Refer to this chapter for disassembly of the User Interface Module (UIM) and top cover. Follow the instructions given in Chapter 4 to remove and replace the compressor assembly. Re-assemble the AVEA and test using this procedure.

The compressor sub-system on the AVEA includes a Compressor PC Board and the Compressor. The sub-assembly is tested and calibrated at the factory and designed to be field installed in the AVEA ventilator. This procedure verifies that the test ventilator delivers the expected minute ventilation when the compressor is supplying air to the ventilator (40 L/min). It also verifies that the compressor activates upon loss of the wall air supply and de-activates when that supply is restored.

### *Equipment Required*

- AVEA Ventilator (Test ventilator)
- Adult Patient Circuit
- Adult Test Lung – Manley or Siemens recommended
- Regulated Air Supply - Range > 30 psig

### *Note*

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*All equipment is as stated or equivalent .*

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## Compressor Check

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 following ventilator settings:

| Control           | Setting    |
|-------------------|------------|
| Tidal Volume (Vt) | 2.0L,      |
| Rate              | 19 bpm,    |
| Peak Flow         | 150 L/MIN. |

12. Change the scale on Flow waveform graphic display to 300 L/min.
13. Press the Freeze button.
14. Verify the flow at the end of inspiration is 135 L/min . or greater..
15. Re-connect wall air supply.
16. Verify compressor shuts off and ventilation continues uninterrupted using the wall air supply.

**Table 5-8 Test Ventilator: (AVEA Ventilator)**

|                  |                                             |                           |
|------------------|---------------------------------------------|---------------------------|
| Setup            | Patient Size                                | Adult                     |
|                  | ET Tube Diameter                            | 7.5 mm                    |
|                  | ET Tube Length                              | 30 cm                     |
|                  | Automatic Tube Compensation (ATC)           | Off                       |
|                  | Leak Compensation                           | Off                       |
|                  | Circuit Compliance Compensation (Circ Comp) | 0.0 mL/cmH <sub>2</sub> O |
|                  | Humidification                              | Off                       |
|                  | Ideal Body Weight                           | 1 Kg                      |
|                  | Barometric Pressure                         | Accurate/current reading  |
| Primary Controls | Breath Type/Mode                            | Volume A/C                |
|                  | Breath Rate (Rate)                          | 15                        |
|                  | BPM                                         |                           |
|                  | Tidal Volume (Volume)                       | 0.50 L                    |
|                  | Peak Flow                                   | 45 L/MIN                  |
|                  | Inspiratory Pause (Insp Pause)              | 0.00 second               |
|                  | Inspiratory Time (I-Time)                   | - - -                     |
|                  | PSV                                         | - - -                     |
|                  | PEEP                                        | 0 cmH <sub>2</sub> O      |
|                  | Inspiratory Flow Trigger (Flow Trig)        | 20.0 L/MIN                |
|                  | % O <sub>2</sub>                            | 21 %                      |



|                    |                                          |                         |
|--------------------|------------------------------------------|-------------------------|
| Advanced Controls  | Vsync                                    | 0 (Off)                 |
|                    | Vsync Rise                               | ---                     |
|                    | Sigh                                     | 0 (Off)                 |
|                    | Waveform                                 | Square                  |
|                    | Bias Flow                                | 2.0 L/MIN               |
|                    | Inspiratory Pressure Trigger (Pres Trig) | 20.0 cmH <sub>2</sub> O |
|                    | PSV Rise                                 | ---                     |
|                    | PSV Cycle                                | ---                     |
|                    | PSV T <sub>max</sub>                     | ---                     |
|                    | Machine Volume (Mach Vol)                | ---                     |
|                    | Volume Limit (Vol Limit)                 | ---                     |
|                    | Inspiratory Rise (Insp Rise)             | ---                     |
|                    | Flow Cycle                               | ---                     |
| Alarm Settings     | High Rate                                | 200 BPM                 |
|                    | High Tidal Volume (High Vt)              | 3.00 L                  |
|                    | Low Exhaled Minute Volume (Low Ve)       | 0 (Off)                 |
|                    | High Exhaled Minute Volume (High Ve)     | 30.00 L/MIN             |
|                    | Low Inspiratory Pressure (Low PPEAK)     | 3 cmH <sub>2</sub> O    |
|                    | High Inspiratory Pressure (High PPEAK)   | 50 cmH <sub>2</sub> O   |
|                    | Low PEEP                                 | 0 cmH <sub>2</sub> O    |
|                    | Apnea Interval                           | 20 seconds              |
| Auxiliary Controls | Manual Breath                            | ---                     |
|                    | Suction                                  | ---                     |
|                    | <sup>a</sup> %O <sub>2</sub>             | Not enabled             |
|                    | Nebulizer                                | Not enabled             |
|                    | Inspiratory Hold (Insp Hold)             | ---                     |
|                    | Expiratory Hold (Exp Hold)               | ---                     |
|                    | Air Supply Pressure                      | > 30 psig               |
|                    | O <sub>2</sub> Supply Pressure           | > 30 psig               |
|                    | AC Line Voltage                          | 115 ± 10 VAC            |

## Checkout Sheet – AVEA Compressor Replacement

Date: \_\_\_\_\_ Hours: \_\_\_\_\_

Old Compressor S/N: \_\_\_\_\_ New Compressor S/N: \_\_\_\_\_

AVEA Ventilator S/N: \_\_\_\_\_ UIM Serial Number: \_\_\_\_\_

| TEST                                                                                    | PASS | FAIL |
|-----------------------------------------------------------------------------------------|------|------|
| Compressor Activates when wall air is turned off                                        |      |      |
| Scroll symbol displays when compressor activates                                        |      |      |
| Ventilator continues to cycle and no alarms initiate when wall air is turned off        |      |      |
| Circuit Disconnect and High Priority alarms initiate when circuit is disconnected       |      |      |
| End inspiration flow reading is 135 L/min or greater                                    |      |      |
| Compressor shuts off when wall air is turned on and ventilation continues uninterrupted |      |      |

I here by certify that the product with the above Serial Number has passed all operational specification and is certified for clinical use (The unit must be signed off before returning to clinical use.)

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**Please complete this check sheet and FAX to VIASYS Technical Support at (714) 283-8471.**

## Power Indicators and Charging Verification.

Power the unit up. Verify the Power On indicator is lit. It will be green.

Ensure that when the unit is connected to AC Power the AC indicator is lit. It will be green.

If the unit is equipped with an external battery, check and verify the external battery charging and status indicators.

Check the internal battery (standard feature) charging and status indicators.

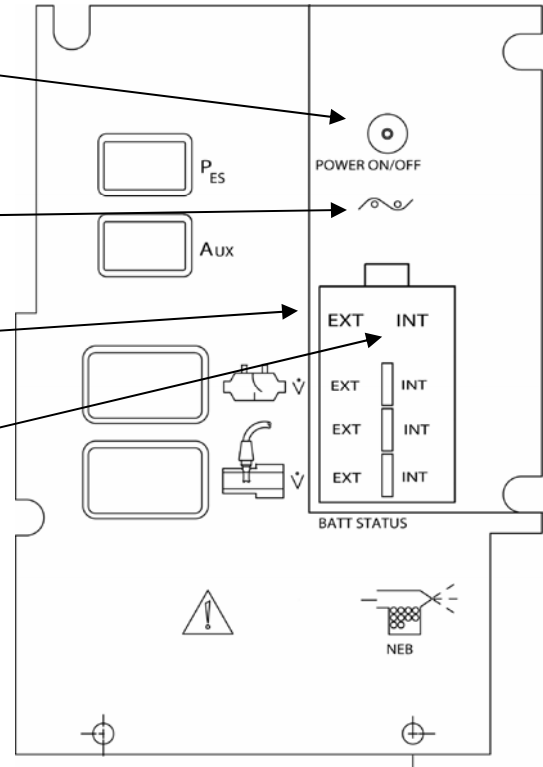
The charging status indicators are:

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 30% for the internal battery)

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



## Battery Run Procedure

Figure 5.5

1. Plug unit in, turn power on and adjust settings as follows:
  - a. *Mode*: Pediatric, Volume A/C
  - b. *Settings*: 40 BPM, Volume 200ml, Peak Flow 30 L/min, PEEP 5cmH<sub>2</sub>O, Flow Trigger 20 L/min, and FIO<sub>2</sub> 21%.
  - c. *Advanced Settings*: Vsync off, Waveform Square, Bias Flow 3 L/min, and Pressure Trigger 20cmH<sub>2</sub>O.
2. Verify that the Power Indicator "EXT" is illuminated and the Power Status is on AC (~).
3. Verify battery indicator LED's function and progressively charge from Red to Yellow to Green.
4. 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.

5. Verify internal batteries. Disconnect external batteries. Verify that the power status indicator “INT” is illuminated and the unit continues to run without interruption. Verify that the “on screen” battery indicator is displayed.



6. Turn unit off.

## 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 O2 Source to the O2 Inlet. (Verify the Air and O2 Inlet monitors read 50 PSI (+/- 3 PSIG). You can check this by scrolling to the air inlet and O2 inlet monitored parameter displays on the left of the Main screen or by pressing the screens button, selecting the Monitor screen and scrolling to the air inlet and O2 inlet parameters and *Accept*.

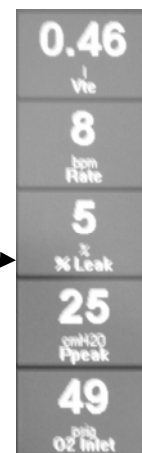


Figure 5.6

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 Low Air alarm should activate.

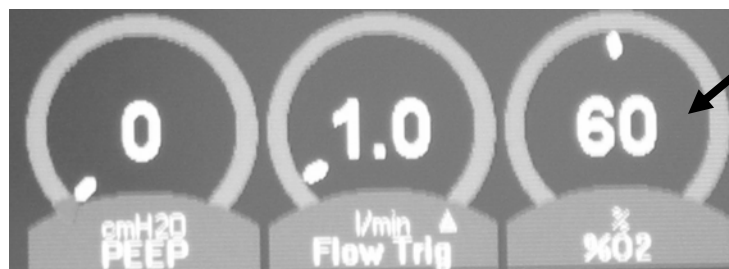


Figure 5.7

4. Change the O2 percentage to 60%.
5. Lower the O2 inlet pressure gage to 18 psi. The Low O2 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.

### Note

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

Record the readings from the external O<sub>2</sub> Analyzer and the AVEA FIO<sub>2</sub> (% O<sub>2</sub>) monitor/setting. Check the FiO<sub>2</sub> (% O<sub>2</sub>) readings per table below to compare set FIO<sub>2</sub> to analyzed FIO<sub>2</sub>.

Table 5.9: FiO<sub>2</sub> Readings

| O <sub>2</sub> % | Tidal Volume | Breath Rate | Peak Flow | % Tolerance |
|------------------|--------------|-------------|-----------|-------------|
| 21%              | 0.50L        | 25          | 30 L/min  | +/- 1%      |
| 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<sub>2</sub>O) 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
  - 20 cm
  - 40 cm

# 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 SerialNumber: \_\_\_\_\_

Hours \_\_\_\_\_ Software Revision \_\_\_\_\_ Other \_\_\_\_\_

If any parts are missing contact VIASYS AVEA 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               |           |      |
| 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 \_\_\_\_\_

## Chapter 6 AVEA Software Upgrade

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 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 requirements section) to the computer hard drive as follows:

- Double click on "My Computer".
- Double click on the CD ROM Drive to open the window & display the files.
- 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.

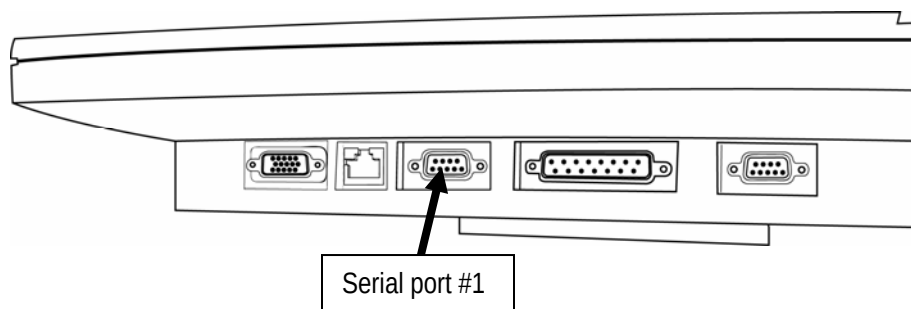
Remove the CD ROM from the computer drive.

#### From an e-mail attachment

- Right click on the e-mail attachment. From the pop-up dialog box select Save As.
- Browse to your desktop and click Save.
- The files should appear on the desktop.

### 2. Connect the AVEA

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



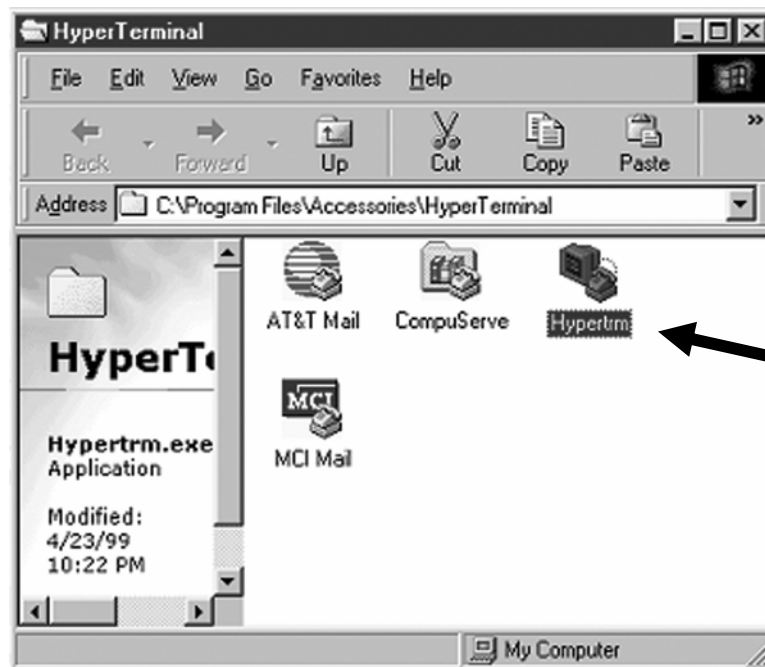
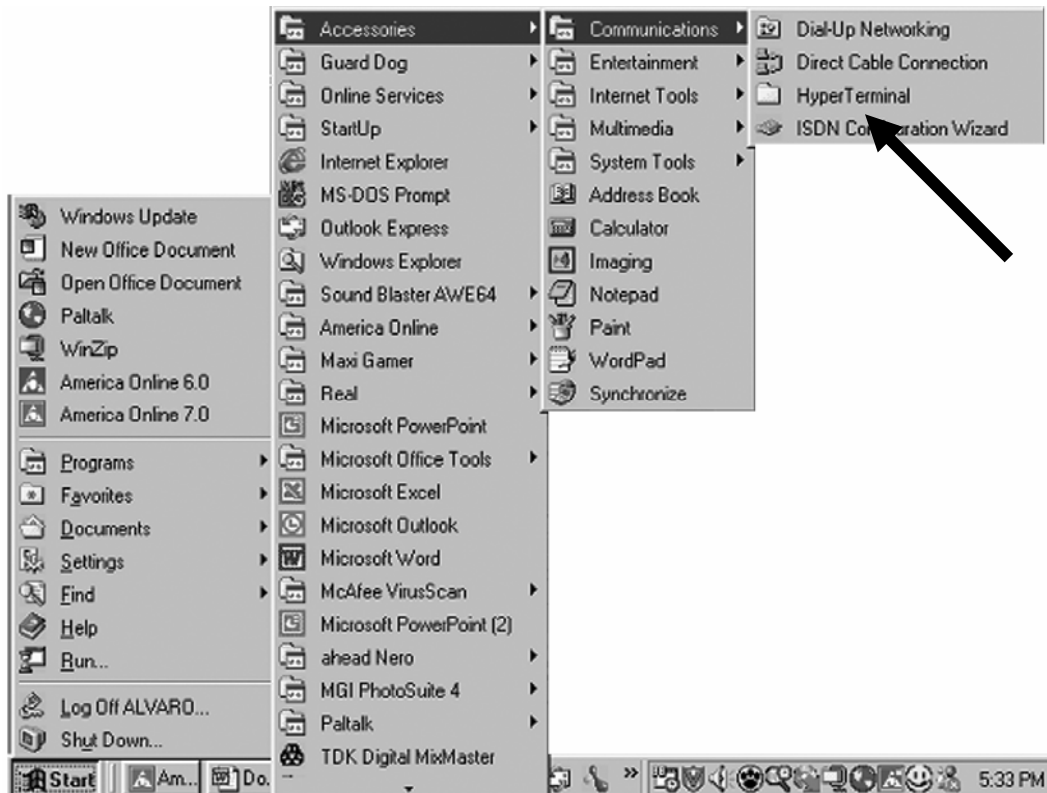
### 3. Open terminal emulation software (*HyperTerminal is used here*)

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

From your desktop, click on the START button at the lower left of the screen.

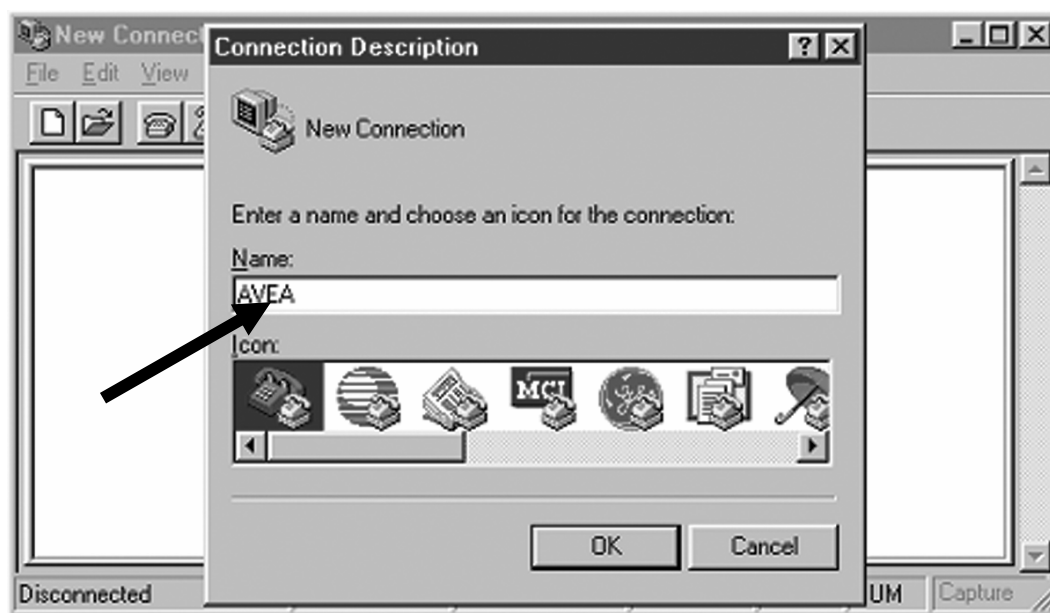
From the pop-up menu, select Programs, then Accessories, then Communications. When the Communications pop-up appears, click on Hyper Terminal.





Double-click the HyperTerminal icon inside the HyperTerminal folder.

The HyperTerminal window opens in the New Connection window.

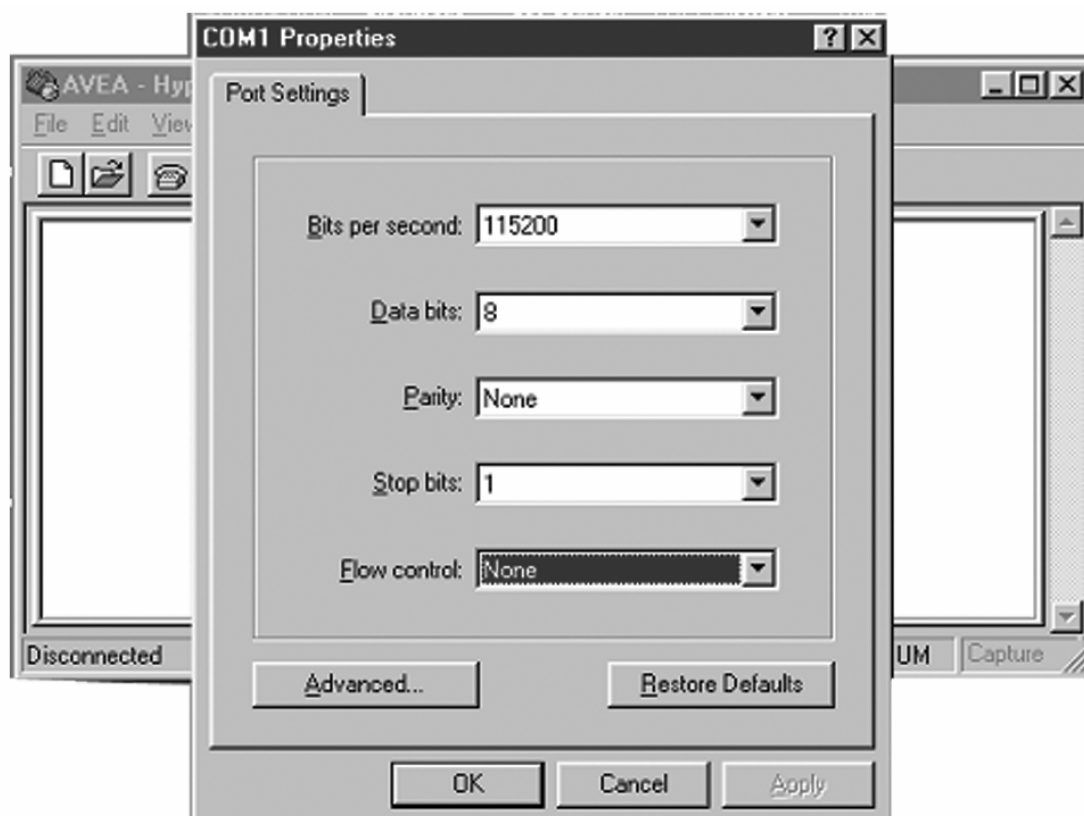


Type AVEA into the Name bar and click OK.

The Connectivity window opens



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

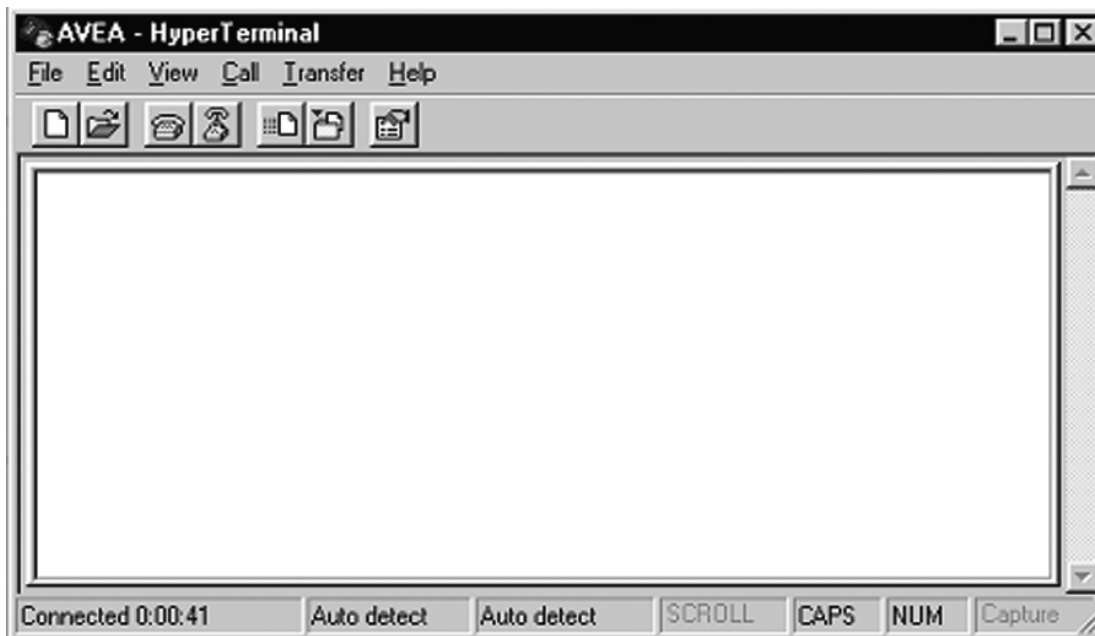


Enter the following values:

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

Click OK

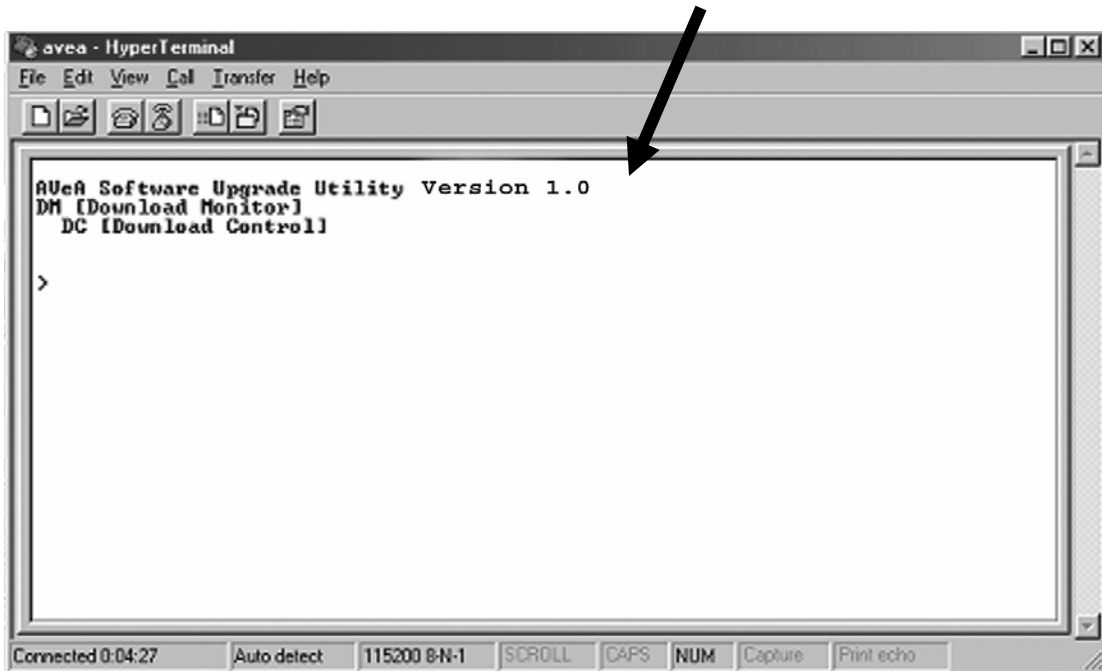
The AVEA HyperTerminal window opens.



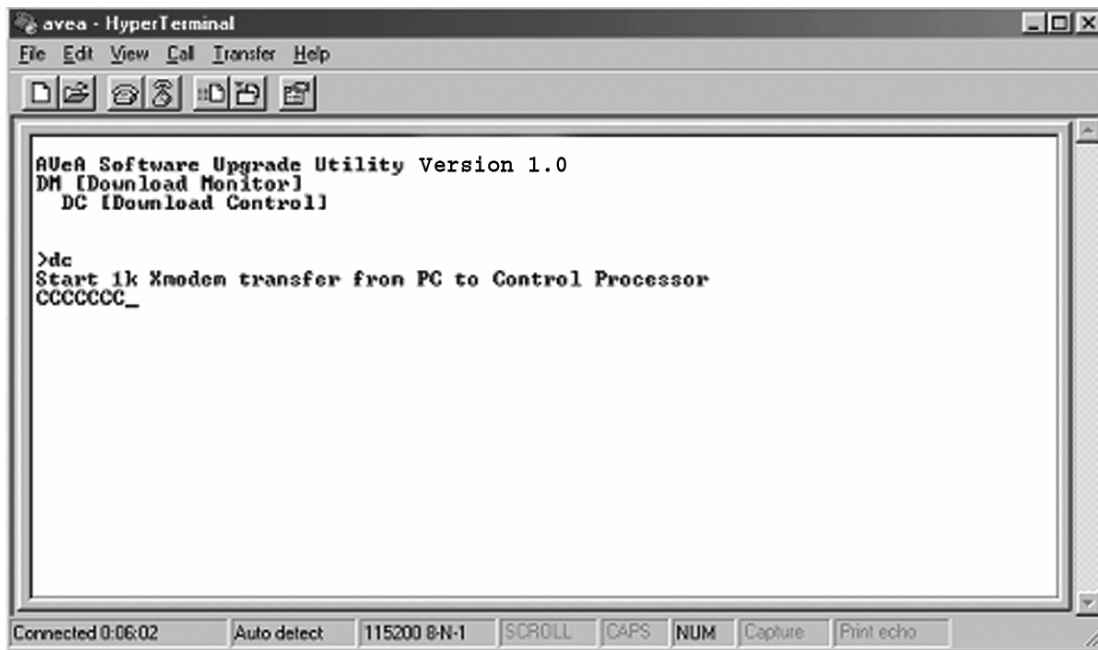
## 4. Power up the AVEA

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.



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



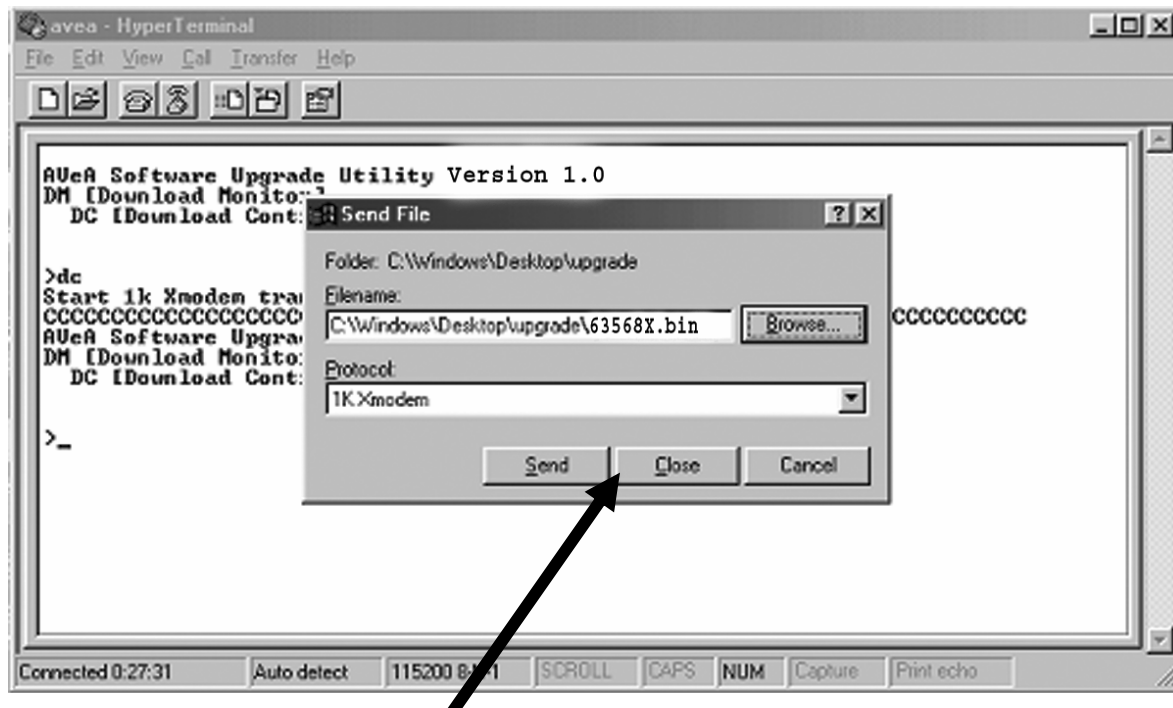
Type DC at the command prompt > and press ENTER to start the download for the Ventilator Control software.

From the Transfer menu, select Send File

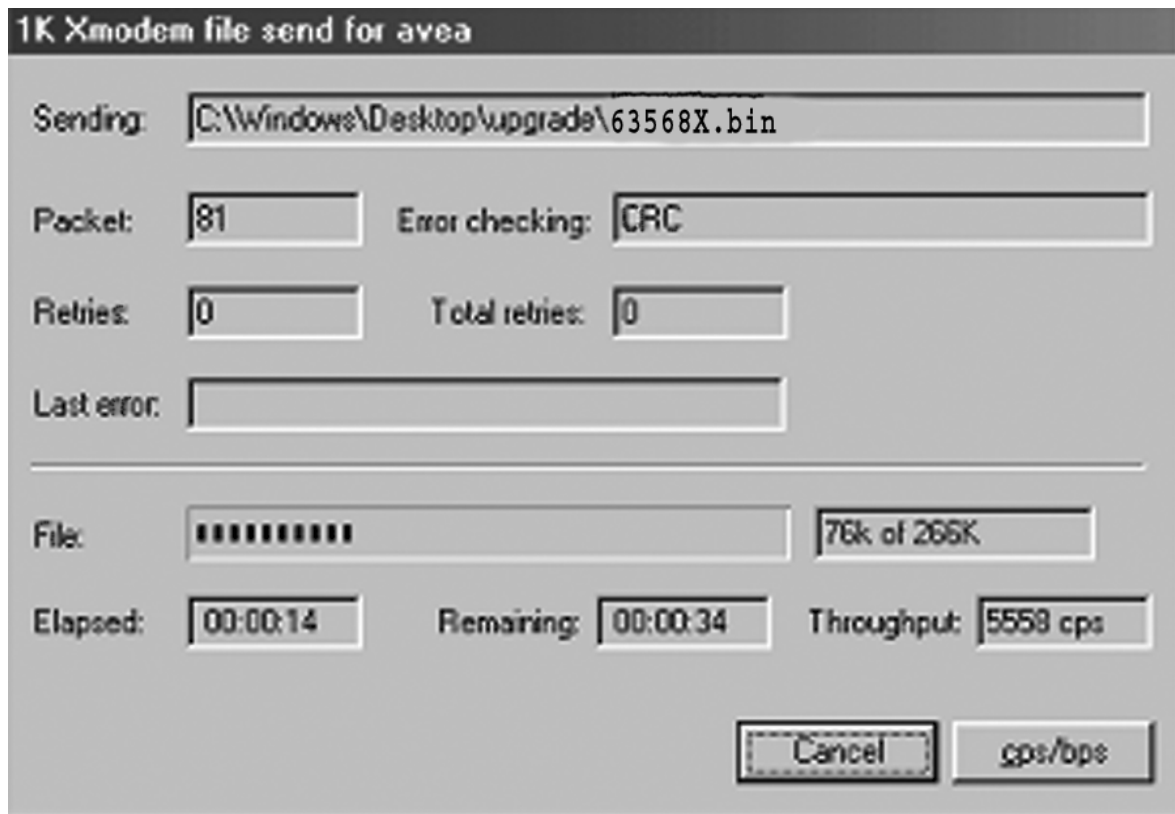
Ensure the protocol is set to "1K XMODEM".

Click Browse and navigate to the desktop where you saved the binary files.

Select the Control file to transfer (e.g. 63568X, bin) and click Send.



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



**1K Xmodem file send for aveva**

Sending:

Packet:  Error checking:

Retries:  Total retries:

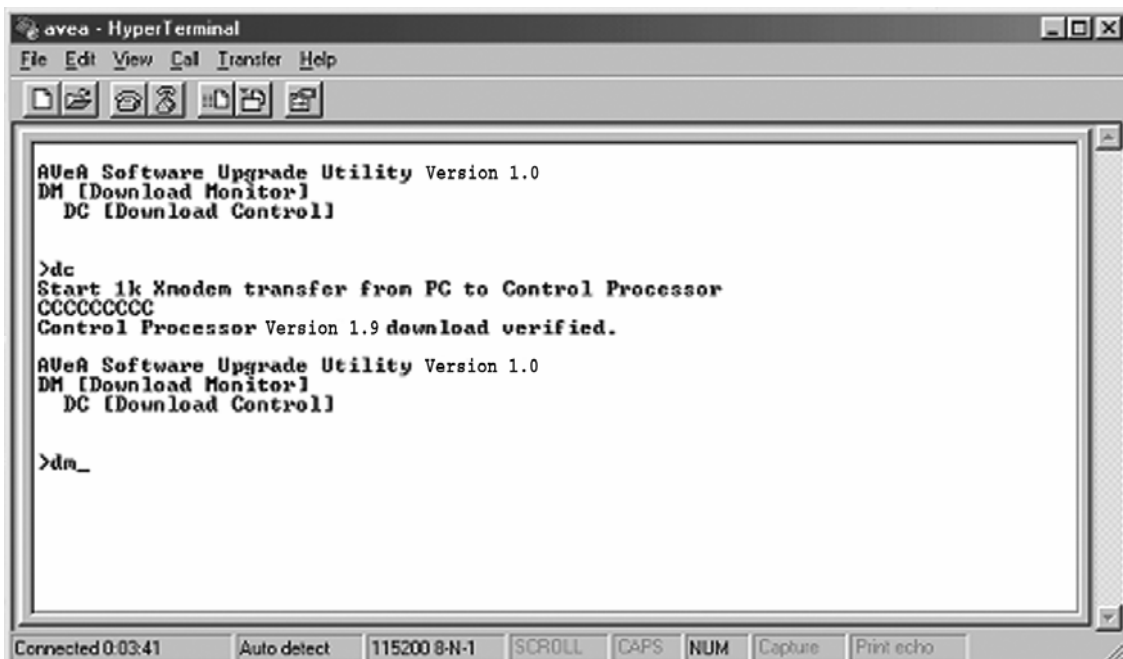
Last error:

---

File:

Elapsed:  Remaining:  Throughput:

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



```

aveva - HyperTerminal
File Edit View Cal Transfer Help

AVEA Software Upgrade Utility Version 1.0
DM [Download Monitor]
DC [Download Control]

>dc
Start 1k Xmodem transfer from PC to Control Processor
CCCCCCCC
Control Processor Version 1.9 download verified.

AVEA Software Upgrade Utility Version 1.0
DM [Download Monitor]
DC [Download Control]

>dm_
    
```

Connected 0:03:41   Auto detect   115200 8-N-1   SCROLL   CAPS   NUM   Capture   Print echo

Repeat the process by typing DM at the command prompt and pressing RETURN to start the download for the Ventilator Monitoring software.

Select the SendFile command from the Transfer menu

Ensure the protocol is set to "1K XMODEM".

Select the Monitor file (e.g. 635X.bin) as the file to send for the monitor program.

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:

VIASYS Respiratory Care Division

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.
  - A. The standard AVEA alarm sound during normal power up.
  - B. That the version as labeled on the CD briefly flashes on the bottom of the UIM.
  - C. The RED vent inop indication appears in the upper right hand of the UIM.
  - D. Warning Default Screen appears, Press Continue.
  - E. 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.
  - A. The current version of software briefly flashes on the bottom of the UIM.
  - B. The SERVICE FUNCTION screen appears.
  - C. The vent inop alarm appears in YELLOW.
  - D. 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:
  - A. OVP screen appears
  - B. All alarms are silenced
7. Perform screen calibration (see page7-1\_)

## Test and Access of the Security System

### ***Note:***

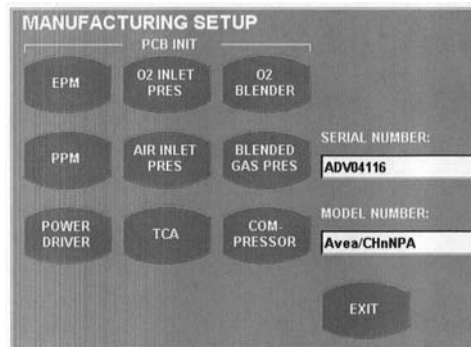
---

*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 Viasys Technical Support Specialist.*

---

1. Access the SERVICE FUNCTION screen as described above and verify the following
  - A. Press the MFG SETUP icon
  - B. Verify that the serial number as displayed matches the serial number on the back of the unit.
  - C. 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 VIASYS Technical Support for Security Codes
  - A. Dial (800) 328-4139. Follow prompts.
  - B. Give the following details to the Technical Support Person
    1. The facility Name.
    2. The S/N of the Unit and UIM.
    3. 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:
  - A. That the MANUFACTURING SETUP screen appears.



- B. That the MODEL NUMBER reads INVALID.
- C. Press the MODEL NUMBER window.
- D. Enter Model Number PASSWORD and ensure the MODEL NUMBER window now indicates the configuration of the unit.
- E. SERIAL NUMBER matches serial tag on pneumatic module. If the serial number does not match contact a Viasys Technical Support Specialist.
- F. 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..*

---

**PCB INIT**  
 DEVICE NAME: EPM  
 DEVICE TYPE: PCB ASSEMBLY  
 REVISION:   
 PART #:   
 LOT #:   
 MFG DATE:  
 Month: 12 Day: 31 Year: 2099  
 CANCEL ACCEPT

### Note:

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

1. At the MFG SETUP screen press EXIT
2. On the Service Functions screen, press CALIBRATE, enter the PASSWORD, and press ACCEPT.

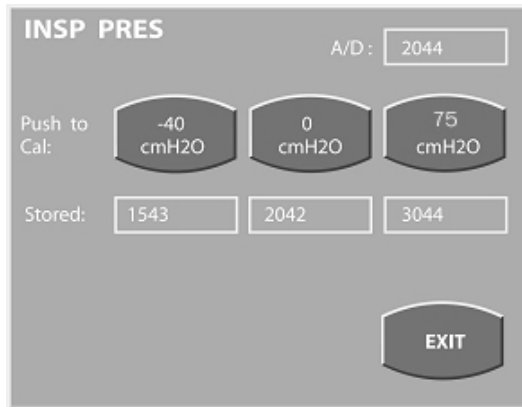
**SERVICE FUNCTIONS**  
 MFG SETUP CALIBRATE  
 OVP MANUAL CONTROL  
 TUNING ERROR LOG  
 Cycle power to exit

**SERVICE FUNCTIONS**  
 SERIAL NUMBER: AEV01588  
 PASSWORD:   
 0 1 2 3 4 5 6 7  
 8 9 A B C D E F  
 <  
 Cancel Accept  
 Cycle power to exit

### 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.*

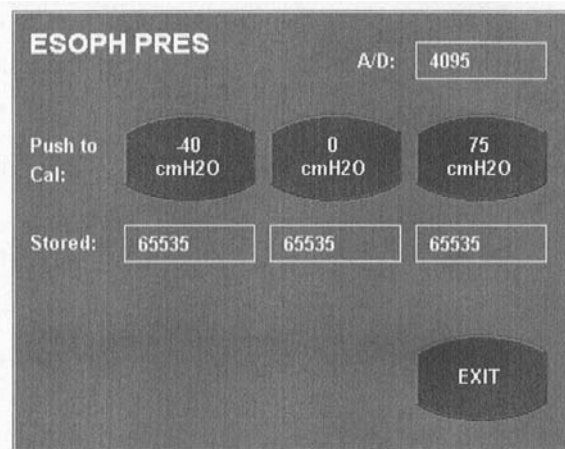
- Press the INSP PRES icon and verify that the stored and A/D information is in the thousands range (EXAMPLE) A/D 2000, Stored: 1500, 2000, 2900 and the message INVALID CALIBRATION does not appear.



### **Note:**

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

- Press EXIT and then Press ESOPH PRES.
- 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.



**INVALID CALIBRATION**

- 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

## Note

---

*Service screens should be accessed without engineering direction.*

---

*Prior to calibration, warm the unit for 30 minutes.*

---

*It is important to note that the Screen Calibration MUST be performed any time the instrument's device configuration is changed, new software is installed or if the flash memory is erased.*

---

*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.*

---

*The screen calibration will be lost under the following circumstances:*

---

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

## Screen Calibration Procedure

### WARNING

Service functions should always be done off patient.

## Equipment Needed

PDA Stylus or similar dull pointed instrument.

## Procedure

Upload ventilator with software Version 3.0 or greater.

Plug the AVEA under test into a suitable AC power source and depress the setup key while powering up the unit.

Select OVP in the Service Functions screen (fig1).



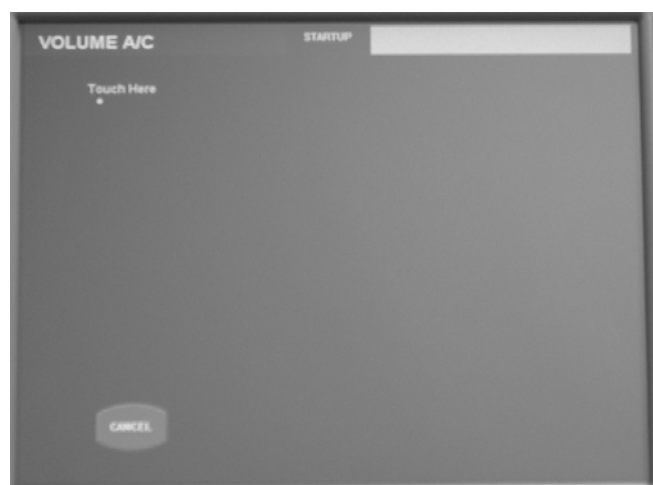
**Figure 7-1 Service Functions Screen**

Select Touch Screen Calibration button and follow the instructions on the screen. You will be prompted to touch points on the upper left, lower right, and middle of the touch screen with the stylus (see figures 3A-C). using a stylus touch on or slightly next to each of these points until prompted to go to the next. **DO NOT USE YOUR FINGER FOR THIS PROCEDURE.** The screen will automatically go back to OVP when complete.

To insure greatest touch screen accuracy, always perform the calibration procedure twice.



**Figure 7-2 OVP Screen**



**Figure 7-3 Upper Left Touch Point**





**Figure 7-4 Lower Right Touch Point**



**Figure 7-5 Center Touch Point**

Power on unit and perform the Manual Alarms Testing section of the AVEA OVP (L2274) to insure accuracy. TO VERIFY SCREEN CALIBRATION, REPEAT THE CALIBRATION PROCEDURE.

## Transducer Calibration

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 not of significance since they are specific to each pressure transducer and will vary with each manufacturer and production lot. Of more significance is that the ventilator and reference/test instruments have been allowed to come to operational temperature (approximately ½ hour) prior to calibration. This will yield the most accurate calibration.

All Pressure Transducers within the AVEA ventilator have been designed with conditioning circuitry that has the proper offset and gains to allow temperature & time drift of characteristics within the specified operating life of the ventilator. In addition, using software to calculate pressure transducers coefficients at the required calibration intervals, compensates for the drift effects over the life of the ventilator.

If the ventilator is operating within the published specifications and no error codes are being generated, the specific A/D counts for particular pressure transducers are not of significance.

## Equipment Required

The following list of parts & tools is recommended for calibrating the AVEA.

| 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 7.7 is recommended for calibrating the low-pressure ports of the AVEA.

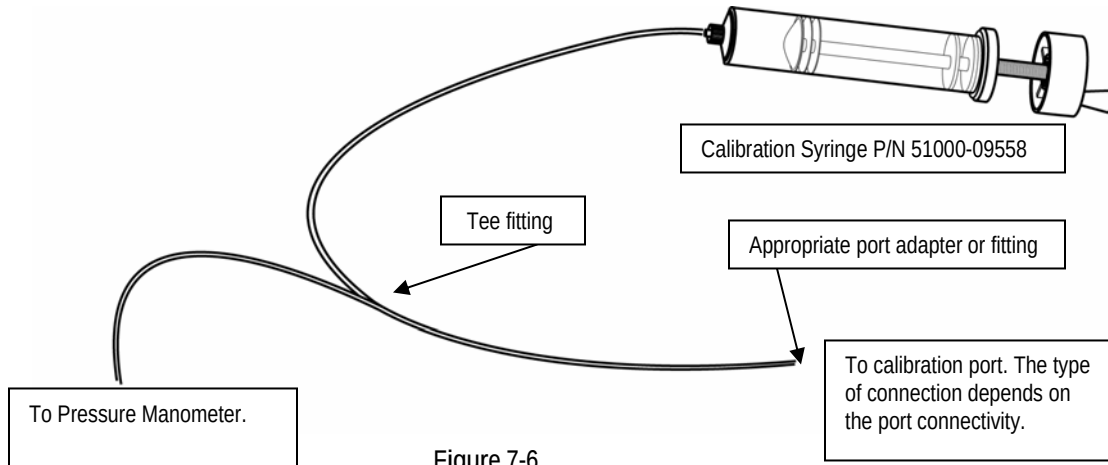


Figure 7-6  
Figure 7-7 Calibration setup #1 for low-pressure gases

### 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.*

## Accessing the Calibration Screen

To access the calibration:

1. When the Service Functions screen appears (see figure 7.8), press Calibrate.
2. The Calibration menu screen will appear (see figure 7.9).

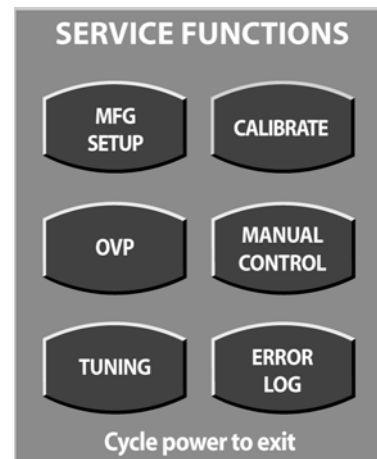


Figure 7-8 Service Functions Screen

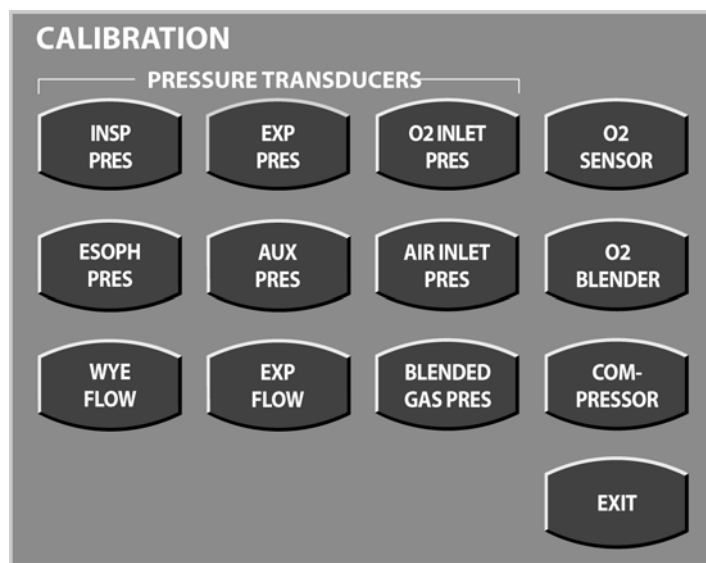


Figure 7-9 Calibration Menu Screen

## Inspiratory Pressure Calibration

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

1. From the Calibration screen menu, press INSP PRES to access the inspiratory pressure transducer calibration screen. See figure 7.10

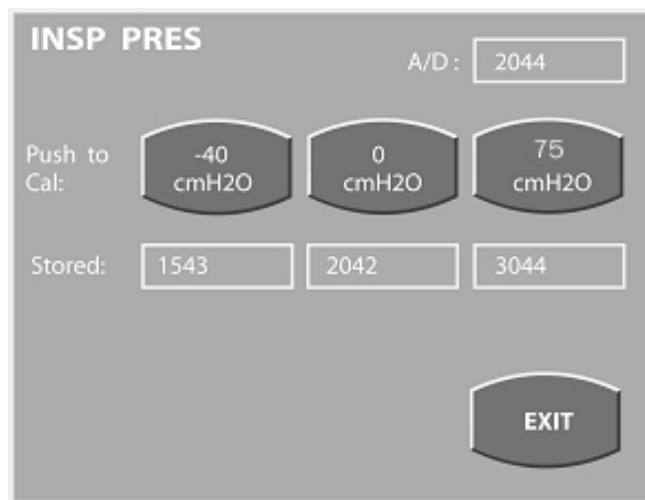


Figure 7-10 Inspiratory pressure transducer calibration screen

2. Disconnect the Luer fitting and tube from port E4 on the gas delivery engine. See figure 7.11. and tubing diagram in appendix B.

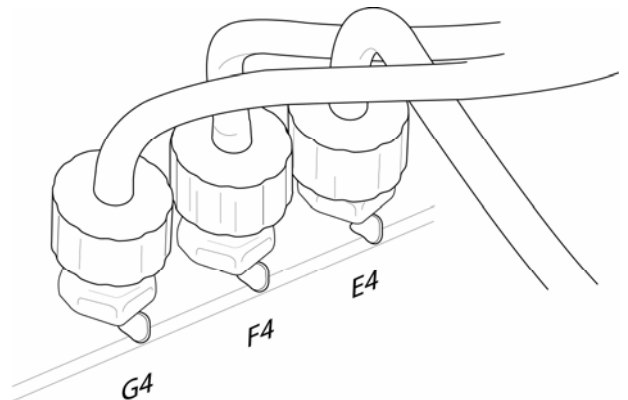
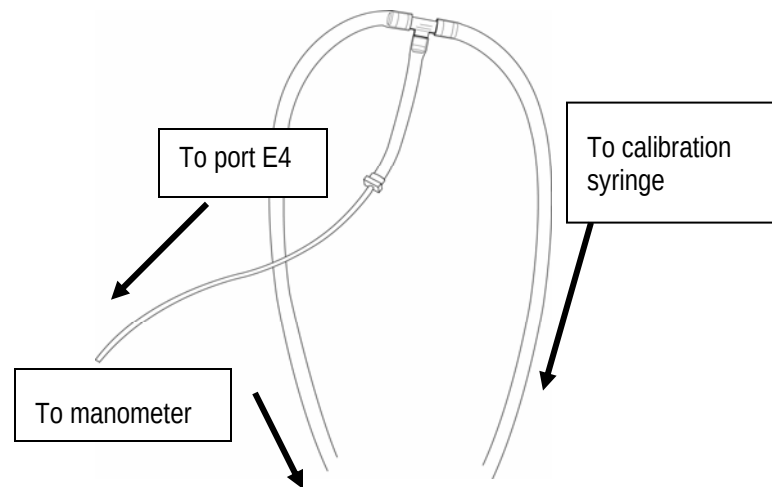


Figure 7-11 Port E4

3. With NOTHING attached to the port, press the Zero (0) calibration button on the touch screen.
4. Attach the calibration assembly shown here to port E4 on the gas delivery engine. To do this attach a length of tube with the appropriate Luer fitting to the Luer receptacle at E4 and connect to the calibration assembly setup using a barbed "T" fitting.

5. Using the calibration syringe P/N 51000-09558; 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 made by Time Meter, recommended). When the correct reading of – 40 cmsH<sub>2</sub>O 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<sub>2</sub>O number on the touch screen then press the corresponding button.
8. Press EXIT to exit.
9. Disconnect calibration set-up from E4.
10. Reconnect the Luer fitting and tube into port E4 on gas delivery engine.



**Figure 7-12    Figure 7.6**

## *Esophageal Pressure Calibration*

1. From the Calibration screen menu, press ESOPH PRES to access the esoph pressure transducer calibration screen. See figure \_\_\_\_\_
2. With NOTHING attached to the port, press Zero (0) calibration icon on the touch screen.
3. Attach the calibration assembly to the esoph port on the front of the unit.
4. Using the calibration syringe P/N 51000-09558, slowly apply negative pressure to –40 cmH<sub>2</sub>O (turn counter-clockwise for negative pressure).
5. Refer to the reading on the calibrated pressure manometer ( RT-200). When the correct reading of –40 cmH<sub>2</sub>O is obtained, press the corresponding icon.
6. For positive pressure, turn the syringe handle clock-wise until a reading of 75 cmH<sub>2</sub>O is obtained, press the corresponding icon.
7. Press EXIT.

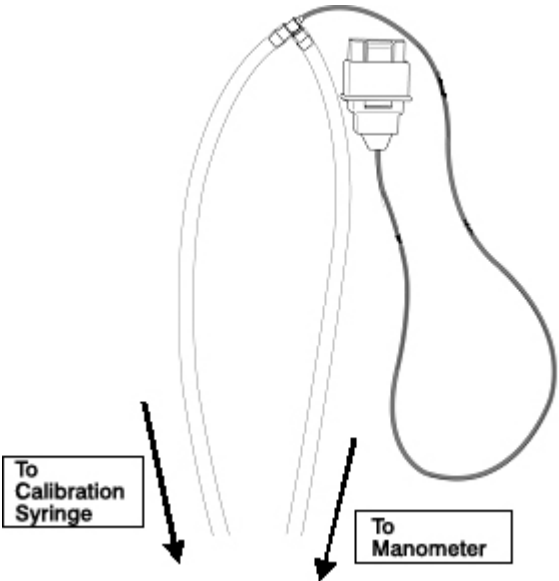
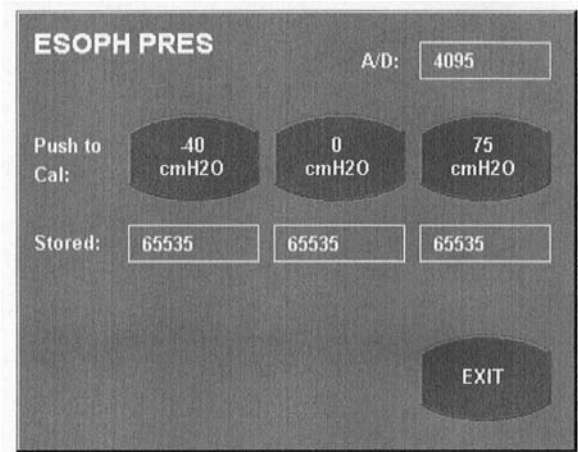


Figure 7-13

## Wye Flow Sensor

1. From the Calibration Screen, press WYE FLOW to access the Wye Flow sensor calibration screen. See figure 7.14.
2. With no sensor attached, press the zero (0 cmH<sub>2</sub>O) button for a zero calibration value.

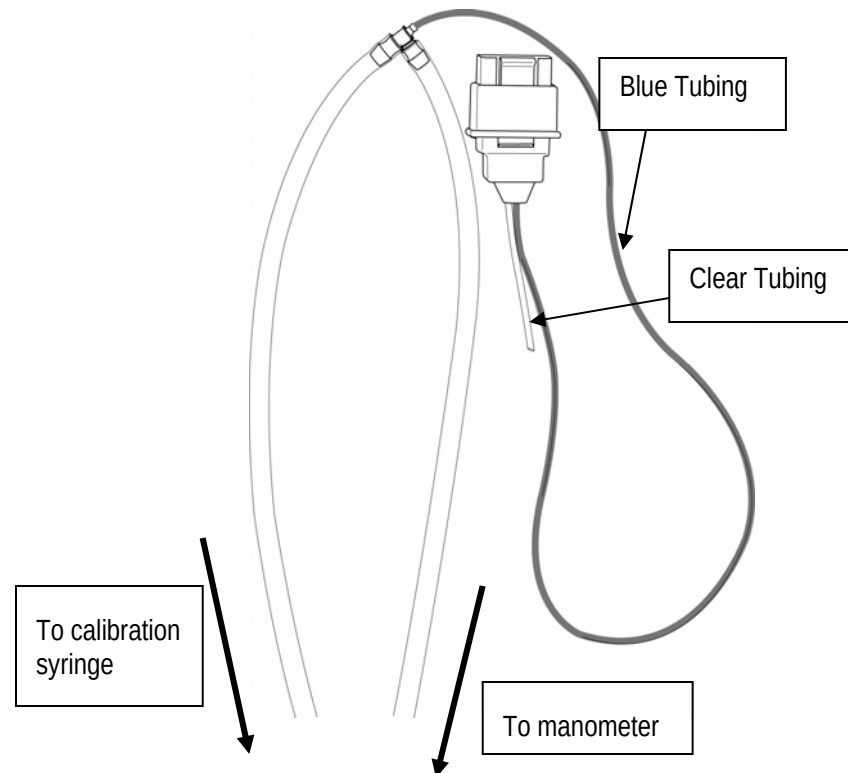


Figure 7-14 Wye flow sensor calibration screen

3. Attach the 51000-40094-sensor connector to 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 -4cmH<sub>2</sub>O for the negative calibration value and plus 4 cmH<sub>2</sub>O for the positive value. Press the appropriate touch screen button when each value is reached to capture and store the value.
5. Exit Wye Flow Sensor screen.



## WARNING

DO NOT APPLY MORE THAN 10cmH<sub>2</sub>O TO THIS PORT. Excessive pressure will damage the AVEA. If this occurs immediately contact Technical Support for instructions.

## Expiratory Pressure

1. From the Calibration Screen, press EXP PRES to access the calibration screen. See figure 7.15.
2. Remove internal expiratory flow sensor.
3. With no sensor attached, press the zero (0 cmH<sub>2</sub>O) button for a zero calibration value.

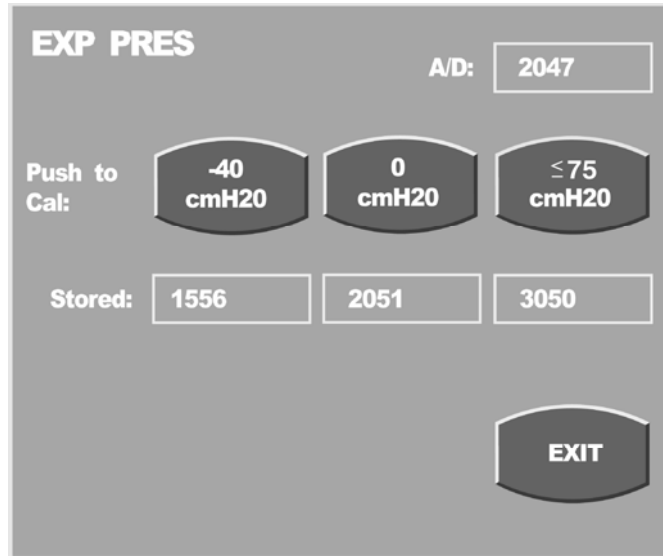
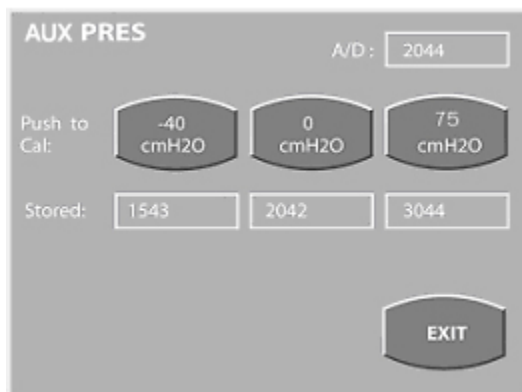
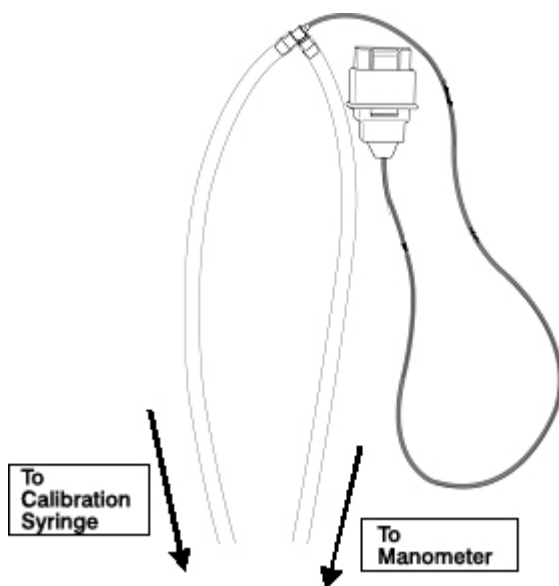


Figure 7-15 Expiratory Pressure calibration screen

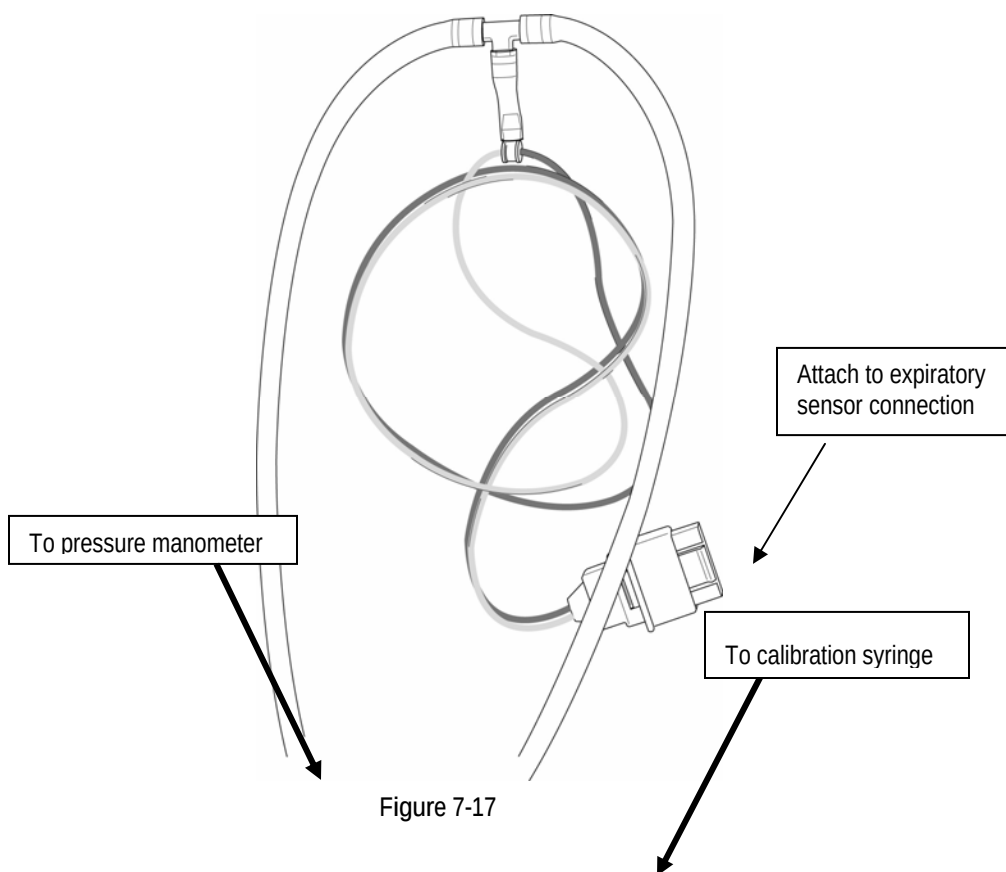
4. From the Calibration screen menu, press AUX PRES to access the aux pressure transducer calibration screen. See figure
5. With NOTHING attached to the port, press Zero (0) calibration icon on the touch screen.
6. Attach the calibration assembly to the aux port on the front of the unit.
7. Using the calibration syringe P/N 51000-09558, slowly apply negative pressure to –40 cmH<sub>2</sub>O (turn counter-clockwise for negative pressure).
8. Refer to the reading on the calibrated pressure manometer (RT-200). When the correct reading of –40 cmH<sub>2</sub>O is obtained, press the corresponding icon.
9. For positive pressure, turn the syringe handle clock-wise until a reading of 75 cmH<sub>2</sub>O is obtained, press the corresponding icon.
10. Press EXIT.





**Figure 7-16**

11. Attach *both tubes* (blue & clear) of the Expiratory Sensor P/N 51000-40094 to the basic calibration tubing assembly using a barbed "T" fitting as shown here.



**Figure 7-17**

12. Connect the tubing assembly to the internal expiratory sensor port. See figure 7.18 for the sensor connector location.

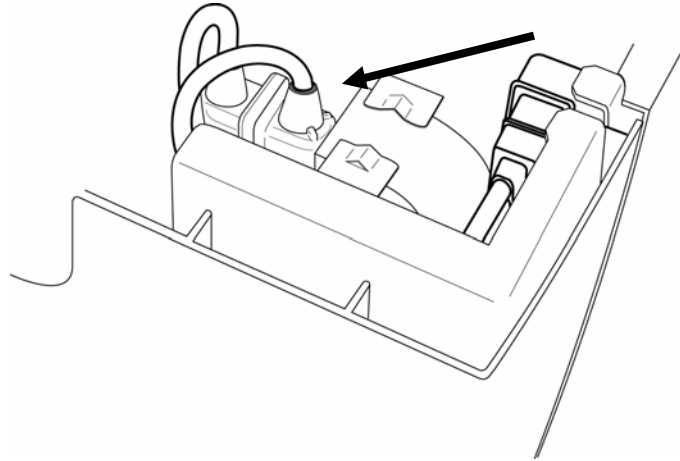


Figure 7-18 Expiratory Sensor connector location

### 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.

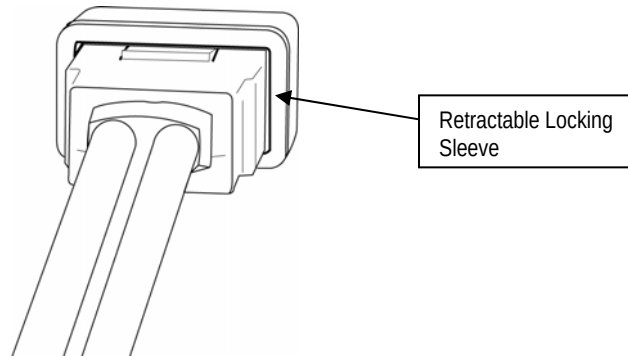


Figure 7-19 Expiratory Sensor Connector

13. Turn the calibration syringe slowly counter clockwise for a negative pressure of  $-40\text{cmH}_2\text{O}$  to establish the negative calibration value and plus  $75\text{cmH}_2\text{O}$  to establish the positive value. Press the appropriate touch screen button when each value is reached to capture and store the calibration.
14. Press EXIT to exit

## Expiratory Flow

1. Press the EXP FLOW touch screen button to access the screen, see figure 7.20.
2. With nothing attached to the ventilator, press the 0 cmH<sub>2</sub>O touch screen button.

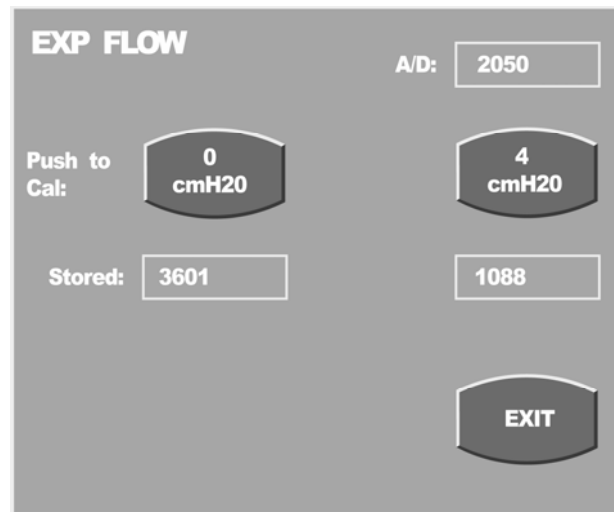


Figure 7-20 Expiratory Flow Calibration Screen

3. Using the same sensor connector and tubing setup as the wye flow calibration, carefully attach the locking sleeved connector to the expiratory flow port as shown in figure 4.11.
4. Turning the calibration syringe clockwise, apply 4-cmH<sub>2</sub>O pos pressure and press the positive pressure touch screen button.

### WARNING

Apply NO MORE THAN 10 cmH<sub>2</sub>O 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 to exit.

## O2 inlet pressure

1. Press O2 INLET PRES from the Calibration screen to access the O2 Inlet pressure calibration screen.
2. With nothing attached to the instrument, press the 0 psig touch screen button.

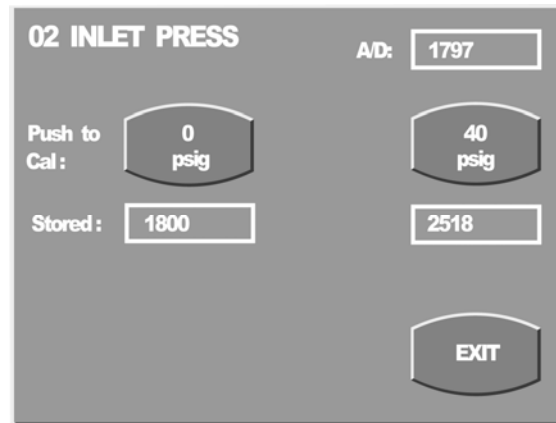


Figure 7-21 O2 Inlet Pressure calibration screen

3. Use a calibrated 0-150 psi regulator and a wall or cylinder supply of medical oxygen.
3. Using a "Y" adapter (see figure 7.22), attach the "Y" adapter shown here to the regulator. A

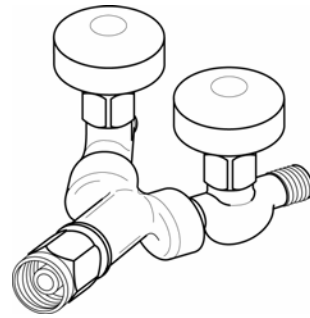


Figure 7-22 "Y" high pressure DISS 1290 adapter

4. Attach one arm of the tubing to the manometer and connect the other (with the correct DISS fitting) to the high pressure O2 inlet on the rear of the instrument shown in figure 7.23.

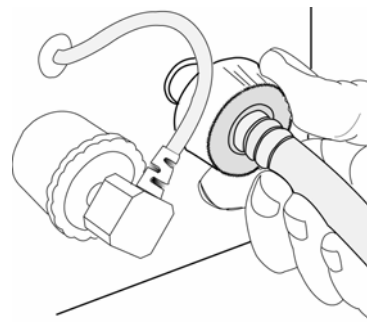


Figure 7-23 O2 hose connection

5. Apply 40psig (2.76 bar) of pressure & press the corresponding touch screen button to calibrate.

## Air inlet Pressure

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.

With nothing connected to the air/blended gas inlet port on the rear of the ventilator, press the 0 psig touch screen button.

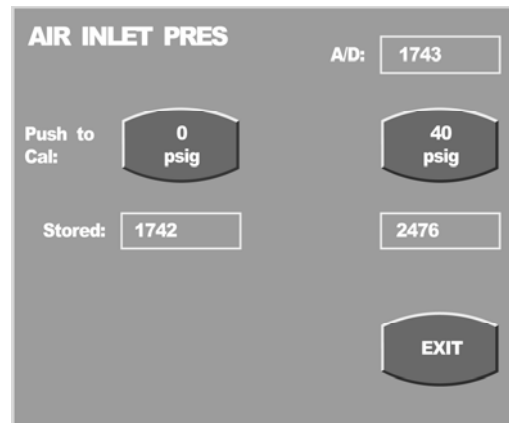
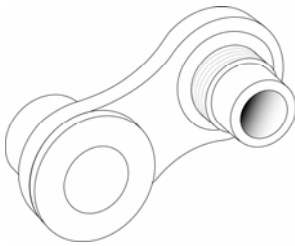


Figure 7-24 Air Inlet Calibration screen

Connect, a wall or cylinder supply of medical grade air through a calibrated 0-150 psi regulator and “Y” adapter P/N to a manometer and to the high-pressure air/heliox inlet on the rear of the ventilator.



Attach the air inlet smart connector to the port on the rear of the ventilator.

Figure 7-26 “Smart” Connector

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.

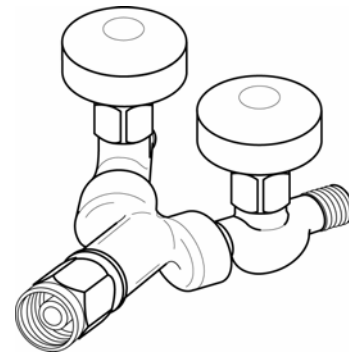


Figure 7-25 “Y” adapter

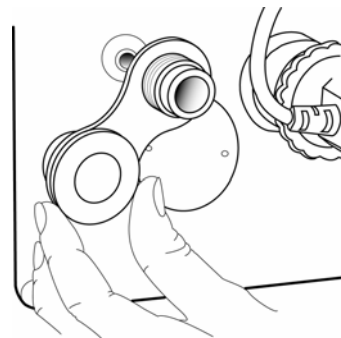


Figure 7-27 Attaching the smart connector

## Blended Gas Pressure

1. Press the BLENDED GAS PRES touch screen button from the Calibration screen to access the blended gas pressure calibration screen.
2. Cut cable tie. Remove metal hose stabilizer.
3. Disconnect compressor output hose.

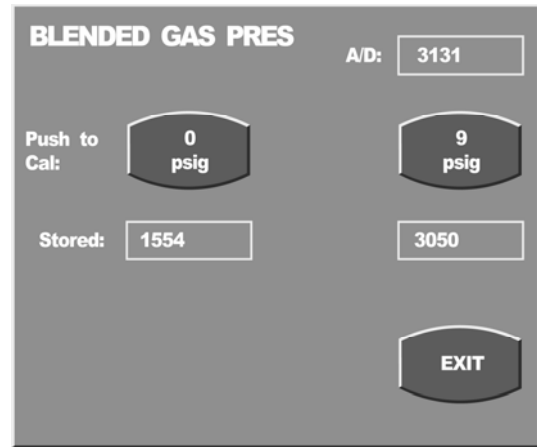


Figure 7-28 Blended Gas Pressure Screen

4. Press 0 psig with nothing connected to the ventilator. Disconnect output tube from the accumulator output to the blender manifold. See figure 7.29.

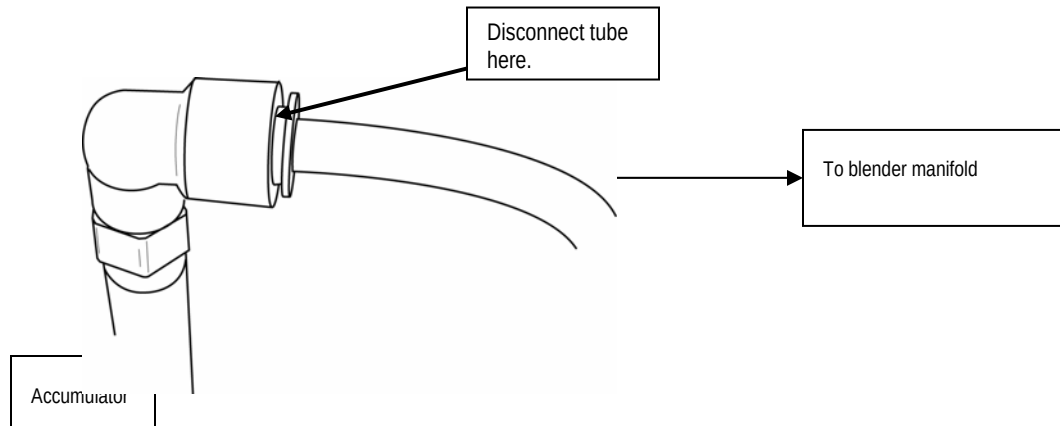
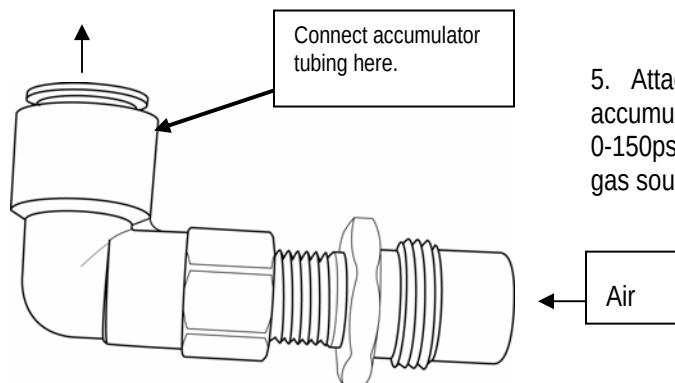


Figure 7-29 Port C2 connection



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

Figure 7-30 Adapter for accumulator tubing.

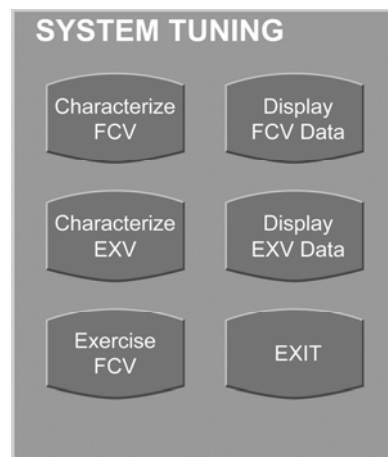
5. Apply 9 psig from the regulator (connected to wall or bottled gas). When the correct reading is obtained on the manometer, press the 9-psig touch screen button.
6. Reconnect and reassemble compressor output hose to blender manifold. Attach metal hose stabilizer. Replace cable tie.
7. Press EXIT to exit.

## Flow and Exhalation valve Characterization/Hysteresis Test

NOTE: ALL CHARACTERIZATIONS MUST BE RUN ON 50PSI WALL AIR TO PASS TESTING.

### Flow Valve Characterization Test

1. On completion of the transducer verification and calibration, press EXIT and return to the SERVICE FUNCTION screen.
2. Connect a patient circuit and test lung.
3. Press the TUNING icon to access the SYSTEM TUNING screen.
4. After entering the password, select EXERCISE FCV icon.
5. Wait at least 10 minutes and then press the CANCEL icon.
6. Disconnect patient circuit and test lung.
7. Press CHARACTERIZE FCV icon and ensure that the message “FCV Characterization in Process” appears in the lower area of the UIM.
8. 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.”



### Note:

*If the message reads FCV Characterization Complete the test has passed successfully. If the message reads failed, recharacterize the FCV will be required. After 3 failed attempts the GDE will require replacement. Contact the Technical Services 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.*

9. Once the FCV Characterization has passed Press Display FCV Data.



10. This data is for reference use only and indicate target flow and final flow determined by the software. Press the continue icon.

| FCV DATA    |            |        |            |
|-------------|------------|--------|------------|
| Target Flow | Final Flow | Counts | Status     |
| 150.0       | 148.16     | 2135   | Pass       |
| 90.0        | 90.29      | 1888   | Pass       |
| 60.0        | 59.69      | 1769   | Pass       |
| 40.0        | 40.31      | 1682   | Pass       |
| 20.0        | 20.12      | 1596   | Pass       |
| 15.0        | 14.99      | 1588   | Pass       |
| 10.0        | 10.00      | 1539   | Pass       |
| 8.0         | 7.99       | 1523   | Pass       |
| 6.0         | 6.00       | 1515   | Pass       |
| 4.8         | 4.81       | 1507   | Pass       |
| 3.8         | 3.78       | 1500   | Pass       |
| 2.8         | 2.78       | 1491   | Pass       |
| 2.2         | 2.19       | 1486   | Pass       |
| 1.6         | 1.62       | 1479   | Pass       |
| 0.8         | 0.80       | 1466   | Pass       |
| 0.4         |            | 1460   | Pass       |
|             |            |        | Mono: Pass |
| CONTINUE    |            |        |            |

## Exhalation Valve Characterization Test

### **Note:**

*For the following test it is required that the complete filter cartridge with filter and jar are install into the unit. Connect calibration tube P/N 10136 from the Inspiratory outlet to the Exhalation inlet.*

1. From the SYSTEM TUNING screen Press the Characterization EXV icon.
2. Ensure that the message EXV Characterization in process appears in the lower area of the UIM.
3. This test will run for 3 -5 minutes and the lower area of the UIM will read EXV Characterization complete or EXV Characterization failed.

### **Note:**

*If the message reads EXV Characterization Complete the test has passed successfully. If the message reads failed recharacterize the EXV. After 3 failed attempts the Exhalation Valve will require replacement(P/N 16319). Exhalation valve is included with this kit.*

4. Once the EXV Characterization has passed Press Display EXV Data.
5. This data is for reference use only and indicate flow and Slope determined by the software. Press the continue icon.
6. Press the EXIT icon.

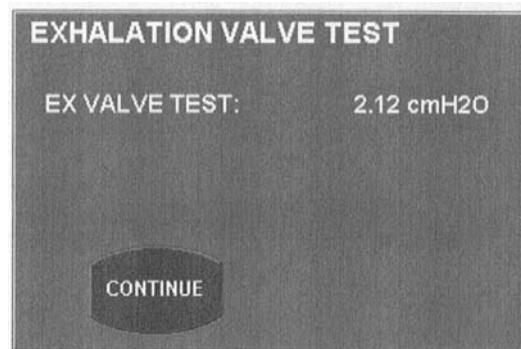
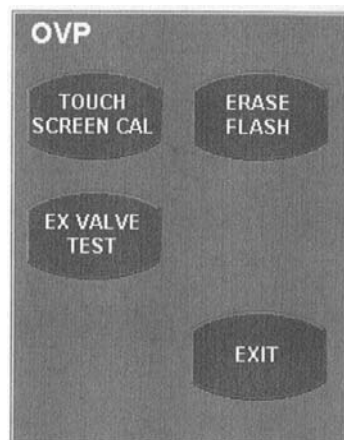
| EXV DATA     |       |           |
|--------------|-------|-----------|
| Flow         | Slope | Intercept |
| 0.4          | 9.560 | 2050      |
| 1.0          | 9.346 | 2037      |
| 2.0          | 8.776 | 2030      |
| 3.0          | 8.627 | 2025      |
| 4.0          | 8.464 | 2023      |
| 5.0          | 8.394 | 2017      |
| Status: Pass |       |           |
| CONTINUE     |       |           |

## Hysteresis Test

### **Note:**

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

1. Press the OVP icon.
2. Press the EX VALVE TEST icon.
3. Press the CONTINUE icon



4. The test may run for up to 5 minutes.
5. The measured hysteresis must be between 1.5 cmH<sub>2</sub>O and 4.5 cmH<sub>2</sub>O.
6. Repeat step 5, 3 times. The maximum variation from any reading shall be 0.6 cmH<sub>2</sub>O

### **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:
  - A. Audible alarm sounds
  - B. SAFETY VALVE OPEN appears in the upper right of the UIM.
  - C. PATIENT SELECT screen appears.
4. Press PATIENT ACCEPT icon and verify the following
  - A. The unit begins to deliver breaths.
  - B. Alarm at the upper right goes to YELLOW.
  - C. CIRCUIT DISCONNECT appears.
5. Press ALARM RESET button.
6. Set the unit as follows:
  - A. Mode Volume A/C Adult
  - B. Breath Rate 4
  - C. PEEP 30
  - D. Volume at 0.50
  - E. Peak Flow at 20
  - F. Press ADV SETTINGS button
  - G. Press Flow Trigger
  - H. Set Bias Flow to .4
  - I. 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. (Refer to illustration below)
9. During the exhalation phase the PEEP level must be stable and +/- 0.1 cmH<sub>2</sub>O through out the expiratory phase



## Chapter 8 Preventive Maintenance

PM kit without compressor P/N 16137

PM kit with compressor P/N 16138

Routine Maintenance Procedures

The following parts are typically replaced on an annual basis:

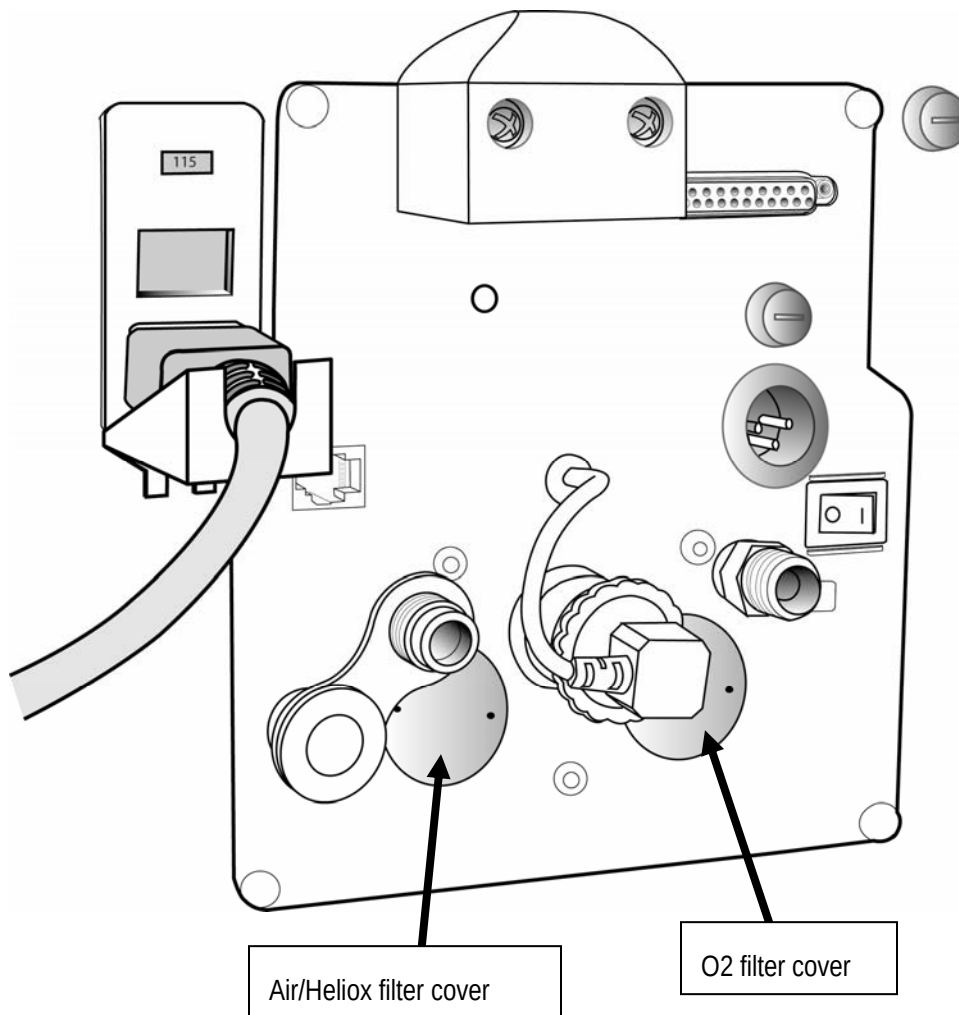
- Air inlet filter
- Oxygen inlet filter
- Compressor inlet filter (if applicable)
- Compressor outlet filter (if applicable)
- Exhalation Diaphragm
- Fan filter

The following service procedures are recommended to be performed annually as well:

1. Remove and replace (items described above)
2. Check Compressor output if applicable
3. Verification testing to confirm the ventilator is functioning within optimum parameters.
4. Screen calibration

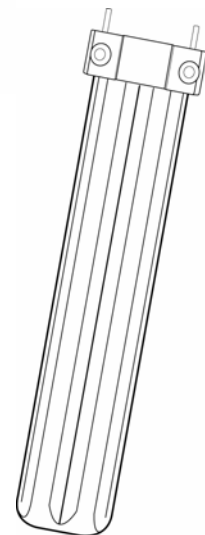
## Replacing the O2 and Air/Heliox filters.

You can access both these gas filters from the rear panel of the ventilator. See figure 8.1 below.



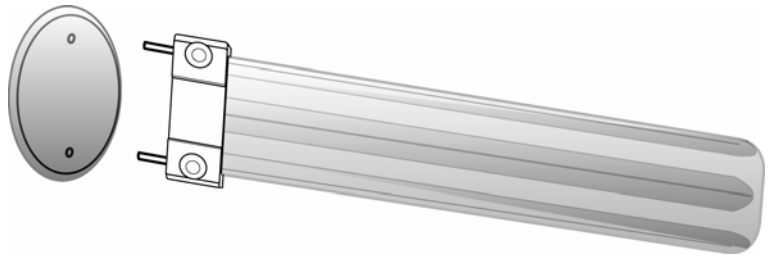
**Figure 8.1 Rear panel**

To remove the O2 & Air/Heliox filter covers, you will need tool number 21735 , Inlet Filter Driver available from Viasys Healthcare Technical Support .

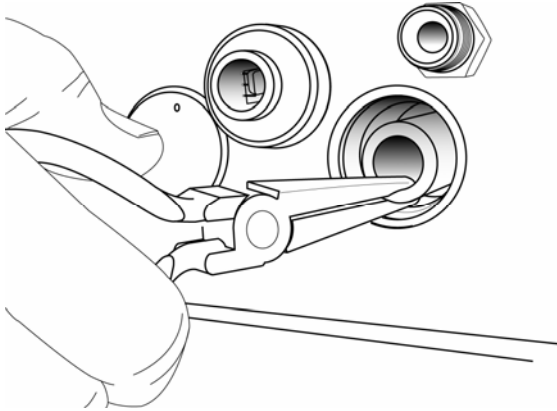


**Figure 8.2 Tool 21735**

Using tool number 21735, unscrew the filter covers to expose the filters.

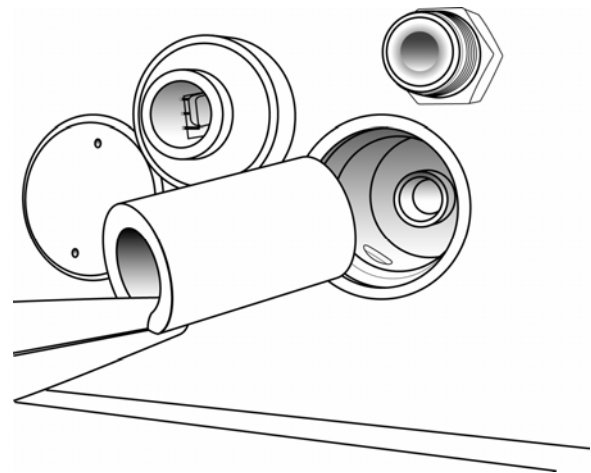


**Figure 8.3 Removing the filter covers**

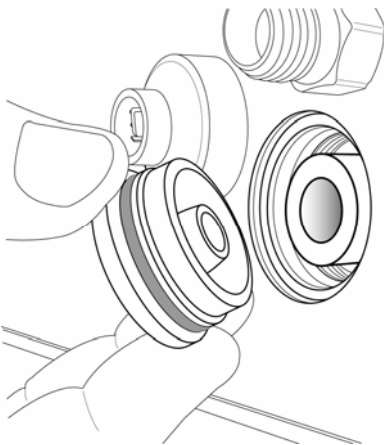


**Figure 8.4 Removing the filter**

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.



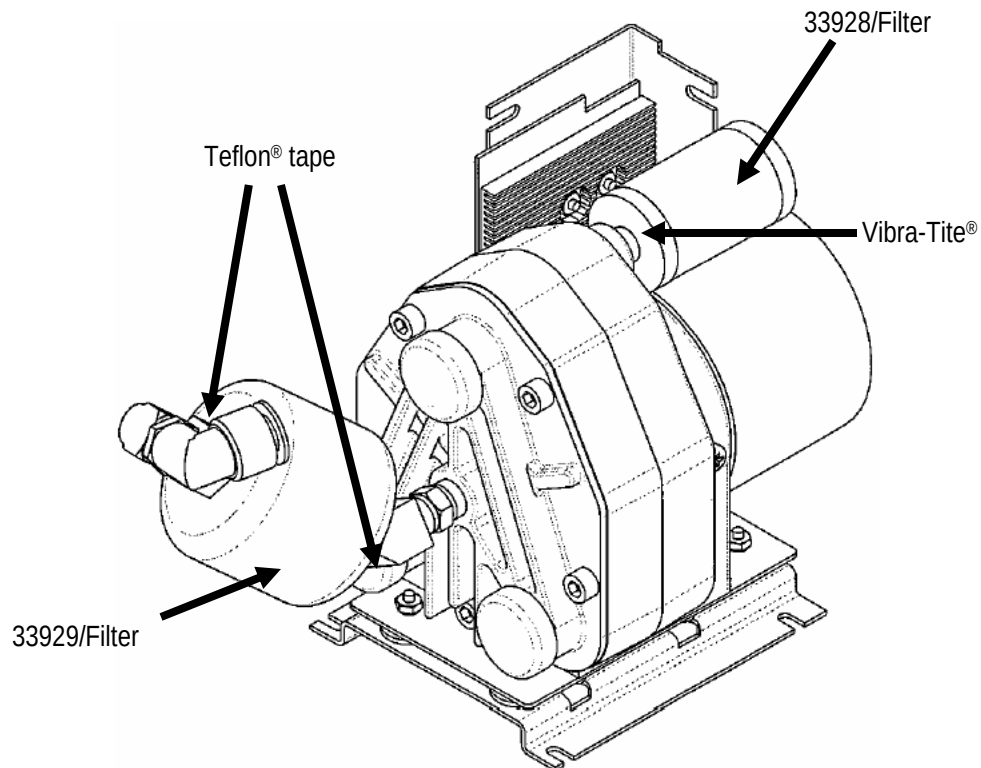
**Figure 8.5 Replacing the filter**



**Figure 8.6 replacing the filter cover**

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

## Replacing the Compressor Inlet & Outlet filters



**Figure 8.7 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 VIASYS Healthcare Critical Care division.

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.

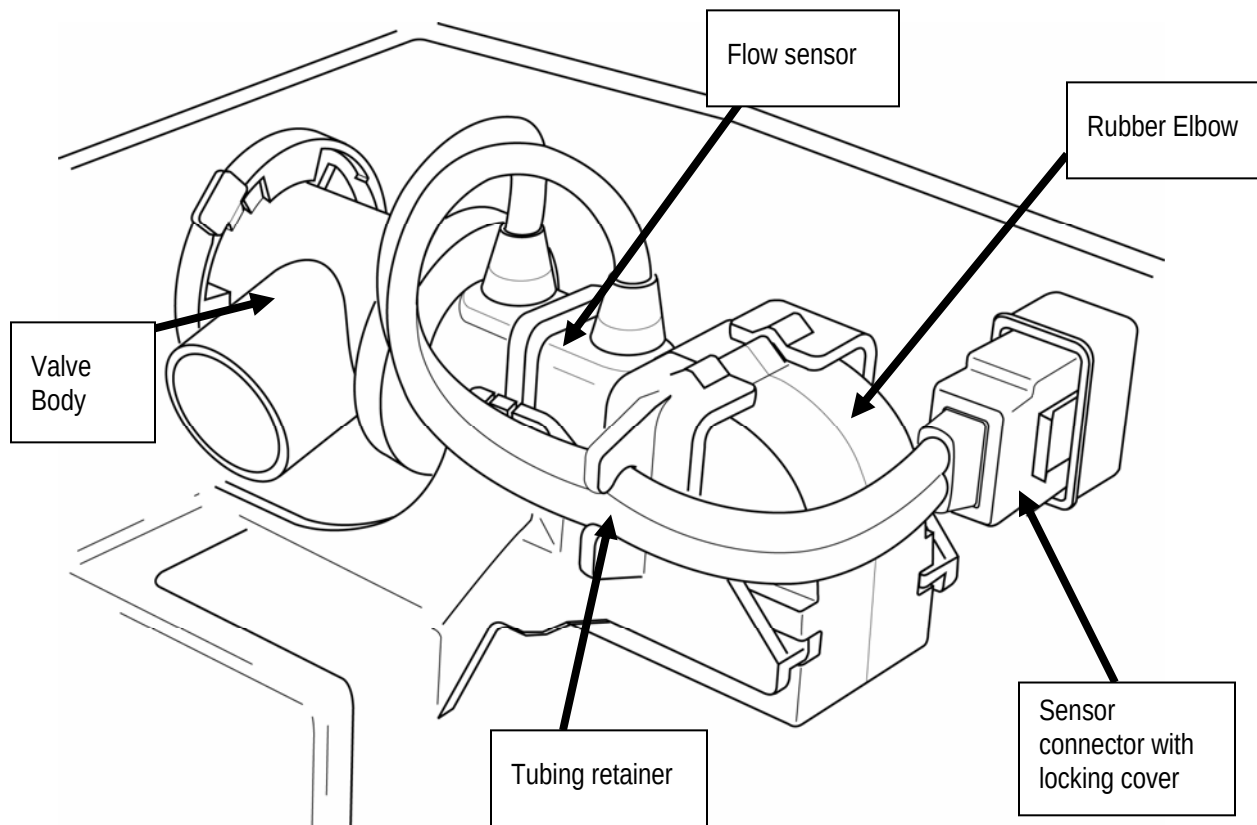


## Replacing the Exhalation Diaphragm P/N 16240

To replace the exhalation valve membrane, first remove the following:

- The UIM
- The top cover
- The exhalation filter/water trap assembly
- The exhalation assembly (corner) cover.

Once the top cover and the exhalation cover have been removed, the exhalation assembly should be accessible (see figure 8.8)

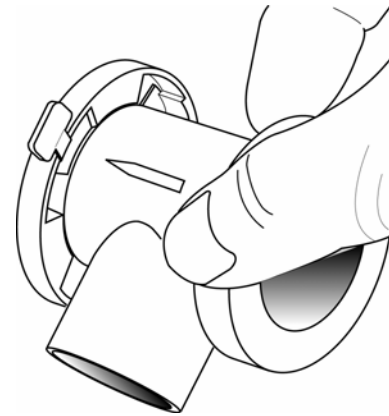


**Figure 8.8 Exhalation assembly**

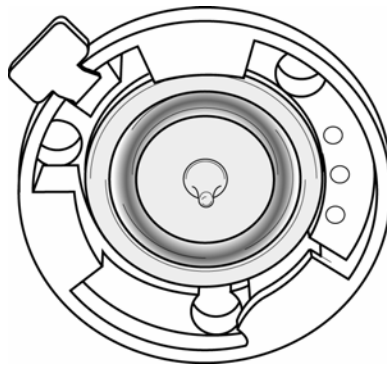
Unplug the sensor connector from the receptacle taking care to retract the locking shroud as you do so. Loosen the tubing from the tubing retainer.

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.

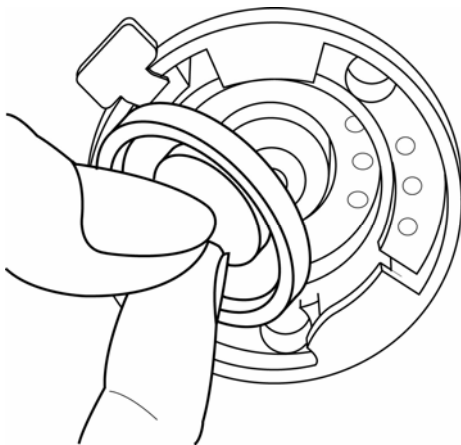
Gently free the flow sensor from the exhalation valve body and pull out towards the front of the AVEA. This will leave the valve body in place.



**Figure 8.9 Disengage valve body**



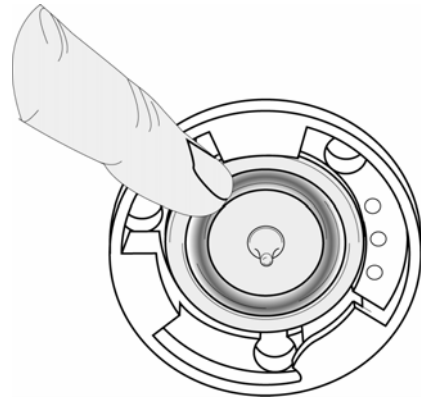
**Figure 8.10 Membrane seated in the valve body.**



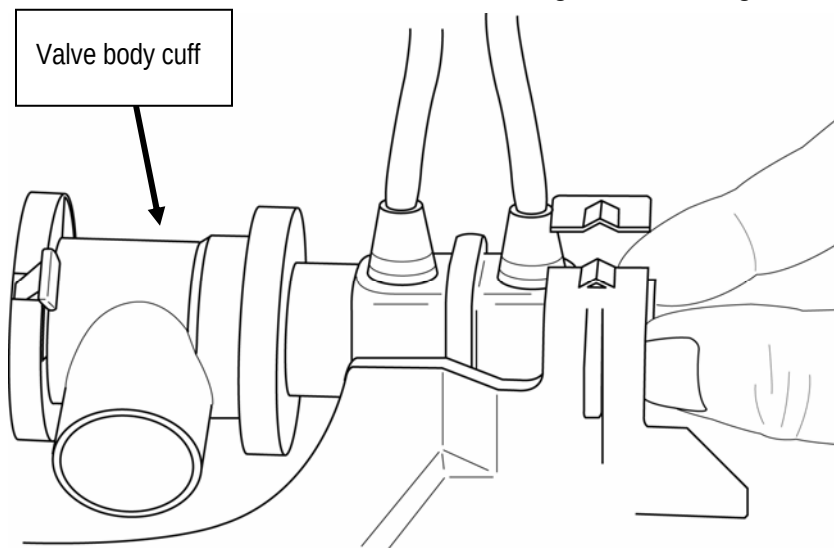
To remove the membrane, grasp the nipple and gently pull away from the valve body.

**Figure 8.11 Removing the membrane**

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



**Figure 8.12 Seating the new membrane**

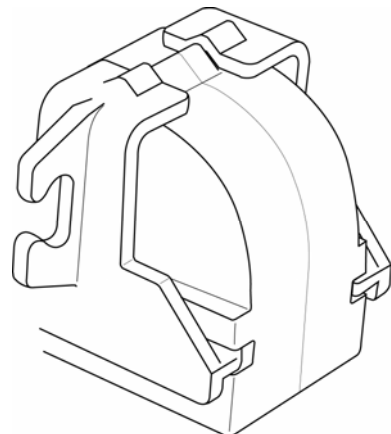


**Figure 8.13 Insert the flow sensor**

Grasp the flow sensor by the smaller diameter orifice and insert into the cuff on the valve body.

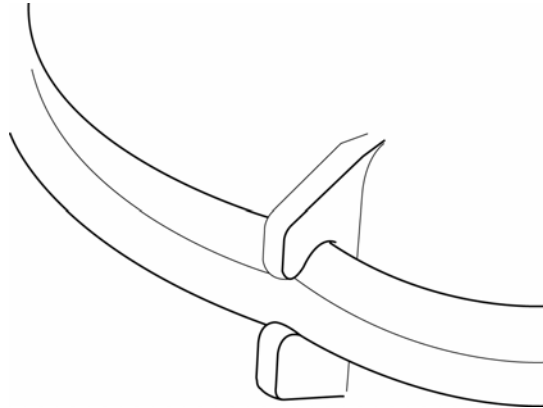
Push the rubber elbow onto the smaller end of the flow sensor taking care to align the groove on each side with the corresponding rail of the molded holder.

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



**Figure 8.14 Align rubber elbow.**

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



**Figure 8.15**

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

## 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 5.1.

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 Bird Products 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 VIASYS Healthcare 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.

| ERROR LOG |       |                         | EXCEPTIONS | EXIT |
|-----------|-------|-------------------------|------------|------|
| 07/02     | 09:20 | Compressor Rotor Locked |            |      |
| 07/02     | 09:20 | Pneumatics Module FTC   |            |      |
| 07/02     | 09:05 | Pneumatics Module FTC   |            |      |
| 07/01     | 09:50 | Compressor Output Low   |            |      |
| 07/01     | 09:50 | Compressor Rotor Locked |            |      |
| 07/01     | 09:50 | Pneumatics Module FTC   |            |      |
| 07/01     | 09:50 | Pneumatics Module FTC   |            |      |
| 07/01     | 09:33 | Bad Cal, FCV            |            |      |
| 07/01     | 09:33 | Pneumatics Module FTC   |            |      |
| 07/01     | 09:32 | Bad Cal, FCV            |            |      |
| 07/01     | 09:21 | Pneumatics Module FTC   |            |      |
| 07/01     | 09:05 | Pneumatics Module FTC   |            |      |
| 07/01     | 08:42 | Exp Temperature Error   |            |      |
| 07/01     | 08:21 | Pneumatics Module FTC   |            |      |
|           |       |                         |            |      |

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.

| EXCEPTION LOG       |                          |
|---------------------|--------------------------|
| Control:            | None                     |
| Monitor: 8/22 12:13 | 1404EA2 Protection Fault |
| CLEAR               | EXIT                     |

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:**

|                         |                          |                     |
|-------------------------|--------------------------|---------------------|
| Pneumatics Module FTC   | Header Error, Compressor | Bad Header, BG PT   |
| HSSC Comm Fault         | Data Error, Compressor   | Trend Data Lost     |
| IFS Voltage Fault       | Bad Cal, Compressor      | Event Log Data Lost |
| TCA A/D Ref Fault       | Invalid Feature, EPM     | Compressor Runtime  |
| IFS A/D Ref Fault       | Header Error, EPM        | Data Error          |
| Compressor Rotor Locked | Data Error, EPM          |                     |
| Compressor Output Low   | Bad Cal, WFS PT          |                     |
| FCV Overcurrent Fault   | Bad Cal, Esoph PT        |                     |
| DPRAM Comm Error, Mntr  | Bad Cal, Aux PT          |                     |
| DPRAM Comm Error, Ctrl  | Bad Sensor Type, HWFS    |                     |
| Data Error, TCA         | Header Error, HWFS       |                     |
| Bad Cal, EFS PT         | Data Error, HWFS         |                     |
| Bad Cal, Insp PT        | Bad ID, HWFS             |                     |
| Bad Cal, Exp PT         | Bad Cal, HWFS            |                     |
| Data Error, Blender     | Header Error, WFS        |                     |
| Bad Cal, Blender        | Data Error, WFS          |                     |
| Data Error, Air Sup PT  | Bad ID, WFS              |                     |
| Bad Cal, Air Sup PT     | Bad Cal, WFS             |                     |
| Data Error, O2 Sup PT   | Settings Lost            |                     |
| Bad Cal, O2 Sup PT      | Config Lost              |                     |
| Data Error, BG PT       | Insp Temperature Error   |                     |
| Bad Cal, BG PT          | Exp Temperature Error    |                     |
| Device Not Found, IFS   | Bad ID, Ctrl PCB         |                     |
| Header Error, IFS       | Header Error, Ctrl PCB   |                     |
| Data Error, IFS         | Bad ID, TCA              |                     |
| Bad ID, IFS             | Header Error, TCA        |                     |
| Bad Cal, IFS            | Bad ID, Power PCB        |                     |
| Device Not Found, EFS   | Header Error, Power PCB  |                     |
| Header Error, EFS       | Bad ID, Blender          |                     |
| Data Error, EFS         | Header Error, Blender    |                     |
| Bad ID, EFS             | Bad ID, Air Supply PT    |                     |
| Bad Cal, EFS            | Header Error, Air Sup PT |                     |
| Bad Cal, FCV            | Bad ID, O2 Supply PT     |                     |
| Bad Model Number        | Header Error, O2 Sup PT  |                     |
| Bad Cal, FiO2           | Bad ID, BG PT            |                     |



Table 9.2: AVEA Mechanical Troubleshooting

**! Remove ventilator from patient with any potential problem**

**! Check error log (and exceptions) with any "Device Error" message on screen**

### 1. Battery/Power Supply

- \* Insure unit is plugged in between patient use.
- \* Refer to service manual for proper battery discharge/charging procedures.
- \* Check all cables/connections and voltages before replacing parts..

| Symptom                                           | Problem                                                                                                                                                                     | Solution(s)                                                                                                                                                                                                   |
|---------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Unit will not power up                            | Blown/incorrect/missing A/C fuse(s)<br>Loose Internal Connection(s)<br>Bad Power Switch<br>Bad Power supply<br>Bad Power Driver PCB<br>UIM problem                          | Check/replace A/C fuses<br>Check all connections<br>Replace Power Switch<br>Replace Power supply<br>Replace Power Driver PCB (GDE)<br>Check UIM cable. Refer to "UIM/Control" section                         |
| No battery indication (LED)                       | Excessively discharged battery state<br>Blown/Missing batt fuse<br>Loose connections<br>Bad Battery PCB<br>Bad LED indicator panel<br>Bad battery<br>Transition Board fault | Charge properly-refer to service manual<br>Check/replace fuse<br>Check connections<br>Replace Battery PCB<br>Replace LED indicator panel<br>Check/replace battery<br>Replace Transition Board                 |
| Will not charge past yellow                       | Excessively discharged battery state<br>Loose connections<br>Bad Battery PCB<br>Bad battery<br>Bad Power Driver PCB                                                         | Charge properly-refer to service manual<br>Check connections<br>Replace Battery PCB<br>Check/replace battery<br>Replace Power Driver PCB (GDE)<br>Cycle battery pack by charging and discharging three times. |
| Decreased run time on battery (internal/external) | Excessively discharged battery state<br>Loose connections<br>Bad Battery PCB<br>Bad battery<br>Bad Power Driver PCB                                                         | Charge properly-refer to service manual<br>Check connections<br>Replace Battery PCB<br>Check/replace battery<br>Replace Power Driver PCB (GDE)<br>Cycle battery pack by charging and discharging three times. |
| Unit wont run on battery (internal/external)      | Blown/missing battery fuse<br>Loose connections<br>Bad battery                                                                                                              | Check/replace fuse<br>Check connections<br>Check/replace battery                                                                                                                                              |

| Symptom                                              | Problem                                                                                                     | Solution(s)                                                                                                            |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
|                                                      | Bad Power PCB                                                                                               | Replace Power PCB (GDE)                                                                                                |
| Unit does not run on A/C                             | Wiring disconnect<br>Defective Power Entry Module<br>Power supply is not recognizing A/C                    | Check all connections-especially by compressor<br>Replace Power Entry Module<br>Replace Power supply                   |
| Excessive battery heat (internal only)               | Battery PCB improperly wired<br>Bad battery PCB<br>Bad thermal fuse<br>Bad battery                          | Check wiring<br>Replace Battery PCB<br>Check/replace battery<br>Check/replace battery                                  |
| Flickering LED                                       | Excessively discharged battery state<br>Loose connections<br>Bad power driver PCB<br>Transition Board fault | Allow to charge-should self-resolve<br>Check connections<br>Replace power driver PCB (GDE)<br>Replace Transition board |
| Alarms when Unit is "off"                            | Excessively discharged battery State<br>Bad LED indicator panel                                             | Allow to charge<br>Replace LED indicator panel                                                                         |
| LED red to green - no yellow (external battery only) | Can occur normally with ext battery charge                                                                  | Perform discharge/recharge cycle                                                                                       |

External battery not detected

System not detecting external battery

Plug unit into A/C. Connect external battery. Then, turn unit on.

## 2. 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.

|                                            |                                                                                                                                                |                                                                                                                                  |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| No compressor function (and no indicator)  | Standard unit - without compressor<br>Bad Air Calibration<br>Bad Blended Gas Calibration<br>Blown fuse on compressor PCB<br>Bad compressor PCB | Option on AVEA 200<br>Check Air Calibration<br>Check Blended gas Calibration<br>Replace compressor PCB<br>Replace compressor PCB |
| No compressor function (indicator present) | Unit is reading air pressure with none present.                                                                                                | Blown Air Pressure Transducer. See Pneumatic troubleshooting                                                                     |
| "Loss of gas" alarms without O2 in use     | Low compressor output<br>Compressor leak<br>Accumulator depletion                                                                              | Check output - replace compressor if necessary<br>Check tubing/connections<br>Check for excessive patient minute                 |

| Symptom                              | Problem                                                           | Solution(s)                                                                                                                  |
|--------------------------------------|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
|                                      |                                                                   | ventilation                                                                                                                  |
| "Loss of air" alarms with O2 in use  | Low compressor output<br>Compressor leak<br>Accumulator depletion | Check output - replace compressor if necessary<br>Check tubing/connections<br>Check for excessive patient minute ventilation |
| Excessive compressor noise/vibration | Incorrect mounting<br>Defective/worn Vibration dampeners          | Insure mounting nuts are present and tightened<br>Replace Vibration dampeners                                                |

### 3. 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

|                                      |                                                                                              |                                                                                                                                      |
|--------------------------------------|----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Erroneous readings from sensor       | Bad Sensor<br>Transducer(s) out of calibration<br>Leak                                       | Change/Replace sensor<br>Recalibrate<br>Check all internal/external connections                                                      |
| No reading from sensor               | Bad sensor (cable/connector)<br>Specified transducer out of cal<br>No communication from EPM | Try different sensor<br>Check error log for specific transducer.<br>Recalibrate<br>Check internal connections. Replace EPM if needed |
| "Device Error" when sensor connected | Bad sensor (cable/connector)<br>Specified transducer out of cal<br>No communication from EPM | Try different sensor<br>Check error log for specific transducer<br>Recalibrate<br>Check internal connections. Replace EPM if needed  |

### 4. Exhalation Valve/Assembly

|                                 |                                                                     |                                                                                                             |
|---------------------------------|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Low measured exhaled volumes    | Internal leak<br>External leak                                      | Re-seat GDE<br>Check all circuit connections<br>Check filter assembly<br>Check/Replace exhalation diaphragm |
| Will not pass EST "leak test"   | Internal leak<br>External leak                                      | Re-seat GDE<br>Check all circuit connections<br>Check filter assembly<br>Check/Replace exhalation diaphragm |
| Valve noise                     | Diaphragm is out of position                                        | Clean/re-seat diaphragm                                                                                     |
| Excessive expiratory resistance | Moisture in Exhalation Filter<br>Clogged/Dirty Exhalation diaphragm | Bypass filter and recheck. Replace if necessary<br>Clean/replace diaphragm                                  |

| Symptom                       | Problem              | Solution(s)   |
|-------------------------------|----------------------|---------------|
| Abnormal expiratory waveforms | Bad expiratory valve | Replace valve |

### 5. Flow Sensors (inc. Wye)

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

### 6. Nebulization System

|                         |                                                                                                                                           |                                                                                                                                                                    |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Nebulizer output absent | Unit running on compressor or flow < 15 L/min<br>Bad Nebulizer Solenoid<br>Transition PCB- bad harness connection<br>Problem on Power PCB | Connect wall air, increase flow (if applicable)<br>Replace Solenoid<br>Replace Transition PCB (if solenoid doesn't fix)*<br>Replace Power PCB (if solenoid doesn't |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Symptom                         | Problem                                                                                                    | Solution(s)                                                                                                               |
|---------------------------------|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
|                                 |                                                                                                            | fix)*                                                                                                                     |
| Nebulizer output reduced/absent | Neb booster output low<br>Kinked tubing externally<br>Kinked tubing internally<br>Bad Neb Booster Solenoid | Adjust Neb booster output<br>Check/replace tubing to nebulizer<br>Check unit for kinks or disconnects<br>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 "\*\*"

## 7. O2 Sensor

|                       |                                                                                              |                                                                                                                                       |
|-----------------------|----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| "***" on FiO2 monitor | FiO2 reading out of upper or lower range                                                     | Run EST with 50 psi oxygen source connected.<br>Recalibrate/replace sensor                                                            |
| O2 reading inaccurate | FiO2 sensor out of calibration<br>Blocked sensor orifice<br>Malfunctioning Blender Assembly. | Run EST with 50 psi oxygen source connected.<br>Recalibrate/replace sensor<br>Insure patency of orifice<br>Replace Blender Assy (GDE) |
| O2 will not read      | Bad O2 sensor<br>Bad O2 sensor cable<br>TCA board problem                                    | Replace sensor<br>Replace sensor cable<br>Replace TCA board (GDE)                                                                     |

## 8. 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.<br>(communications failure) | Bad connections/cable<br>EPROM failure<br>Incorrect calibration | Check connections/replace cable<br>Replace Air PCB-recalibrate<br>Recalibrate |
|                  | Incorrect pressure reading             | Bad Transducer<br>Incorrect calibration                         | Replace Air PCB-recalibrate<br>Recalibrate                                    |
| O2 Pressure PCB  | Vent Inop.<br>(communications failure) | Bad connections/cable<br>EPROM failure<br>Incorrect calibration | Check connections/replace cable<br>Replace O2 PCB-recalibrate                 |

| Component               | Symptom                                | Problem                                                                                   | Solution(s)                                                                                |
|-------------------------|----------------------------------------|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
|                         |                                        |                                                                                           | Recalibrate                                                                                |
|                         | Incorrect pressure reading             | Bad Transducer<br>Incorrect calibration                                                   | Replace 02 PCB<br>Recalibrate                                                              |
| Blended Gas PCB         | Vent Inop.<br>(communications failure) | Bad connections/cable<br>EPROM failure<br>Incorrect calibration                           | Check connections/replace cable<br>Replace Blended Gas PCB-recalibrate<br>Recalibrate      |
|                         | Incorrect pressure reading             | Bad Transducer<br>Incorrect calibration                                                   | Replace Blended Gas PCB-recalibrate<br>Recalibrate                                         |
| Blender                 | Vent Inop.                             | Bad connections/cable<br>EPROM failure<br>Incorrect calibration                           | Check connections/replace cable<br>Replace Blender (GDE)<br>Recalibrate                    |
|                         | FiO2 Inaccuracy                        | Blender Assembly Failure<br>Regulator Relay out of balance<br>Leak                        | Replace Blender (GDE)<br>Recalibrate<br>Regulator Relay<br>Check all pneumatic connections |
| Flow Control Valve      | Inspiratory Noise                      | FCV out of characterization<br>Defective FCV                                              | Re-characterize FCV *<br>Replace FCV (GDE)                                                 |
|                         | Flow Abnormalities                     | FCV out of characterization<br>Defective FCV                                              | Re-characterize FCV *<br>Replace FCV (GDE)                                                 |
| Inspiratory Flow Sensor | Autocycling                            | Leak at FCV/IFS<br>Bad IFS                                                                | Check all connections<br>Replace IFS (GDE)                                                 |
|                         | Incorrect delivery                     | Leak at FCV/IFS<br>Bad IFS                                                                | Check all connections<br>Replace IFS (GDE)                                                 |
|                         | Vent Inop                              | Bad Connection/cable<br>Bad IFS                                                           | Check all connections/replace cable<br>Replace IFS (GDE)                                   |
| Safety Relief Valve     | Breath delivered-no output to patient  | Leak in safety solenoid tubing/connections<br>Bad safety solenoid<br>Problem in TCA board | Check all connections<br>"<br>Replace safety solenoid                                      |

| Component | Symptom                                     | Problem           | Solution(s)                            |
|-----------|---------------------------------------------|-------------------|----------------------------------------|
|           |                                             |                   | Replace TCA (GDE)                      |
|           | Mechanical overpressure release prematurely | Incorrect Setting | Reset overpressure setting * (replace) |

All items marked with an "\*" are done at factory.

## 9. UIM/Control System

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

*Aivea*



# Chapter 10 Parts List

## Note

*The list of components given in this manual are for reference only. For a comprehensive part list contact VIASYS Respiratory Care 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<br>NIST P/N 16132 |
| ALARM SPEAKER                                   | 51000-40818                      |
| COMPREHENSIVE CART                              | 33976                            |
| COMPRESSOR/SCROLL PUMP ASSEMBLY (INCLUDES PCBA) | 51000-09750A                     |
| CUSTOM TRANSPORT CART KIT                       | 11372                            |
| Rack, tank, cart assembly                       | 33978                            |
| 12V/12 amp lead acid battery (set of 2)         | 16179                            |
| Battery tray (screw, washer, nut)               | 33977                            |
| Wire harness                                    | 16217                            |
| EPM BOARD (INCLUDES PCBA)                       | 51000-40848A                     |
| EXHALATION CORNER                               |                                  |
| Exhalation filter cartridge (holds filter)      | 51000-40640                      |
| Filter capsule (non-disposable)                 | 33987                            |
| Water trap assembly                             | 50000-40035                      |
| Water trap adapter                              | 22095                            |
| Bottle, 125 ml.                                 | 33985                            |
| EXHALATION VALVE ASSEMBLY                       | 16319A                           |
| EXHALATION FLOW SENSOR ASSEMBLY                 | 51000-40023                      |
| Elbow, orange                                   | 51000-40525                      |
| EXTERNAL BATTERY (2 pack)                       | 16179                            |
| FAN/CABLE ASSEMBLY                              | 51000-40861                      |
| FRONT INTERFACE PANEL, PNEUMATIC MODULE         | 51000-40635                      |
| GDE                                             | 16222A                           |
| Cable assembly, battery upgrade                 | 16243                            |

| Description                                                      | Part Number                 |
|------------------------------------------------------------------|-----------------------------|
| HEATER ASSEMBLY<br>Bracket, thermal fuse                         | 51000-40824<br>22018        |
| HELIOX "SMART" CONNECTOR DISS                                    | 51000-40918                 |
| HELIOX 15 FT. HOSE                                               | 50000-40042                 |
| INFANT TEST LUNG (INGMAR)                                        | 34057                       |
| INTERNAL BATTERIES<br>Fuse (10 amp slow blow)<br>Fuse holder A/C | 68339A<br>71690<br>68159    |
| NEBULIZER ASSEMBLY                                               | 51000-40026                 |
| POWER DRIVER BOARD, PCBA, REV C                                  | 52290                       |
| POWER ENTRY MODULE                                               | 51000-40827                 |
| POWER SUPPLY KIT<br>Power supply<br>Sense cable                  | 16230A<br>16388<br>16366    |
| SECONDARY ALARM ASSEMBLY KIT                                     | 16316                       |
| STANDARD CART                                                    | 15986                       |
| TCA BOARD, PCBA<br>Fuse                                          | 51000-40310A<br>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                       |
| UIM INTERNATIONAL                                                | 16260                       |
| UIM MOUNTING ARM ASSEMBLY                                        | 51000-40072                 |

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 O2 reg adj tool                    | 51000-08258 |
| Filter removal tool                            | 21735       |
| Ftg. DISS, air, male 1/4 NPT                   | 52000-00133 |
| Ftg. Fem. R/A Elbow 12mm OD                    | 32002       |
| Ftg. O2, 1/4 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       |

|                                                                                                                                                                                                                                                                                                                       |                                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| <p>In addition, with comprehensive software, you will need:</p> <p>    Esophageal catheter extension tube (10 pack)</p> <p>    Adult esophageal catheter (8F)</p> <p>    / Pediatric esophageal catheter (6F)</p> <p>3.0 and high software rev, you will need:</p> <p>    Tool, Exhalation Valve Characterization</p> | <p>50000-09920</p> <p>7003100 &amp;/or</p> <p>7003401</p><br><p>10136</p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|

## 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       |
| FILTER REMOVAL TOOL                                                                    | 21735       |
| Note: The exhalation diaphragm may be ordered separately in a package of 10 P/N 16240D |             |

## Communications

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

### 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 & P pole mount kit                                         | 69302       |
| Filter capsule (non-disposable)                              | 33987       |
| Neonatal Hot Wire Flow Sensor                                | 51000-40081 |
| 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 |

### 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 |

## 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       |

# Appendices

## Contact & 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 VIASYS Respiratory Care Customer Care:

#### **Technical Service**

Hours: 7:00 AM to 3:30 PM (PST) Monday through Friday

Phone: (800) 231-2466

Fax: (714) 283-8471

#### **VIASYS Respiratory Care 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:

#### **VIASYS Respiratory Care Customer Service:**

Hours: 7:00 AM to 3:30 PM (PST)

Monday through Friday

Phone: (800) 231-2466

Fax: (714) 283-8473

(714) 283-8493

## 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. VIASYS Respiratory Care 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 VIASYS Respiratory Care technical support or your local VIASYS Respiratory Care representative for information.

### *AVEA Schematics*

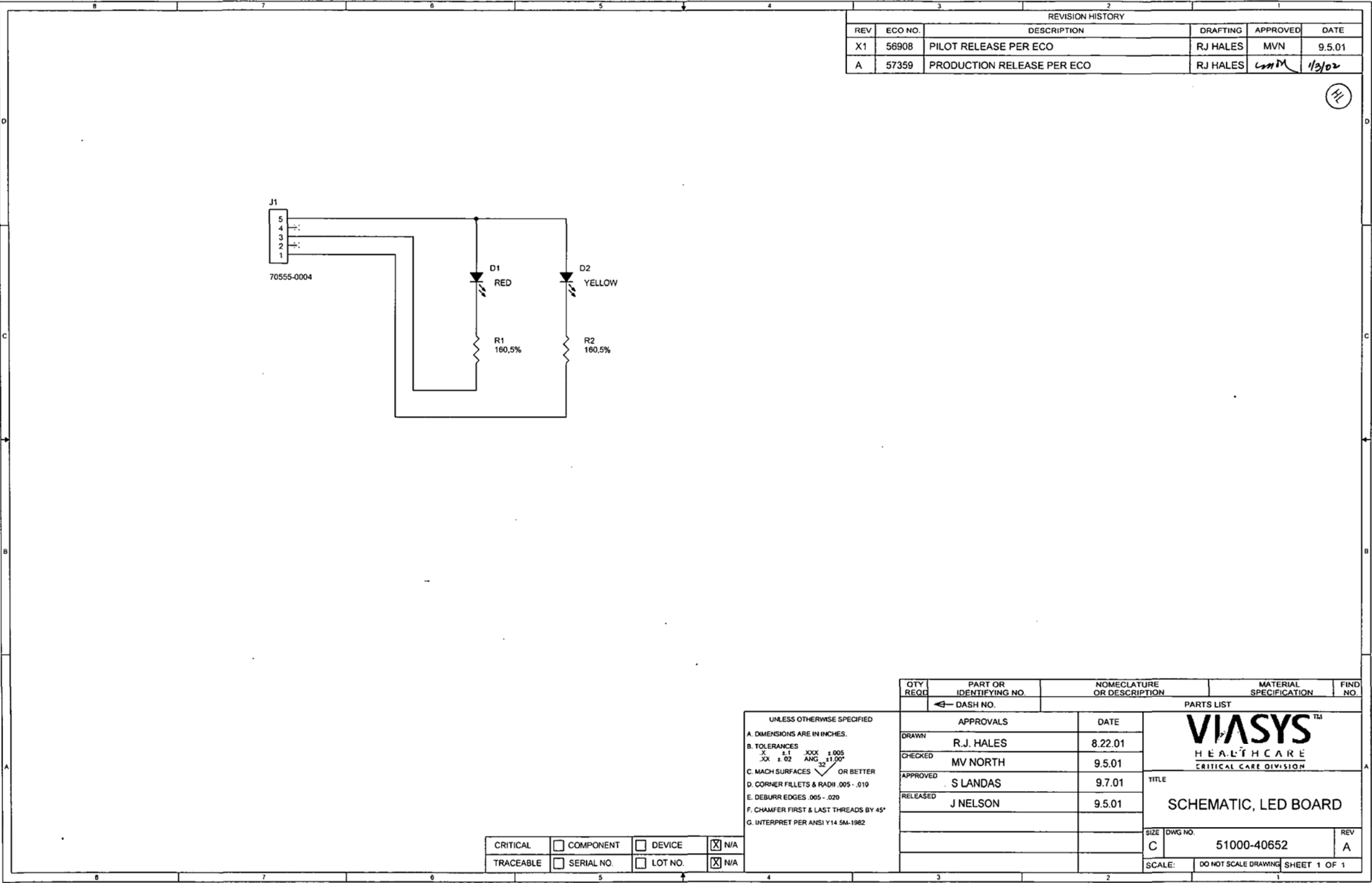
|              |                                |
|--------------|--------------------------------|
| 51000-40652  | LED BOARD                      |
| 51000-40702  | HOURLMETER                     |
| 51000-40342  | INSPIRATORY FLOW VALVE         |
| 51000-40292  | O2 BLENDER                     |
| 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*

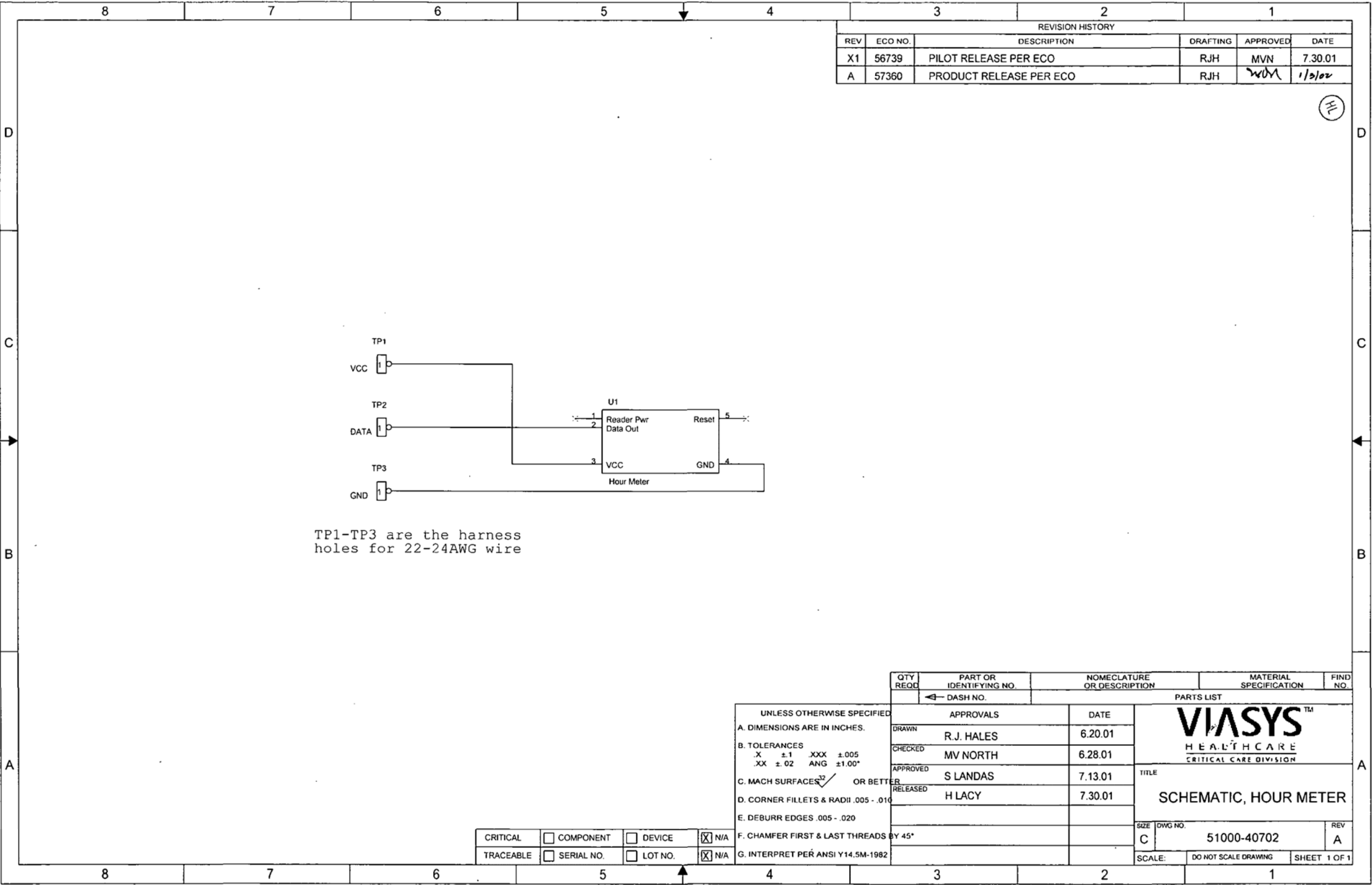
|             |                                  |
|-------------|----------------------------------|
| 51000-40431 | PCBA, EXHALATION FLOW TRANSITION |
| 52331       | PCBA, BACKUP ALARM               |
| 51000-40841 | TUBING DIAGRAM                   |
| 51000-09742 | PNEUMATIC DIAGRAM            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



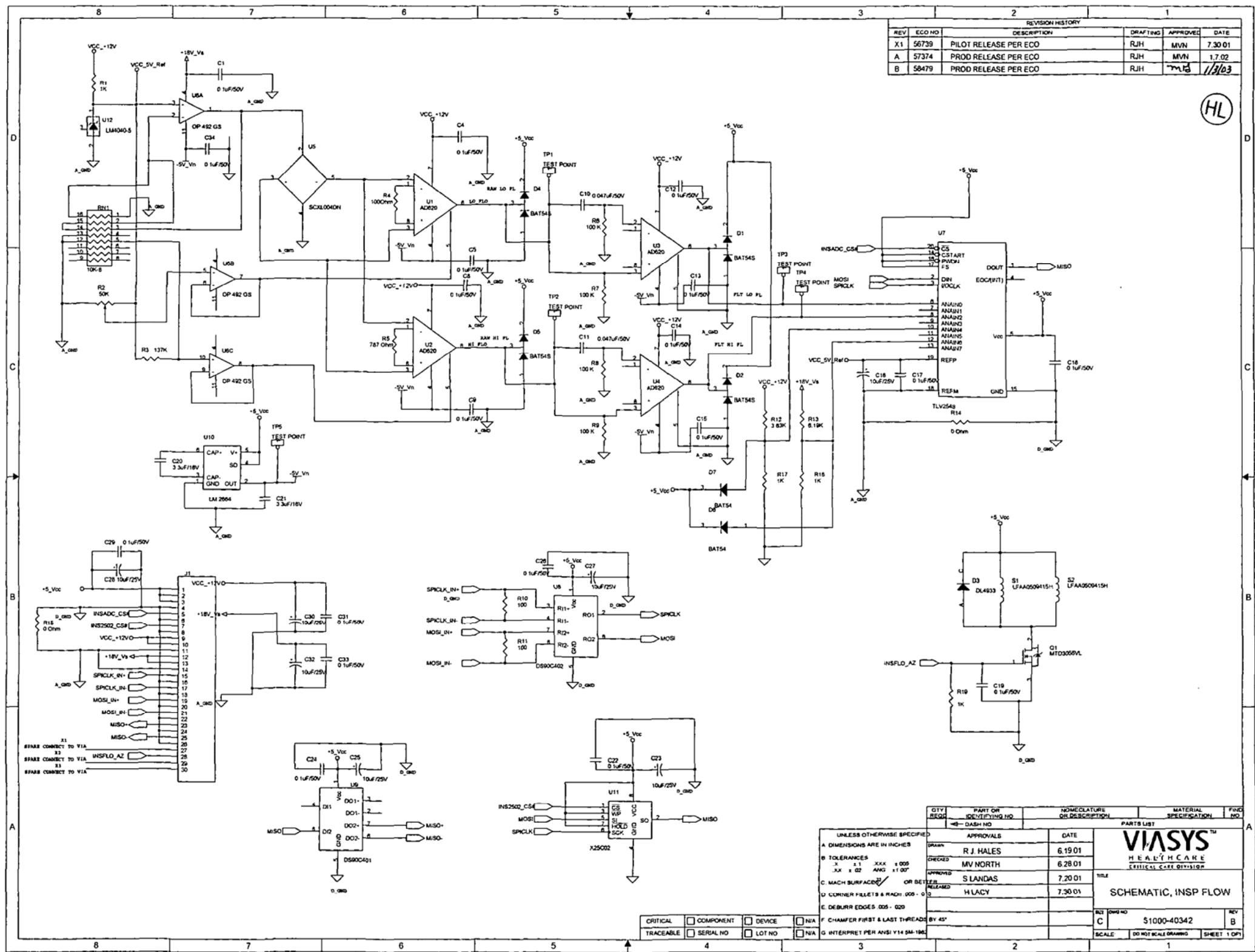
LED Board



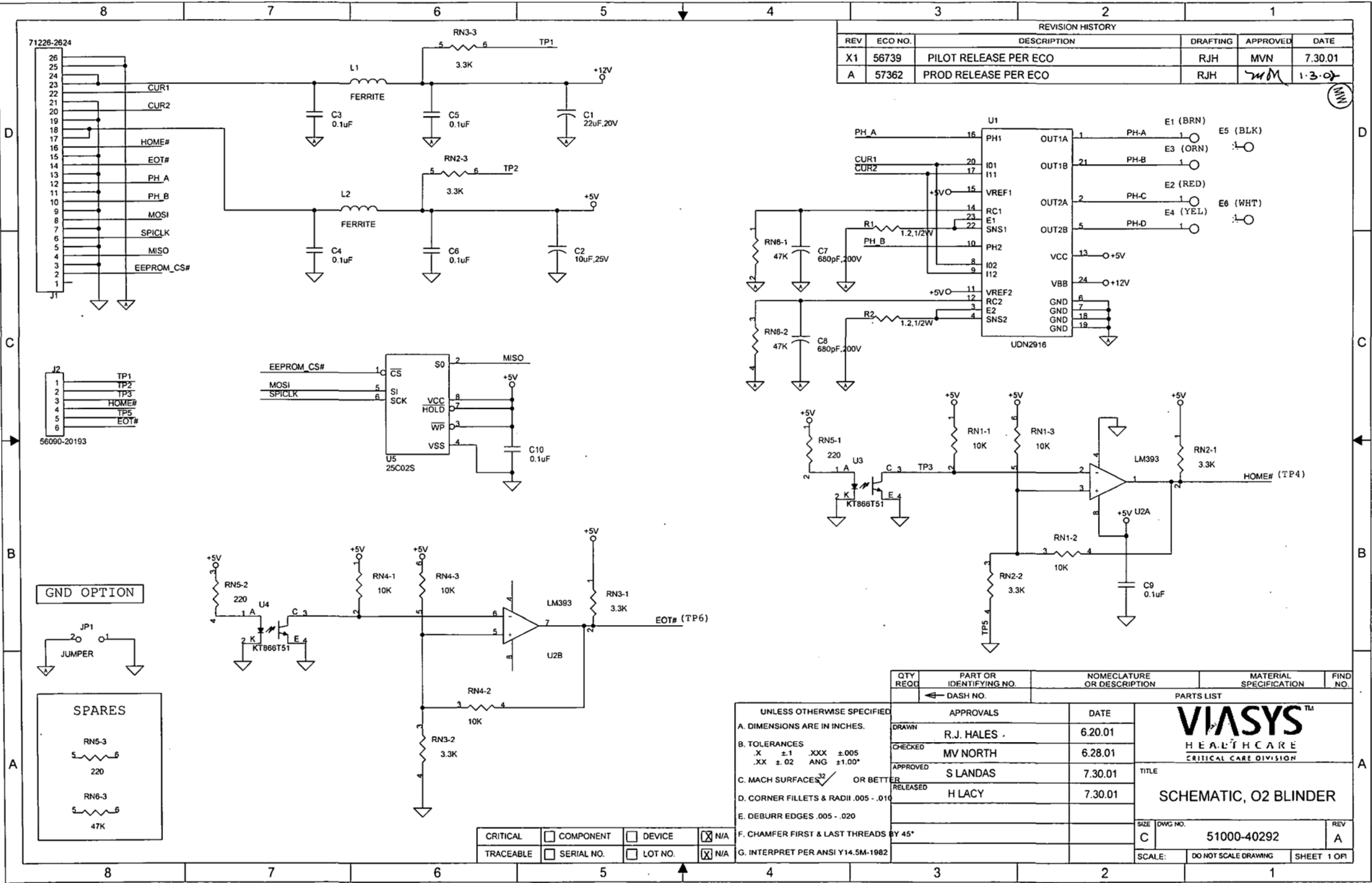
## Hour Meter



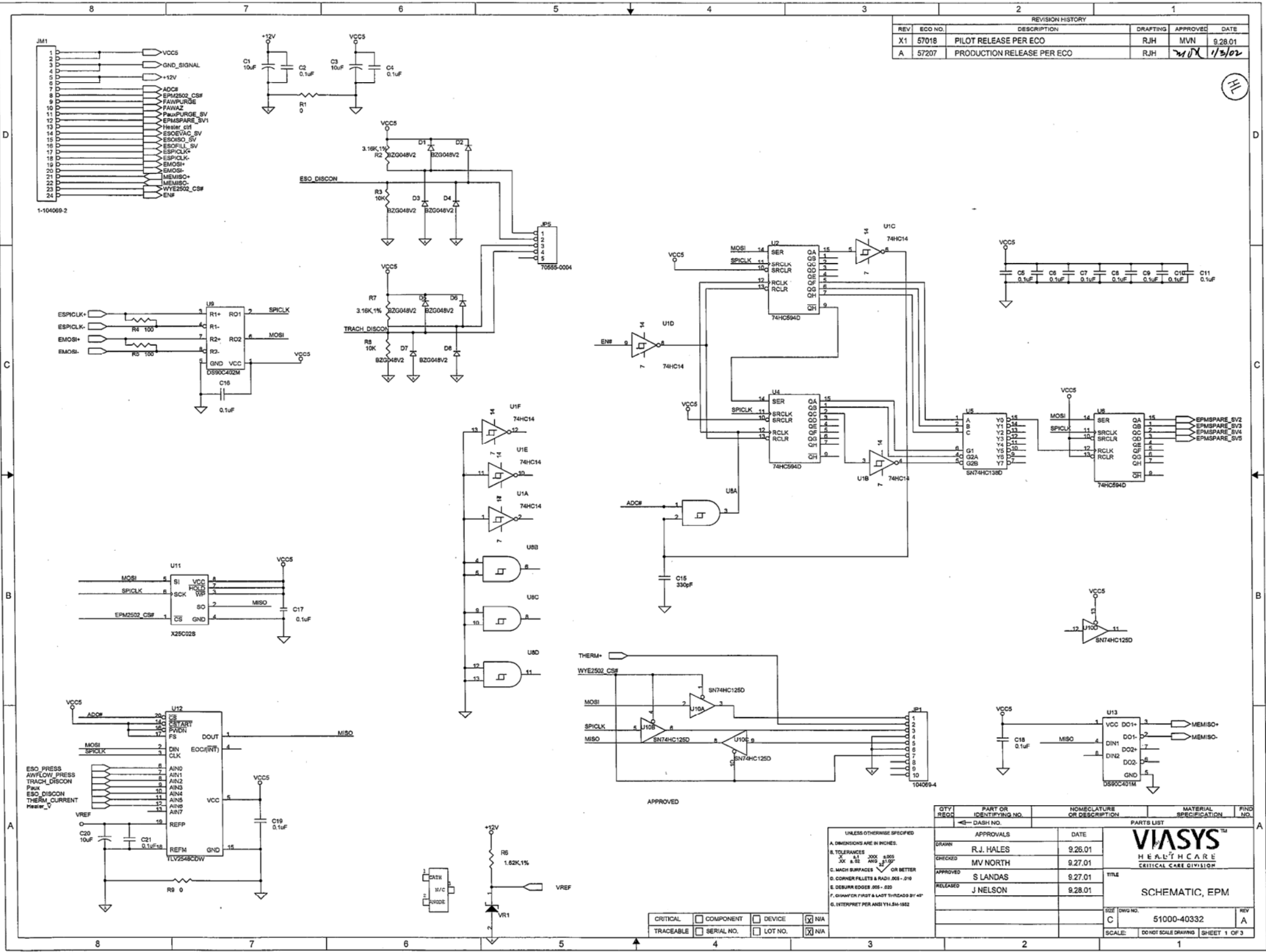
Inspiratory Flow Valve

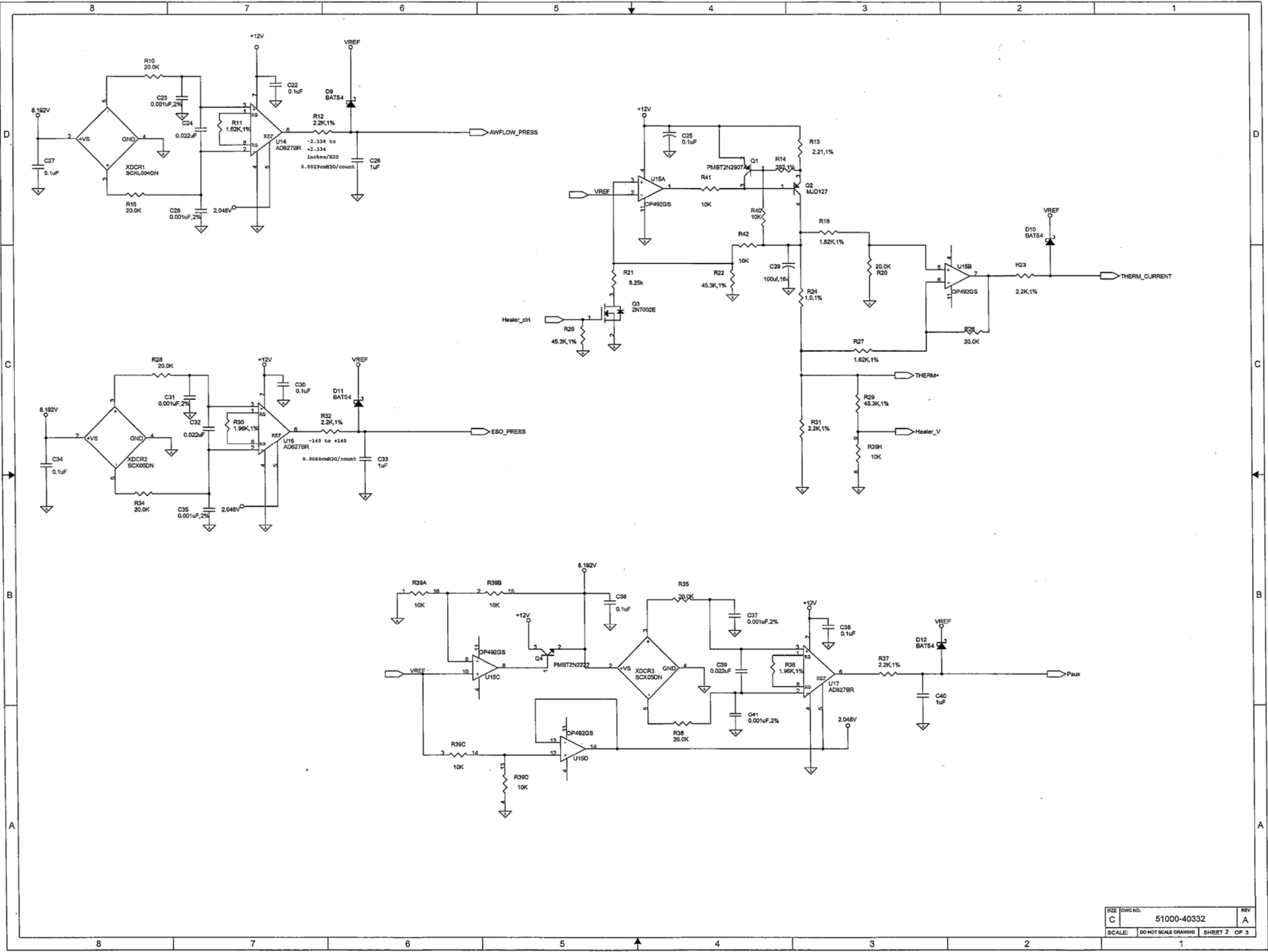


O<sub>2</sub> Blender

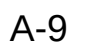


EPM Board



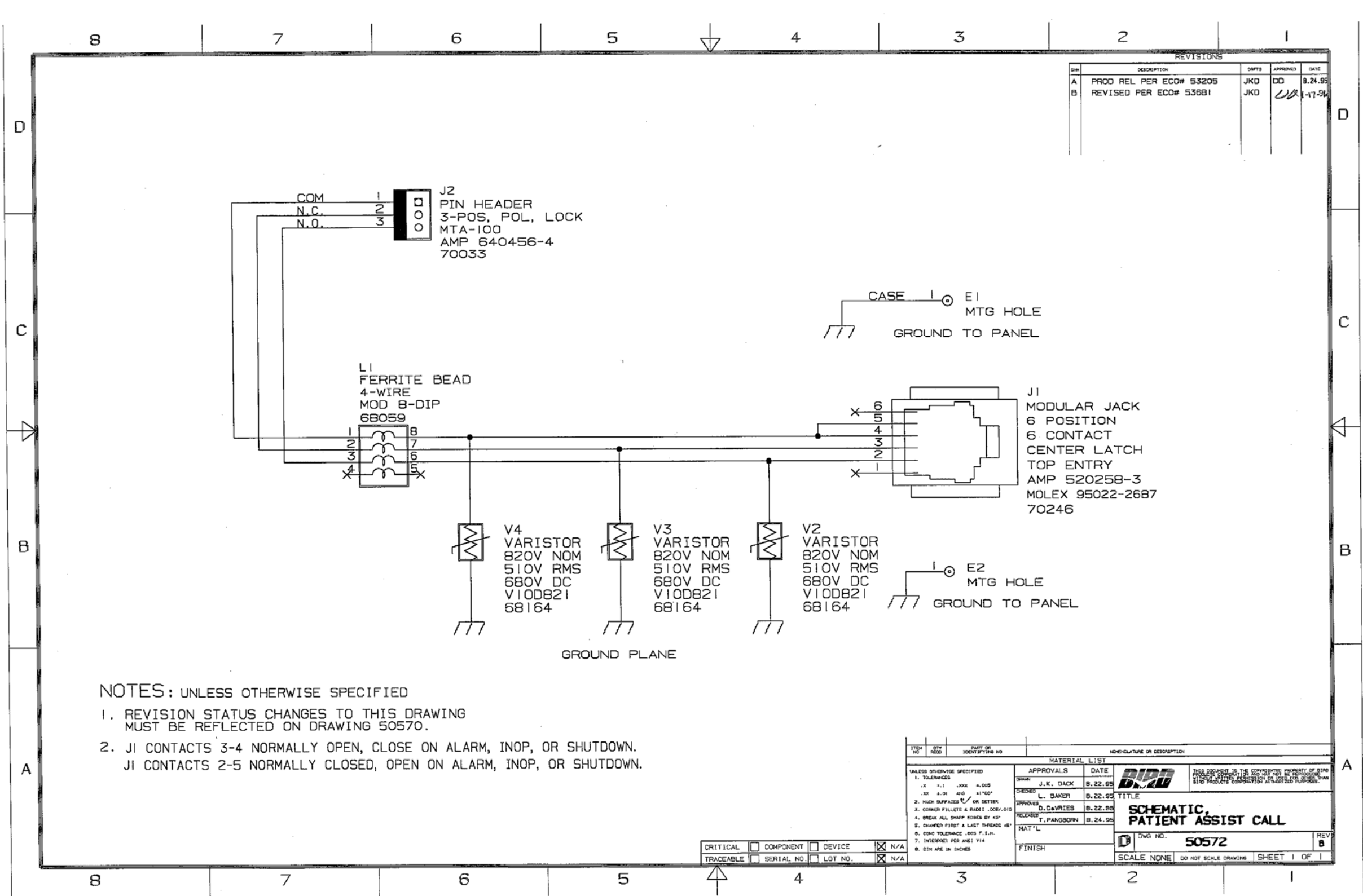






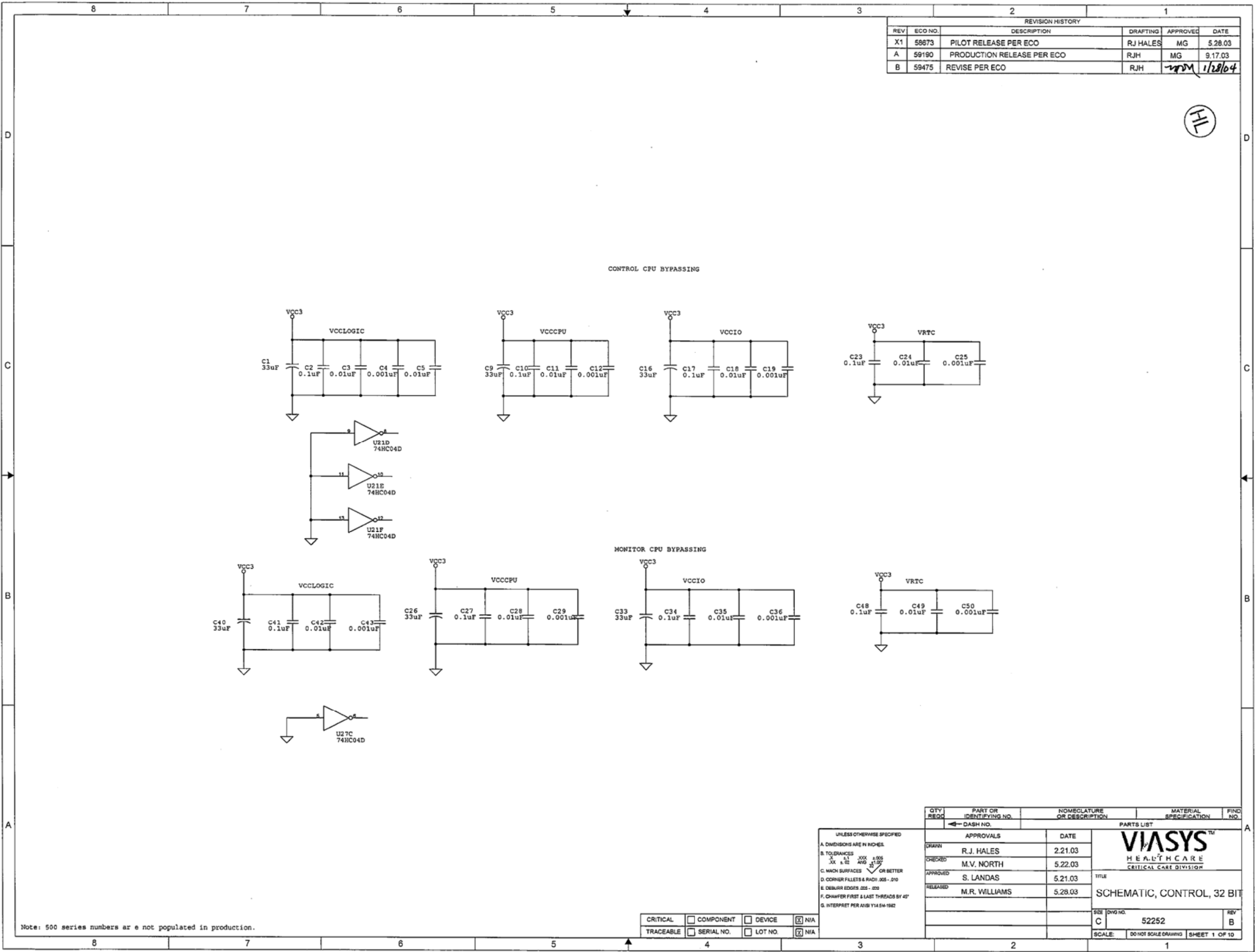


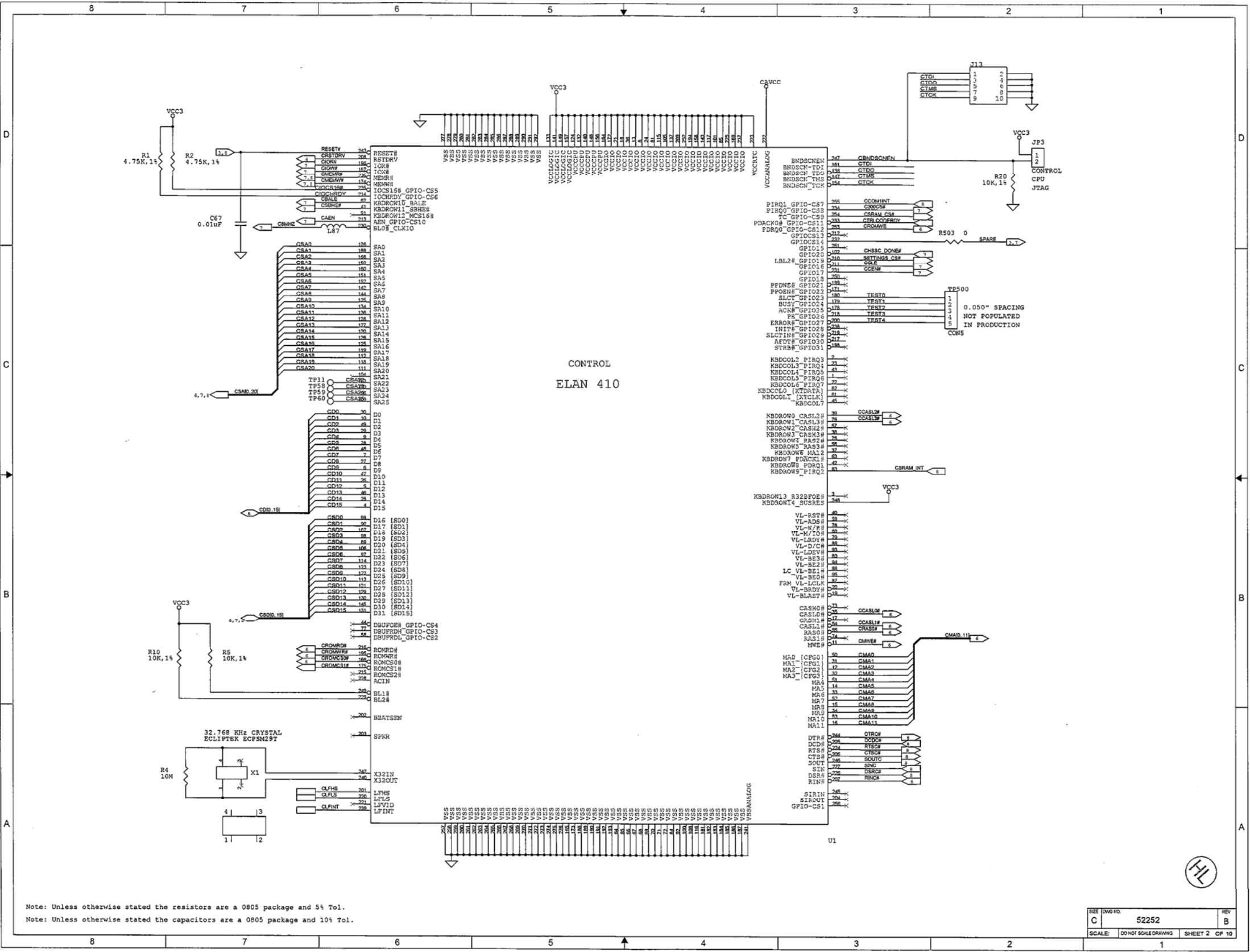
Patient Assist Call

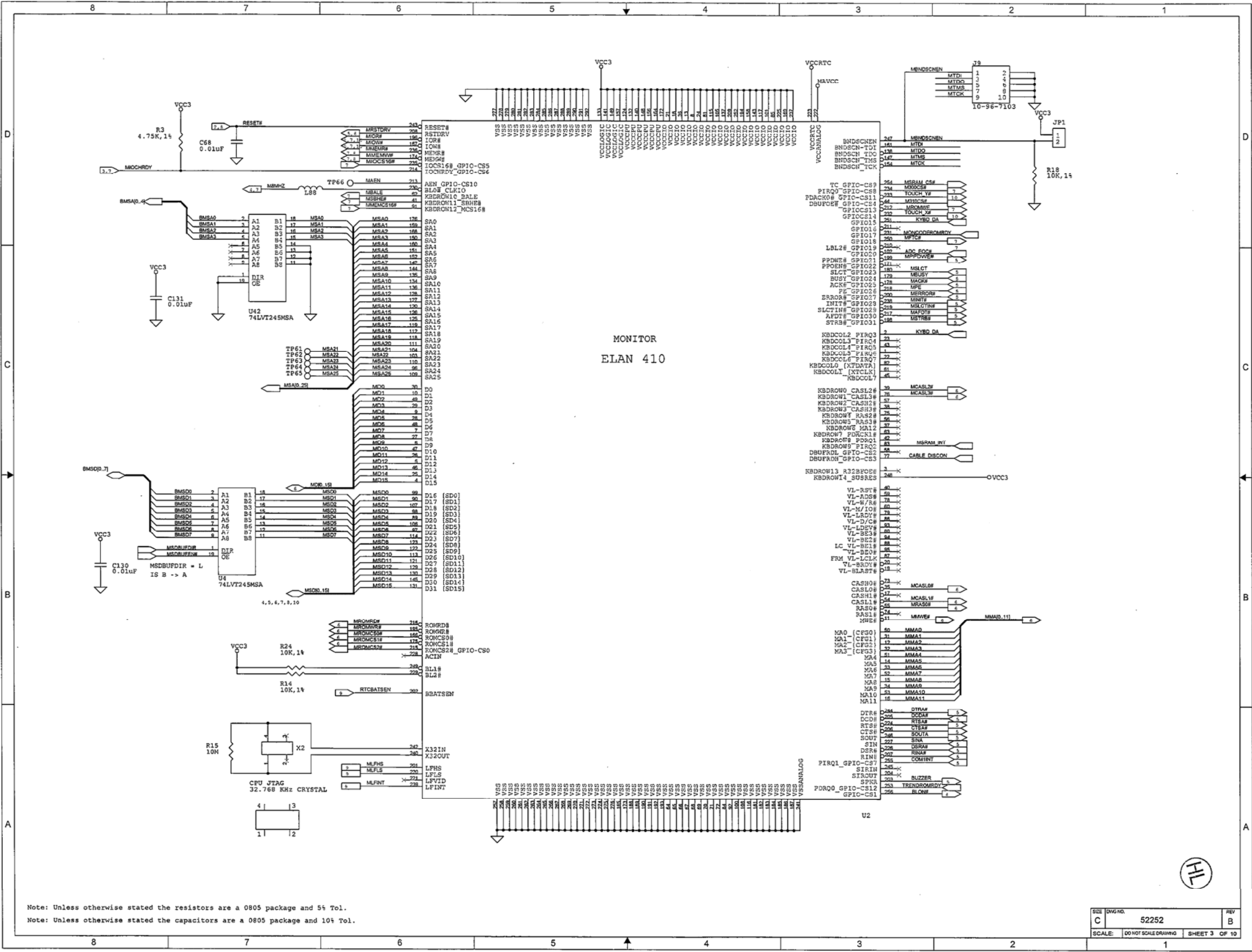




Control, PCBA, 32 Bit





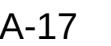


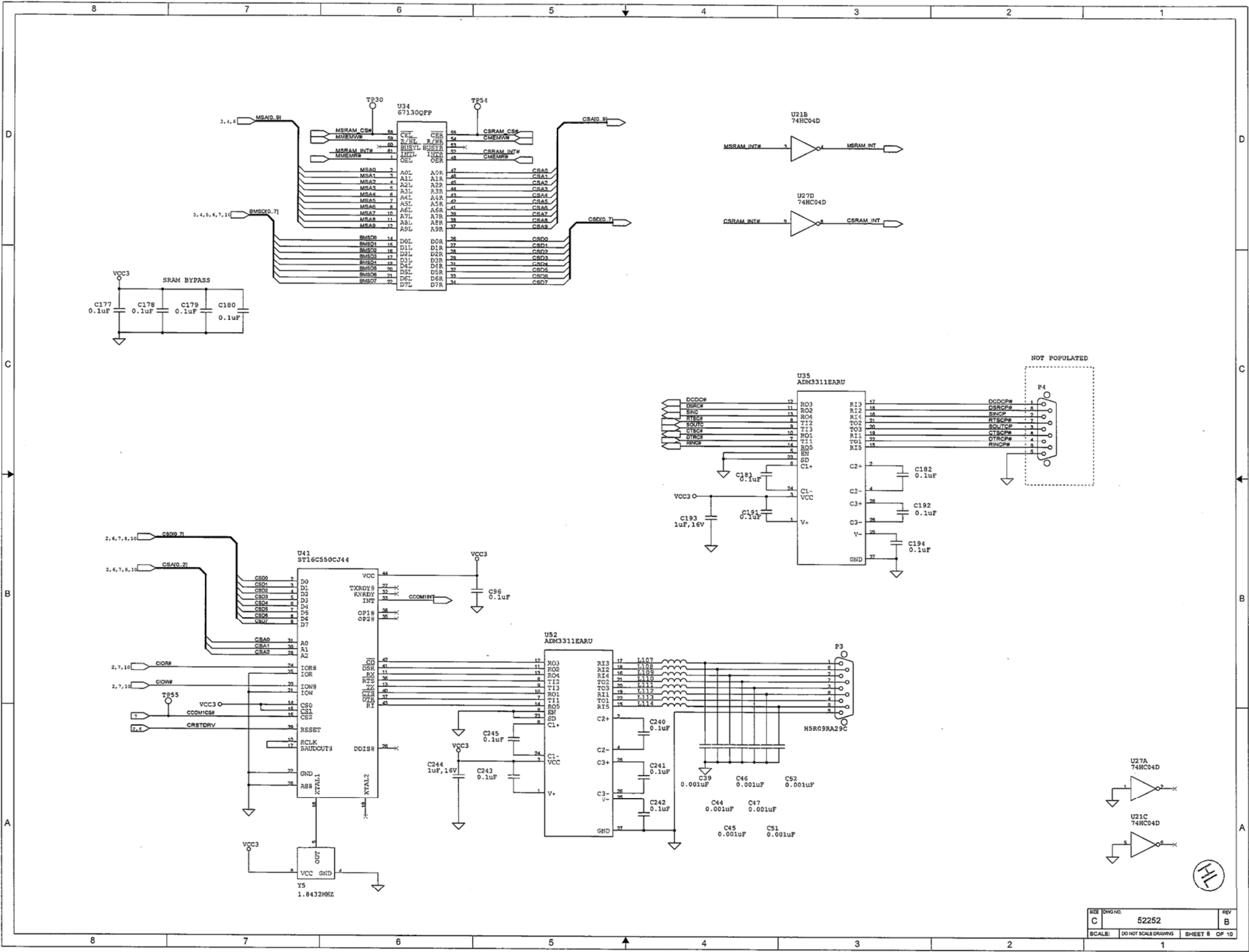




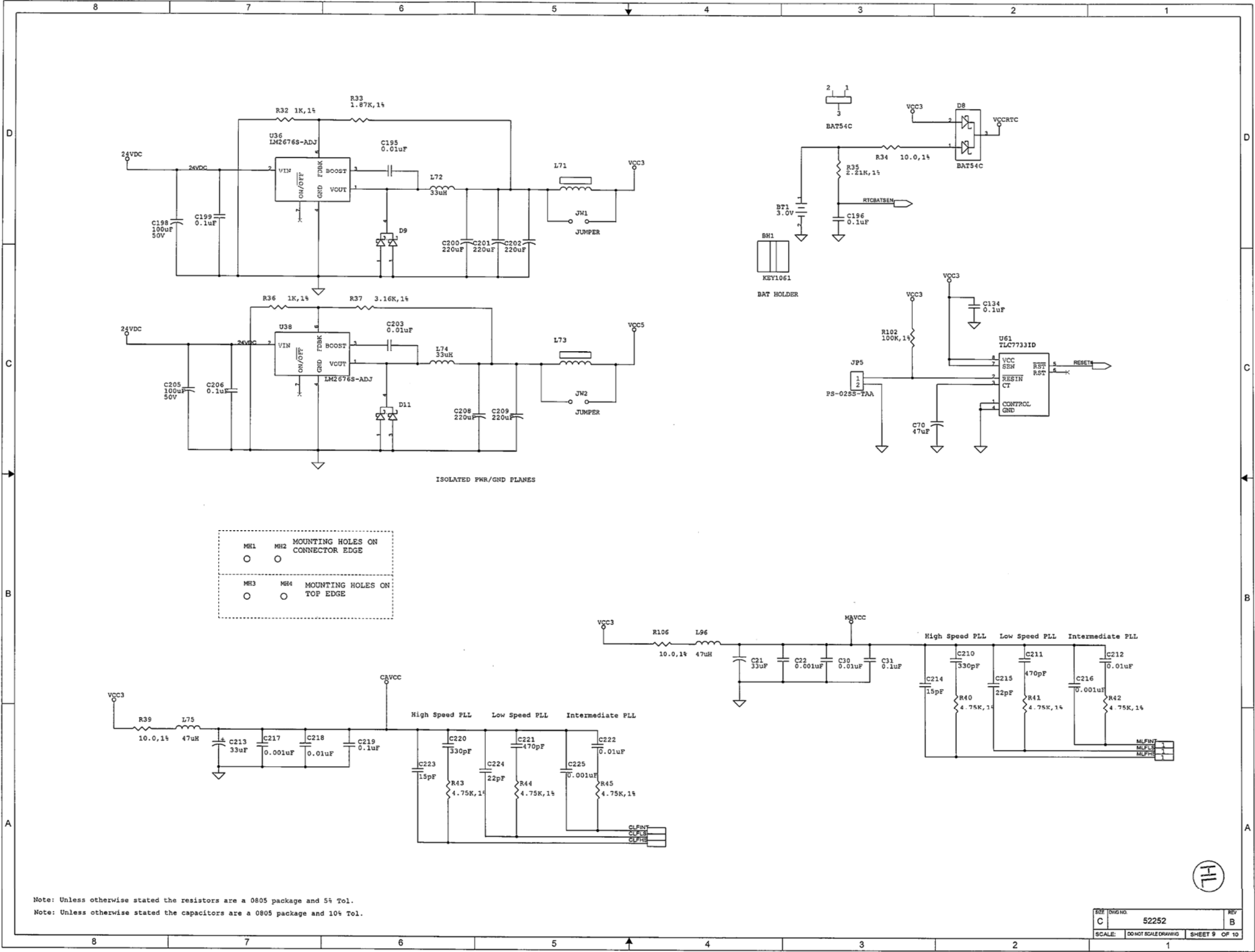


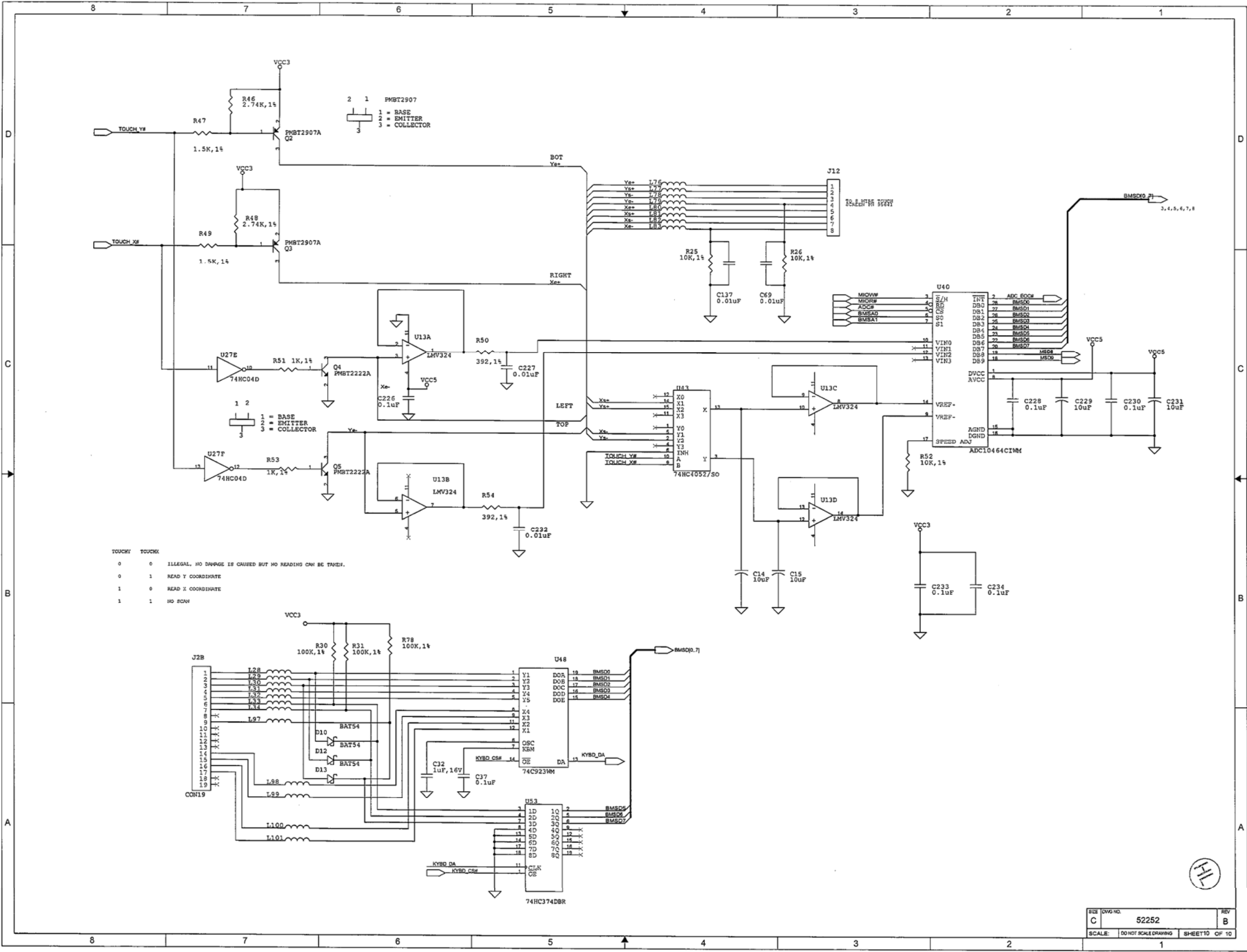




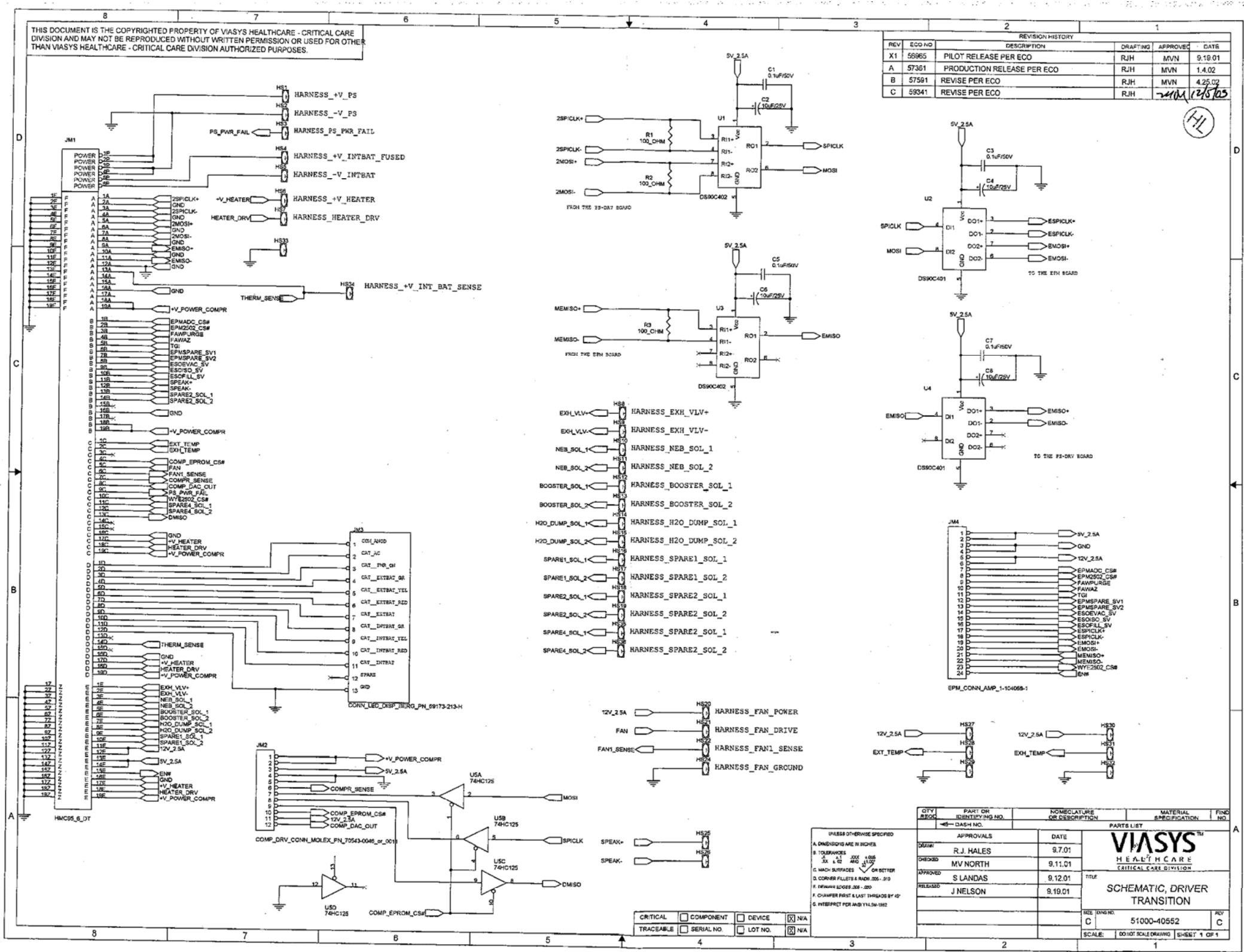








# PCBA, Driver Transition



PCBA, Power Driver Board

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| 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      | <i>WKP</i> | 2/24/05 |

UNLESS OTHERWISE SPECIFIED

A. DIMENSIONS ARE IN INCHES.

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

C. MACH SURFACES  $\sqrt{32}$  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

TRACEABLE

☐ COMPONENT

☐ SERIAL NO.

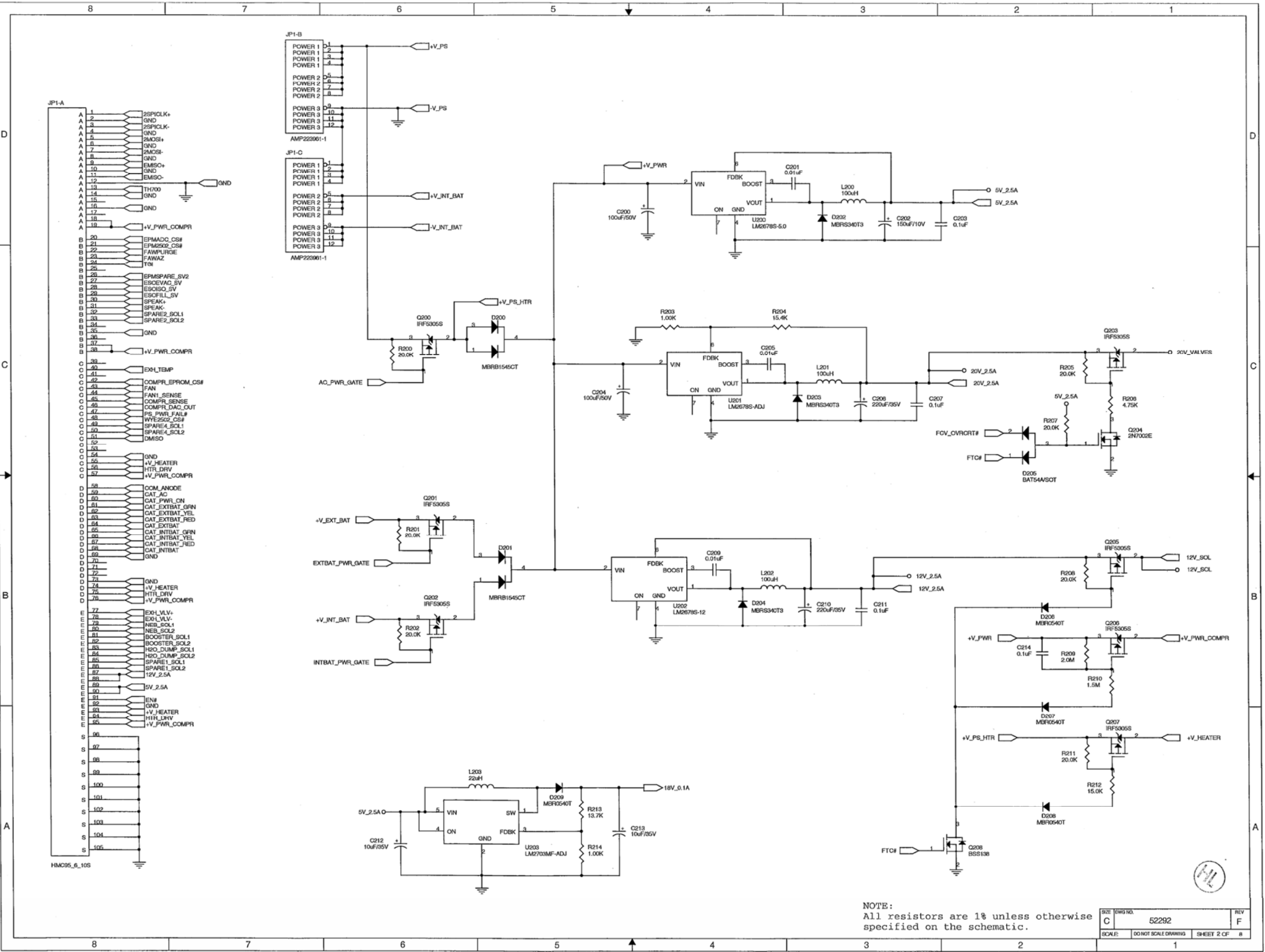
☐ DEVICE

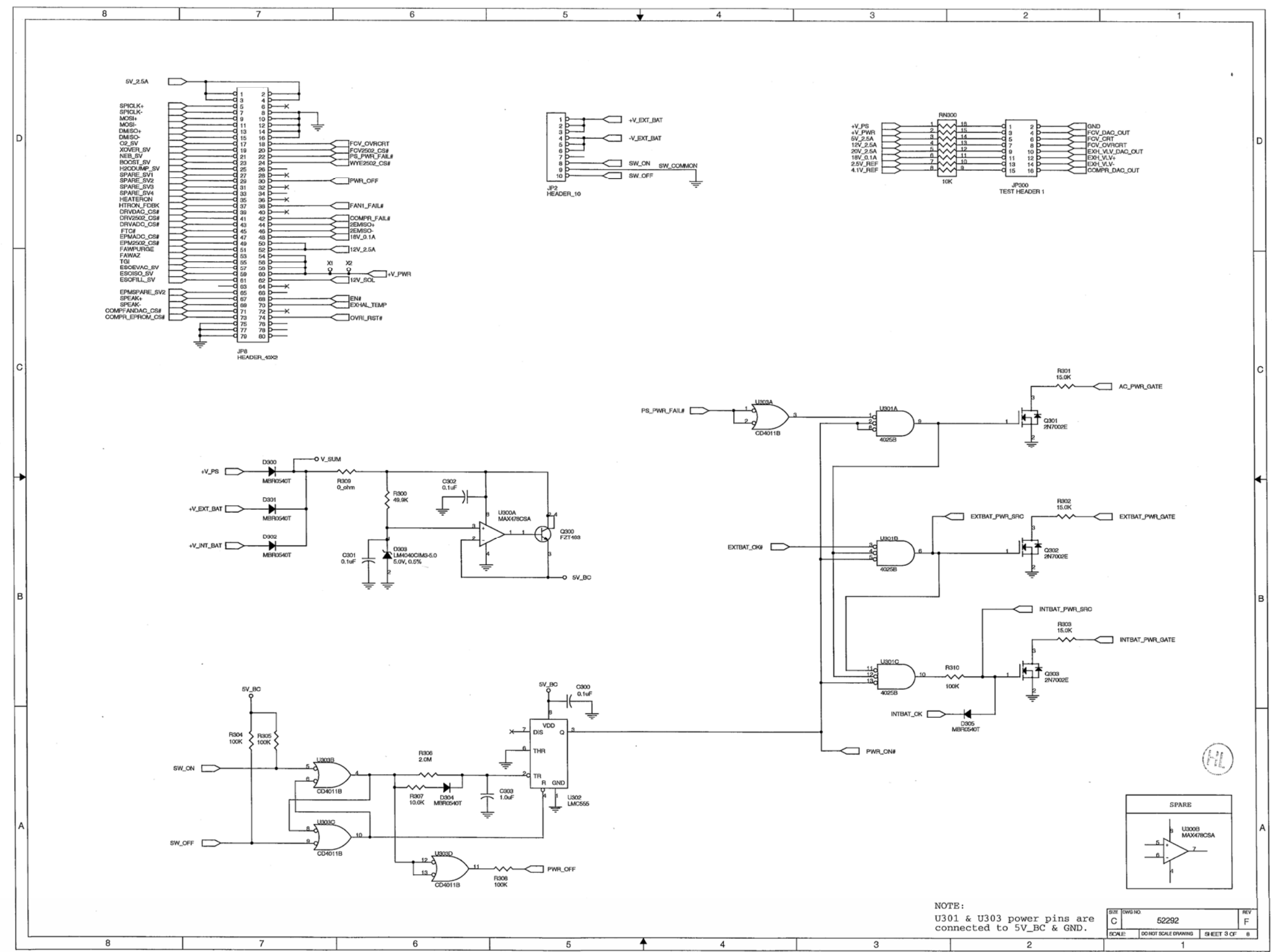
☐ LOT NO.

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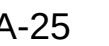
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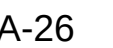
| QTY REQD           | PART OR IDENTIFYING NO.<br>← DASH NO. | NOMECLATURE OR DESCRIPTION | MATERIAL SPECIFICATION                                                                                                                                                                                       | FIND NO. |
|--------------------|---------------------------------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| PARTS LIST         |                                       |                            |                                                                                                                                                                                                              |          |
| APPROVALS          |                                       | DATE                       | <div><div>VIASYS<sup>TM</sup></div><div>HEALTHCARE</div><div>CRITICAL CARE DIVISION</div></div> <div>TITLE</div> <div>SCHEMATIC, POWER DRIVER</div> <div>SIZE DWG NO.<br/>C 52292</div> <div>REV<br/>F</div> |          |
| DRAWN RJ HALES     |                                       | 9.9.03                     |                                                                                                                                                                                                              |          |
| CHECKED M. GREEN   |                                       | 9.18.03                    |                                                                                                                                                                                                              |          |
| APPROVED S. LANDAS |                                       | 9.18.03                    |                                                                                                                                                                                                              |          |
|                    |                                       |                            |                                                                                                                                                                                                              |          |
|                    |                                       |                            |                                                                                                                                                                                                              |          |
| RELEASED H. LACY   |                                       | 9.19.03                    | SCALE: DO NOT SCALE DRAWING SHEET 1 OF 1                                                                                                                                                                     |          |



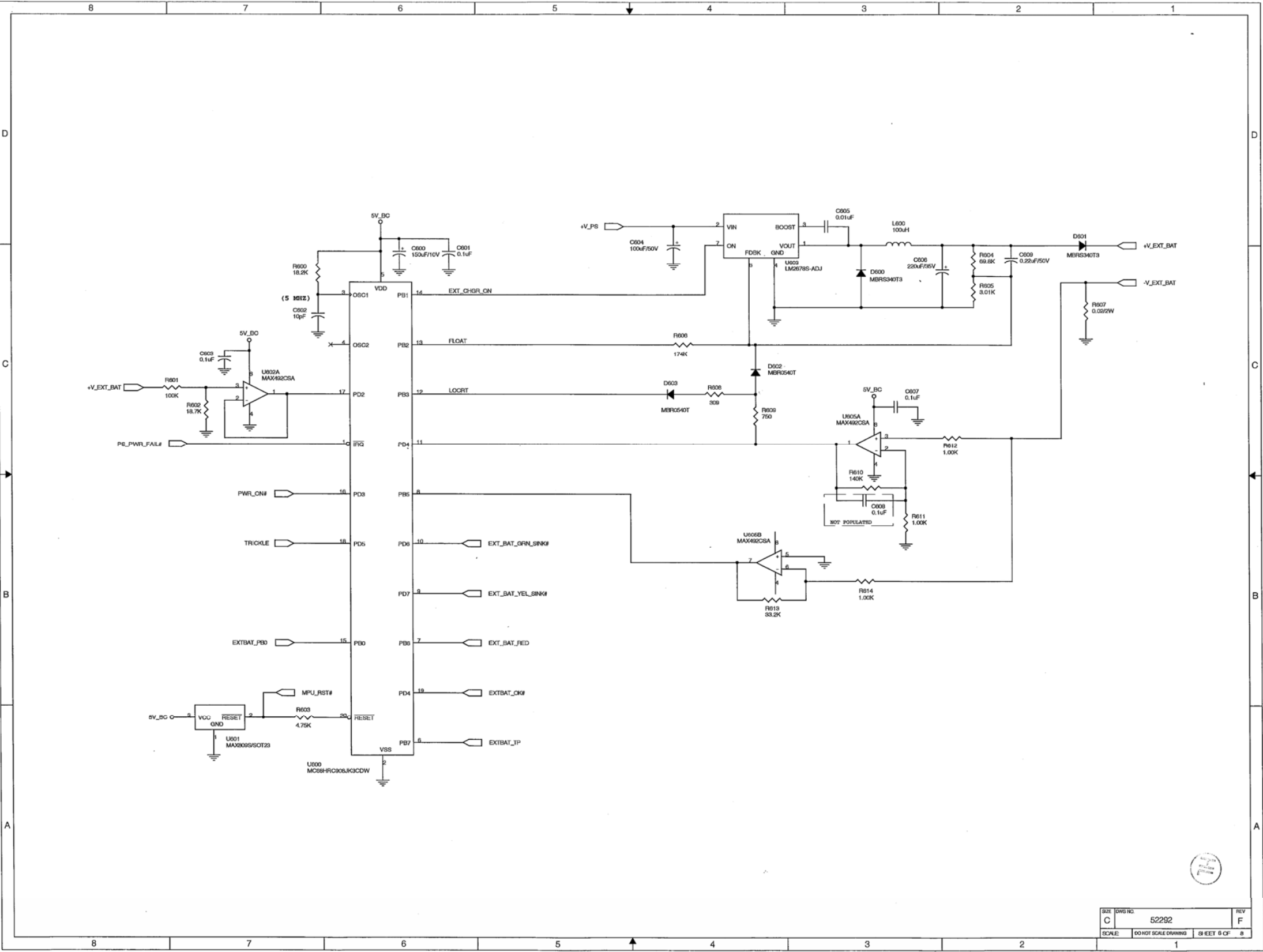


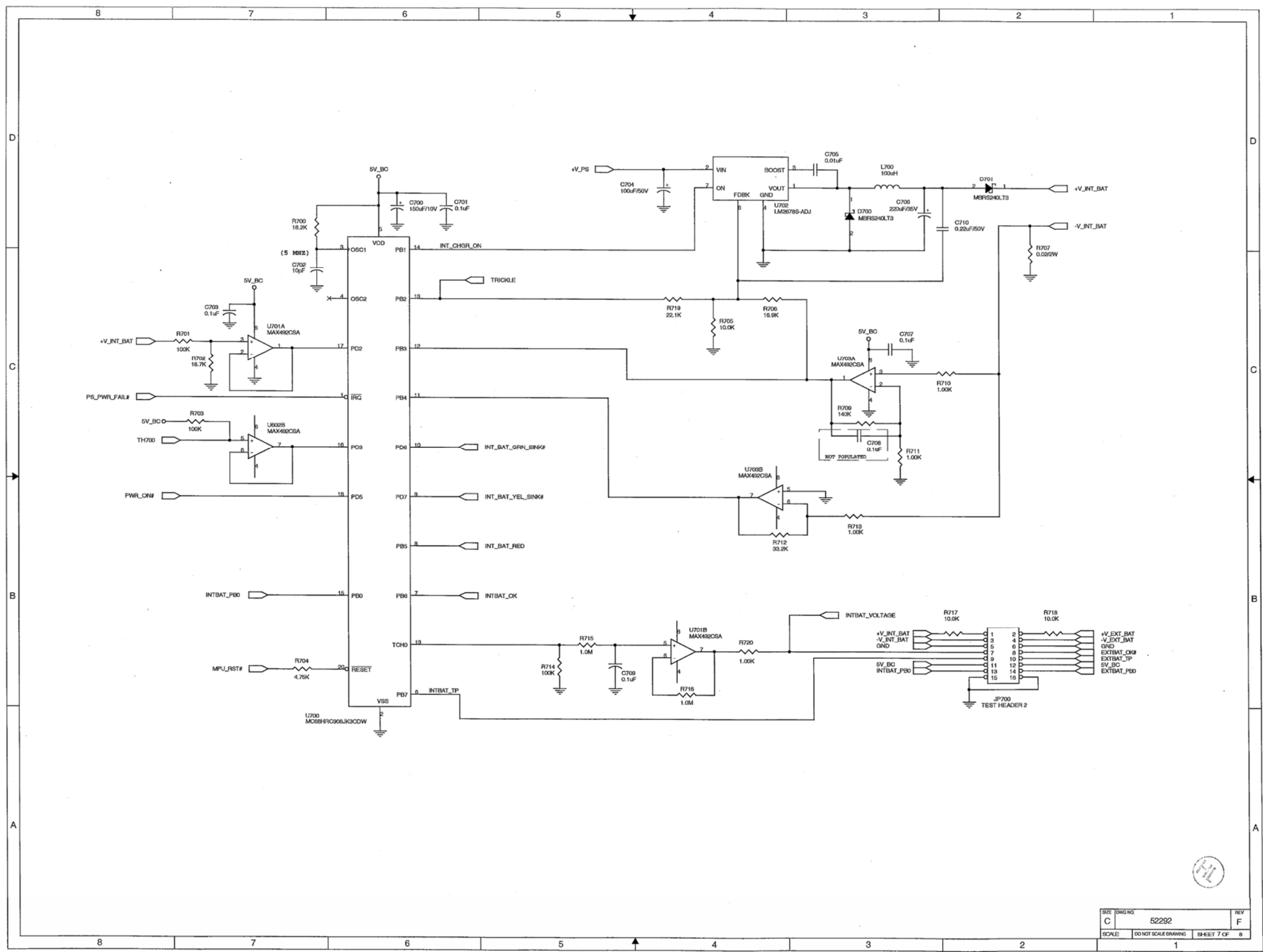


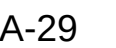




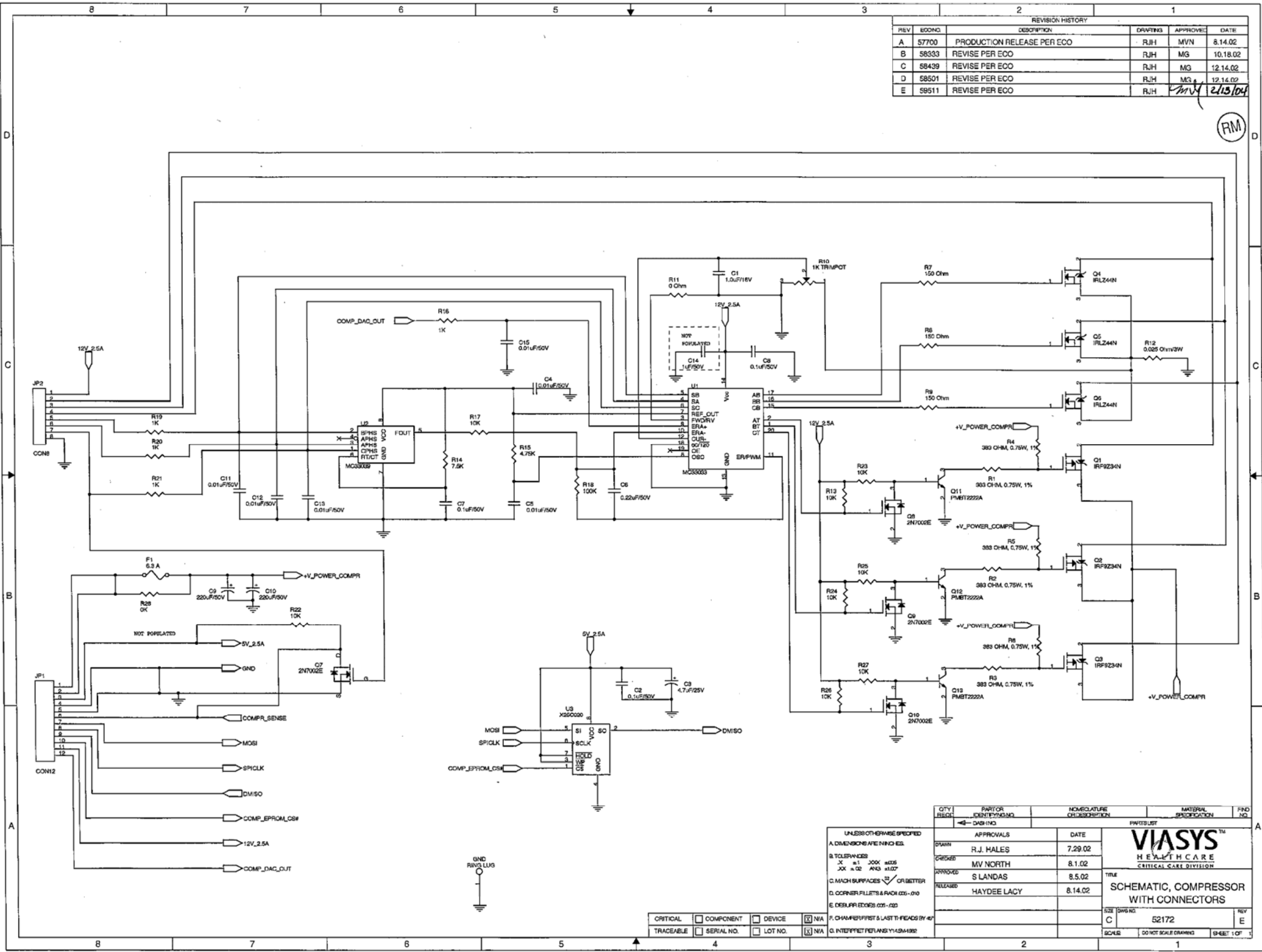




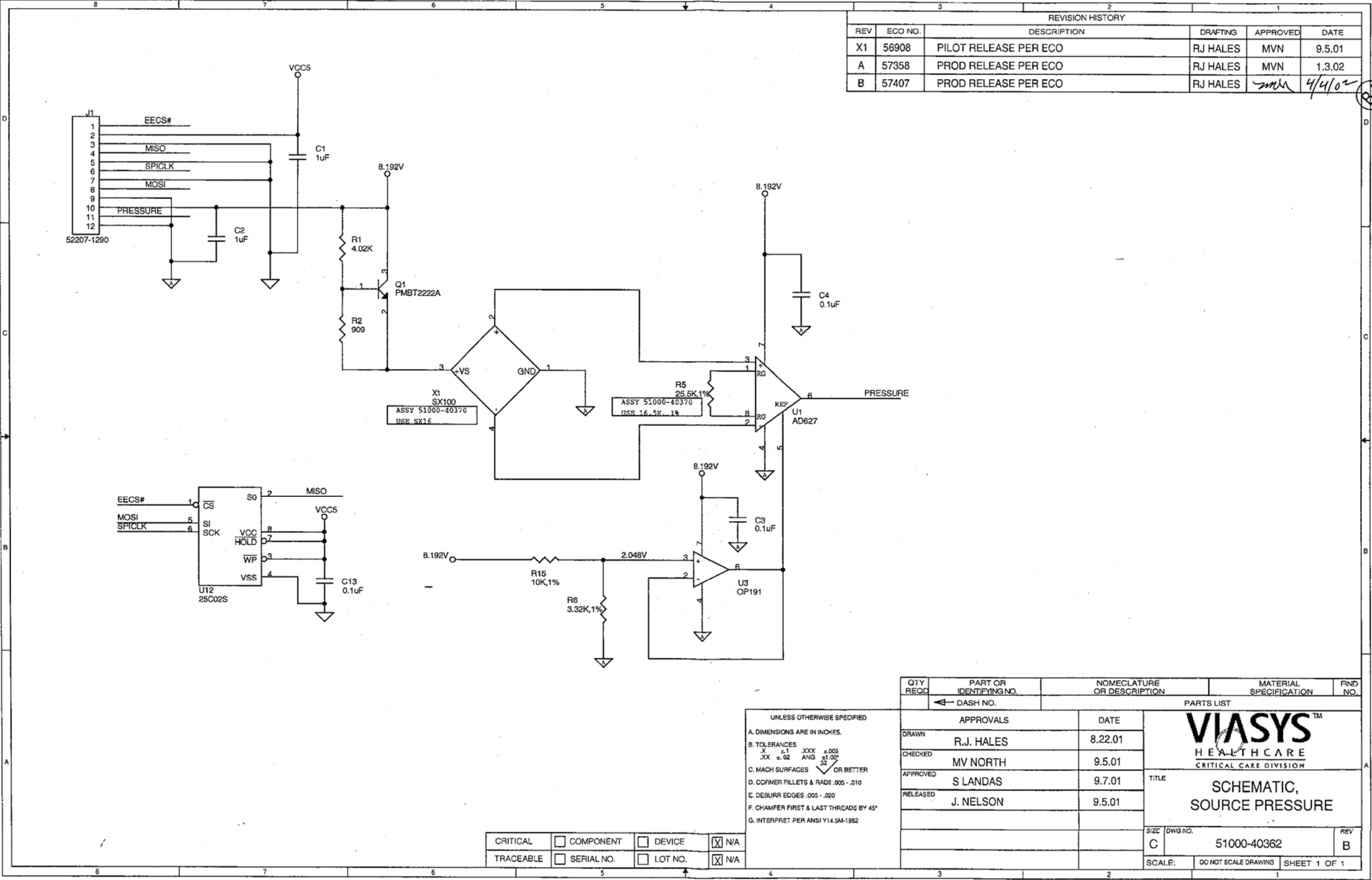




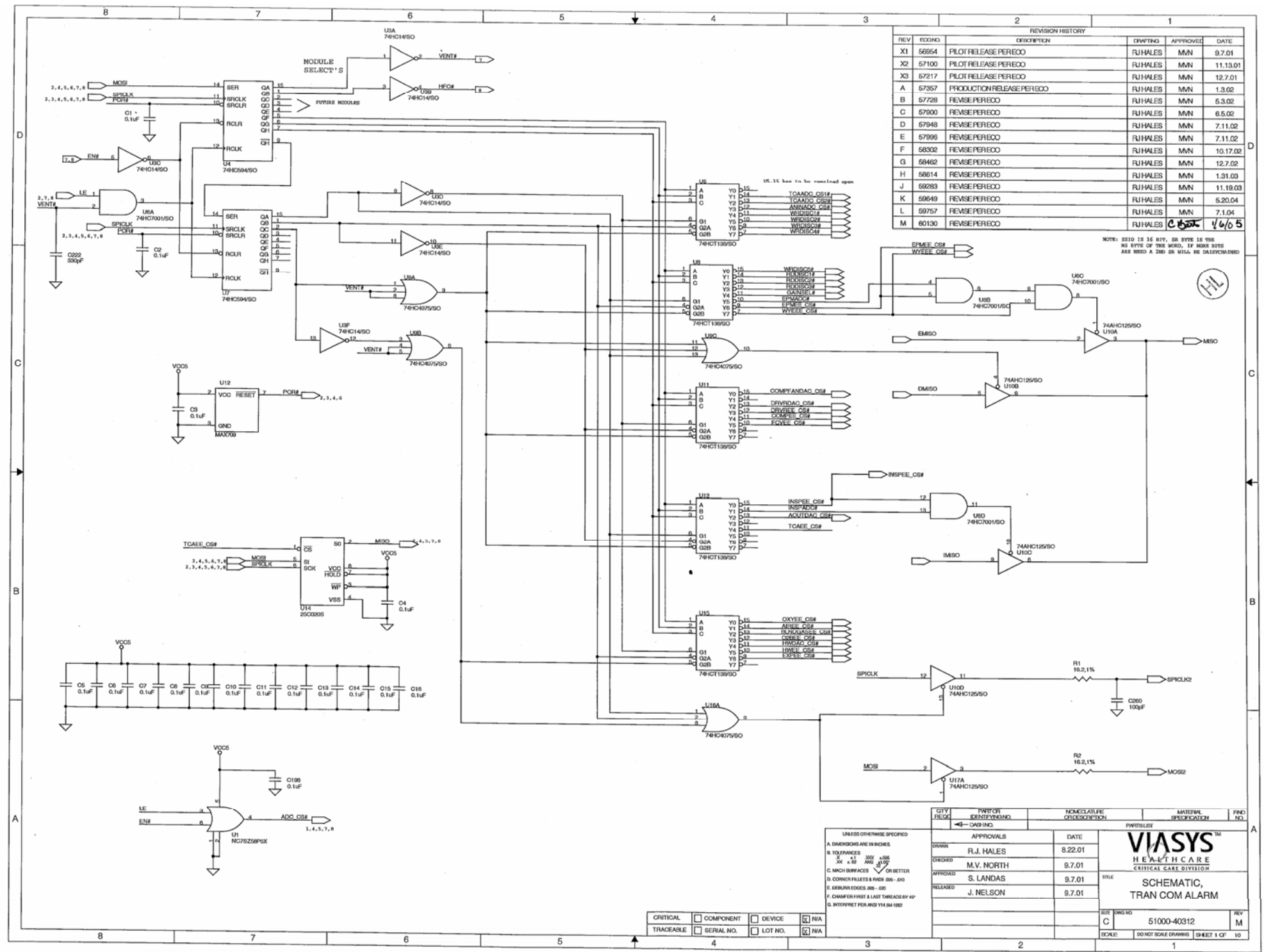
PCB Compressor with Connectors



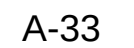
PCBA, Supply Pressure

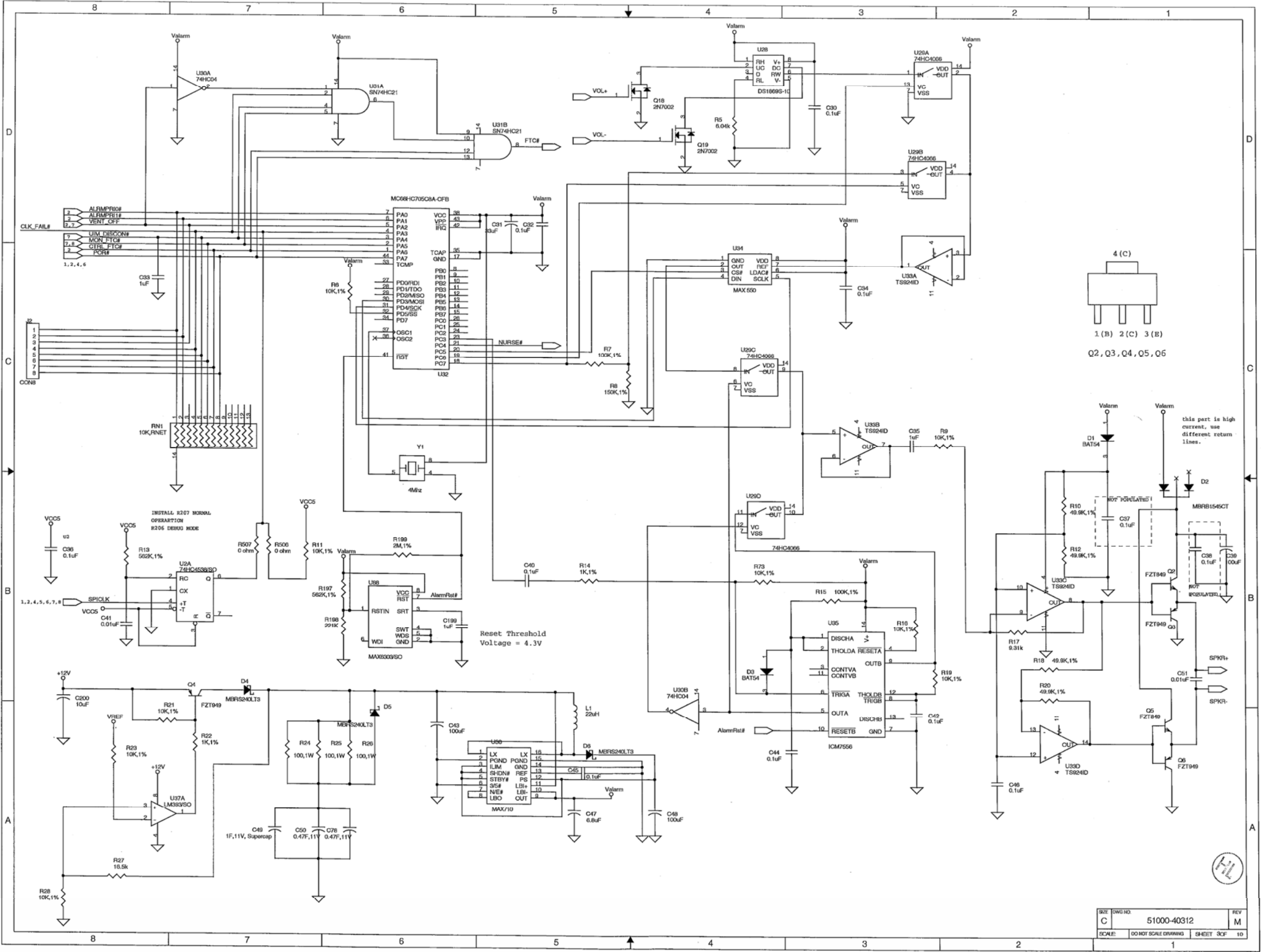


Trans Com Alarm

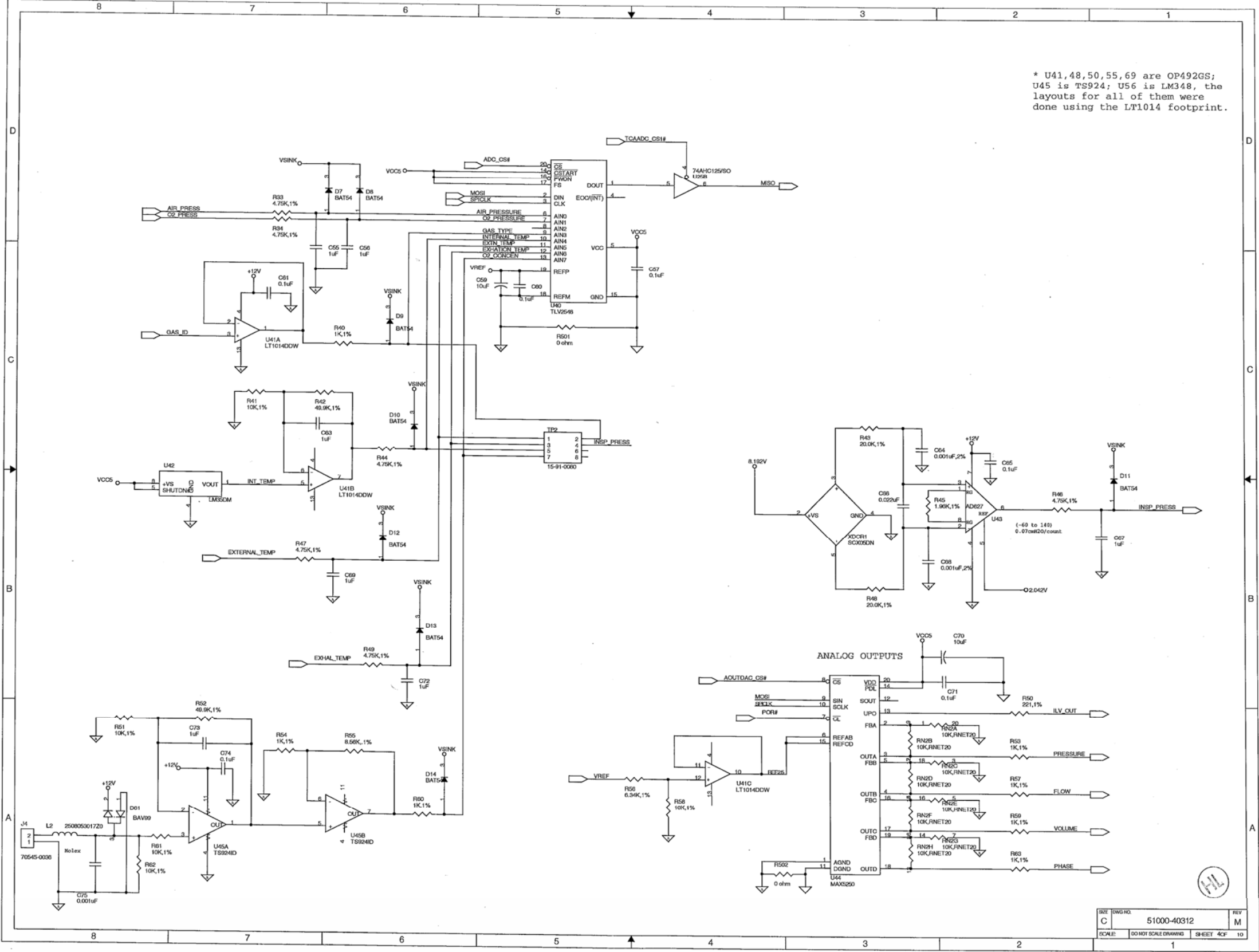


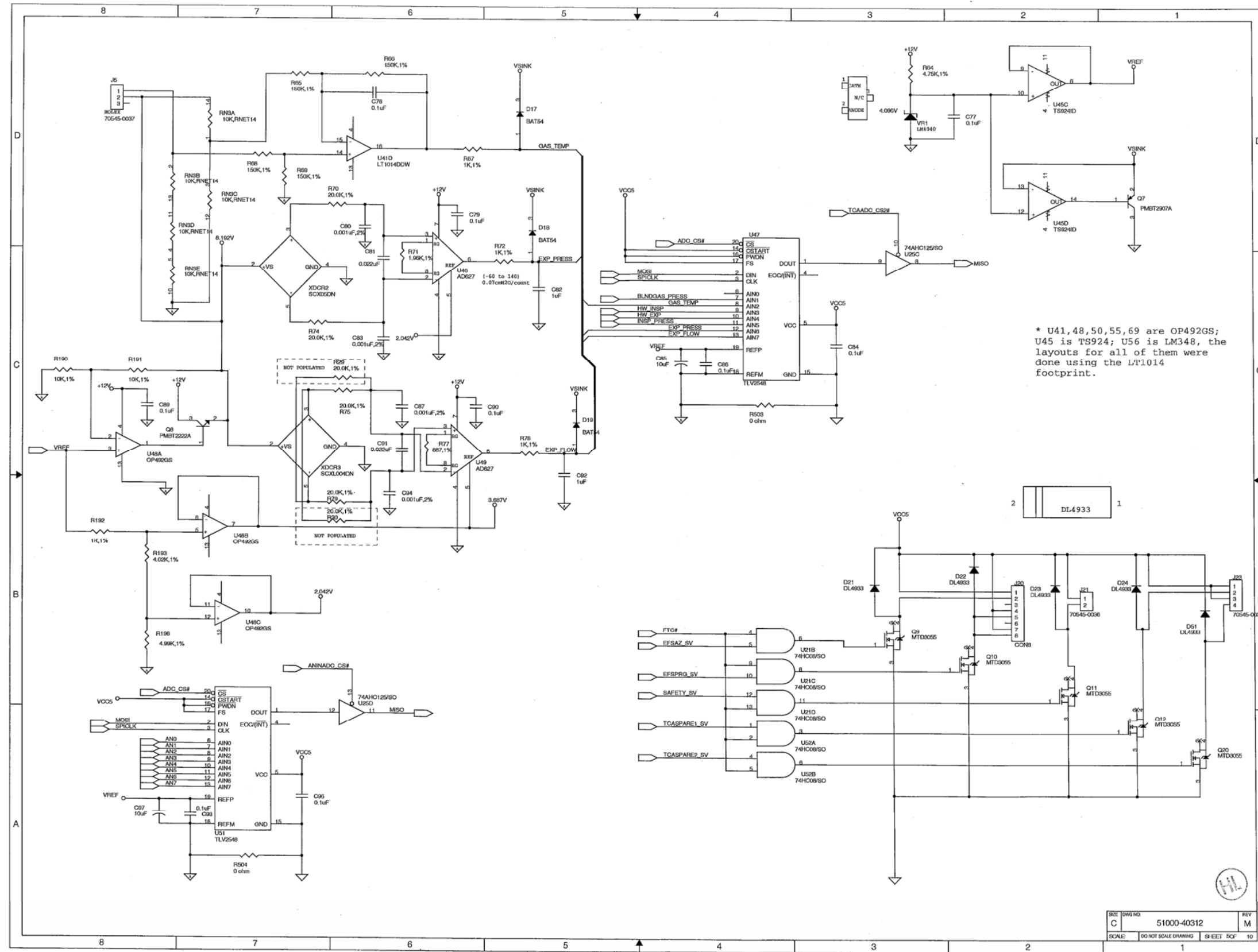


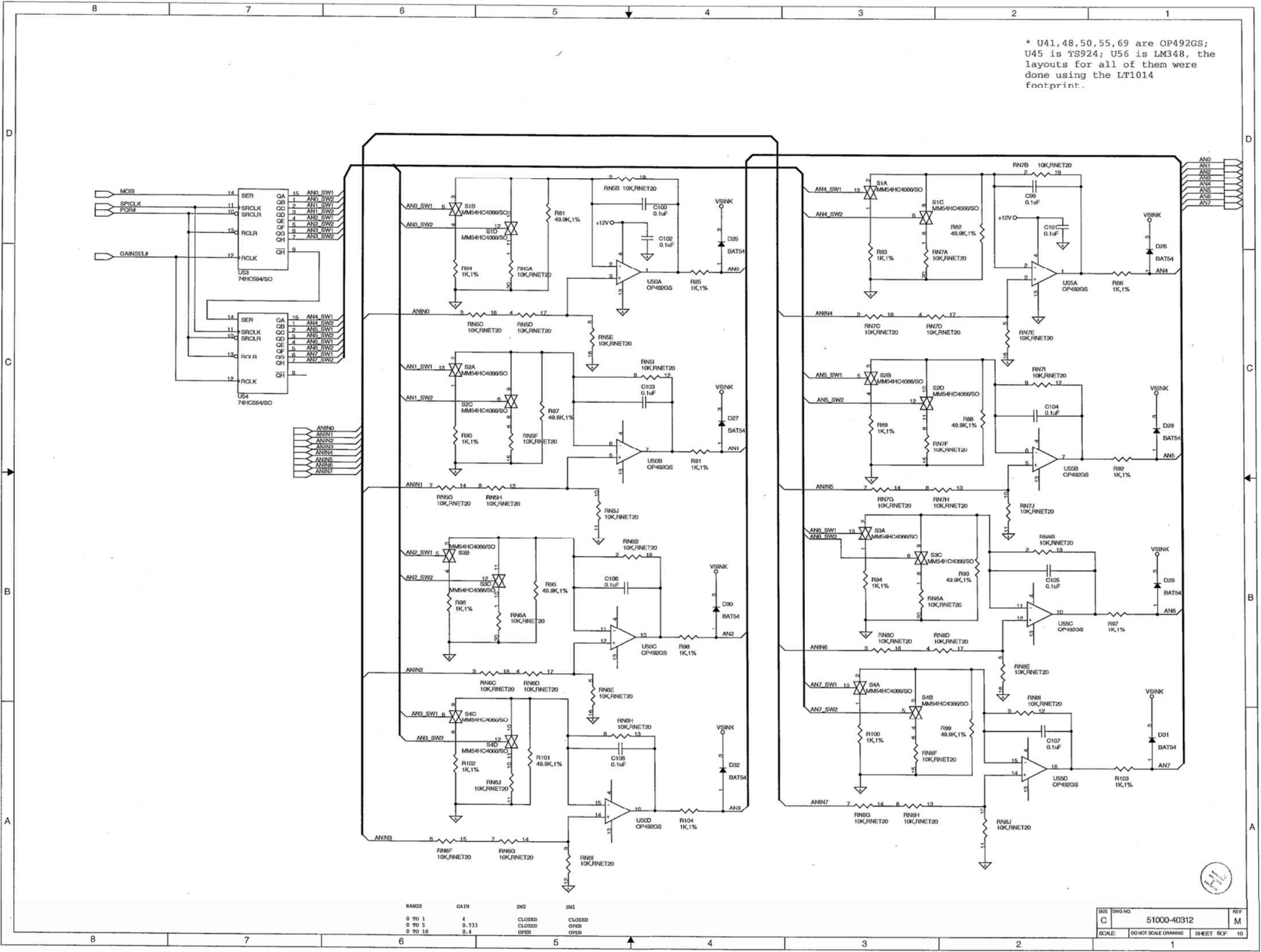




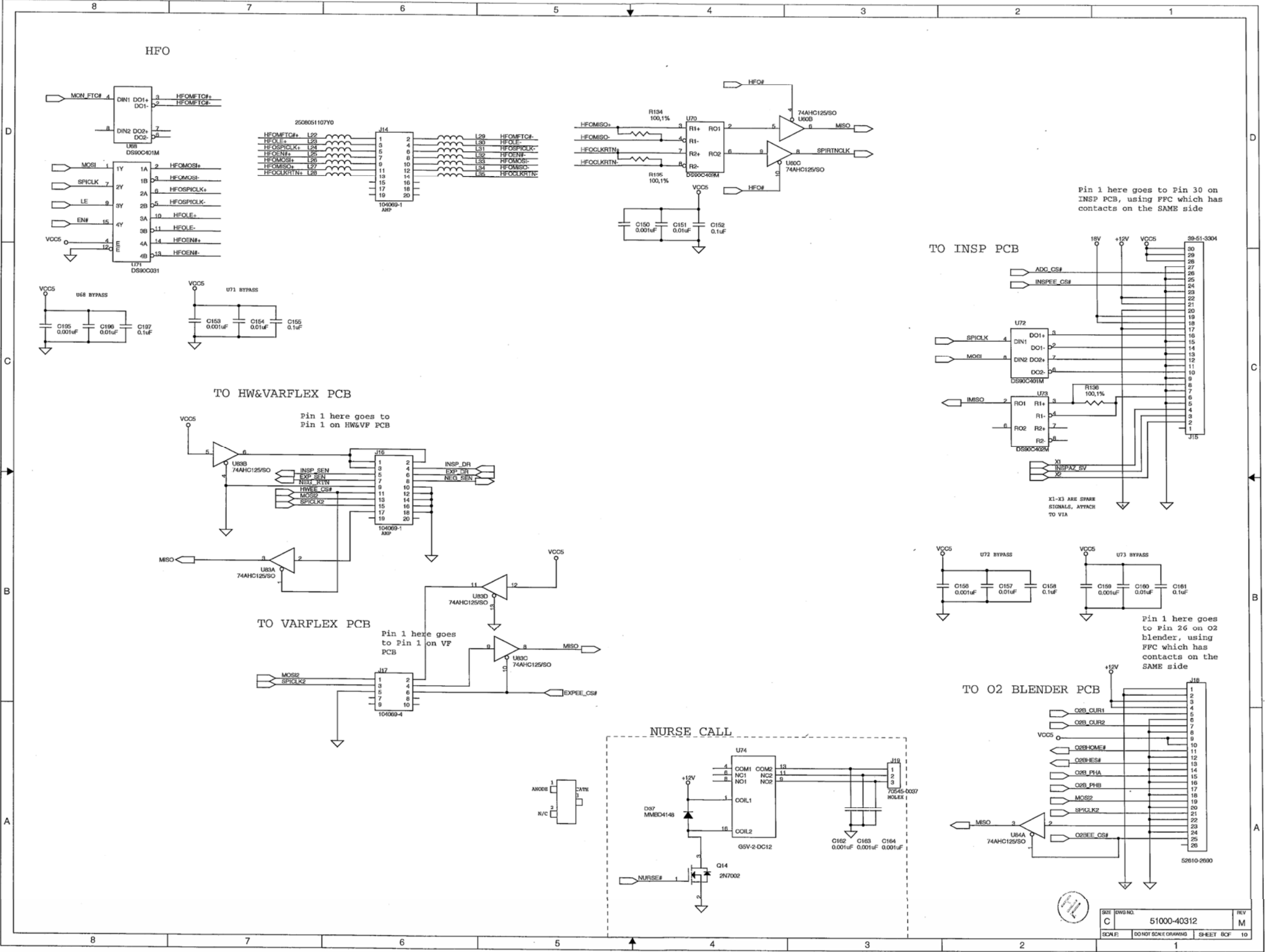


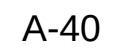




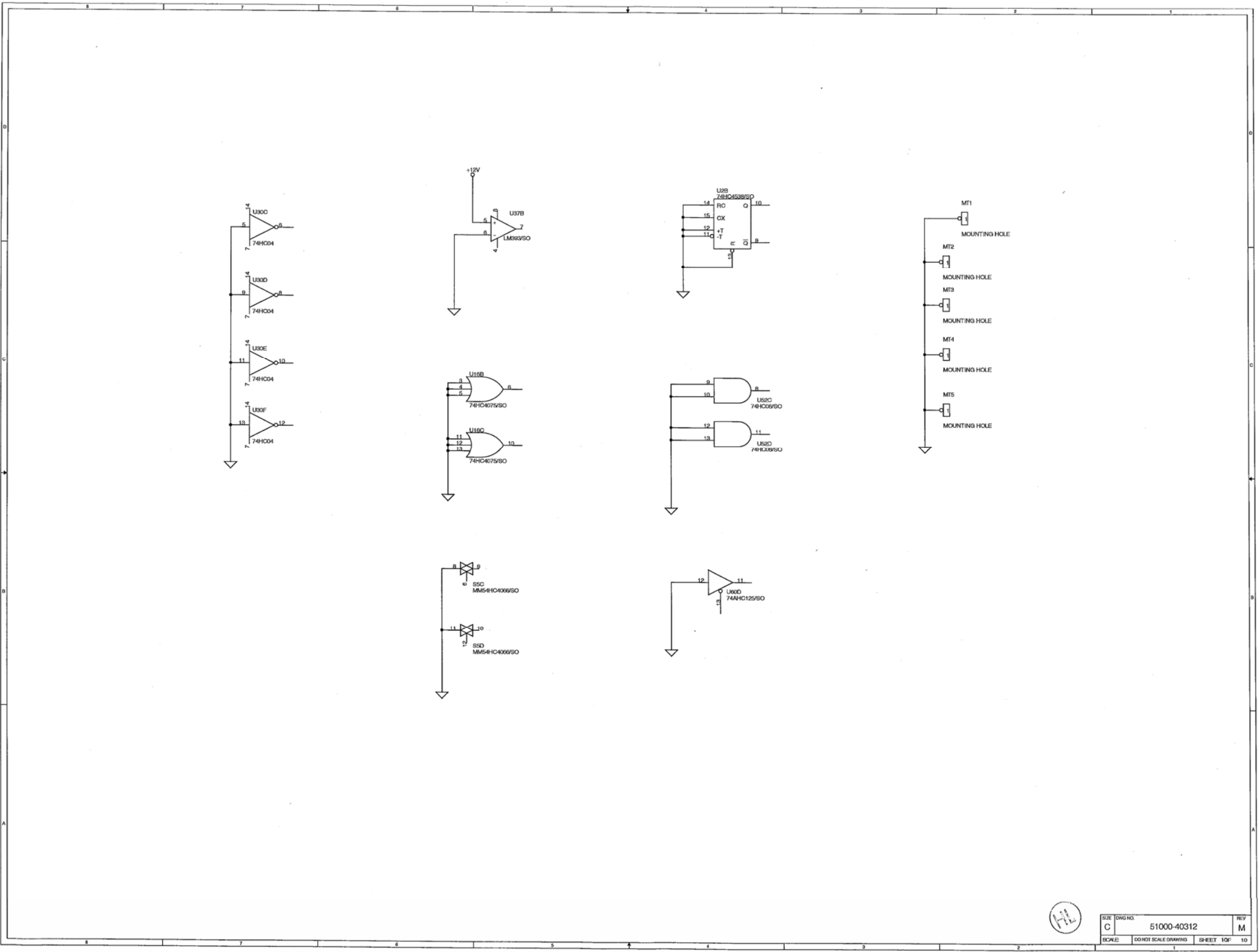




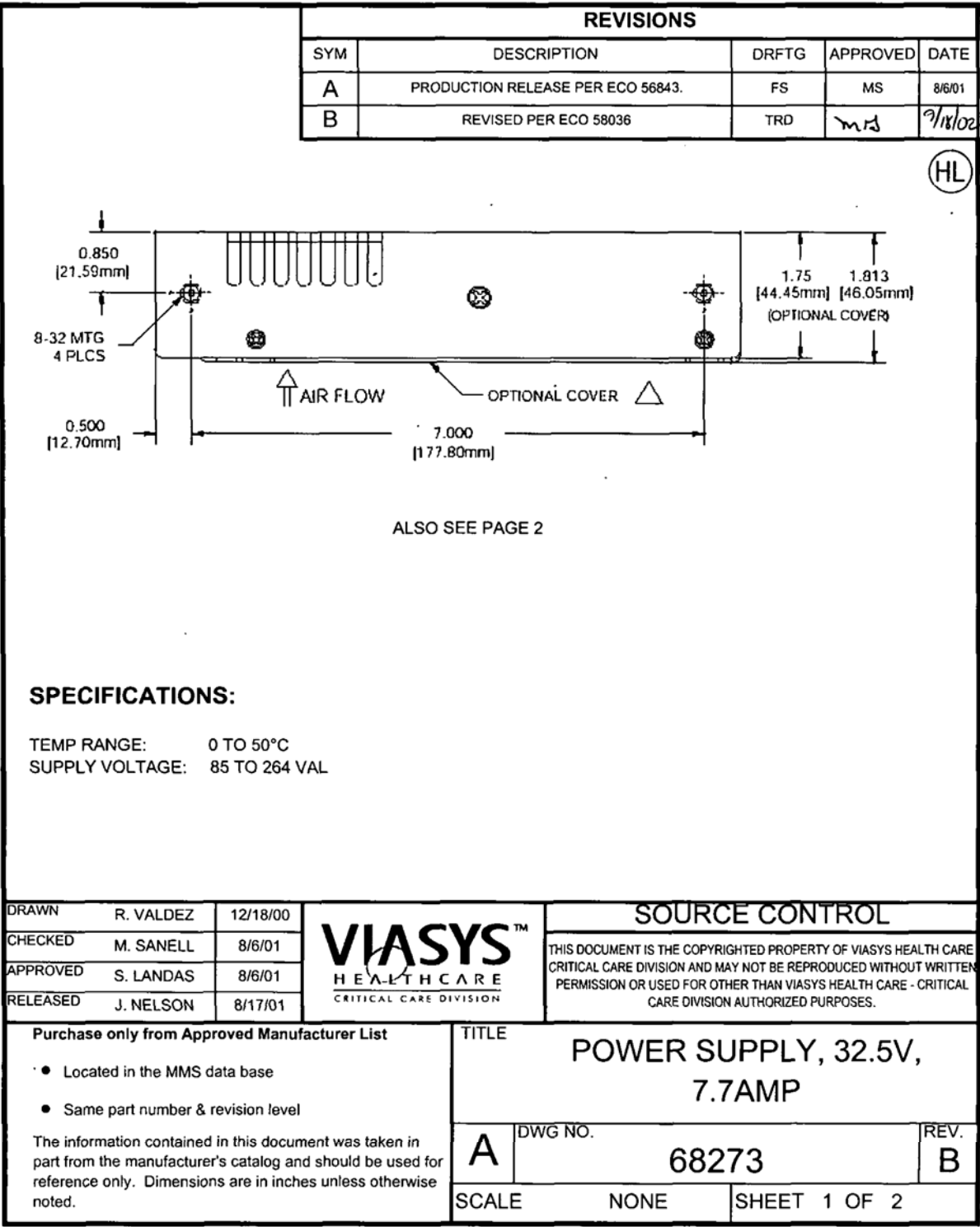




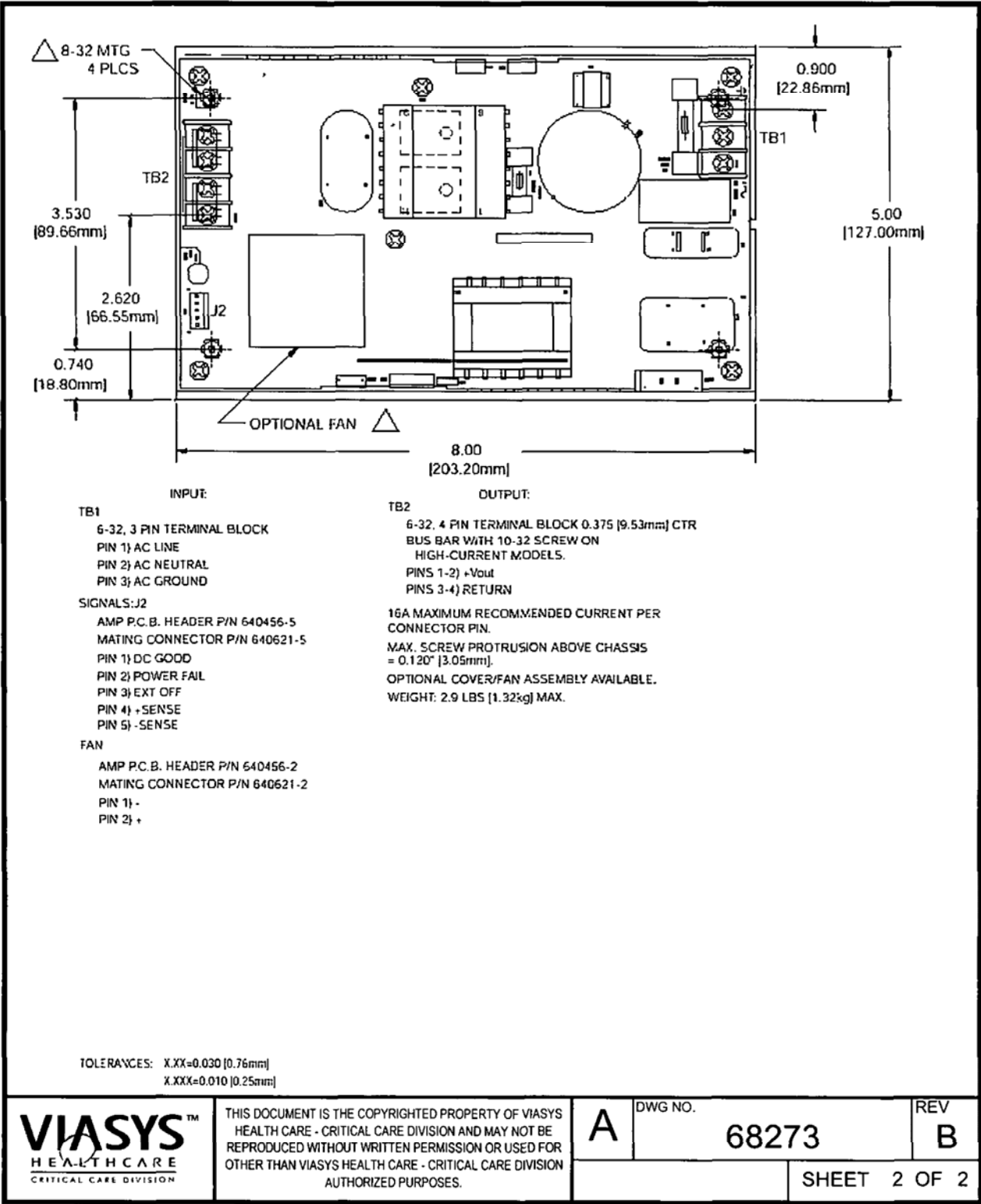




Power Supply







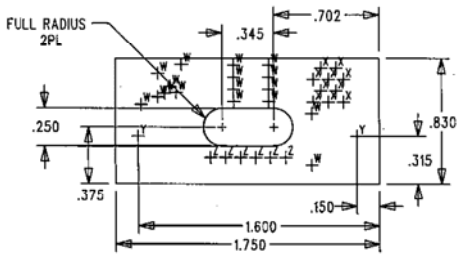
# PCBA, Exhalation Flow Transition

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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.

|           |                                     |                                  |                                         |
|-----------|-------------------------------------|----------------------------------|-----------------------------------------|
| CRITICAL  | <input type="checkbox"/> COMPONENT  | <input type="checkbox"/> DEVICE  | <input checked="" type="checkbox"/> N/A |
| TRACEABLE | <input type="checkbox"/> SERIAL NO. | <input type="checkbox"/> LOT NO. | <input checked="" type="checkbox"/> N/A |



| 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      | <i>[Signature]</i> | 1-3-02  |

| 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<br>A. DIMENSIONS ARE IN INCHES.<br>B. TOLERANCES:<br>.X ± .1 .XXX ± .005<br>.XX ± .02 ANG ± 1.00°<br>C. MACH SURFACES 63 OR BETTER.<br>D. CORNER FILLETS & RADII .005-.010.<br>E. DEBURR EDGES .005-.020.<br>F. CHAMFER FIRST & LAST THREAD 45°<br>G. INTERPRET PER ANSI Y14.5M-1982 |                         | APPROVALS                   | DATE                   | VIASYS™<br>HEALTHCARE<br>CRITICAL CARE DIVISION<br><br>TITLE<br>PCB, EXHALATION FLOW TRANSITION<br><br>SIZE B DRW NO. 51000-40431 REV. A<br>SCALE: 1 : 1 DO NOT SCALE DRAWING SHEET 1 OF 1 |         |
|                                                                                                                                                                                                                                                                                                                 |                         | 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 |

PCBA, Backup Alarm

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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  |

SILKSCREEN (TOP SIDE)

SOLDERMASK (TOP SIDE)

LAYER 1 (TOP SIDE)

LAYER 2 (BOTTOM SIDE)

SOLDERMASK (BOTTOM SIDE)

SILKSCREEN (BOTTOM SIDE)

0.062"  
+/-0.006"

|           |                                     |                                  |                                         |
|-----------|-------------------------------------|----------------------------------|-----------------------------------------|
| CRITICAL  | <input type="checkbox"/> COMPONENT  | <input type="checkbox"/> DEVICE  | <input checked="" type="checkbox"/> N/A |
| TRACEABLE | <input type="checkbox"/> SERIAL NO. | <input type="checkbox"/> LOT NO. | <input checked="" type="checkbox"/> N/A |

| 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

A. DIMENSIONS ARE IN INCHES.

B. TOLERANCES:  
.X ± .1  
.XX ± .02  
ANG ± 1.00°

C. MACH SURFACES 63 OR BETTER.

D. CORNER FILLETS & RADII .005-.010.

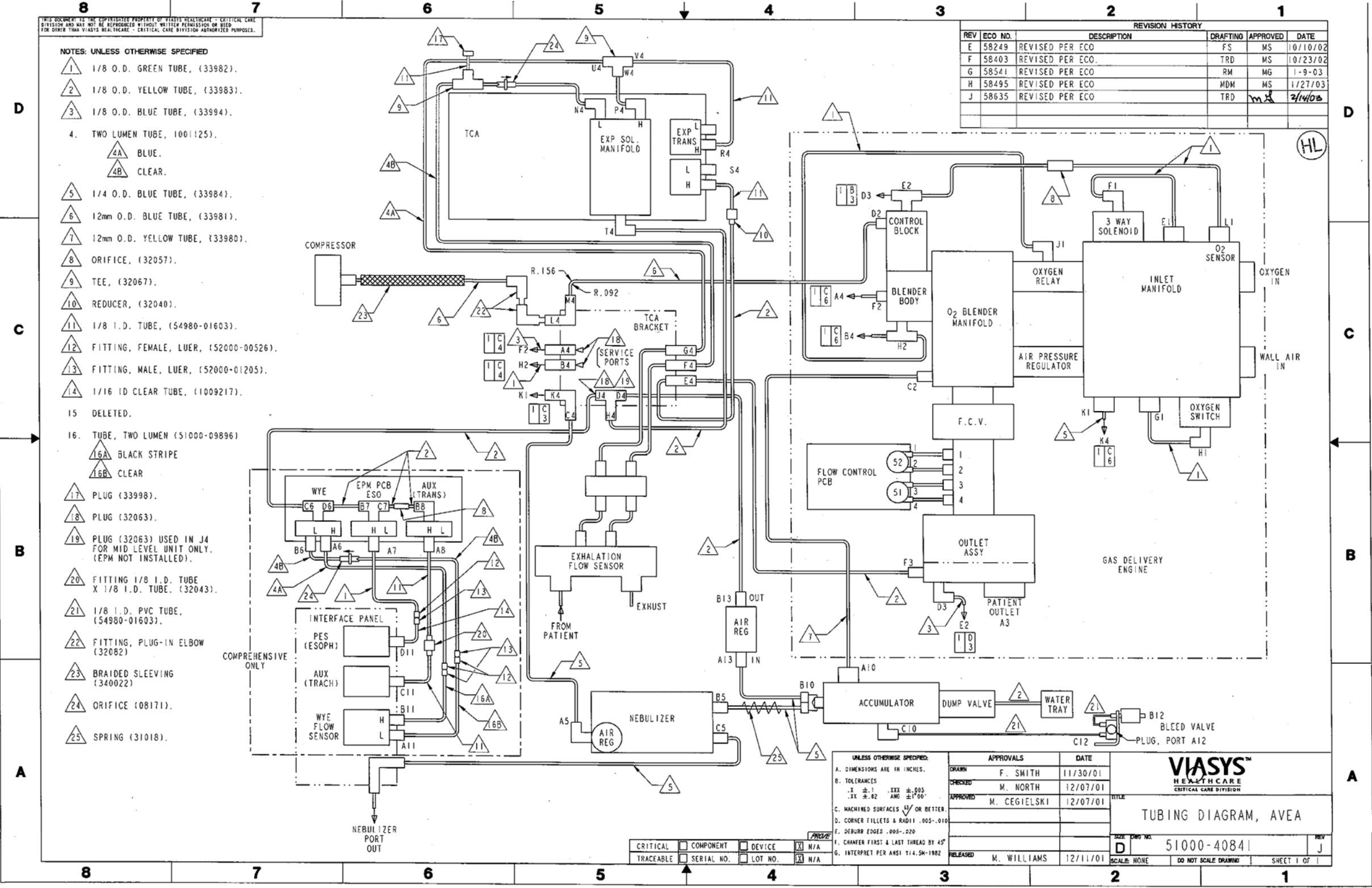
E. DEBURR EDGES .005-.020.

F. CHAMFER FIRST & LAST THREAD 45°

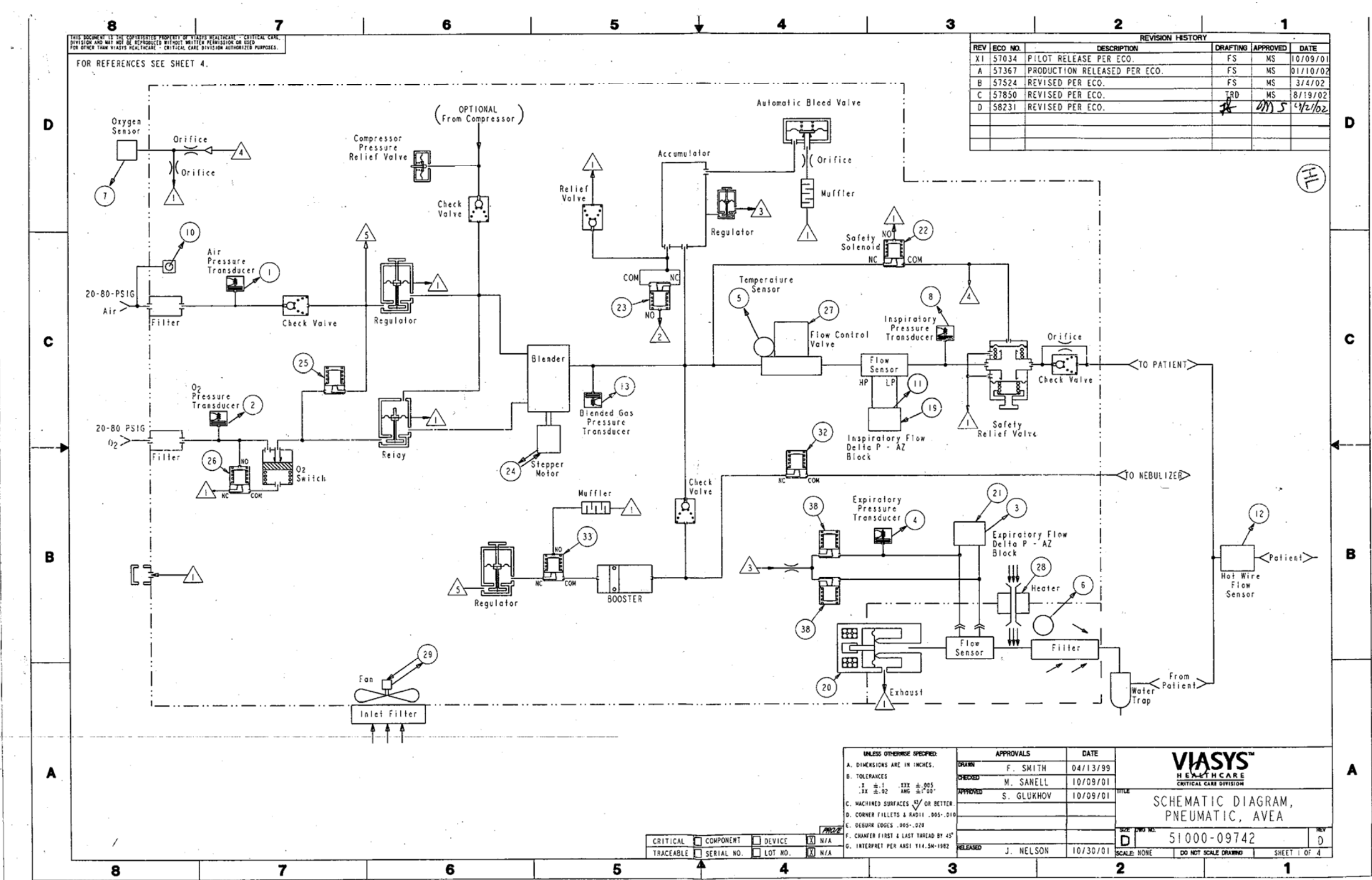
G. INTERPRET PER ANSI Y14.5M-1982

| QTY REQD                   | PART OR IDENTIFYING NO. | NOMENCLATURE OR DESCRIPTION | MATERIAL SPECIFICATION | FIND NO.                                                    |
|----------------------------|-------------------------|-----------------------------|------------------------|-------------------------------------------------------------|
|                            | DASH NO.                | PART LIST                   |                        |                                                             |
| UNLESS OTHERWISE SPECIFIED |                         | APPROVALS                   | DATE                   | VIASYS <sup>™</sup><br>HEALTHCARE<br>CRITICAL CARE DIVISION |
|                            |                         | DRAWN R.J. HALES            | 5.19.04                |                                                             |
|                            |                         | CHECKED M GREEN             | 5.26.04                |                                                             |
|                            |                         | APPROVED M BERRYHILL        | 5.27.04                |                                                             |
|                            |                         |                             |                        |                                                             |
|                            |                         |                             |                        | TITLE                                                       |
|                            |                         |                             |                        | PCB, BACKUP ALARM                                           |
|                            |                         |                             |                        | SIZE B                                                      |
|                            |                         |                             |                        | DRW NO. 52331                                               |
|                            |                         |                             |                        | REV. A                                                      |
|                            |                         | RELEASED R MILLETARY        | 5.27.04                | SCALE: 1 : 1                                                |
|                            |                         |                             |                        | DO NOT SCALE DRAWING                                        |
|                            |                         |                             |                        | SHEET 1 OF 1                                                |

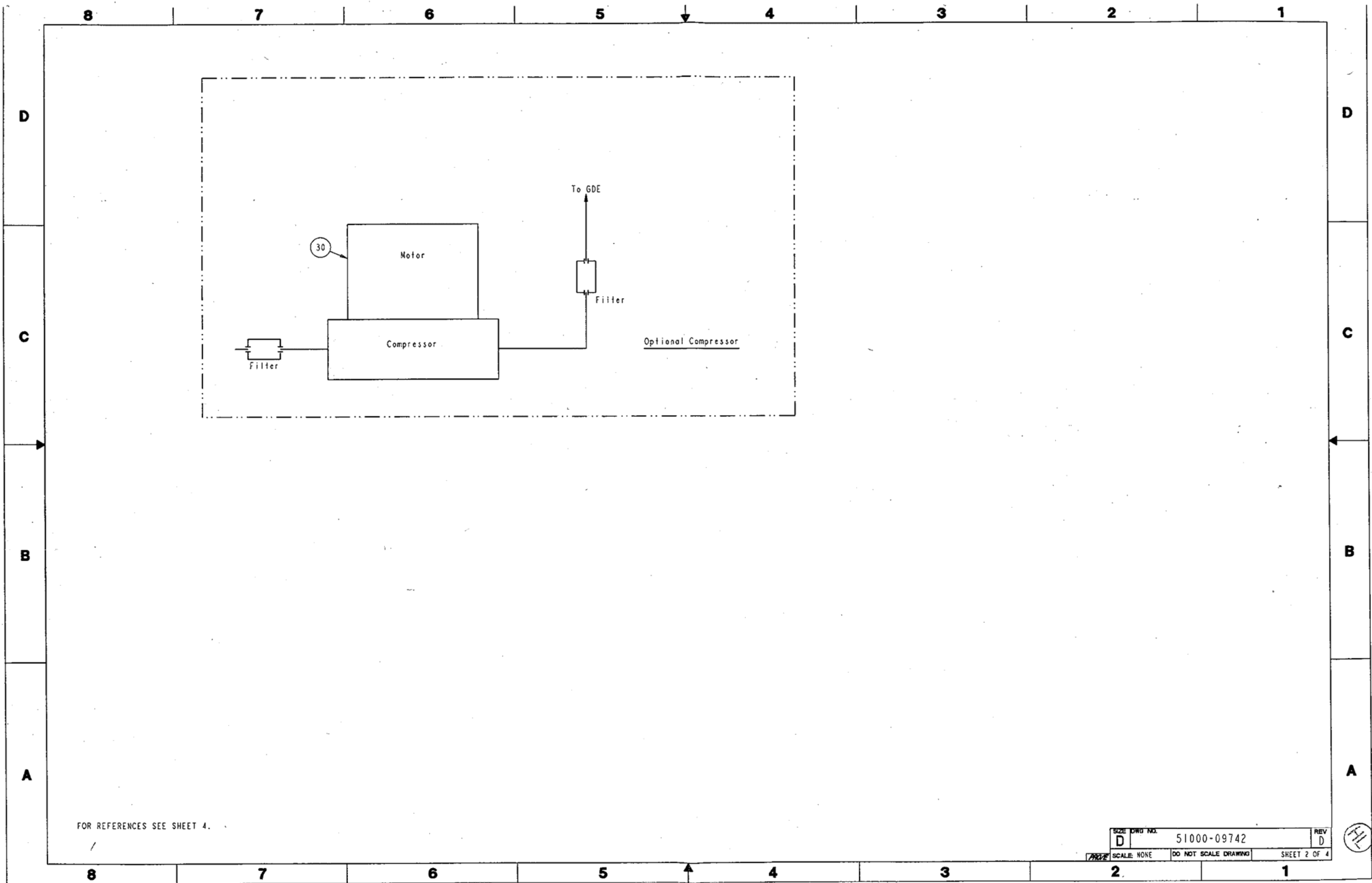
Tubing Diagram

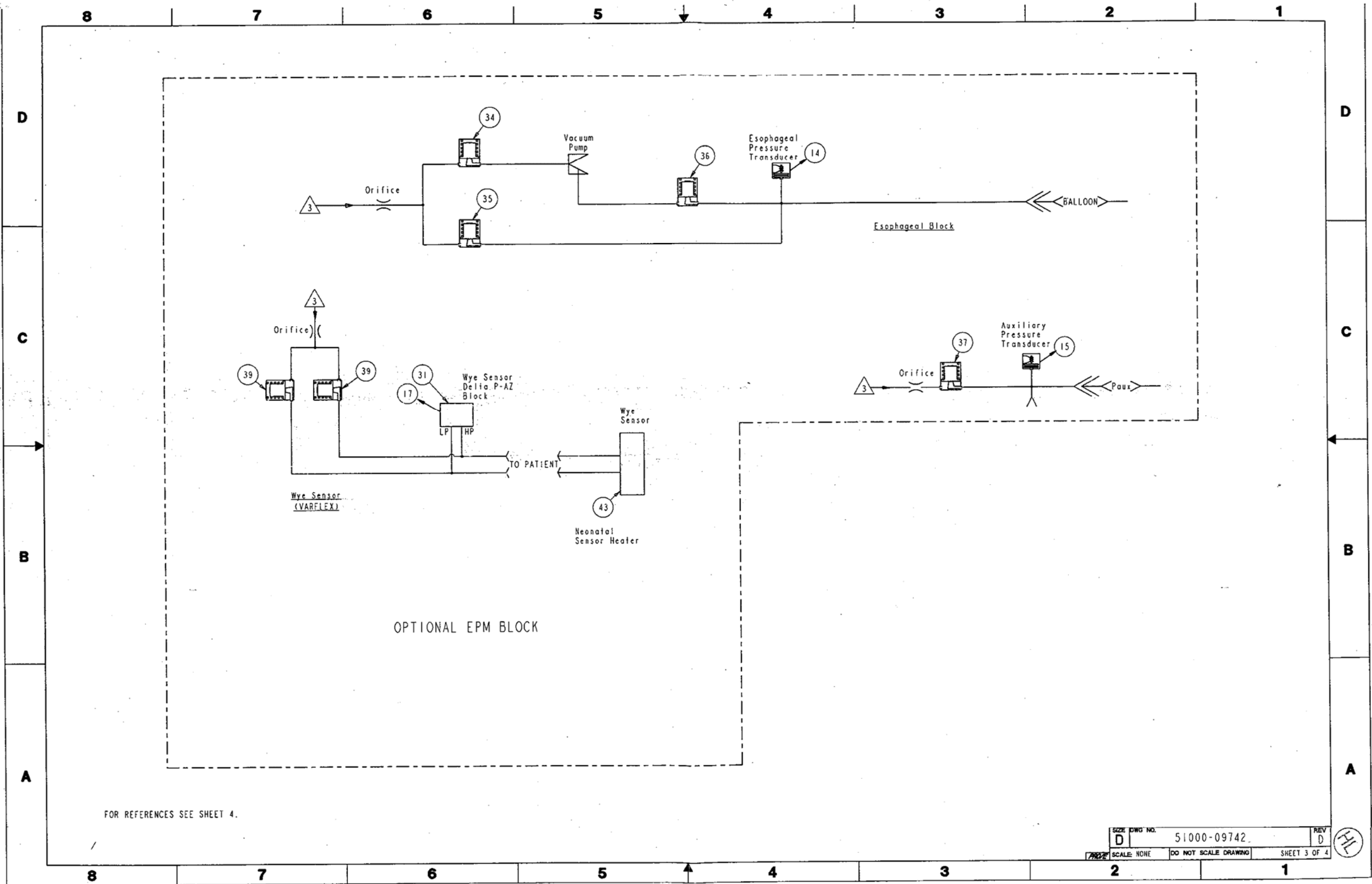


Pneumatic Diagram

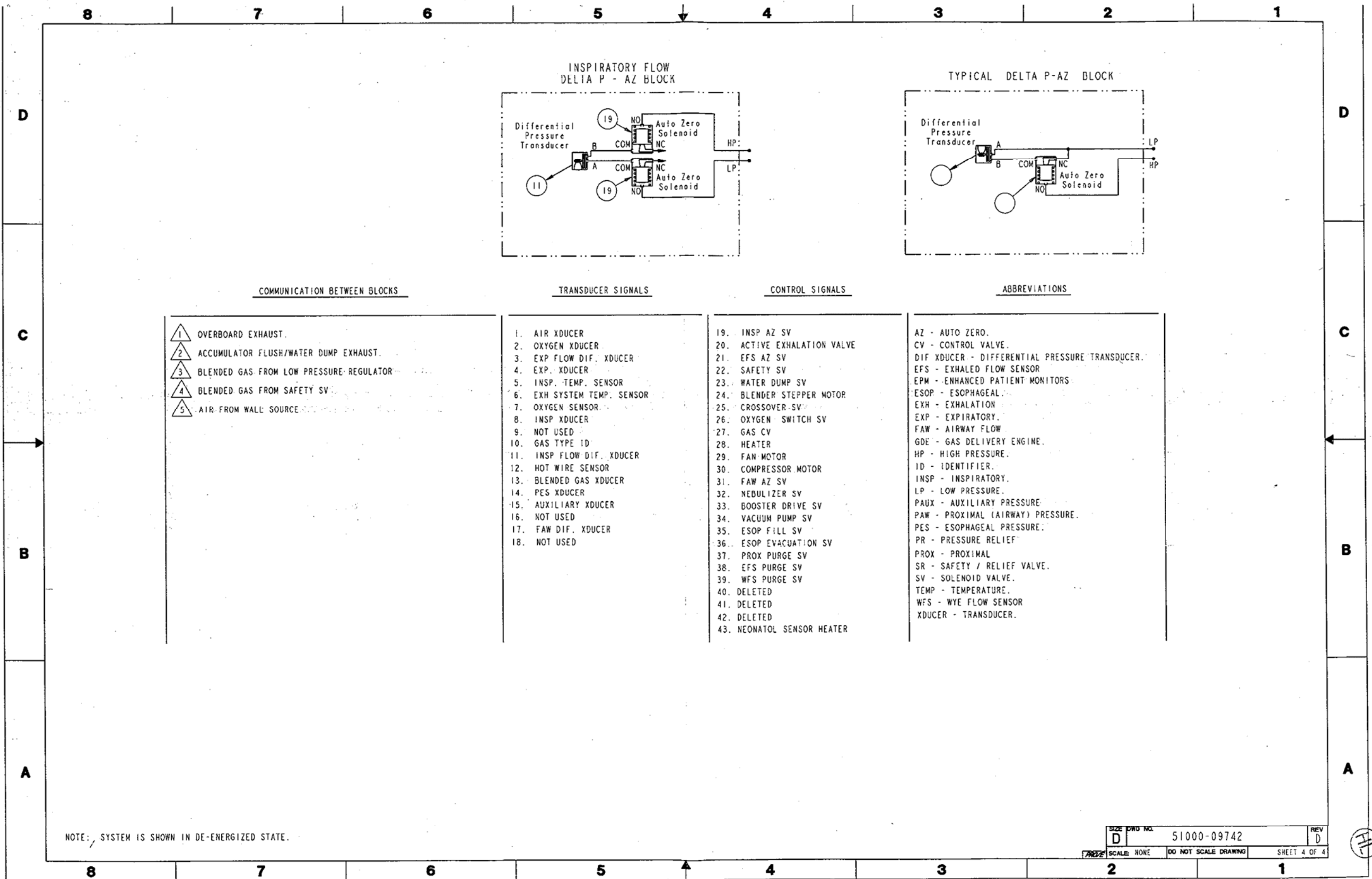




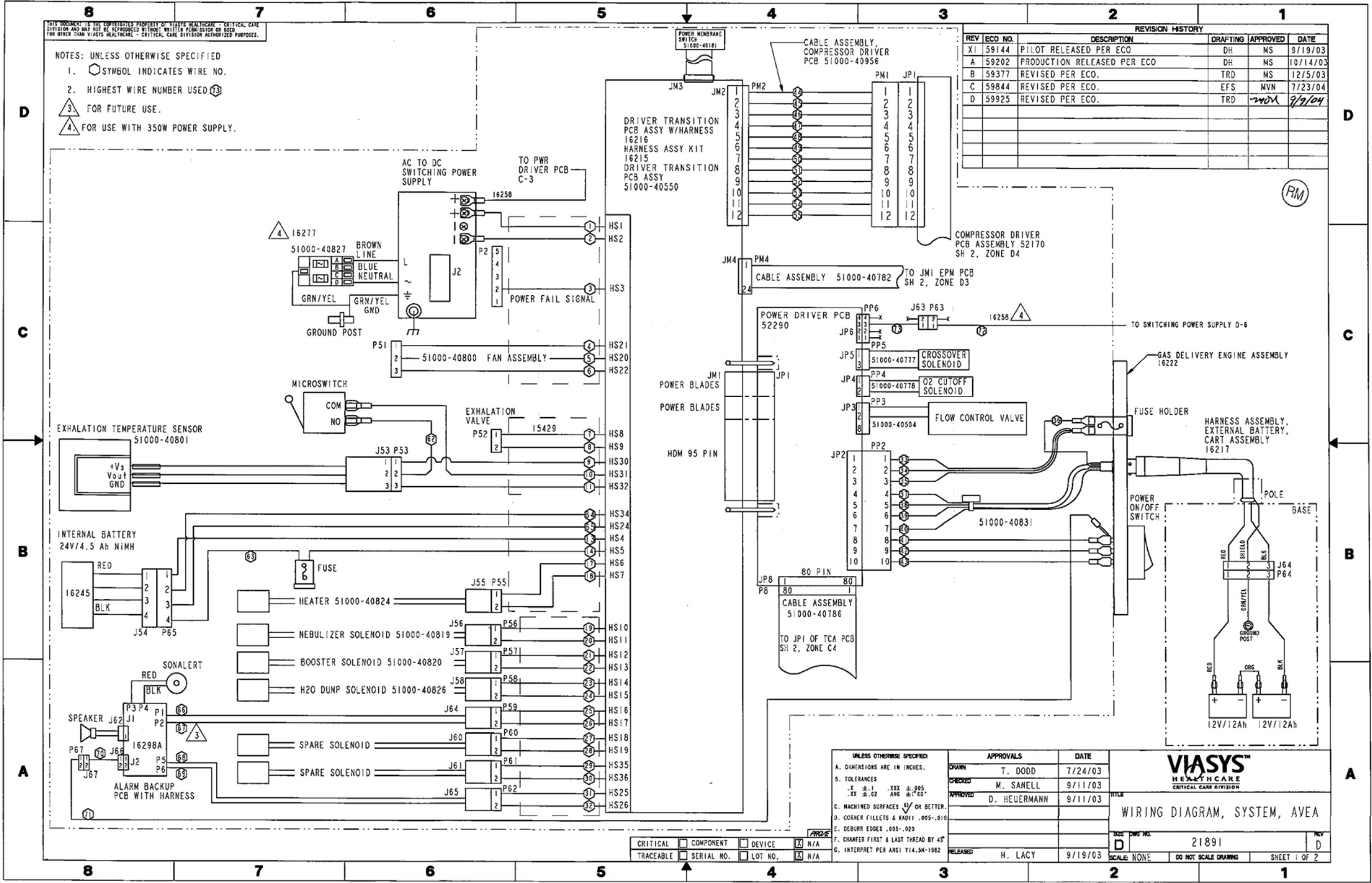


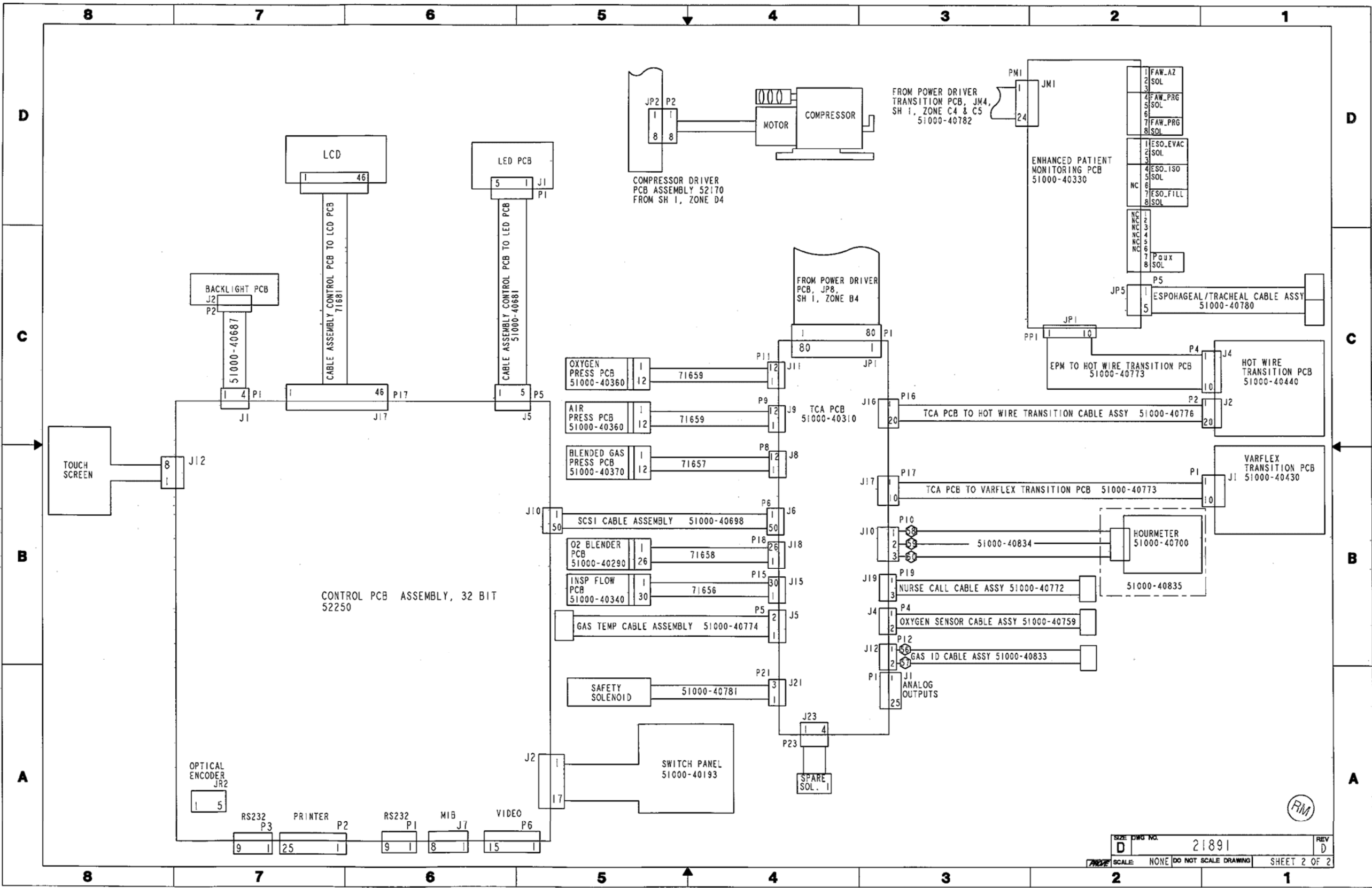






Wiring Diagram







# 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 within specification for a minimum duration of 30 minutes when operated on the internal battery. With the compressor active; one hour on a 50 PSI air source. Maximum charge time to achieve a full charge is 8 to 12 hours.

### External Battery:

22.0 to 26.4 VDC With use of the external batteries, the ventilator will operate for 2 hours with compressor active and 6 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 <sub>2</sub> O                    |
| Scale:       | 1 cmH <sub>2</sub> O/25 mV                       |
| Accuracy:    | ± 50 mV or ± 5% of reading, whichever is greater |
| Zero Offset: | 1.5 VDC at 0 cmH <sub>2</sub> O                  |

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:  $\pm 10\%$  of reading or  $\pm 30$  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:  $\pm 10\%$  of reading or  $\pm 30$  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)

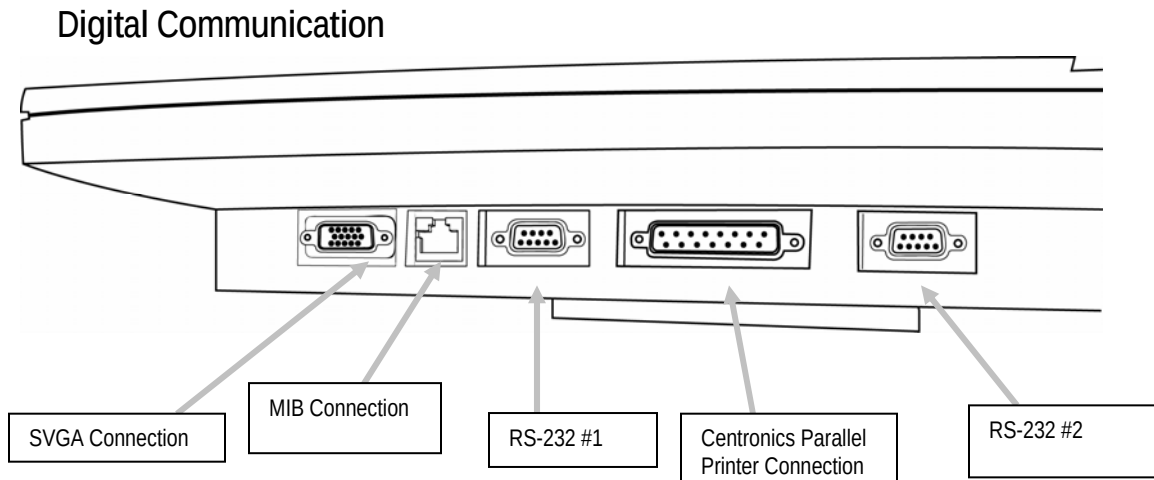
Accuracy:  $\pm 10\%$  of reading or  $\pm 30$  mV, whichever is greater

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).



**Figure A-1 Connections beneath the UIM screen**

The ventilator has two RS-232 ports on the 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 Viasys applications.

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

## 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, press:

SCREENS → UTILITIES → INPUT/OUTPUT → RS 232 Output:

Rotate the DATA DIAL until the applicable selection appears.

Press the “ACCEPT” button.

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.

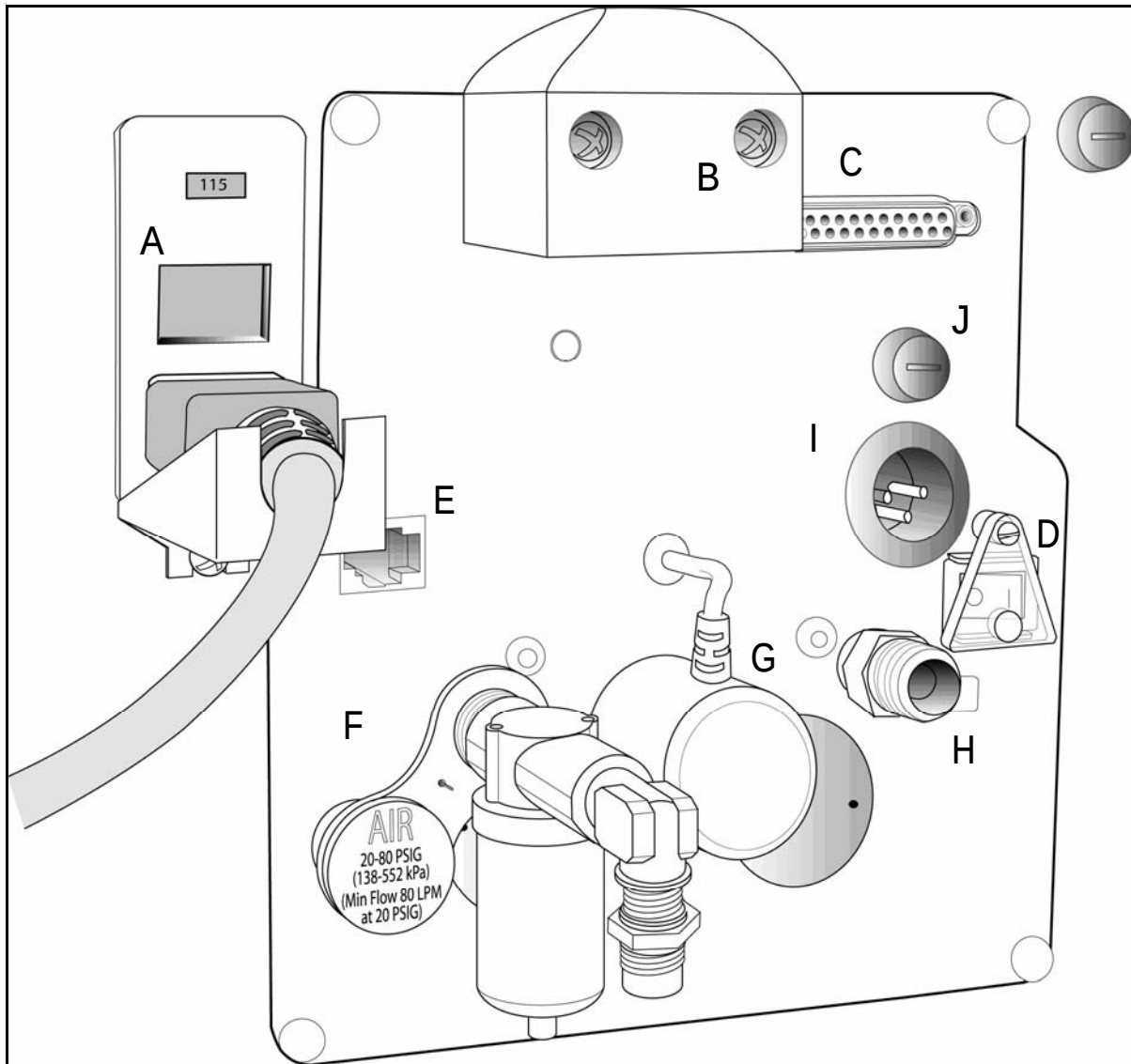
When properly connected, the communication ICON in the AVEA INPUT/OUTPUT screen will be present.

### **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 A-2    Figure 2.19 Rear Panel**

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

## ***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 & 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<sub>2</sub>).

The bleed to the O<sub>2</sub> 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 | ≤ 73 lbs. |
| Compressor        | ≤ 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<sub>2</sub>O at 20 L/min for the Intervene 255 Filter (small) and 4cm H<sub>2</sub>O at 100 L/min for the 725 (large) filter.

Compliance:

The compliance for the small filter is < 0.5 ml/cmH<sub>2</sub>O and for the large filter is < 0.4 ml/cmH<sub>2</sub>O

Materials:

Materials used in the construction of both filters have passed USP Class VI 121° C Plastic and Cytotoxicity 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 cmH<sub>2</sub>O at 20 L/min.

Compliance:

The compliance of both water trap assemblies including the collection bottle is < 0.2 ml/cmH<sub>2</sub>O.

| Wave | Sigh | Ptrig | Vsync | Trise Vsync | Tsync high | Tsync low | PSVhigh |
|------|------|-------|-------|-------------|------------|-----------|---------|
|------|------|-------|-------|-------------|------------|-----------|---------|

|             |             |                        |                                                        |
|-------------|-------------|------------------------|--------------------------------------------------------|
| Definition: | Fbias       | L/min x10              | Bias Flow (Bias Flow)                                  |
|             | Vmach       | mL x10                 | Machine Volume (Mach Vol)                              |
|             | Vlimit      | mL x10                 | Volume Limit (Vol Limit)                               |
|             | Trise       | 1..9                   | Pressure Control Rise Time (Rise Time)                 |
|             | Fcycle      | % ?5                   | Flow Cycle % of PIFR (Flow Cycle)                      |
|             | Trise-psv   | 1..9                   | PSV Rise Time (PSV Rise)                               |
|             | Fcycle-psv  | %                      | PSV Flow Cycle % of PIFR (PSV Cycle)                   |
|             | Tmax-psv    | sec x100               | PSV Maximum Inspiratory Time (PSV Tmax)                |
|             | Wave        | 0/1                    | Decelerating Flow Volume Waveform OFF/ON (Waveform)    |
|             | Sigh        | 0/1                    | Sigh Volume Breath OFF/ON (Sigh)                       |
|             | Ptrig       | cmH <sub>2</sub> O x10 | Pressure Trigger Sensitivity (Pres Trig)               |
|             | Vsync       | 0/1                    | Vsync mode OFF/ON (Vsync)                              |
|             | Trise-Vsync | 1..9                   | Vsync Rise Time (Vsync Rise)                           |
|             | Tsync-high  | %                      | Sync Window % of APRV/BiPhasic Time High (T High Sync) |
|             | Tsync-low   | %                      | Sync Window % of APRV/BiPhasic Time Low (T Low Sync)   |
|             | PSVhigh     | 0/1                    | PSV OFF/ON with APRV/BiPhasic Pres High(T High PSV)    |

Body Size: 8 words (32 bytes). Each field, signed 16-bit integer; little endian.

Value: Per definition.

RUSSIAN

TURKISH

JAPANESE

### Alm FiO<sub>2</sub> (O<sub>2</sub> Alarm)

Definition: Enable/Disable setting of FiO<sub>2</sub> Alarm.

Size: Two (2) bytes; unsigned 16-bit integer; little endian.

|        |          |   |
|--------|----------|---|
| Value: | ENABLED  | 0 |
|        | DISABLED | 1 |

Aout (Analog Output Type)

Definition: Selection of Flow Waveform for Analog Output.

Size: Two (2) bytes; unsigned 16-bit integer; little endian.

|        |              |   |
|--------|--------------|---|
| Value: | Wye Flow     | 0 |
|        | Machine Flow | 1 |

ILV Mode (ILV Mode)

Definition: Independent Lung Ventilation configuration of ventilator.

Size: Four (4) bytes; unsigned 32-bit integer; little endian.

|        |            |   |
|--------|------------|---|
| Value: | ILV OFF    | 0 |
|        | ILV MASTER | 1 |
|        | ILV SLAVE  | 2 |

Ain Gain(Analog Input Gain)

Definition: Selection of Amplifier Gain applied to Analog Inputs.

Size: Two (2) bytes; unsigned 16-bit integer; little endian.

|        |                 |        |
|--------|-----------------|--------|
| Value: | High Gain; 0-1V | 0xFFFF |
|        | Med. Gain; 0-5V | 0xAAAA |
|        | Low Gain; 0-10V | 0x0000 |

Pbaro (Baro Pres)

Definition: Barometric pressure setting of ventilator environment.

Size: Two (2) bytes; signed 16-bit integer; little endian.

Value: Per definition; mmHg.

Operational Settings Data

| 1st  |     |         |         |           |       | 7th   |
|------|-----|---------|---------|-----------|-------|-------|
| Mode | AAC | ETT Len | ETT Dia | Leak Comp | CCC k | Humid |

Body Size: 4 words (16 bytes); each field see below.

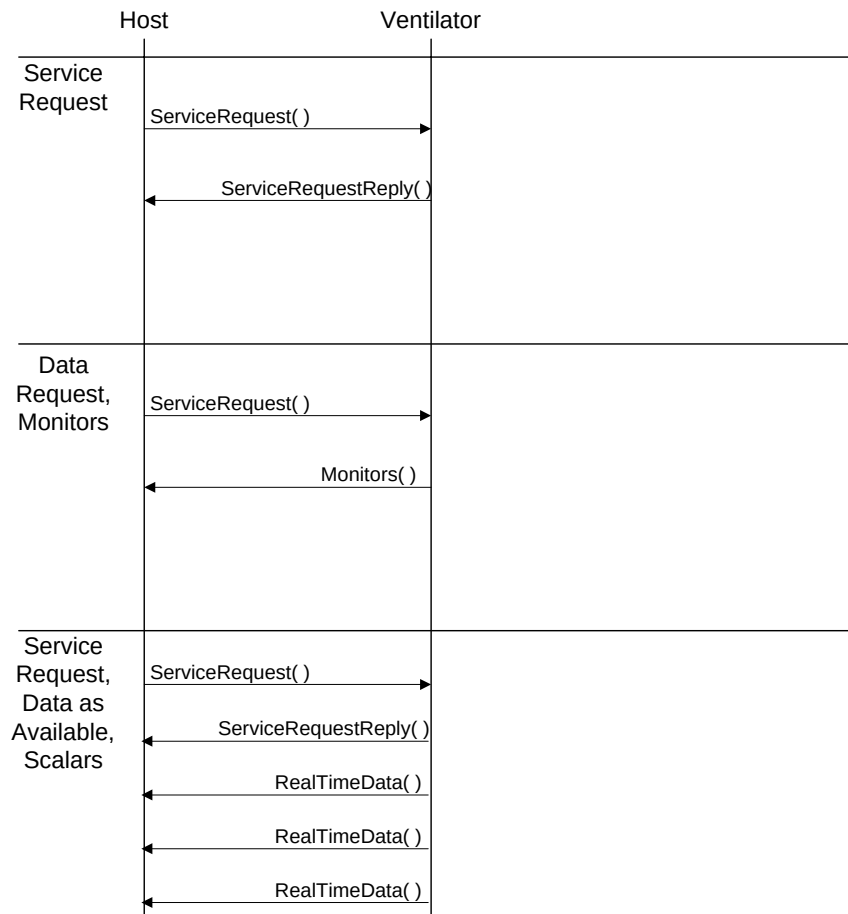
Value: N/A.

Mode (Mode)

Definition: Breath delivery Mode setting.

## Exchange Protocol

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



### 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 %O2 setting when Heliox is being used.                                                                                |

| AVEA MESSAGE BAR TEXT                         | CAUSE                                                                                                                                                               |
|-----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| "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"                         | <b><u>Service State Only:</u></b><br>Validation failure, while calibration dialog box is active for selected device.                                                |
| "Error saving Serial/Model Number"            | <b><u>Service State Only:</u></b><br>On accept of Serial Number or Model Number Change.                                                                             |
| Clear Messages                                | <b><u>Service State Only:</u></b><br>Validation success, while calibration dialog box is active for selected device.                                                |
| "FCV Characterization in progress."           | <b><u>Service State Only:</u></b><br>On start of Flow Control Valve characterization procedure.                                                                     |
| "FCV Characterization complete."              | <b><u>Service State Only:</u></b><br>On successful completion of Flow Control Valve characterization procedure.                                                     |
| "FCV Characterization failed."                | <b><u>Service State Only:</u></b><br>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.                                                                                                          |
| "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.                                                                    |



| AVEA MESSAGE BAR TEXT                   | CAUSE                                                                              |
|-----------------------------------------|------------------------------------------------------------------------------------|
| "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

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.

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".

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

Table G.1 Altitude to Barometric Pressure Conversion<sup>1</sup>

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

<sup>1</sup> CRC Handbook of Chemistry and Physics 61st Edition, 1980-1981, CRC Press, Inc. Boca Raton, Florida

## Monitor Ranges and Accuracies

| DISPLAY                                                                                                                                                                                                                                                                                                                           | DESCRIPTION                                                                                                       | RANGE        | ACCURACY                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------|
| <b>VOLUME MONITORS</b>                                                                                                                                                                                                                                                                                                            |                                                                                                                   |              |                                                                                                                                  |
| 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     | ( $\pm 20\text{ml} + 10\%$ of reading)-<br>Adult machine sensor<br>( $\pm 1\text{ ml} + 10\%$ of reading)-<br>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     | ( $\pm 20\text{ml} + 10\%$ of reading)-<br>Adult machine sensor<br>( $\pm 1\text{ ml} + 10\%$ of reading)-<br>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     | ( $\pm 20\text{ml} + 10\%$ of reading)-<br>Adult machine sensor<br>( $\pm 1\text{ ml} + 10\%$ of reading)-<br>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     | ( $\pm 20\text{ml} + 10\%$ of reading)-<br>Adult machine sensor<br>( $\pm 1\text{ ml} + 10\%$ of reading)-<br>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      | ( $\pm 20\text{ml} + 10\%$ of reading)-                                                                                          |
| % Leak                                                                                                                                                                                                                                                                                                                            | Percent leakage. The difference between the inspired and exhaled tidal volumes in terms of % difference.          | Derived      | Derived                                                                                                                          |

| DISPLAY                         | DESCRIPTION                                                                 | RANGE                          | ACCURACY                                                                          |
|---------------------------------|-----------------------------------------------------------------------------|--------------------------------|-----------------------------------------------------------------------------------|
| 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                                                                           |
| <b>RATE/TIME MONITORS</b>       |                                                                             |                                |                                                                                   |
| Rate                            | Breath Rate.                                                                | 0 to 200 bpm                   | $\pm 3\%$ or $\pm 2$ bpm whichever is greater                                     |
| Spon Rate                       | Spontaneous breath rate.                                                    | 0 to 200 bpm                   | $\pm 3\%$ or $\pm 2$ bpm whichever is greater                                     |
| Ti                              | Inspiratory time.                                                           | 0.00 to 99.99 sec              | $\pm 0.03$ sec                                                                    |
| Te                              | Exhalation Time.                                                            | 0.00 to 99.99 sec              | $\pm 0.03$ sec                                                                    |
| I:E                             | Inspiratory/expiratory ratio<br><i>Note: Not active for demand breaths.</i> | 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 <sup>2</sup> /min/L | Derived from accuracies for spontaneous breath rate and spontaneous minute volume |
| <b>PRESSURE MONITORS</b>        |                                                                             |                                |                                                                                   |
| Ppeak                           | Peak inspiratory pressure.<br>Not active with spontaneous breaths           | 0 to 120 cmH <sub>2</sub> O    | $\pm 3.5\%$ of reading or $\pm 2$ cmH <sub>2</sub> O, whichever is greater        |
| Pmean                           | Mean airway pressure.                                                       | 0 to 120 cmH <sub>2</sub> O    | $\pm 3.5\%$ of reading or $\pm 2$ cmH <sub>2</sub> O, whichever is greater        |
| Pplat                           | Plateau pressure. If no plateau occurs, then the monitor displays *<br>* *  | 0 to 120 cmH <sub>2</sub> O    | $\pm 3.5\%$ of reading or $\pm 2$ cmH <sub>2</sub> O, whichever is greater        |
| PEEP                            | Positive end expiratory pressure.                                           | 0 to 60 cmH <sub>2</sub> O     | $\pm 3.5\%$ of reading or $\pm 2$ cmH <sub>2</sub> O, whichever is greater        |
| Air Inlet                       | Air inlet gas supply pressure.                                              | 0 to 80 psig                   | $\pm 5$ psig (1.4 – 5.5 bar)                                                      |
| O <sub>2</sub> Inlet            | Oxygen inlet gas supply pressure.                                           | 0 to 80 psig                   | $\pm 5$ psig (1.4 - 5.5 bar)                                                      |
| <b>GAS COMPOSITION MONITORS</b> |                                                                             |                                |                                                                                   |

| DISPLAY           | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                       | RANGE                                 | ACCURACY                                                                 |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|--------------------------------------------------------------------------|
| FiO <sub>2</sub>  | Delivered percent O <sub>2</sub> .                                                                                                                                                                                                                                                                                                                                                                                | 0 to 100%                             | ± 3%                                                                     |
| <b>MECHANICS</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                   |                                       |                                                                          |
| Cdyn              | Dynamic Compliance (C <sub>DYN</sub> and C <sub>DYN</sub> / Kg), absolute and normalized to patient weight.                                                                                                                                                                                                                                                                                                       | 0 to 300 ml/cmH <sub>2</sub> O        | Derived                                                                  |
| Cdyn/Kg           |                                                                                                                                                                                                                                                                                                                                                                                                                   | 0.00 to 5.00 ml/cmH <sub>2</sub> O·kg |                                                                          |
| Cstat             | Respiratory System Compliance (C <sub>RS</sub> ), (a.k.a. Static Compliance C <sub>STAT</sub> ), absolute and normalized to patient weight.<br><i>Note: This requires an Inspiratory Hold maneuver.</i>                                                                                                                                                                                                           | 0 to 300 ml/cmH <sub>2</sub> O        | Derived                                                                  |
| Cstat/Kg          |                                                                                                                                                                                                                                                                                                                                                                                                                   | 0.00 to 5.00 ml/cmH <sub>2</sub> O·kg |                                                                          |
| Rrs               | Respiratory system resistance.<br><i>Note: Calculation is performed during an Inspiratory Hold maneuver.</i>                                                                                                                                                                                                                                                                                                      | 0 to 100 cmH <sub>2</sub> O/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 |
| 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 <sub>ES</sub> ). Requires an esophageal balloon.                                                                                                                                                                                                                                                                                     | 0 to 300 mL/cmH <sub>2</sub> O        | ± 10%                                                                    |
| C <sub>LUNG</sub> | 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 <sub>2</sub> O        | ± 10%                                                                    |

| DISPLAY      | DESCRIPTION                                                                                                                                                                                                                                                 | RANGE                                 | ACCURACY                                                      |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|---------------------------------------------------------------|
| $C_{20} / C$ | 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                          | $\pm 10\%$                                                    |
| $R_{RS}$     | 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 <sub>2</sub> O/L/sec     | $\pm 10\%$                                                    |
| $R_{PEAK}$   | 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 <sub>2</sub> O/L/sec | $\pm 10\%$                                                    |
| $R_{IMP}$    | 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 <sub>2</sub> O/L/sec | $\pm 10\%$                                                    |
| $R_{LUNG}$   | 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 <sub>2</sub> O/L/sec | $\pm 10\%$                                                    |
| $dP_{AW}$    | The difference between peak airway pressure ( $P_{PEAK AW}$ ) and baseline airway pressure ( $PEEP_{AW}$ ).                                                                                                                                                 | –120 to 120 cmH <sub>2</sub> O        | $\pm 2$ cm H <sub>2</sub> O or $\pm 5\%$ whichever is greater |
| $dP_{ES}$    | The difference between peak esophageal pressure ( $P_{PEAK ES}$ ) and baseline esophageal pressure ( $PEEP_{ES}$ ).                                                                                                                                         | –120 to 120 cmH <sub>2</sub> O        | $\pm 2$ cm H <sub>2</sub> O or $\pm 5\%$ whichever is greater |
| AutoPEEP     | The airway pressure at the end of an expiratory hold maneuver. Requires a passive patient.                                                                                                                                                                  | 0 to 50 cmH <sub>2</sub> O            | $\pm 2$ cm H <sub>2</sub> O or $\pm 5\%$ whichever is greater |

| DISPLAY                    | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | RANGE                         | ACCURACY                                                       |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|----------------------------------------------------------------|
| 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 <sub>2</sub> O    | $\pm 2$ cm H <sub>2</sub> O or $\pm 5\%$ whichever is greater  |
| AutoPEEP <sub>E</sub><br>s | The difference between esophageal pressure measured at the end of exhalation (PEEP <sub>ES</sub> ) minus the esophageal pressure measured at the start of a patient-initiated breath (P <sub>ES start</sub> ) 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 <sub>AW</sub> ) and the airway pressure when the patient initiates a breath (P <sub>AW start</sub> ). Requires an esophageal balloon. | 0 to 50 cmH <sub>2</sub> O    | $\pm 2$ cm H <sub>2</sub> O or $\pm 5\%$ whichever is greater  |
| Ptp Plat                   | Transpulmonary pressure during an inspiratory hold, which is the difference between the airway plateau pressure (P <sub>PLAT AW</sub> ) and the corresponding esophageal pressure. Requires an inspiratory hold and esophageal balloon.                                                                                                                                                                                                                                                                                   | –60 to 120 cmH <sub>2</sub> O | $\pm 2$ cm H <sub>2</sub> O or $\pm 5\%$ whichever is greater  |
| P <sub>tp</sub> 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 <sub>2</sub> O | $\pm 2$ cmH <sub>2</sub> O or $\pm 5\%$ , whichever is greater |
| MIP                        | The maximum negative airway pressure that is achieved by the patient, during an expiratory hold maneuver.                                                                                                                                                                                                                                                                                                                                                                                                                 | –60 to 120 cmH <sub>2</sub> O | $\pm 2$ cmH <sub>2</sub> O or $\pm 5\%$ , whichever is greater |
| P <sub>100</sub>           | The negative pressure that occurs 100 ms after an inspiratory effort has been detected.                                                                                                                                                                                                                                                                                                                                                                                                                                   | –60 to 120 cmH <sub>2</sub> O | $\pm 2$ cmH <sub>2</sub> O or $\pm 5\%$ , whichever is greater |

| DISPLAY          | DESCRIPTION                                                                                                                                                                                                                                                              | RANGE                     | ACCURACY   |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------|
| WOB <sub>V</sub> | The summation of airway pressure (P <sub>AW</sub> ) minus the baseline airway pressure (PEEP <sub>AW</sub> ) times the change in tidal volume to the patient ( $\Delta V$ ) during inspiration, and normalized to the total inspiratory tidal volume (V <sub>Ti</sub> ). | 0.00 to 20.00<br>Joules/L | $\pm 10\%$ |
| WOB <sub>P</sub> | Patient Work of Breathing (WOB <sub>P</sub> ), 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<br>Joules/L | $\pm 10\%$ |
| WOB <sub>I</sub> | 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<br>Joules/L | $\pm 10\%$ |
|                  |                                                                                                                                                                                                                                                                          |                           |            |

## Note

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*Monitored values are displayed as BTPS*

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## Sensor Specifications & Circuit Resistance

Table E.1 Varflex® Flow Sensor

| Sensor                            | Infant 15 mm                                                      | Adult 15 mm                                                       |
|-----------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------|
| Part Number                       | 7002500                                                           | 7002300                                                           |
| Type                              | Single Use                                                        | Single Use                                                        |
| Circuit Location                  | Wye                                                               | Wye                                                               |
| <b>Performance Specifications</b> |                                                                   |                                                                   |
| Flow Range                        | 0.024 to 30 L/min                                                 | 1.2 to 180 L/min                                                  |
| Diff Pres Range                   | ± 5.72 cmH <sub>2</sub> O                                         | ± 5.72 cmH <sub>2</sub> O                                         |
| Accuracy*                         | ± (0.012 L/min + 5% or reading                                    | ± (0.1 L/min + 5% or reading                                      |
| Resistance                        | 4.5 cmH <sub>2</sub> O @ 30 L/min                                 | 2.4 cmH <sub>2</sub> O @ 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 <sub>2</sub> O                                    | -140 to 140 cmH <sub>2</sub> O                                    |
| Calibration (EEPROM)              | 29 Point Curve                                                    | 29 Point Curve                                                    |
| Linearity                         | < 1% between points                                               | < 1% between points                                               |
| Operating Temperature             | 5° to 40° C<br>41° to 104° F                                      | 5° to 40° C<br>41° to 104° F                                      |
| <b>Physical Specifications</b>    |                                                                   |                                                                   |
| 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<br>Flap – Mylar<br>Tubing – PVC<br>Connector - ABS | Sensor – Lexan<br>Flap – Mylar<br>Tubing – PVC<br>Connector - ABS |

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

\* Includes ± 1% for linearity & 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 E-2 Hot Wire Flow Sensor

|                                   |                                                                                                                                     |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Part Number                       | 51000-40081                                                                                                                         |
| Type:                             | Multiple use heated wire                                                                                                            |
| Circuit Location:                 | Wye                                                                                                                                 |
| <b>Performance Specifications</b> |                                                                                                                                     |
| Flow Range:                       | 0 (+/- 0.002) to 30 L/min                                                                                                           |
| Vol. Accuracy:                    | +/-10%                                                                                                                              |
| Flow Resistance:                  | 15 cmH <sub>2</sub> O @ 20 L/min                                                                                                    |
| Dead Space:                       | 0.8 mL                                                                                                                              |
| Freq. Response*:                  | 16 Hz                                                                                                                               |
| Calibration:                      | 36 point curve                                                                                                                      |
| Linearity:                        | < 2%                                                                                                                                |
| Operating Temperature:            | 5 to 40°C                                                                                                                           |
| <b>Physical Specifications</b>    |                                                                                                                                     |
| Sensor length                     | 1.68"                                                                                                                               |
| Diameter Insp (Vent Side)         | 15 mm OD                                                                                                                            |
| Diameter Exp (Patient Side)       | 15 mm OD                                                                                                                            |
| Tube length                       | N/A                                                                                                                                 |
| Connector                         | Pin & Socket type                                                                                                                   |
| Weight                            | < 10g (not including wire)                                                                                                          |
| Service Life                      | 25 cycles                                                                                                                           |
| Sterilization                     | Steam Autoclave                                                                                                                     |
| Materials                         | Sensor - Delrin<br>Wire – Platinum<br>Screen – Stainless Steel 304 or 316<br>Pin – PhBz, gold over nickel plated<br>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<sub>2</sub>O) at 60 L/min for adult patients
- 0.6 KPA (6cmH<sub>2</sub>O) at 30 L/min for pediatric patients
- 0.6 KPA (6cmH<sub>2</sub>O) 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<sub>2</sub>O 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 <sub>2</sub> O |
| Peak Flow            | 8.0 L/min             |
| Inspiratory Time     | 0.35 sec              |
| PEEP                 | 0 cmH <sub>2</sub> O  |
| Flow Trigger         | 20 Lmin               |
| % O <sub>2</sub>     | 21 %                  |
| Bias Flow            | 5 L/min               |
| Pressure trigger     | 20 cmH <sub>2</sub> O |

2. Select waveform P<sub>insp</sub>

With the patient wye blocked, allow the baseline pressure (PEEP) to stabilize for 10 seconds and press the FREEZE key.

Use the data dial to read the pressure from the P<sub>insp</sub> waveform. The pressure must not exceed 4cmH<sub>2</sub>O 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:

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

Range: 0 to 500 b<sup>2</sup>/min/L

Resolution: 1 b<sup>2</sup>/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 ( $dP_{ES}$ ).

$$C_{CW} = \frac{V_{te}}{dP_{ES}}$$

Range: 0 to 300 mL/cmH<sub>2</sub>O

Resolution: 1 mL/cmH<sub>2</sub>O

Note: Requires an esophageal balloon catheter.

Accuracy:  $\pm 10\%$

## 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.

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

Range: 0 to 300 mL/cmH<sub>2</sub>O

Resolution: 1 mL/cmH<sub>2</sub>O

Note: Requires an Inspiratory Hold maneuver and an esophageal balloon catheter.

Accuracy:  $\pm 10\%$

## 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:  $\pm 10\%$

## 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<sub>2</sub>O/L/sec

Resolution: 0.1 cmH<sub>2</sub>O/L/sec

Limitation: Active for volume breaths only.

Note: Requires an Inspiratory Hold maneuver.

Accuracy:  $\pm 10\%$

## 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<sub>2</sub>O/L/sec

Resolution: 0.1 cmH<sub>2</sub>O/L/sec

Accuracy:  $\pm 10\%$

## 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<sub>2</sub>O/L/sec

Resolution: 0.1 cmH<sub>2</sub>O/L/sec

Note: Requires an Inspiratory Hold maneuver and a tracheal catheter.

Accuracy:  $\pm 10\%$

## 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<sub>2</sub>O/L/sec

Resolution: 0.1 cmH<sub>2</sub>O/L/sec

Note: Requires an Inspiratory Hold maneuver and a tracheal catheter.

Accuracy:  $\pm 10\%$

## 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:  $\pm 10\%$

## 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:  $\pm 10\%$

## 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<sub>2</sub>O

Resolution: 1 cmH<sub>2</sub>O

Accuracy:  $\pm 2\text{cmH}_2\text{O}$  or  $\pm 5\%$ , 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<sub>2</sub>O

Resolution: 1 cmH<sub>2</sub>O

Accuracy:  $\pm 2\text{cmH}_2\text{O}$  or  $\pm 5\%$ , whichever is greater

## AutoPEEP<sub>AW</sub>

AutoPEEP<sub>AW</sub>, is the airway pressure at the end of an expiratory hold maneuver.

Range: 0 to 50 cmH<sub>2</sub>O

Resolution: 1 cmH<sub>2</sub>O

Accuracy:  $\pm 2\text{cmH}_2\text{O}$  or  $\pm 5\%$ , whichever is greater

## Note

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*Requires a passive patient.*

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## Delta AutoPEEP<sub>AW</sub> (dAutoPEEP<sub>AW</sub>)

Delta AutoPEEP<sub>AW</sub> (dAutoPEEP<sub>AW</sub>), 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<sub>2</sub>O

Resolution: 1 cmH<sub>2</sub>O

Note: Requires a passive patient.

Accuracy:  $\pm 2\text{cmH}_2\text{O}$  or  $\pm 5\%$ , whichever is greater

## AutoPEEP<sub>ES</sub>

AutoPEEP<sub>ES</sub> is defined as the difference between esophageal pressure measured at the end of exhalation (PEEP<sub>ES</sub>) minus the esophageal pressure measured at the start of a patient-initiated breath (P<sub>ES start</sub>) 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<sub>AW</sub>) and the airway pressure when the patient initiates a breath (P<sub>AW start</sub>).

$$\text{AutoPEEP}_{\text{ES}} = (\text{PEEP}_{\text{ES}} - \text{P}_{\text{ES start}}) - (\text{PEEP}_{\text{AW}} - \text{P}_{\text{AW start}})$$

Range: 0 to 50 cmH<sub>2</sub>O

Resolution: 1 cmH<sub>2</sub>O

Note: Requires an esophageal balloon catheter.

Accuracy:  $\pm 2\text{cmH}_2\text{O}$  or  $\pm 5\%$ , whichever is greater

## Transpulmonary Pressure, Plateau (P<sub>tp</sub> 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<sub>PLAT AW</sub>) and the corresponding esophageal pressure.

$$\text{P}_{\text{tp Plat}} = \text{P}_{\text{PLAT AW}} - \text{P}_{\text{ES}}$$

Range: -60 to 120 cmH<sub>2</sub>O

Resolution: 1 cmH<sub>2</sub>O

Accuracy:  $\pm 2\text{cmH}_2\text{O}$  or  $\pm 5\%$ , whichever is greater

## Note

*Requires an inspiratory hold and an esophageal catheter.*

### Transpulmonary Pressure, AutoPEEP ( $P_{\text{tp}}$ PEEP)

Transpulmonary pressure, AutoPEEP ( $P_{\text{tp}}$  PEEP) is the difference between the corresponding airway and esophageal pressures at the end of the expiratory hold during an AutoPEEP maneuver.

$$P_{\text{tp}}\text{PEEP} = P_{\text{AW}} - P_{\text{ES}} \text{ (at the end of an expiratory hold)}$$

Range:  $-60$  to  $120\text{ cmH}_2\text{O}$

Resolution:  $1\text{ cmH}_2\text{O}$

Accuracy:  $\pm 2\text{ cmH}_2\text{O}$  or  $\pm 5\%$ , 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  $120\text{ cmH}_2\text{O}$

Resolution:  $1\text{ cmH}_2\text{O}$

Accuracy:  $\pm 2\text{cmH}_2\text{O}$  or  $\pm 5\%$ , 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.

$$P_{100} = P_{\text{end } 100} - \text{PEEP}_{\text{AW}}$$

Range:  $-60$  to  $120\text{ cmH}_2\text{O}$

Resolution:  $1\text{ cmH}_2\text{O}$

Accuracy:  $\pm 2\text{cmH}_2\text{O}$  or  $\pm 5\%$ , whichever is greater

### Ventilator Work of Breathing ( $\text{WOB}_V$ )

Ventilator Work of Breathing ( $\text{WOB}_V$ ), is defined as the summation of airway pressure ( $P_{\text{AW}}$ ) minus the baseline airway pressure ( $\text{PEEP}_{\text{AW}}$ ) times the change in tidal volume to the patient ( $\Delta V$ ) during inspiration, and normalized to the total inspiratory tidal volume ( $V_{\text{ti}}$ ).

If  $P_{\text{AW}} > \text{PEEP}_{\text{AW}}$ ,



$$WOB_V = \frac{\sum_{Insp} (P_{AW} - PEEP_{AW}) \Delta V}{V_{ti}}$$

Range: 0.00 to 20.00 Joules/L

Resolution: 0.01 Joules/L

Accuracy:  $\pm 10\%$

### 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.

$$WOB_P = WOB_{LUNG} + WOB_{CW}$$

$$\text{where } WOB_{LUNG} = \sum_{T_{start}}^{T_{iend}} (PEEP_{ES} - P_{ES}) \Delta V \quad (\text{if } PEEP_{ES} > P_{ES} \text{ and } V > 0)$$

$$\text{and } WOB_{CW} = \frac{V_P^2}{2C_{CW}} \quad (\text{if } PEEP_{ES} > P_{ES})$$

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:  $\pm 10\%$

### Note

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*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:

$$WOB_I = \int_0^{V_{ti}} (PEEP_{AW} - P_{TR}) * \frac{dV}{dt},$$

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:  $\pm 10\%$

## **Note**

---

*Requires a tracheal catheter.*

---

## Glossary

|                     |                                                                                                                                                                                                                                                                                                                                            |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Breath Interval     | Elapsed time from the start of one breath to the start of the next.                                                                                                                                                                                                                                                                        |
| Preset              | An operator set ventilator parameter.                                                                                                                                                                                                                                                                                                      |
| Trigger             | Value at which the ventilator initiates delivery of a breath as a result of measured patient effort.                                                                                                                                                                                                                                       |
| BTPS                | Body Temperature at Ambient Pressure, Saturated.                                                                                                                                                                                                                                                                                           |
| ATPD                | Ambient Temperature, Ambient Pressure, Dry.                                                                                                                                                                                                                                                                                                |
| 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                                                                                                                                                                                                                                                                                                                         |
| PEEP                | Positive End Expiratory Pressure.                                                                                                                                                                                                                                                                                                          |
| AC                  | Alternating Current (mains electricity).                                                                                                                                                                                                                                                                                                   |
| 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 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                                                                                                                                                                                                                                                                                                  |
| Button              | A push button switch used to toggle a function on or off.                                                                                                                                                                                                                                                                                  |
| cmH <sub>2</sub> O  | Centimeters of water pressure.                                                                                                                                                                                                                                                                                                             |
| Controls            | Any button, switch, or knob that allows you to modify the ventilator's behavior.                                                                                                                                                                                                                                                           |
| Event               | An anomalous condition that occurs during ventilator operation.                                                                                                                                                                                                                                                                            |
| Flow                | The rate at which gas is delivered. Measured in liters per minute (L/min).                                                                                                                                                                                                                                                                 |
| Indicators          | A visual element showing operational status.                                                                                                                                                                                                                                                                                               |
| L                   | Liters. A unit of volume.                                                                                                                                                                                                                                                                                                                  |
| LED                 | Light Emitting Diode                                                                                                                                                                                                                                                                                                                       |
| L/min               | Liters per minute. A unit of flow.                                                                                                                                                                                                                                                                                                         |
| Mode                | An operating state of the ventilator that determines the allowable breath types.                                                                                                                                                                                                                                                           |
| Monitored Parameter | A measured value displayed in the monitor window.                                                                                                                                                                                                                                                                                          |
| O <sub>2</sub>      | Oxygen                                                                                                                                                                                                                                                                                                                                     |

|                               |                                                                                                                                                                                                                               |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Patient Breathing Circuit     | The tubing that provides the ventilatory interface between the patient and ventilator.                                                                                                                                        |
| Paw                           | Airway Pressure. Measured in cmH <sub>2</sub> O at the exhalation valve.                                                                                                                                                      |
| 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).                                                                                                                   |
| 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.                                                                                            |
| 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.                                                                                                                                                                   |

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