Achieva

Technical Manual

Ventilator with Flow Acceleration Limit and Apnea Backup

PURITAN
BENNETT

For further information, contact your Puritan-Bennett representative, or contact Nellcor Puritan Bennett directly by calling 1.800-NELLCOR

Contents

Introduction 1-1
Chapters 1-2
Conventions 1-3
Warranty considerations 1-3
Tools and equipment 1-4

Description 2-1
Overview 2-1
General description 2-1
Features of Achieva Ventilators 2-4
Front view 2-5
Top panel 2-6
Display and controls 2-8
Back and sides 2-14
Breath types and ventilation modes 2-16
Volume breaths in assist/control mode 2-16
Continuous Positive Airway Pressure (CPAP) 2-28
Specifications 2-30
Standard compliance 2-37
FCC Part 68 information 2-37

Testing 3-1
Overview 3-1
Scope 3-1
Frequency 3-1
Documentation 3-2
Ventilation equipment 3-2
Test equipment 3-2
Calibration of test equipment 3-3

Qualifications of test personnel . . . 3-3
Supplies . . . 3-3
Standard ventilation parameters . . . 3-4
Connections . . . 3-4
Visual inspection . . . 3-5
Pneumatic test . . . 3-6
Power system checkout . . . 3-9
Assist/control ventilation mode checkout . . . 3-11
SIMV ventilation mode checkout . . . 3-14
Pressure-controlled ventilation mode checkout . . . 3-16
Pressure support mode checkout . . . 3-17
Achieva ventilator operational checklist . . . 3-18

Theory of operation . . . 4-1
Pneumatic system . . . 4-1
Components . . . 4-1
Operation . . . 4-3
System control . . . 4-4
Micro-controller . . . 4-5
System memory . . . 4-5
Real-time clock . . . 4-5
Motor drive control . . . 4-6
System analog monitoring circuitry . . . 4-6
System analog control . . . 4-7
Watchdog . . . 4-7
Digital inputs . . . 4-8
Digital outputs . . . 4-8
Micro-controller I/O ports . . . 4-9
System power . . . 4-9
Power system control . . . 4-13

Maintenance . . . 5-1
Cleaning ventilator surfaces . . . 5-1
Replaceable parts . . . 5-3
Flatpak filter . . . 5-4
Changing the fuses . . . 5-5
Periodic maintenance . . . 5-8

Schematics . . . 6-1

Service 7-1
Service information 7-1
Limited warranty 7-2

Appendix: Oxygen Adapter Assembly. A-1
Canadian A-1
Dräger. A-2
Australian A-3
NIST A-4
UK. A-5
French. A-6

Index I-1

Figures

Schematics

Drawings

Figure 2-1: Front view . . . 2-5
Figure 2-2: Top panel . . . 2-6
Figure 2-3: Display and controls . . . 2-8
Figure 2-4: Rear and side view . . . 2-14
Figure 2-5: Volume Breaths in Assit/Control Mode . . . 2-17
Figure 2-6: Controlled (machine) Breath Delivery . . . 2-19
Figure 2-7: Pressure Control in Assist/Control Mode . . . 2-21
Figure 2-8: Mandatory Volume Breaths in SIMV Mode . . . 2-23
Figure 2-9: Spontaneous Breaths Assisted with Pressure-supported Breaths . . . 2-25
Figure 2-10: Supported Breaths Maintain Selected Pressure . . . 2-27
Figure 2-11: Continuous Positive Airway Pressure (CPAP) . . . 2-29
Figure 3-1: Front panel view . . . 3-6
Figure 3-2: Blocking exhalation manifold . . . 3-7
Figure 4-1: Pneumatic diagram . . . 4-2
Figure 4-2: Block diagram of control system . . . 4-4
Figure 4-3: Power supply inputs . . . 4-10
Figure 5-1: Replacing Flatpak filter . . . 5-4
Figure 5-2: Removing fuse holder . . . 5-6
Figure 5-3: Replacing fuses . . . 5-7
Schematic 6-1: Logic board—notes for schematics . . . 6-2
Schematic 6-2: Logic board—microprocessors . . . 6-3
Schematic 6-3: Logic board—memory/address select . . . 6-4
Schematic 6-4: Logic board—switch inputs . . . 6-5
Schematic 6-5: Logic board—LED indicators/controls . . . 6-6
Schematic 6-6: Logic board—miscellaneous digital I/O . . . 6-7
Schematic 6-7: Logic board—alarm and monitor circuits . . . 6-8
Schematic 6-8: Logic board——communications driver . . . 6-9
Schematic 6-9: Logic board—pressure sensor circuits . . . 6-10
Schematic 6-10: Logic board—flow sensor circuits . . . 6-11
Schematic 6-11: Logic board—primary ADC circuits . . . 6-12
Schematic 6-12: Logic board—serial ADC . . . 6-13
Schematic 6-13: Logic board—serial ADC circuits . . . 6-14
Schematic 6-14: Logic board—DAC circuits . . . 6-15
Schematic 6-15: Logic board—connectors and EMI filters . . . 6-16

Schematic 6-16: Logic board—connectors and modem port 6-17
Schematic 6-17: Power board schematic notes 6-18
Schematic 6-18: Power board—motor drive 6-19
Schematic 6-19: Power board—power On/Off circuits 6-20
Schematic 6-20: Power board—switching power supplies 6-21
Schematic 6-21: Power board—system power entry 6-22
Schematic 6-22: Miscellaneous Circuitry 6-23
Schematic 6-23: Power board—connectors and EMI filters 6-24
Drawing 6-1: Ventilator assembly drawing 6-25
Drawing 6-2: Ventilator assembly drawing 6-26
Drawing 6-3: Rear panel assembly drawing 6-27
Drawing 6-4: Right end assembly drawing 6-28
Drawing 6-5: Right end assembly drawing 6-29
Drawing 6-6: Front panel assembly drawing 6-30
Drawing 6-7: Piston assembly drawing 6-31
Drawing 6-8: Manifold assembly drawing 6-32
Drawing 6-9: Power supply assembly drawing 6-33

Tables

Table 1-1: Recommended Equipment and Suppliers 1-4
Table 3-1: Equipment and Recommended Supplier 3-2
Table 3-2: Standard Ventilation Parameters 3-4
Table 3-3: Power system checkout 3-9
Table 3-4: Assist/Control ventilation mode checkout 3-12
Table 3-5: SIMV mode checkout 3-14
Table 3-6: Pressure-controlled mode checkout 3-16
Table 3-7: Pressure support 3-17
Table 4-1: Power sources and priority levels 4-10

Chapter 1: Introduction

This technical manual provides procedures for testing and maintaining the Achieva model volume ventilators. It is not intended to be a complete maintenance document; therefore, it contains no disassembly, repair, or reassembly instructions.

Refer any repairs or adjustments that exceed the scope of this manual to a Puritan Bennett Technical Support Representative by calling:

800.255.6774

This manual is intended for use only by technicians who have successfully completed Puritan Bennett training on this product.

Puritan Bennett believes the information herein is accurate but accepts no responsibility for errors, omissions, or misrepresentation.

PURITAN-BENNETT CORPORATION FURTHER DECLINES ANY WARRANTIES, EXPRESSED OR IMPLIED, FOR THE REPAIRED PRODUCT, INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

It is the user’s responsibility to ensure that the product has been properly repaired and that it is in safe and proper operating condition before it is put into use.

Chapters

This manual consists of the following sections:

1 Introductio: Discusses the purpose of the manual, gives an overview of the contents of the various chapters, and describes the conventions used for warnings, cautions, and notes.

2 Description: Provides a description of the systems, features, controls, and labels on the Achieva ventilators. Also included is a description of the ventilation modes and a table of technical specifications.

3 Testing: Provides procedures for verifying the correct operation of the ventilator.

4 Theory of operation: Provides a description of the systems and principles that make the ventilator operate.

5 Maintenance: Provides cleaning and maintenance information, a list of user-replaceable parts, and a maintenance schedule.

6 Schematics: Provides electrical schematic diagrams of the ventilator's circuitry. Provides exploded views of the ventilator and lists of its components.

7 Service: Provides service and limited warranty information.

Appendix: Information regarding the oxygen adapter assembly.

Index: An alphabetical list of topics, and their locations, in this manual.

Conventions

Throughout this manual, Warnings, Cautions, and Notes mean the following:

Indicates a condition that can place the patient, caregiver, or other individuals at risk of injury. — Warning

Indicates a condition that can damage the equipment. — Caution

Indicates points of particular emphasis that make the operation of the ventilator more efficient or convenient. — Note

Warranty considerations

Do not make any service repairs on this equipment during the stated warranty period. Any unauthorized work immediately voids the warranty. Puritan Bennett will not be liable for any repairs attempted by the owner. Any such attempted repairs other than specified non-warranty repairs void the warranty.

Tools and equipment

The following tools and equipment will be needed for the tasks listed.

Table 1-1: Recommended Equipment and Suppliers

Task	Equipment	Recommended Supplier
Monthly verification	Achieva Ventilator Operational Checklist	Photocopy last page of Chapter 3
Ventilation mode checkout	Respirometer (hand-held)	Wright
		Fraser-Harlake
		Ferrairs Medical
	Stop Watch	Any
Changing fuses	Small slotted screwdriver	Any
	Fuses	Any 5 x 20 mm, 250V, 3.15A slow blow
Power switchover test	External battery and cable	Puritan Bennett
Cleaning	Mild detergent	Any

Chapter 2: Description

This chapter describes the systems, features, controls, and labels on the Achieva ventilators. Also included is a description of the ventilation modes and a table of technical specifications.

Overview

Indications for Use

The Achieva Ventilator is intended to provide ventilatory support for pediatric and adult patients who require positive pressure mechanical ventilation. Patients should weigh no less than 11 pounds (5 kg). The ventilator is for use in home, institutional, and non-emergency transport settings.

Contra-Indications

Achieva ventilators are not intended for the delivery of anesthetic gases.

Caution

Do not use or store in the presence of strong electromagnetic fields such as those surrounding MRI equipment.

General description

The Achieva Portable Volume Ventilator with Flow Acceleration Limit and Apnea Back Up is an electro-mechanical device used to assist a patient's respiratory efforts. It consists of four major subsystems: AIR DELIVERY; POWER MANAGEMENT; USER INTERFACE; and SYSTEM CONTROL.

Air delivery

The AIR DELIVERY subsystem filters and delivers the prescribed amount of air to the patient. The air delivery subsystem consists of:

- a pump assembly
- a pneumatic porting assembly
- a filter system

Power management

The POWER MANAGEMENT subsystem manages the power distribution for the ventilator and consists of five elements:

- an internal battery
- an external battery (if used)
- An AC line power source
- an internal battery charger
- a power system control function

The AC line power source is the primary source and should be used when available. The external battery supplies power when the AC line source is disconnected. The internal battery supplies power when no external power source is available. The internal battery charger maintains the internal battery in a charged state (when an external power source is available).

User interface

The USER INTERFACE subsystem enables the caregiver to change the operating and ventilation parameters, and it alerts the caregiver when an alarm condition exists. This subsystem consists of two elements:

- the top panel, which has alarm and power indicators, two keys, and a pressure/battery charge level meter
- the control/display panel, which has an alphanumeric display and keys that allow the operator to control operational and ventilation parameters

System control

The SYSTEM CONTROL subsystem manages, monitors, and diagnoses the operation of the other subsystems. The control subsystem has five functions:

- The monitoring function stores information for later retrieval.
- The diagnostics function examines the ventilator operation for failures.
- The air delivery control function orchestrates the delivery of air to the patient.
- The interface control function enables communication between the unit and the operator.
- The power system control function manages the ventilator’s acquisition and distribution of electrical power.

Features of Achieva Ventilators

The Achieva ventilators are available in three models described in the table below. The model number is indicated on the front door of the ventilator.

	Achieva	**Achieva PS**	**Achieva PSO2**
Modes of Ventilation			
ASSIST/CONTROL	Yes	Yes	Yes
with PRESSURE CONTROL Capability	Yes	Yes	Yes
SIMV	Yes	Yes	Yes
with CPAP	Yes	Yes	Yes
with PRESSURE SUPPORT	**No**	Yes	Yes
Spontaneous (PRESSURE SUPPORT)	**No**	Yes	Yes
with CPAP	**No**	Yes	Yes
Dial-in PEEP (3-20 cmH_2O)	Yes	Yes	Yes
Flow Triggering	Yes	Yes	Yes
Internal O_2 Blender	**No**	**No**	Yes
Internal Modem	**No**	Yes*	Yes*
Access to Stored Events with the Report Generator Software	Yes	Yes	Yes
Pediatric Capability	Yes	Yes	Yes
Internal Battery	Yes	Yes	Yes
External Battery Capability	Yes	Yes	Yes
Portability	Yes	Yes	Yes
* Available only in the U.S. and Canada			

Front view

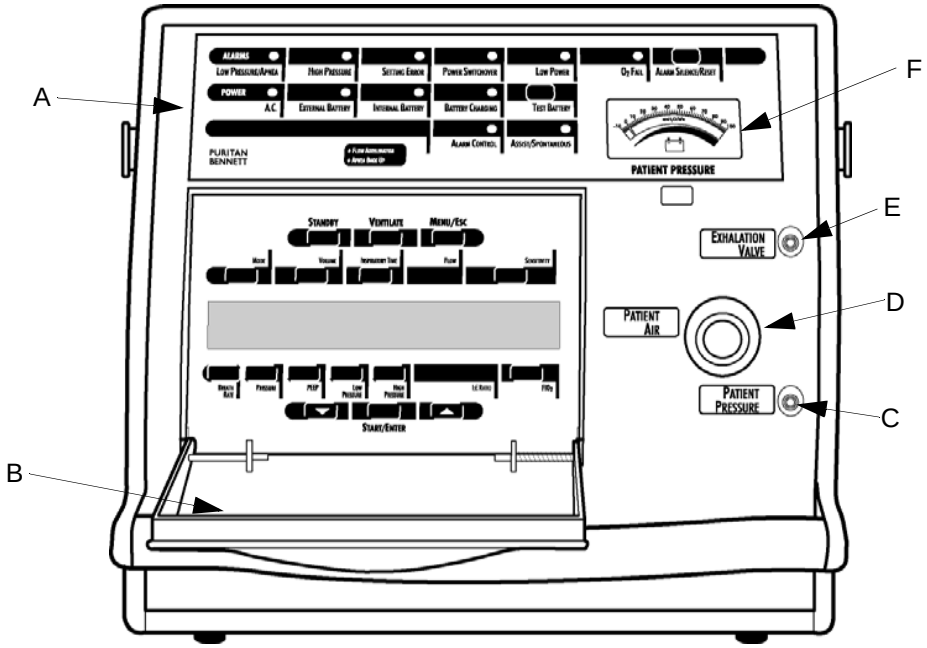


Figure 2-1: Front view

A Top panel

B Door panel

C Patient pressure port

D Patient air port

E Exhalation valve port

F Patient pressure meter

Top panel

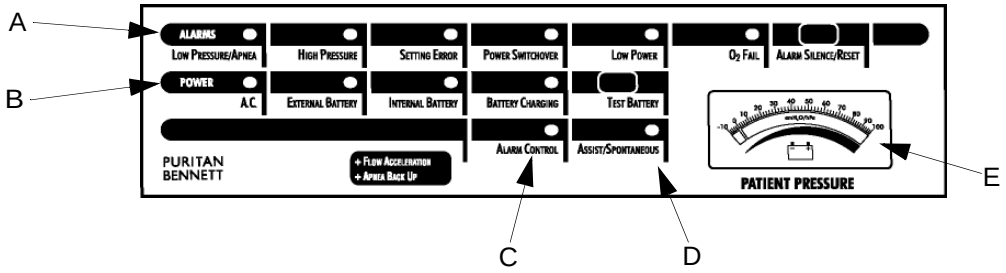


Figure 2-2: Top panel

A ALARM INDICATORS

The corresponding alarm indicator will flash when an alarm condition is detected. The indicators are turned off when the alarm condition is corrected and the ALARM SILENCE/RESET key is pressed.

The Achieva ventilators are equipped with the following alarm indicators:

- LOW PRESSURE/APNEA
- HIGH PRESSURE
- SETTING ERROR
- POWER SWITCHOVER
- LOW POWER
- O2 FAIL (Only on Achieva PSO_2)

B POWER Lights

The power lights indicate which electrical source the ventilator is currently using and whether the internal battery is being charged. The power lights include

- A.C.
- EXTERNAL BATTERY
- INTERNAL BATTERY
- BATTERY CHARGING

C Alarm Control Light

The ALARM CONTROL light flashes when the audible alarm has been presilenced. The ALARM CONTROL light will light continuously when the nonlatching audible alarm feature is active.

D ASSIST/SPONTANEOUS Light

The ASSIST/SPONTANEOUS indicator lights each time the patient's effort is greater than the sensitivity setting.

E PATIENT PRESSURE METER

The PATIENT PRESSURE meter shows the level of pressure that is currently in the patient circuit.

Display and controls

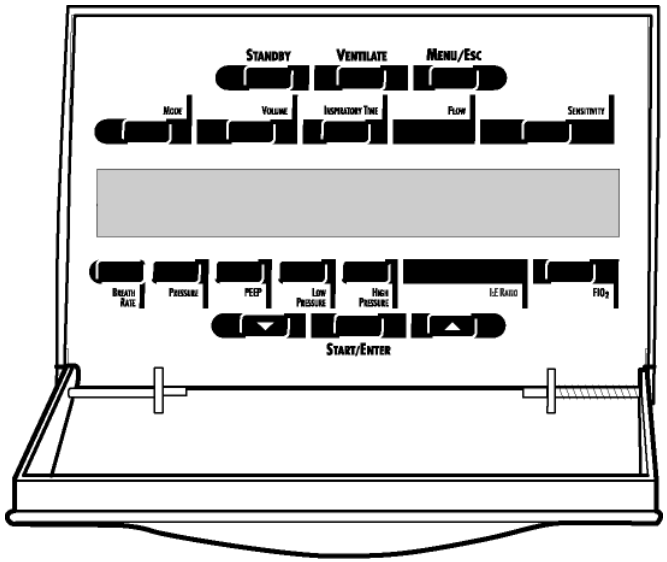


Figure 2-3: Display and controls

The CONTROL/DISPLAY panel consists of

- an alphanumeric display that shows current operating parameters and ventilator information
- push-button keys that the operator uses to make selections

The CONTROL/DISPLAY panel is located behind the ventilator's front door panel.

Following is a description of the keys' functions.

STANDBY

Use the STANDBY key to place the ventilator in the standby mode, a state where no air is being delivered and the internal battery is being charged.

VENTILATE

Use the VENTILATE key to deliver air to the patient.

MENU/ESC

The MENU/ESC key activates the menu options on the ventilator's display.

UP and DOWN arrow keys

The up and down arrow keys operate in three ways:

- When a ventilation parameter is flashing, use the up/down keys to scroll to the required setting.
- When the MENU/ESC button has been pushed, use the up/down keys to scroll to the required menu.
- Pressing the up/down keys when neither a menu nor a parameter is active will cause the last alarm message to be displayed.

START/ENTER

When the ventilator is in Standby, pressing the START/ENTER key will activate the display. The START/ENTER key is also used to accept the currently flashing parameter as the new setting.

Before pressing the Start/Enter key, check all parameters for appropriateness.

Caution

MODE

The MODE section of the display screen shows the current ventilation mode setting. Pressing the MODE key causes the current mode on the display to flash and allows the ventilation mode to be changed.

VOLUME

The VOLUME section of the display screen shows the volume of air that is set to be delivered to the patient's lungs during volume breaths. Pressing the VOLUME key causes the current volume setting to flash and allows it to be changed.

INSPIRATORY FLOW ACCELERATION LIMIT

Selecting the INSPIRATORY FLOW ACCELERATION LIMIT in the menu key permits control during a pressure-supported or a pressure-controlled breath. When this feature is ON, the actual flow rate during the inspiratory phase of a pressure-supported or a pressure-controlled breath cannot exceed 180 LPM.

INSPIRATORY TIME

The INSPIRATORY TIME section of the display screen shows the length of time it takes the ventilator to deliver the volume breaths and pressure control breaths to the patient. Pressing the INSPIRATORY TIME key causes the current inspiratory time setting to flash and allows it to be changed.

FLOW

The FLOW section of the display shows the average air flow during setup and, ten seconds after ventilation begins, it shows the peak flow delivered to the patient. The calculated value of the average air flow during setup is given in liters/minute.

SENSITIVITY

During setup, the SENSITIVITY section of the display screen shows the value of the flow trigger sensitivity setting; during ventilation, it displays what trigger criteria was met to cycle an assisted breath. Pressing the SENSITIVITY key causes the current sensitivity setting to flash and allows it to be changed.

Note

When using PEEP, set the Pressure Trigger in addition to SENSITIVITY (Flow Trigger). The Pressure Trigger setting can be accessed and changed as a menu option.

BREATH RATE

The BREATH RATE section of the display screen shows the rate at which volume and pressure control breaths are delivered. Pressing the BREATH RATE key causes the current breath rate setting to flash and allows it to be changed.

PRESSURE

The PRESSURE section of the display shows the pressure level maintained during a pressure-supported breath and the maximum pressure allowed during a pressure-controlled breath. Pressing the PRESSURE key causes the current pressure support or pressure control setting to flash and allows it to be changed.

The PEEP (Positive End Expiratory Pressure) section of the display screen shows the pressure maintained at the end of a delivered breath. Pressing the PEEP key causes the current PEEP setting to flash and allows it to be changed. You should also set the pressure trigger when using PEEP. The pressure trigger will function relative to the PEEP setting baseline. When using PEEP, use the pressure trigger along with sensitivity (Flow Trigger). The pressure trigger setting can be accessed and changed as a menu option.

LOW PRESSURE

The LOW PRESSURE limit section of the display shows the minimum pressure that must be exceeded to prevent a Low Pressure alarm. The Low Pressure alarm sounds after two consecutive cycles below the low pressure limit. The Low Pressure alarm sounds for a Valley alarm after two consecutive breath cycles that **do not** fall below the low pressure limit. Pressing the LOW PRESSURE key causes the current low pressure limit setting to flash and allows it to be changed.

Warning

Some circuit components will defeat a Low Pressure alarm by keeping the pressure in the circuit above the alarm limit. Examples of these components include hydrated heat and moisture exchangers (HMEs), adapters, and tracheostomy tubes. If the patient circuit is disconnected from the patient, but still connected to these components, a Low Pressure alarm may not sound. See the *Achieva Ventilator Clinician's* and *User's Manuals* for details.

HIGH PRESSURE

The HIGH PRESSURE section of the display shows the highest pressure the ventilator will allow without sounding the High Pressure alarm and limiting the breath. Pressing the HIGH PRESSURE key causes the current high pressure limit setting to flash and allows it to be changed.

I:E RATIO

The I:E RATIO display shows the ratio of inspiratory to expiratory time. The Achieva ventilators permit a range of inspiratory times from 0.2 seconds to 5.0 seconds. The I:E ratio is calculated according to this formula:

I:E Ratio = [(60/Breath Rate) - Inspiratory Time] / Inspiratory Time

F_IO_2 (Only on Achieva PSO2)

The F_IO_2 display shows the set enriched oxygen level. Pressing the F_IO_2 key causes the current F_IO_2 level setting to flash and allows it to be changed. A setting of over 21 will activate the internal oxygen blender.

For the Achieva ventilator models that do not have the oxygen function, the F_IO_2 key is present, but it has no label and is inoperative.

Note

Flow and pressure measurements are displayed on the LCD screen of the ventilator. Flow is measured at the output port of the ventilator. These measurements must be corrected for altitude (using the ALTITUDE setting) and have an accuracy of ±2 LPM at nominal barometric pressures. Pressure measurements are taken at the patient end of the breathing circuit. Pressure measurements are relative to the current atmospheric pressure and have an accuracy of ±2.5 cm H_2O.

Back and sides

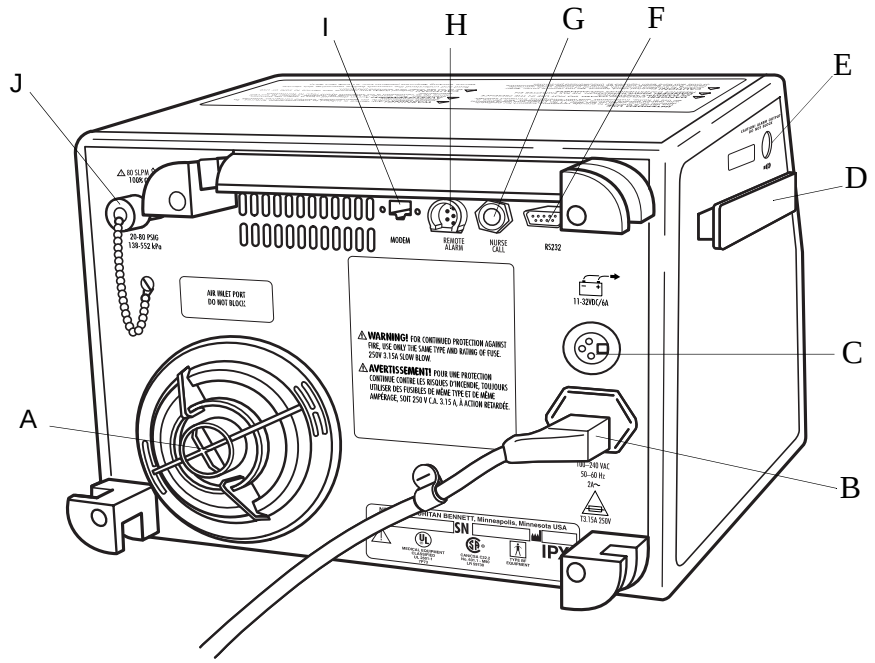


Figure 2-4: Rear and side view

A Inlet Filter
Filters air as it enters the ventilator.

B Power Cord Connector

C External Battery Connector

D Side Rail
Used for mounting some accessories on the ventilator.

E Audible Alarm Port (on side of ventilator)
DO NOT BLOCK.

F Communications Connector (RS-232 Port)
This connector is used to connect a printer, external modem, or a Report Generator-equipped computer directly to the ventilator. Follow the accessory manufacturer's connection instructions for the appropriate connection procedure.

G Nurse Call Output
The ventilator can be connected to nurse call stations through this output.

H Remote Alarm Connector
The remote alarm cable plugs into the remote alarm cable jack on the back of the ventilator. Be sure it is firmly in place. The cable slips in only if you have the button on the end of the connector facing down. To remove the cable from the ventilator, press the button and pull the connector straight out.

I Modem Connector (only on Achieva PS and Achieva PSO2 in the US and Canada)
A telephone cord is plugged into the ventilator's modem connector. Insert the cord with the tab facing down until you feel it click. Plug the other end of the cord into your telephone outlet.

J Oxygen Input Connection (only on Achieva PSO_2)
Connect the optional internal O_2 blender to an oxygen source with a standard oxygen connection hose. Screw the hose fitting tightly onto the oxygen input connection.

Breath types and ventilation modes

Breath types available on the Achieva ventilators are:

- volume breaths in ASSIST/CONTROL MODE
- pressure-controlled breaths in ASSIST/CONTROL MODE
- mandatory volume breaths in SIMV mode
- pressure-supported breaths in SIMV or spontaneous MODES
- CPAP in SIMV or spontaneous modes

Volume breaths in assist/control mode

In ASSIST/CONTROL mode, with PRESSURE set to 0, each delivered breath will be of the selected VOLUME, delivered over the selected INSPIRATORY TIME. Inspiration is triggered by patient-generated flow or pressure drop (for assisted breaths) or by the ventilator (for controlled breaths; BREATH RATE is the controlling parameter). For both controlled and assisted breaths, the inspiration is limited by the volume, and is cycled by volume and time.

See the waveforms, Figure 2-5.

Note

- P_{aw} = Peak airway pressure
- $\dot{V}$ = flow
- V_t = Tidal volume

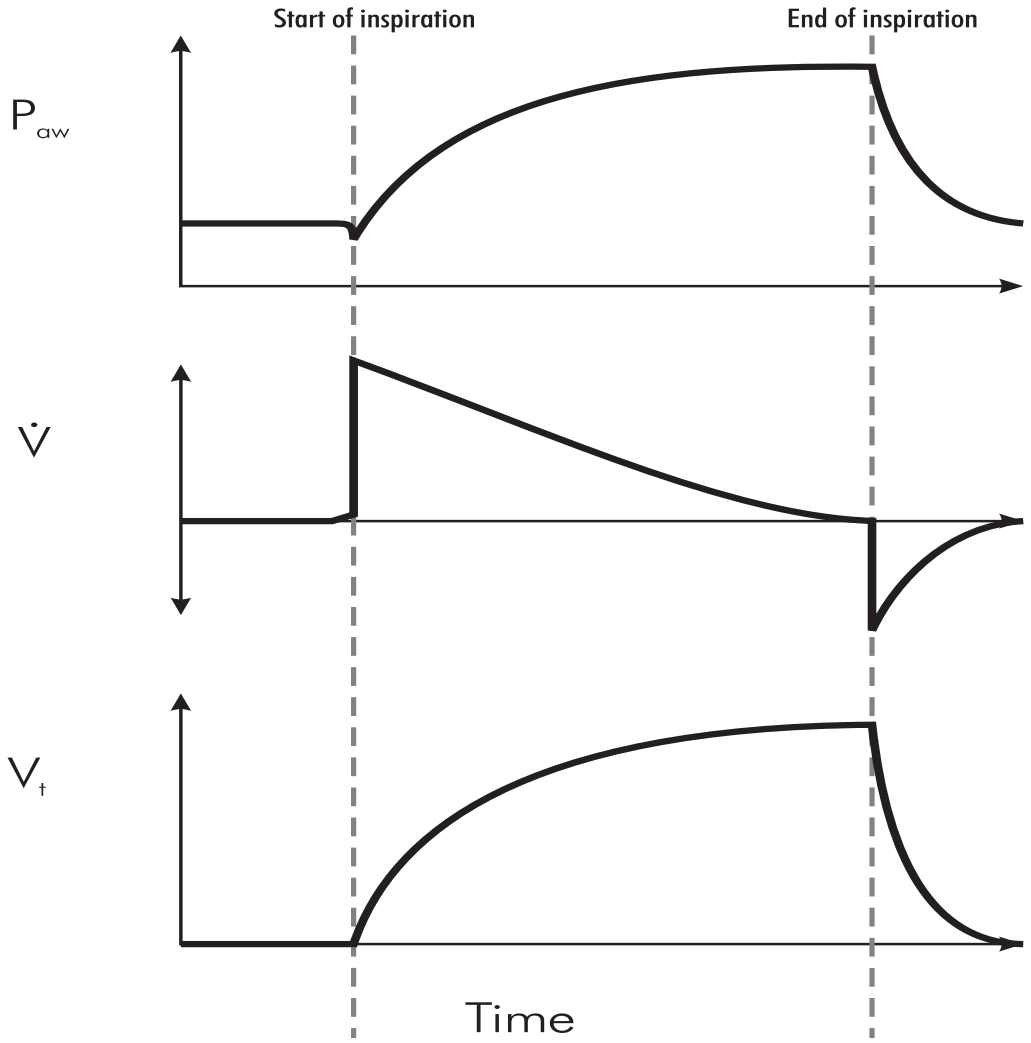


Figure 2-5: Volume Breaths in Assit/Control Mode

ASSIST/CONTROl mode guarantees a maximum period between breaths, as determined by the BREATH RATE setting. In the waveform on the opposite page, the ventilator delivers a controlled (machine) breath, and calculates the time before another controlled breath must be delivered. The ventilator delivers a second controlled breath at the conclusion of that machine-calculated breath time (for simplicity, we will use the term *period* for "machine-calculated breath time"). Following the second controlled breath, but before another period can elapse, the patient's effort triggers an assisted (or patient-initiated) breath. This restarts the period. At the conclusion of the period, the ventilator delivers another controlled breath.

See the waveforms, Figure 2-6.

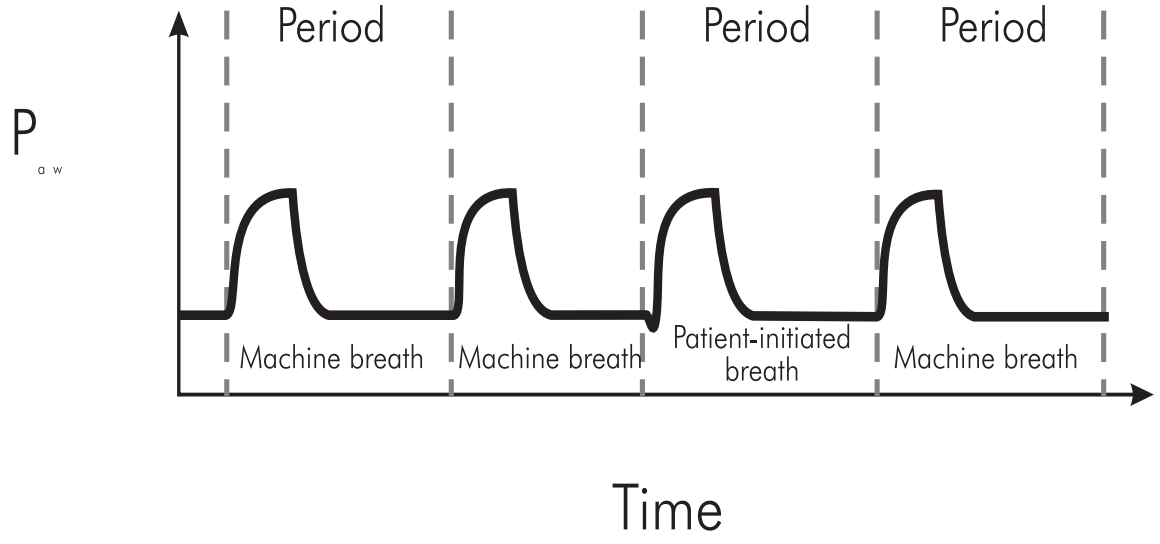


Figure 2-6: Controlled (machine) Breath Delivery

Pressure-control in assist/control mode

In ASSIST/CONTROL MODE, with PRESSURE set greater than 0, each delivered breath will maintain the selected pressure over the selected INSPIRATORY TIME. Inspiration is triggered by patient-generated flow or pressure drop (for assisted breaths) or by the ventilator (for controlled breaths; BREATH RATE is the controlling parameter). For both controlled and assisted breaths, the inspiratory pressure is limited to the PRESSURE setting, and is cycled by time. See the waveforms on the facing page.

Inspiratory Flow Acceleration Limit and Expiratory Sensitivity

Inspiratory flow acceleration limit controls flow during a pressure-supported or pressure-controlled breath. By selecting the inspiratory Flow Acceleration Limit feature, the operator can control flow during pressure-supported and pressure-controlled breaths. The inspiratory Flow Acceleration Limit feature has settings of ON or OFF. When the Flow Acceleration Limit feature is ON, the actual flow rate during the inspiratory phase of a pressure-supported or a pressure-controlled breath cannot exceed 180 LPM.

The operator can also set the expiratory sensitivity level, which is a percentage of peak flow at which a pressure-supported breath will be terminated. The expiratory sensitivity level has settings of 15% to 55% in 10% increments. However, do not adjust this setting while in ASSIST/CONTROL MODE.

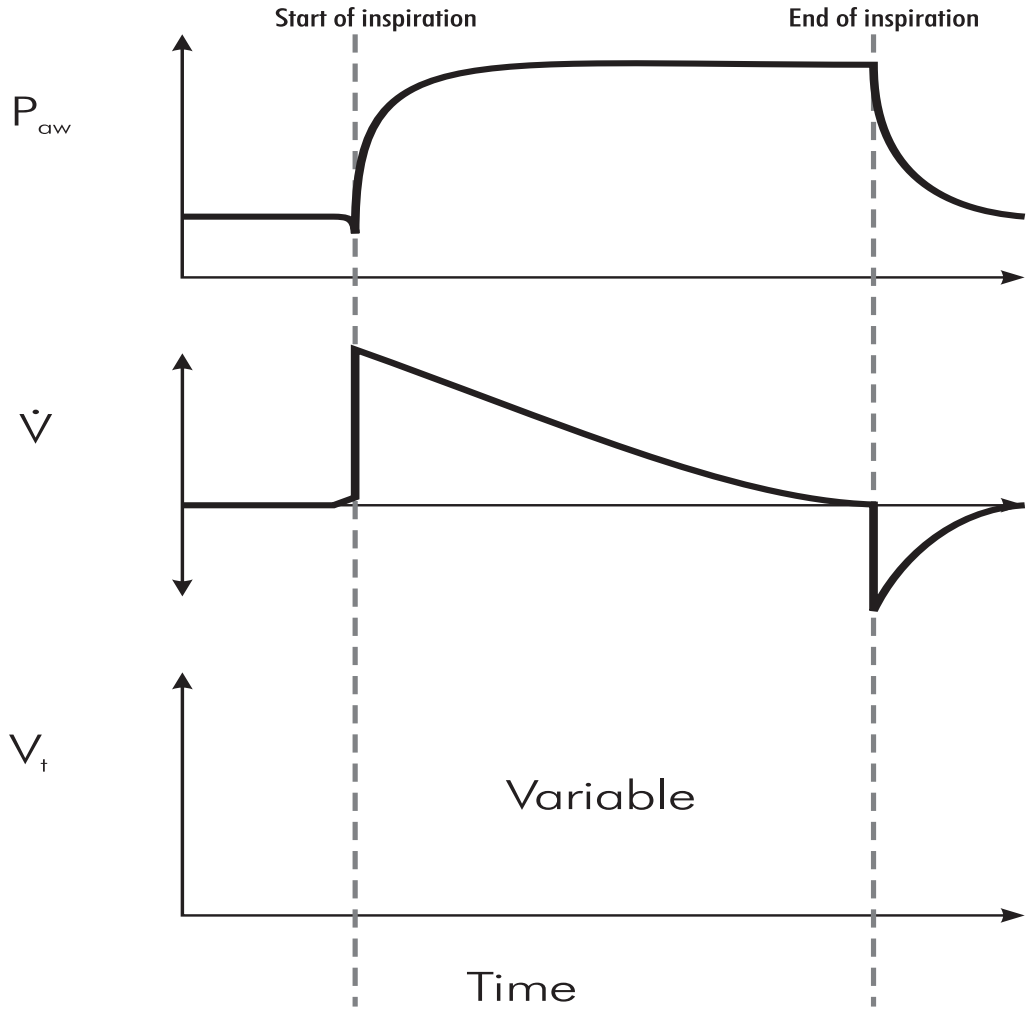


Figure 2-7: Pressure Control in Assist/Control Mode

Mandatory volume breaths in SIMV mode

In SYNCHRONIZED INTERMITTENT MANDATORY VENTILATION (SIMV), the mandatory volume breaths deliver the selected volume over the selected inspiratory time. Inspiration is triggered by patient-generated flow or pressure drop (for assisted breaths) or by the ventilator (for controlled breaths; BREATH RATE is the controlling parameter). For both controlled and assisted breaths, the inspiration is limited by the volume, and is cycled by volume and time.

See the waveforms on the next page, Figure 2-8.

SIMV mode will also assist spontaneous breaths with pressure-supported breaths.

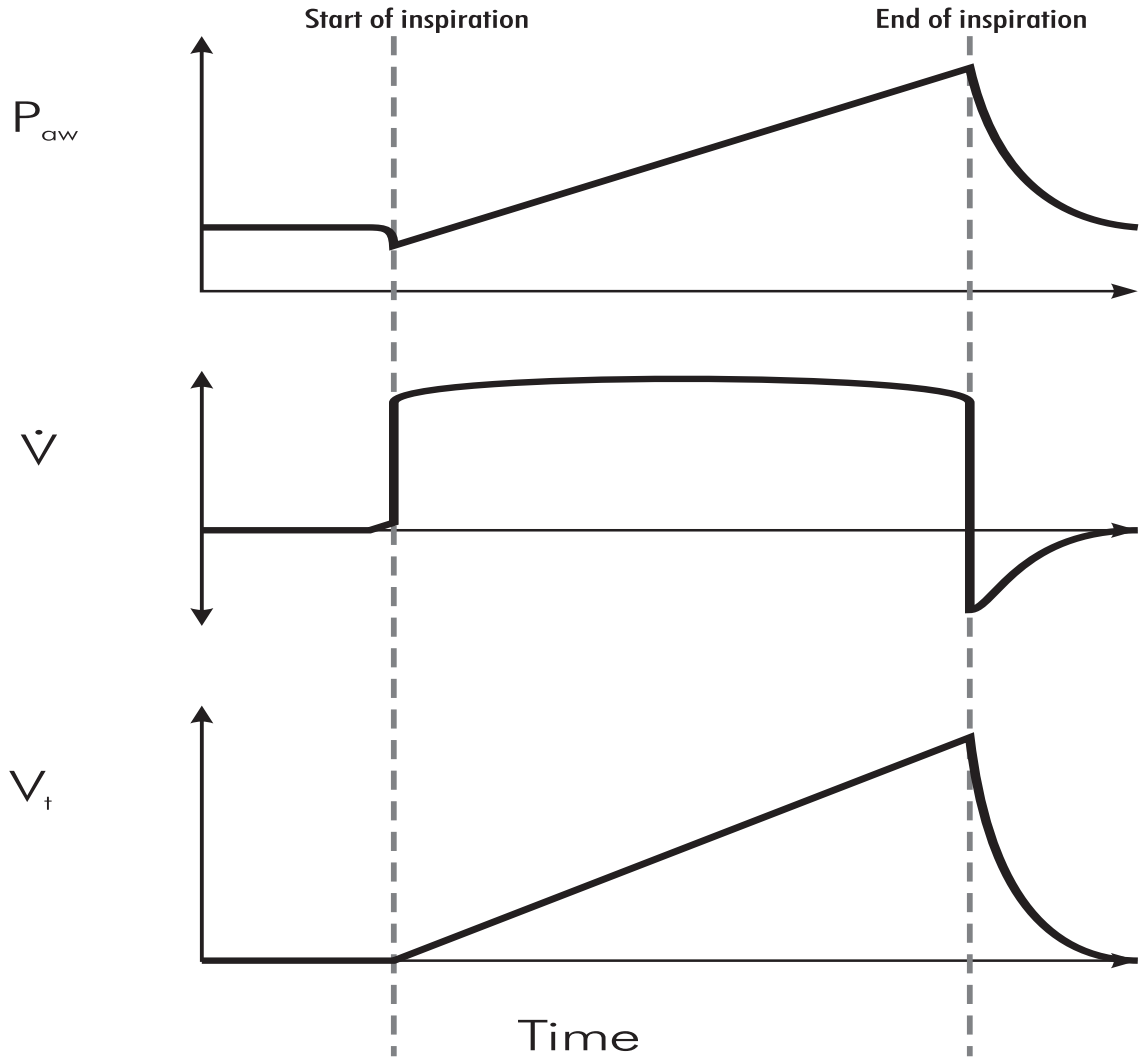


Figure 2-8: Mandatory Volume Breaths in SIMV Mode

In SIMV mode, the ventilator delivers volume breaths, as determined by the BREATH RATE setting, and spontaneous breaths are assisted with pressure-supported breaths.

In the waveforms on the opposite page, Figure 2-9, the breath in the first machine-calculated breath time is due to a lack of patient effort in the preceding machine-calculated breath time; that is, the first breath shown is actually associated with a preceding machine-calculated breath time (for simplicity, we will use the term *period* for "machine-calculated breath time"). The second breath shown is delivered because of the absence of patient effort in the first period shown. Before the next period elapses, the patient initiates an assisted volume breath. Although it continues into the third period, it fulfills the requirements of the second period. The second patient-initiated volume breath fulfills the requirements of the third period. Therefore, the ventilator does not deliver another breath until the fourth period has elapsed.

The patient-initiated breath that starts in the fifth period fulfills the requirements for the fifth period. The **first** patient-initiated breath in period six fulfills the requirements for period six; therefore, the **second** patient-initiated breath in period six is delivered as a pressure-supported breath. Because of the patient activity in period six, no breath is delivered in period seven; therefore, a breath is delivered at the start of period eight to fulfill the requirements of period seven.

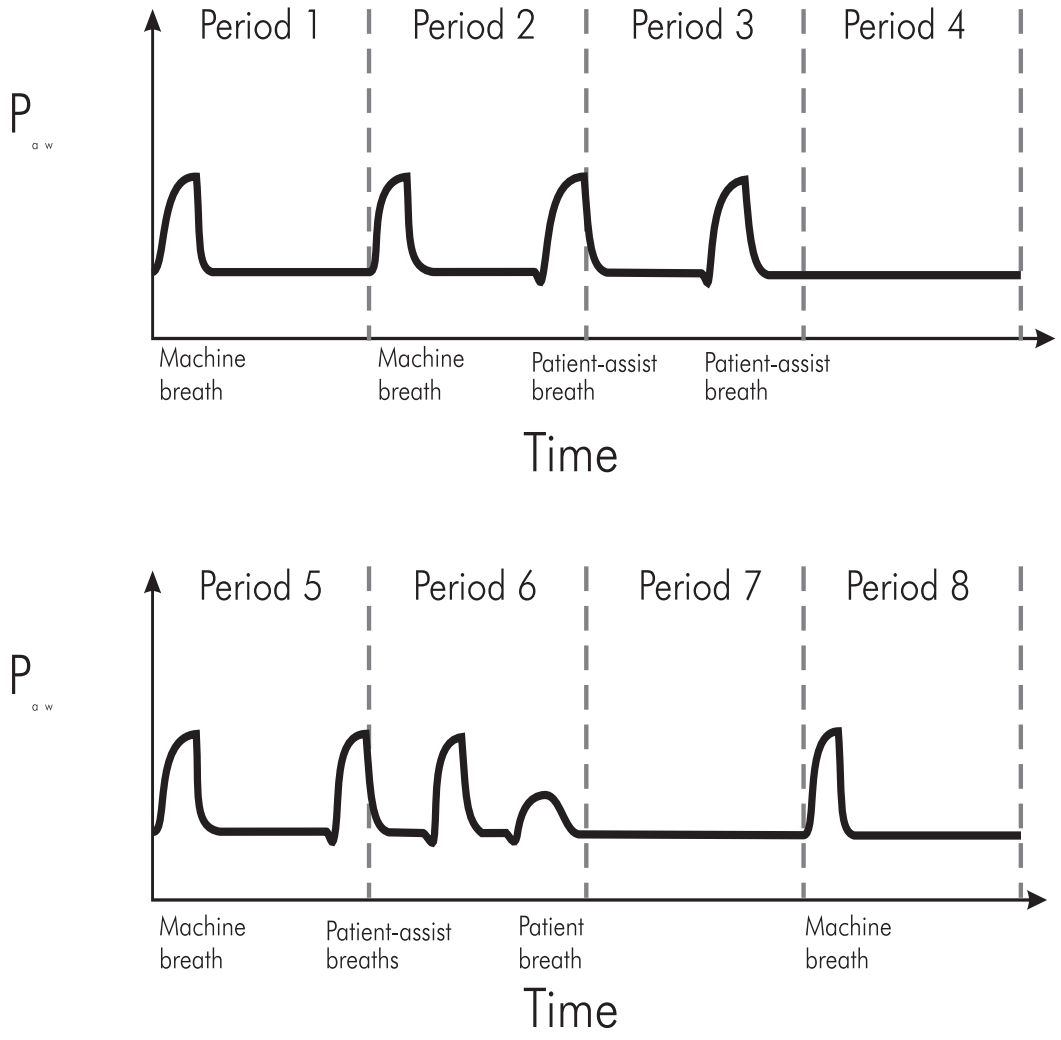


Figure 2-9: Spontaneous Breaths Assisted with Pressure-supported Breaths

Pressure-supported breaths

In SIMV or SPONTANEOUS modes, the supported breaths maintain the selected pressure. Inspiration is triggered by patient-generated flow or pressure drop. When Flow Acceleration Limit is on, maximum flow is limited to 180 lpm. When Flow Acceleration Limit is off, the maximum flow is delivered and is cycled to expiration when the flow drops to the Expiratory Sensitivity setting (between 15% and 55% of peak flow in 10% increments).

In SIMV, additional mandatory volume breaths will be delivered, depending on the selected BREATH RATE.

Pressure-supported breaths is available only on the Achieva PS and Achieva PSO2.

See the waveforms on the opposite page, Figure 2-10.

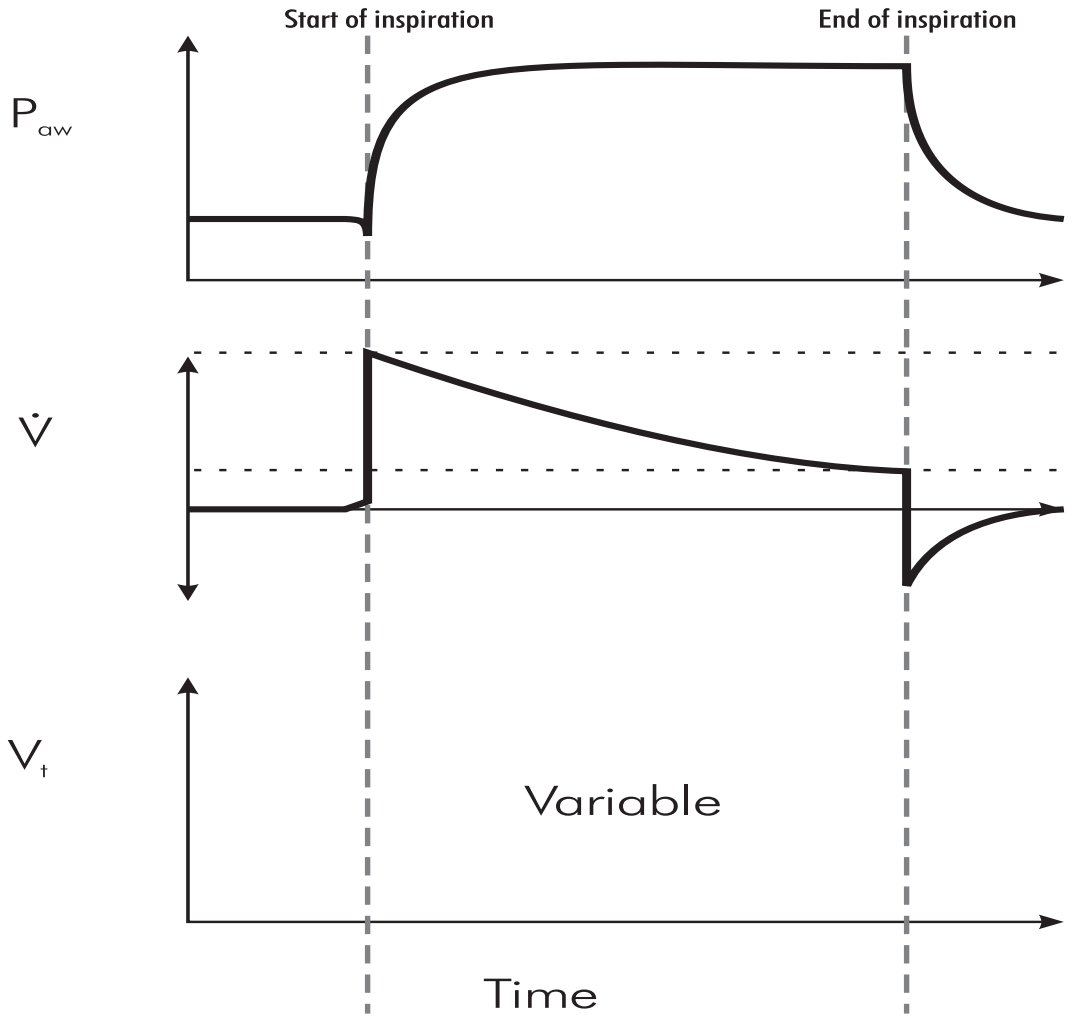


Figure 2-10: Supported Breaths Maintain Selected Pressure

Continuous Positive Airway Pressure (CPAP)

CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) is available in SIMV (all models) or SPONTANEOUS modes (Achieva PS and Achieva PSO2). PRESSURE must be set to 0. The ventilator maintains pressure at the selected PEEP over the entire breath cycle. Inspiration is triggered by patient-generated flow or pressure drop. Inspiration is limited by the pressure, and is cycled by the patient when the flow drops to the EXPIRATORY SENSITIVITY setting (between 15% and 55% of the peak flow).

In SIMV, additional mandatory volume breaths will be delivered, dependent on the selected BREATH RATE.

See the waveforms on the next page, Figure 2-11.

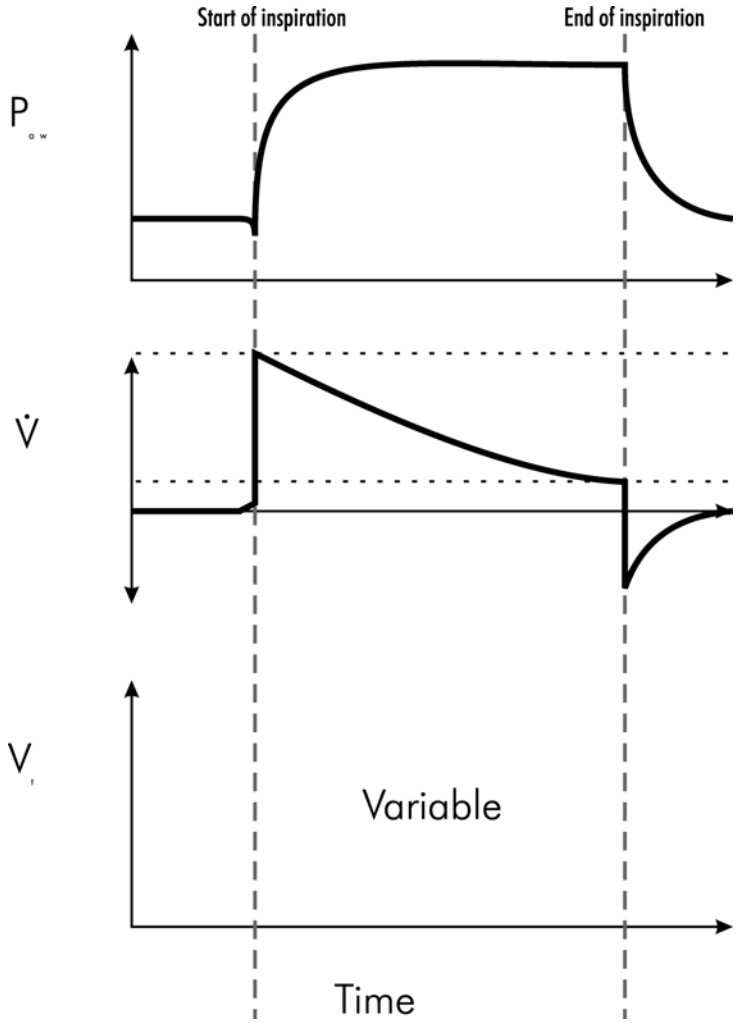


Figure 2-11: Continuous Positive Airway Pressure (CPAP)

Specifications

Power	
Power Line	100 to 240 VAC, 50 to 60 Hz
External DC Power	See your ventilator's back panel for specific voltage ranges.
	Operating time: At least 19 hours under normal load, and 5.5 hours under heavy load* (24 VDC)
Internal Battery	24 VDC (nominal)
	Operating time: At least 4 hours under normal load, and 1 hour under heavy load*
	Gel cell, sealed Lead Acid, backup power
	Lithium Battery, Memory power
Standard Power Converters	90 to 200 VAC
Fuses	250V, 3.15A, 5X20 mm, slow blow
Power Usage	
Maximum	75 W
Minimum	10 W
Type	Positive Pressure Volume ventilator
Motor	3-Phase Brushless Motor
Pump	Piston, 50 ml to 2200 ml tidal volume capability
Protection against electrical shock	Type of protection: Class I Degree of protection: Type BF
*Normal Load: Mode = Assist/Control, Volume = 1000 ml, Breath Rate = 10 BPM, Inspiratory Time = 1.5 seconds, F_IO_2 = 21%, Sensitivity = 5 LPM, PEEP = 0 cmH_2O/hPa, Vent pres.=30 cmH_2O/hPa Heavy Load: Mode = Assist/Control, Volume = 1500 ml, Breath Rate = 20 BPM, Inspiratory Time = 1.0 seconds, F_IO_2 = 100%, Sensitivity = 5 LPM, PEEP = 20 cmH_2O/hPa, Vent pres.=60 cmH_2O/hPa	

Indicators	
Normal Events	
Patient Pressure Meter	Displays patient pressure, -10 to + 100 cmH_2O/hPa; also displays battery charge when TEST_BATTERY button is pressed.
Alphanumeric Display	Shows current operating parameters and ventilator information.
Power	Green LEDs indicate operating power source: AC, External Battery, Internal Battery.
Battery Charging	Green LED indicates the unit is charging the internal battery.
Assist/Spontaneous	Green LED indicates that the patient's effort exceeds the sensitivity setting.
Alarm Control	Red LED flashes at 1 second intervals during a presilence condition and continuously lights when the nonlatching alarm feature is active.
Alarms	Flashing red LEDs: Low Pressure/Apnea, Low Power, High Pressure, Setting Error, Power Switchover, O_2 Fail (O_2 Fail available only on Achieva PS and Achieva PSO2).
Audible Alarms	
One-Second Beep	Relief Valve Test Failure, User Self-Test Error, Leak Test Failure
Repeated Single Beep	Power switchover
Repeated Three Pulses	Extremely Low Internal Battery, High Pressure, Invalid I:E Ratio, High Pressure<Low Pressure, Volume Error, Rate Error, Inspiratory Error, Oxygen Alarm, Pressure Differential Error
Repeated Five Pulses	Low Pressure, Valley, Exhale Fail, Apnea, Battery Charge Depleted, Vent Inop
Continuous Tone	Microprocessor failure
Single Beep Every Five Minutes	Low internal battery.
One Second Beep Every Thirty Minutes	Minor Fault.

One Beep Every Fifteen Minutes	Ventilator is ventilating, and a serious fault is detected.
Three Second Tone	Ventilator is in standby mode, and a serious fault is detected.
Alarm Volume	85 db or 70 db at a distance of 1 meter
Controls	
Alarm Silence/Reset	1. Silences audible alarms during an alarm condition. 2. Silences an alarm before a known alarm condition occurs. 3. Used to reset an alarm after the alarm condition has been corrected.
Test Battery	1. When the test battery key is pressed, the Patient Pressure Meter shows the charge level of the battery currently in use. 2. Activates printer.
Standby	Used to place the ventilator in the Nonventilate State, disabling the delivery of air.
Ventilate	Enables the ventilator to deliver air to the patient.
Mode	Causes the current mode on the display to flash and allows the mode to be changed.
Setting keys	Volume, Inspiratory Time, Sensitivity, Breath Rate, Pressure, PEEP, Low Pressure, High Pressure, F_IO_2 (Achieva PSO_2 only).
Menu/Esc	Activates and deactivates the menu on the ventilator's display.
START/ENTER	Used to accept the currently flashing parameter as the new setting. Activates display.
Up and Down Arrow Keys	Increases or decreases the parameter settings or menu levels. Pressing when the submenu is not active and a parameter has not been selected will cause the last alarm message to be displayed.

Settings	
Volume	For Assist/Control 50 ml to 2200 ml in 10-ml steps. For SIMV 50 ml to 1750 ml in 10-ml steps. Accurate to ± 10 ml for 50-500 ml and ± 10% (max 75 ml) for 100–2200 ml.
Inspiratory Time	0.2 to 5.0 seconds in increments of 0.1 seconds. Accurate to ±10%.
Sensitivity	Flow: 3 to 25 LPM in 1 LPM increments. Accurate to ±2.0 LPM. Off or 1 to 15 cmH_2O in 1 cmH_2O/hPa increments. Accurate to ±2.5 cmH_2O/hPa.
Breath Rate	1 BPM to 80 BPM in steps of 1BPM. Accurate to ±10% or 1 BPM, whichever is greater.
Pressure	0 to 50 cmH_2O/hPa in 1 cmH_2O/hPa increments. Accurate to ±2.5 cmH_2O/hPa of the setting, once the pressure reaches the setting. Pressure support settings below 3 cmH_2O/hPa default to 3 cmH_2O/hPa.
PEEP	0 and 3 to 20 cmH_2O /hPa in 1 cmH_2O/hPa increments. Accurate to ±2.5 cmH_2O/hPa.
Low Pressure	1 to 59 cmH_2O /hPa in increments of 1 cmH_2O /hPa. Activates within ±2.5 cmH_2O /hPa.
High Pressure	2 to 80 cmH_2O /hPa in increments of 1 cmH_2O /hPa. Activates within ±2.5 cmH_2O /hPa.

O_2 Level (only for Achieva PS and Achieva PSO2)	21% to 100% for tidal volumes greater than or equal to 100 ml; 21% to 70% for tidal volumes less than 100 ml in 1% increments. Accuracy: 50 to 90 ml, 0_2 settings < = 70% $\pm$ 10% 0_2; 100 to 2200 ml, O_2 settings <50%, $\pm$ 5% O_2, all other O_2 settings, $\pm$ 10% of settings. Supply pressures of less than 45 PSIG may result in reduced O_2 performance at some settings. Optimum performance is achieved at 65 PSIG O_2 supply pressure. It may take several minutes for the oxygen concentration to stabilize. The capacity of the O_2 blender is a function of tidal volume and inspiratory time, which in combination influence peak flow. As peak flows increase (large tidal volumes combined with short inspiratory times), the limit of the O_2 flow capacity is approached. The set O_2 concentration cannot be delivered if the flow capacity of the O_2 blender has been exceeded. In this case, an O_2 fail alarm will occur. To ensure the prescribed oxygen concentration is delivered to the patient, measure the delivered gases with a calibrated oxygen analyzer at all times.
Altitude	0 to 4500 meters in increments of 100 meters (or 0 to 14,760 feet in increments of 328 feet). (Set in menu system.)
Connectors	
Modem Jack (Achieva PS and Achieva PSO2)	RJ 11 phone connector to connect the optional internal modem to telephone lines.
Communications Port	RS-232 connector for Achieva Report Generator computer, printer, or external modem.
O_2 Inlet (Achieva PS and Achieva PSO2)	9/16–18, DISS 1240 THD.
External Battery Connector	3-pin male receptacle for 24-Volt DC input.
Power Entry Module	EIA dual-fuse power entry module.
	Provides connections for hot, neutral, and grounded conductors.
	The receptacle incorporates fuses in the hot and neutral lines.

Inlet Filter	Intake for patient air. Screw off cap for filter change. 98% efficient at 0.3microns.
Patient Pressure Port	Port for connection to the proximal pressure line of the patient circuit. For 3/16-in I.D. tube.
Remote Alarm Connector	Connector for remote alarm.
Nurse Call Connector	Connector for Nurse Call Station.
Patient Air	22-mm O.D./15-mm I.D. ISO Fitting
Exhalation Valve Port	Port for connection to the exhalation valve of the patient circuit. For 1/8-in I.D. tube.
Environment	
Operating	5°C to 40°C (41°F to 104°F), 10% to 90% RH.
Storage	-20°C to 50°C (-4°F to 122°F), 10% to 90% RH.
	When moving the ventilator from a non-operating to an operating environment, allow a minimum of one-hour temperature stabilization before use.
	When storing the ventilator, the battery must be recharged every thirty days. Storage above or below specified operating temperatures may affect battery life.

Miscellaneous	
Maintenance	Preventative maintenance must be performed by qualified personnel every 6000 operating hours, or recertification every twelve (12) months, whichever occurs first.
Dimensions	10.75 in X 13.30 in X 15.60 in (27.3 X 33.8 X 39.6 cm)
Weight	Less than 32 lbs.
Resistance Factor	Maximum of 4.5 cmH_2O/hPa @60 LPM
Compliance Factor	1.25 mL/hPa for A/C breaths 2.50 mL/hPa for Pressure Support breaths
Emergency Pressure Relief	90 ± 10 cmH_2O
Response time	75 milliseconds (under the following conditions): Resistance = 5 cmH_2O/hPa/L/seconds; Compliance = 50 ml/cmH_2O/hPa; Breath Rate = 20 BPM; Volume = 1500 ml; Pressure Support = 10 cmH_2O/hPa; PEEP = 5 cmH_2O/hPa. Response time varies inversely with the displayed flow rate, and directly with the selected trigger level.
Flow (average)	2.0 LPM to 150 LPM

The Achieva ventilators are intended to operate within its specifications if they are properly maintained, and the service schedule is followed.

The Achieva ventilators are protected against electrostatic contact discharge of up to eight kilovolts (8 kV). Electrostatic discharge greater than eight kilovolts may damage the ventilator.

Standard compliance

The ventilator complies with the following international agency standards:

- IEC 601-1 Medical Electrical Equipment, 1988 Part 1: General Requirements for Safety[1]
- IEC 601-1-2 Medical Electrical Equipment, Part 1: General Requirements for Safety, Part 2: Collateral Standard - Electromagnetic Compatibility Requirements and Tests
- CAN/CSA-C22.2 No.601.1-M90 Medical Electrical Equipment Part 1: General Requirements for Safety[1]
- UL2601-1 Medical Electrical Equipment, Part I: General Requirements for Safety (1994)[1]

FCC Part 68 information

This information applies to Achieva PS and Achieva PSO2 ventilators, which are equipped with an internal modem. These units have a MODEM label near the modem connector on the back panel.

Use the ringer equivalence number (REN) to determine the number of devices you can connect to the telephone line. Excessive RENs on the telephone line may result in devices not ringing in response to an incoming call. In most, but not all areas, the sum of the RENs should not exceed five (5). Contact the telephone company to determine the maximum REN for the calling area.

The required USOC jack for the Achieva ventilator is USOC RJ11C.

1. Classified as Class 1 and internally powered; Type BF; drip proof, not suitable for use in the presence of flammable anesthetics, continuous operation.

An FCC compliant telephone cord and modular plug is provided with this equipment. This equipment is designed to be connected to the telephone network or premises wiring using a compatible modular jack which is Part 68 compliant.

If the Achieva ventilator causes harm to the telephone network, the telephone company will notify you in advance. If advance notice is not practical, the telephone company will notify the customer as soon as possible. Also, you will be advised of your right to file a complaint with the FCC if you believe it is necessary.

The telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the operation of the Achieva ventilator. If this happens, the telephone company will provide advance notice in order for you to make the necessary modifications to maintain uninterrupted service.

If you experience trouble with the Achieva ventilator, please contact Nellcor Puritan Bennett, phone number 800.255.6774 for repair and/or warranty information. If the trouble is causing harm to the telephone network, the telephone company may request that you remove the Achieva ventilator from the network until the problem is resolved.

Do not make repairs. Doing so voids the user’s warranty.

Do not install the Achieva ventilator on public coin service telephone. Connection to party line service is subject to state tariffs. (Contact your state public utilities commission for information.)

Note

Puritan Bennett recommends that the customer install an AC surge arrestor in the AC outlet to which this device is connected. This is to avoid damaging the equipment caused by local lightning strikes and other electrical surges.

Chapter 3: Testing

This section provides procedures for verifying the correct operation of the ventilator.

Overview

The following test procedures are designed to minimize the need for special test equipment and to eliminate the need for disassembly of the ventilator. The use of a stop watch limits the accuracy of tests involving time and rate. Therefore, before accepting or rejecting a unit based on these tests, make sure that the results are not due to procedural error.

Scope

The checkout procedure in this section includes:

- visual inspection of controls, attachments, accessory items, and external surfaces.
- pneumatic testing of the patient circuit for function and leaks.
- testing of power functions, including battery recharging.
- verification of ventilation modes.
- measuring of ventilation parameters.
- checking of alarm and indicator functions.

Calibration and testing beyond the scope of this manual should be referred to an authorized service technician.

Frequency

Testing should be performed monthly.

Documentation

The operational checklist, located at the end of this section, should be reproduced and used each time a test is performed. A copy of the completed checklist should be maintained in the health care provider's file.

Ventilation equipment

In addition to the ventilator, the following Nellcor Puritan Bennett equipment is required for a complete verification test:

- patient circuit with test lung
- exhalation manifold valve
- bacteria filter
- DC power cable assembly
- 24 VDC battery

Test equipment

The following test equipment is also needed.

Table 3-1: Equipment and Recommended Supplier

Equipment	Recommended Supplier
Respirometer (hand-held)	Wright
	Fraser-Harlake
	Ferrairs Medical
Stop Watch	Any

Calibration of test equipment

Verify that the calibration procedures comply with the test instrumentation requirements adopted by the testing organization. Verify also that the calibration period has not lapsed.

Qualifications of test personnel

Testing should be performed by a qualified operator or service technician familiar with the function, setup, and operation of the ventilator. For basic operational instructions, refer to Chapter 2 of this manual.

Supplies

- mild detergent
- absorbent wipes or clean towels or cloths

Standard ventilation parameters

Unless otherwise stated, use the following standard ventilation parameters.

Table 3-2: Standard Ventilation Parameters

MODE	Standby
VOLUME	500 ml
INSPIRATORY TIME	1.5 seconds
SENSITIVITY	5 LPM
BREATH RATE	10 BPM
PRESSURE SUPPORT	0
PEEP	0
LOW PRESSURE	10 cmH_2O/hPa
HIGH PRESSURE	80 cmH_2O/hPa
FiO_2	21%

Connections

Unless otherwise specified, make the following external connections to the ventilator:

- power plug to AC power (three prong, grounded)
- patient hose (with exhalation manifold) to PATIENT AIR port (front panel)
- 500-ml test lung to exhalation manifold
- proximal pressure tube to PATIENT PRESSURE port (front panel)
- exhalation valve tube to the EXHALATION VALVE port (front panel)
- connect to a fully charged external battery.

Do not use the ventilator if it does not pass all of the verification tests. Refer the ventilator to a Nellcor Puritan Bennett Service Technician or call 800.255.6774 for repair and calibration.

Warning

Visual inspection

Cleaning. Prior to inspecting and testing the ventilator, clean the exterior with a mild detergent. Do not allow liquid cleaning agents to penetrate the inside of the ventilator.

Any liquid leaking into the ventilator or its connections may damage the unit or result in an electrical shock hazard.

Warning

Cabinet. Examine the cabinet for scratches, dents, or deformities. Side mounting brackets should be securely attached. Rubber feet should be in place and not broken or cracked.

Top Panel. Check the control/display panel for cracks or breaks. Check the PRESSURE METER window for scratches and debris. The meter needle should be within one division of 0 cmH_2O/hPa if the ventilator is plugged into AC power.

Control/Display Panel. Open the magnetically secured door and examine the control/display panel for scratches, dents and dirt.

Front Panel Connections. Check the front panel connection ports for cracks, dents or bent tubes. Make sure they are free of foreign matter.

Rear Panel. Check the rear panel for dirt and damage. Examine the power cord for damaged insulation. Check the plug for bent pins or breaks. Examine the external battery connector and communications port for secure attachment and straight connector pins.

Inlet Air Filter. Unscrew the cap to the inlet air filter and replace the fiber air filter. Use only filters supplied by Nellcor Puritan Bennett. Follow the instructions for replacing the filter.

Caution

Correct any problems found during the visual inspection before proceeding to unit checkout.

Pneumatic test

The ventilator's built-in user self-test can be used to test the ventilator's pneumatic system for leaks and response to high pressure conditions. The ventilator must be in Standby mode.

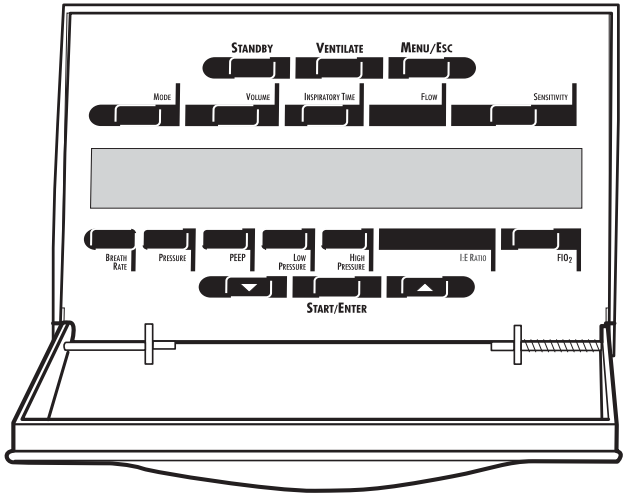


Figure 3-1: Front panel view

1. While Standby, press the MENU/ESC key.
2. The user self-test is the first item in the menu. The display screen will read

   Press ENTER to begin
   User Self-Test

3. Press the START/ENTER key.

   The display screen will read

   Occlude patient's
   end-of-breathing circuit

4. Block the part of the exhalation manifold that connects to the patient, as shown below. It is important that you make a tight seal and do not let any air escape.

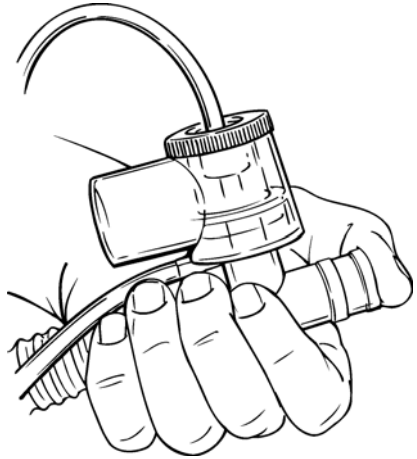


Figure 3-2: Blocking exhalation manifold

Warning

A ventilator patient is highly susceptible to respiratory infections. Dirty or contaminated equipment may be a source of infection. Clean equipment is essential for successful ventilation. Be sure to wash your hands thoroughly before and after contact with the patient circuit.

The display screen will read

Press ENTER when ready
to begin test

5. When you have a good seal on the exhalation manifold, press the START/ENTER key.

   The ventilator will push air into the circuit as it runs the test.

6. If the ventilator passes the test, this message will be displayed:

   TEST PASSED
   ENTER: repeat ESC: exit

   Press the START/ENTER switch to repeat the test, or the MENU/ESC switch to end the test.

7. If the ventilator fails the test, one of three messages will be displayed:

   a. Test ERROR
      Refer to MANUAL

      If this message is displayed, it means the test was not conducted properly.

      - Press the ALARM SILENCE/RESET switch. The display screen will indicate that the test was a failure, as shown here:

        Test FAILED
        ENTER: repeat ESC: exit

      - Check all the connections in the patient circuit, including the blockage in the exhalation manifold.
      - Press START/ENTER to repeat he test.

   b. Leak Test FAILED
      Refer to MANUAL

      If this message is displayed, it means that there is a leak in the patient circuit somewhere between the patient air port and the blockage you created at the exhalation manifold.

      - Acknowledge the alarm condition by pressing the ALARM SILENCE/RESET switch. The display screen will indicate that the test was a failure.

        Test FAILED
        ENTER: repeat ESC: exit

      - Press START/ENTER to repeat the test.
      - If the ventilator fails the test again, try using a new patient circuit and repeat the test. If the ventilator fails with a new patient circuit, contact your equipment supplier or Nellcor Puritan Bennett.

c. Relief valve test FAILED
Refer to MANUAL

If this message is displayed, it means that the ventilator's relief valve did not function properly.

- If the ventilator fails the test again, contact your equipment supplier or Nellcor Puritan Bennett.

Power system checkout

The following procedure verifies that the ventilator selects the correct power source. It also verifies that power switchover occurs upon power failure and that the proper alarm and indicators are activated.

Prior to beginning the checkout procedure, set the standard ventilation parameters from Table 3-3. Record the pass/fail determination on a copy of the operational checklist, located at the end of this chapter.

Table 3-3: Power system checkout

Key/Action	From	To	Desired Response
AC Power Cord	Unplugged	Plugged in	Indicator lights & audible alarm on for 2 seconds; A.C. and BATTERY CHARGING lights come on; ventilator cycles once; PRESSURE METER at 0 ± 2 cmH_2O/hPa.
MODE	Standby	Assist/ Control	Indicator lights & audible alarm on for 2 seconds; A.C. remains on; ventilator cycles at 10 ± 1 BPM; PRESSURE METER indicates pressure excursion.
External Battery Power Cord		Plugged in	Connect external battery.

Table 3-3: Power system checkout (Continued)

Key/Action	From	To	Desired Response
AC Power Cord	Plugged in	Unplugged	POWER SWITCHOVER light on; alarm sounds; EXTERNAL BATTERY LED and BATTERY CHARGING lights stay on; A.C. LED is off; ventilator continues to cycle.
ALARM SILENCE/ RESET		Press	Alarm and indicator turn off
Disconnect External Battery			POWER SWITCHOVER light on; alarm sounds; INTERNAL BATTERY light on; EXTERNAL BATTERY light off; ventilator continues cycling.
ALARM SILENCE/ RESET		Press	Audible and visual alarms turn off
TEST BATTERY		Press & hold	PRESSURE METER indicates charge condition of internal battery: INTERNAL BATTERY light comes on.
AC Power Cord	Unplugged	Plugged in	INTERNAL BATTERY light goes OFF; A.C. light comes on; Battery Charging light comes on.
MODE	Assist/ Control	Standby	Completes Power System Checkout

Assist/control ventilation mode checkout

Verify the ASSIST/CONTROL Mode functions by performing the following checkout procedure. Record the results on a copy of the Operational Checklist located at the end of this chapter. Prior to beginning the checkout procedure, set the standard ventilation parameters from the chart on page 2-4.

The following symbol will assist you when you use the ASSIST/CONTROL Mode functions. Press this key to enter an increase or decrease in quantities.

START/ENTER function setting key: 

Note

Volume variation will be a function of the respirometer accuracy, which is flow-rate dependent. See the respirometer manual. Ventilator volume change occurs at a rate of 100 ml/breath cycle.

Table 3-4: Assist/Control ventilation mode checkout

Key/Action	From	To	Desired Response
MODE	Standby	Assist/ Control	Indicator lights & audible alarm on for 2 seconds; A.C. LED and BATTERY CHARGING lights on; PRESSURE METER registers pressure
Measure breath time with the stop watch.			Rate equals 10 ± 1 BPM
Replace test lung and patient hose with respirometer. Block EXHALATION VALVE port.			Volume reads 500 ± 100 ml
VOLUME	500	1000 ◄┘	Respirometer volume reads 1000 ± 120 ml
VOLUME	1000	2000 ◄┘	Volume reads 2000 ± 200 ml
VOLUME Replace test lung and patient hose	2000	500 ◄┘	Completes Volume check
Measure I-TIME			Should be 1.5 seconds ± 10%
VOLUME	500	1000 ◄┘	Should be 1.5 seconds ± 10%
INSPIRATORY TIME	1.5	3.0 ◄┘	Should be 3.0 seconds ± 10%

Table 3-4: Assist/Control ventilation mode checkout (Continued)

Key/Action	From	To	Desired Response
INSPIRATORY TIME	3.0	4.5 ◄┘	SETTING ERROR alarm
Reset INSPIRATORY TIME	4.5	1.5 ◄┘	Alarm, LED off; completes I-TIME and SETTING ERROR check
HIGH PRESSURE	80	25 ◄┘	Pressure increase on meter stops at HIGH PRESSURE setting; HIGH PRESSURE LED flashes; alarm sounds
ALARM SILENCE/ RESET	Press		Alarm off; HIGH PRESSURE LED flashes. In one minute, alarm reactivates.
VOLUME	1000	500 ◄┘	HIGH PRESSURE LED and audio alarm continue until pressure is below HIGH ALARM setting, then alarm is off; LED remains on.
ALARM SILENCE/ RESET	Press		LED extinguishes
HIGH PRESSURE	25	80 ◄┘	Completes HIGH PRESSURE check
Remove test lung			At second breath, alarm sounds, LOW PRESSURE/APNEA LED flashes
ALARM SILENCE/ RESET	Press		Alarms off; LED flashes. After one minute alarm reactivates.
Replace test lung			Alarm off
ALARM SILENCE/ RESET	Press		LOW PRESSURE/APNEA LED turns off. This completes the LOW PRESSURE/ APNEA Checkout.

SIMV ventilation mode checkout

This procedure verifies those operational functions unique to the SIMV mode. Functions that are verified in the Assist/Control mode are not repeated. Therefore, it is necessary to test the Assist/Control mode in addition to SIMV.

Prior to beginning the checkout procedure, set the standard ventilation parameters from the chart on page 2-4. Record the pass/fail results on a copy of the Operational Checklist, located at the end of this chapter.

Note

In SIMV mode, the ventilator coordinates assisted breaths with the patient's inspiratory effort. Therefore, measured breath rates will vary somewhat from the rate set for the BREATH RATE parameter.

Table 3-5: SIMV mode checkout

Key/Action	From	To	Desired Response
AC Power cord	Unplugged	Plugged in	Indicator lights & audible alarm on for 2 seconds; A.C. and BATTERY CHARGING light on; ventilator cycles once; PRESSURE METER at 0 ± 1 cmH_2O/hPa
MODE	Standby	SIMV	Indicators & audible alarm on for 2 seconds
BREATH RATE	10	6	
SENSITIVITY	0	5	
Squeeze test lung to simulate 2 or 3 spontaneous breaths at about 6-second intervals			ASSIST/SPONTANEOUS LED flashes; pressure gauge dips negative; ventilation occurs synchronized to simulated effort

Table 3-5: SIMV mode checkout (Continued)

Key/Action	From	To	Desired Response
Cease spontaneous effort			A mandatory breath will occur within 20 seconds after spontaneous breaths cease and will continue at the 6 ± 1 BPM rate; no alarms activate.
BREATH RATE Within 20 seconds after switching to 4, simulate breaths	6	4	ASSIST/SPONTANEOUS LED lights; ventilation occurs, synchronized to effort.
Cease spontaneous effort			In 20 ± 0.5 seconds after last spontaneous breath, alarm on, LOW PRESSURE/ APNEA LED on; ventilator delivers 10 ± 1 BPM
ALARM SILENCE	Press		Light and alarm off; 10 BPM delivery stops in 20 ± 0.5 seconds; alarm reactivates
ALARM SILENCE/ RESET	Press		Light & alarm deactivate; 10 BPM delivery stops.
Within 20 seconds, simulate breaths			ASSIST/SPONTANEOUS LED flashes; breaths delivered; light and alarm off
MODE	SIMV	Standby	This completes SIMV check.

Pressure-controlled ventilation mode checkout

The following procedure only verifies those functions unique to the PRESSURE CONTROL mode of ventilation. Those functions that are verified in the Assist/Control mode are not repeated here. Perform an Assist/Control checkout in addition to PRESSURE CONTROL mode checkout.

Prior to beginning the checkout procedure, set the standard ventilation parameters from the chart on page 2-4. Record results on a copy of the Operational Checklist, located at the end of this chapter.

Table 3-6: Pressure-controlled mode checkout

Key/Action	From	To	Desired Response
AC Power Cord	Unplugged	Plugged in	Indicator lights & audible alarm on for 2 seconds; A.C. and BATTERY CHARGING lights are on; ventilator cycles once; PRESSURE METER at 0 ± 1 cmH_2O/hPa
MODE	Standby	Assist Control	Alarms and indicators on for 2 seconds; ventilator commences cycling at 10 ± 1 BPM
PRESSURE	0	10	
Observe PRESSURE METER			Pressure indicated on meter rises to 10 cmH_2O/hPa.
MODE	Assist Control	Standby	This completes Pressure-control check.

Pressure support mode checkout

The following procedure only verifies those functions unique to the PRESSURE SUPPORT mode of ventilation. Those functions that are verified in the Assist/Control mode are not repeated here. Perform an Assist/Control checkout in addition to PRESSURE SUPPORT mode checkout.

Prior to beginning the checkout procedure, set the standard ventilation parameters from the chart on page 2-4. Record results on a copy of the Operational Checklist, located at the end of this chapter.

Table 3-7: Pressure support

Key/Action	From	To	Desired Response
AC Power Cord	Unplugged	Plugged in	Indicator lights & audible alarm on for 2 seconds; A.C. and BATTERY CHARGING lights are on; ventilator cycles once; PRESSURE METER at 0 ± 1 cmH_2O/hPa
MODE	Standby	Spontaneous	Alarms and indicators on for 2 seconds
PRESSURE	0	10	
Observe PRESSURE METER			Pressure indicated on meter rises to 10 cmH_2O/hPa.
MODE	Assist Control	Standby	This completes Pressure-Control Check.

Achieva ventilator operational checklist

Owned by:	Serial #	Hour Meter Reading:	Date:
User:		Serviced by:	
Address:		Address:	
City:		City:	
State & Zip:		State & Zip:	
User Phone:		Service Representative:	

Test	Operation	Test Results	Pass	Fail
Visual	Inspect	As specified	r	r
Set standard parameters	Procedure	Not applicable		
Connections	Procedure	Not applicable		
Pneumatic Test	Perform Test	As specified in procedure.	r	r
Power System	Perform Tests	As specified in procedure.	r	r
Assist/Control Mode	Perform Tests	As specified in procedure.	r	r
SIMV Mode	Perform Tests	As specified in procedure.	r	r
Pressure Control Mode	Perform Tests	As specified in procedure.	r	r
Pressure Support Mode	Perform Tests	As specified in procedure.	r	r

Comments:	
Signature:	Date:

Chapter 4: Theory of operation

This chapter provides an operating theory for the Achieva ventilators.

Pneumatic system

Note

Text in **bold sans-serif font** refers to the labels in the illustration; see *Pneumatic diagram* on page 4-2.

Components

Pump — Airflow is created by a 7-in diameter mechanical piston pump. The piston is driven by a brushless DC motor through a 96:1 speed reduction gearbox. The pump is capable of delivering volumes of 50 to 2200 ml and pressures up to 90 ± 10 cmH_2O/hPa.

Manifold — The manifold channels and directs the airflow within the ventilator. The manifold also provides a means to mount various valves and transducers.

Valves — Check valves are used to control the air flow direction. They are accessible for replacement by authorized personnel should they become worn, dirty, or otherwise faulty. The manifold is equipped with a mechanical relief valve that will protect the patient from high pressures. It is set to 90 ± 10 cmH_2O/hPa.

Exhalation Manifold — The exhalation manifold is a pneumatically operated, three-way valve that directs the patient's inspired and expired flow. It may also be used as an integral part of the PEEP system. It is available in both a disposable and reusable version. They are easily disassembled, cleaned, and reassembled.

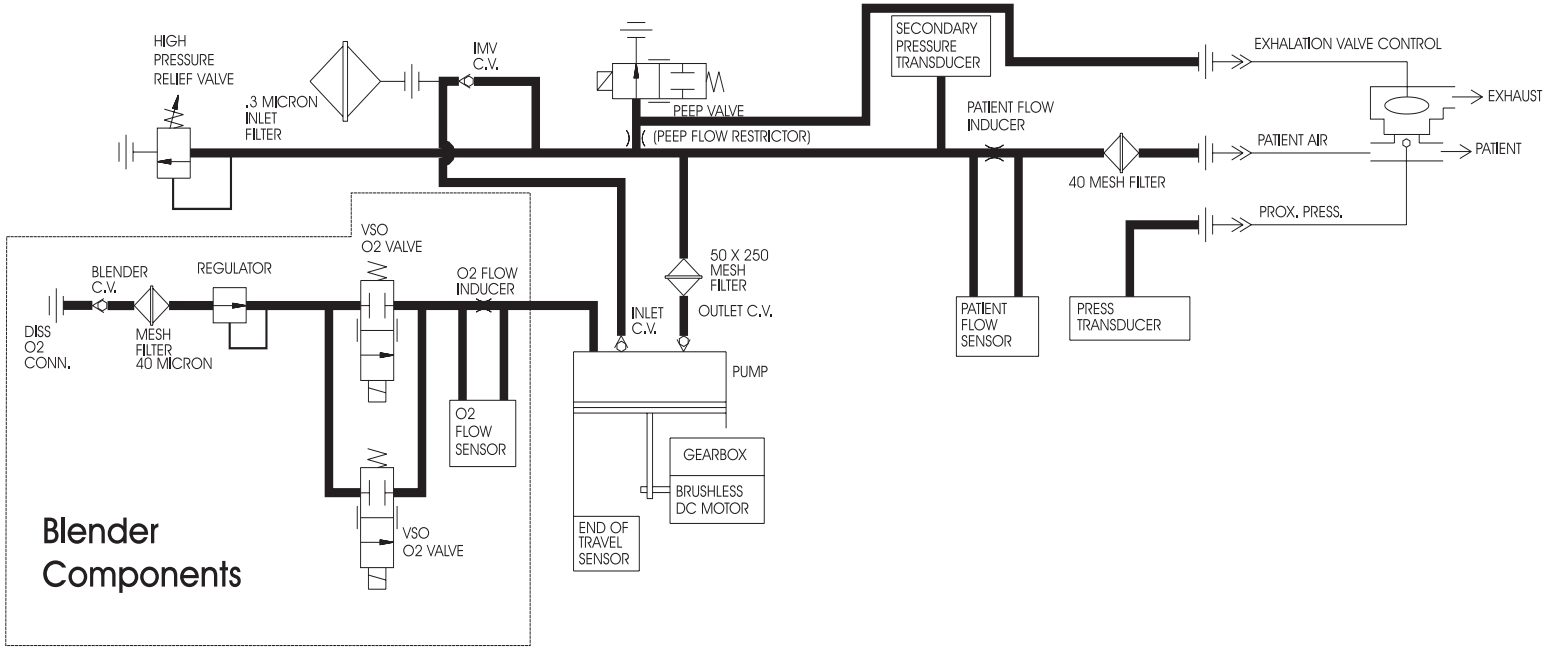


Figure 4-1: Pneumatic diagram

Operation

Pump — The withdrawal stroke of the piston in the mechanical piston **pump** draws air into the ventilator through a **0.3 micron inlet filter**. Air enters the cylinder through the **inlet c.v.** (check valve) and, if called for, is mixed with oxygen from the blender (available only on Achieva PSO2). The combined gases become pressurized by the forward piston stroke and exit through the **pump outlet c.v.** (check valve) and through a **50 X 250 mesh filter**. The gas passes through one additional **40-mesh filter** just before leaving the ventilator through the **patient air outlet tube**.

Supplemental Oxygen — The internal oxygen blender (available only on Achieva PSO2) is shown in the **Blender Components** box on the pneumatic diagram. Oxygen enters the blender through the **DISS O_2 connector**, and then passes through the **blender c.v.** (check valve) and the **mesh filter (40 micron)**. The **regulator** drops the pressure to 55 psig before feeding the oxygen to two parallel **VSO O_2 valves**. The ventilator allows enough oxygen into the pump to reach the selected concentration. If the ventilator determines that the measured flow rates are insufficient for the selected **FIO_2** settings **O_2 FAIL** alarm will sound.

Ventilator by-pass — Ventilator by-pass uses a parallel path incorporated into the manifold. This path bypasses the pump and allows air to move directly to the **patient air outlet tube** after passing through the **0.3 micron inlet filter** and the **ventilator by-pass c.v.** (check valve). This allows the patient to breathe spontaneously in the event of complete ventilator failure.

PEEP — The **PEEP valve** is a voltage-sensitive orifice (VSO) that controls the mushroom valve in the exhalation manifold. With the VSO open, the mushroom valve is deflated, resulting in a PEEP level of 0 cmH_2O/hPa. With the VSO fully closed, the mushroom valve is fully seated, and the maximum PEEP pressure in the patient circuit is 20 cmH_2O/hPa. As a safety measure, the VSO is normally open to deflate the mushroom valve. This allows the patient, in the event of ventilator failure, to breathe through the exhalation manifold.

System control

The block diagram below provides an overview of the control system.

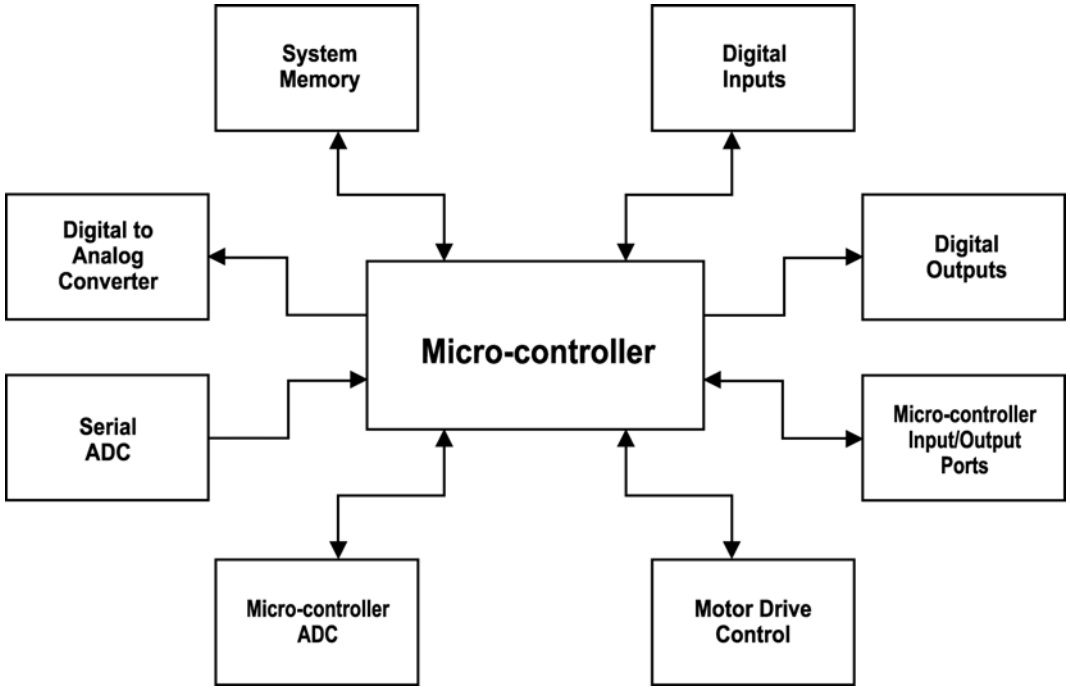


Figure 4-2: Control System block diagram

Micro-controller

The ventilator is controlled by a micro-controller via software stored in flash memory.
The micro-controller consists of:

- 16-bit Central Processing Unit (CPU)
- Systems Integration Module (SIM)
- 1024 bytes of Static RAM
- 8-channel, 10-bit Analog to Digital Converter
- Serial port
- Two 16-bit timer/counters
- Two Pulse Width Modulator (PWM) output channels

System memory

System memory consists of three modules:

Flash Memory — stores the software instructions for system operation.

Static Random Access Memory (SRAM) — provides temporary storage of data. A lithium back-up battery allows data stored in SRAM to be retained when other power sources fail.

Non-Volatile Random Access Memory (NVRAM) — The ventilator uses Non-Volatile Random Access Memory (NVRAM) for storing ventilator parameter settings. The NVRAM is backed up by a battery (BBU).

Real-time clock

The ventilator has a real-time clock that can be set by the user and read by the micro-controller. The clock keeps track of the year, month, day, hours, and seconds. The real-time clock is backed up by a battery and can maintain data for a minimum of 9 years from the date of manufacture.

Motor drive control

The motor drive controls the brushless DC motor that drives the piston. This circuitry allows the micro-controller to control the motor position, speed, and direction. The motor drive includes protective fault detection and safety logic. The motor drive will function with a power input of 11V DC to 32V DC. (*See your ventilator's back panel for specific voltage ranges*.)

System analog monitoring circuitry

The System Analog Monitoring circuitry converts the following analog signals to a voltage that is within the range (0 to 5V DC) of the micro-controller's internal analog to digital converter (ADC) and the external serial A/D converter circuits, as described here:

- Primary pressure sensor
- Secondary pressure transducer
- Primary flow sensor
- Power bus sense
- Internal battery voltage
- Internal battery current
- External battery voltage
- Battery charger current
- Piston motor current
- Amplified flow transducer
- O_2 flow sensor
- +10 voltage reference sense
- Alarm power voltage sense
- ADC +5 reference
- External battery current

System analog control

The system analog control circuitry converts micro-controller digital data into analog signals for controlling the following ventilator systems:

The Panel Meter Control — is a 0 to 1 milliamp source and corresponds to patient pressures of -10 to 100 cmH_2O/hPa.

The Exhalation/ PEEP Valve — requires linear control of its Voltage Sensitive Orifice (VSO) Valve. The Exhalation/PEEP valve is normally an open valve, and the failsafe state is open. The watchdog circuitry provides a redundant means (separate from the micro-controller) to remove power from the Exhalation/PEEP valve.

The Piston Oxygen Blender Control — is normally a closed valve. The failsafe state is closed. The watchdog circuitry provides a redundant means (separate from the micro-controller) to remove power from the Piston Oxygen Blender Valve.

Watchdog

The ventilator includes two watchdog circuits that detect micro-controller faults. When activated, these circuits cause the ventilator to enter the safe state. The safe state is defined as

- PEEP valve open
- Oxygen blender valves closed
- Audible alarm activated
- Piston stopped
- All LEDs activated

Digital inputs

The digital input section provides the micro-controller with the means to monitor the status of

- Input switches and the
- Watchdog circuit

Digital outputs

Through the digital output circuitry, the micro-controller controls the on/off status of the following systems:

- Battery charger
- Modem controller
- Remote alarm and nurse call port
- Audible alarm
- Alarm and power LEDs
- LCD (Alphanumeric) display. In addition to turning the LCD on or off, the micro-controller also sends the information displayed on it. The LCD is illuminated during updating of the ventilation parameters and during the initial 30 seconds of an alarm condition.
- External battery
- Power supervisory circuit

Micro-controller I/O ports

The micro-controller I/O ports handle the following signals:

- End-of-travel sensor
- Piston motor fault
- Ventilate/standby mode input
- Battery charger level control
- Power bus low power input
- 24V battery status input
- Remote alarm reset input
- Memory watchdog active

System power

The ventilator can draw its power from an external source (either AC or a battery) or from the internal battery. The power system provides several DC voltage levels for the ventilator circuitry and the internal battery charger. The power system provides status signals to the micro-controller to indicate which source is active. The power system also provides analog signals that the micro-controller can use to determine the following:

- internal battery voltage and current
- external DC input voltage
- battery charger current
- status of the battery charger control lines

Refer to *Figure 4-3: Power supply inputs* and *Table 4-1: Power sources and priority levels* on page 4-10.

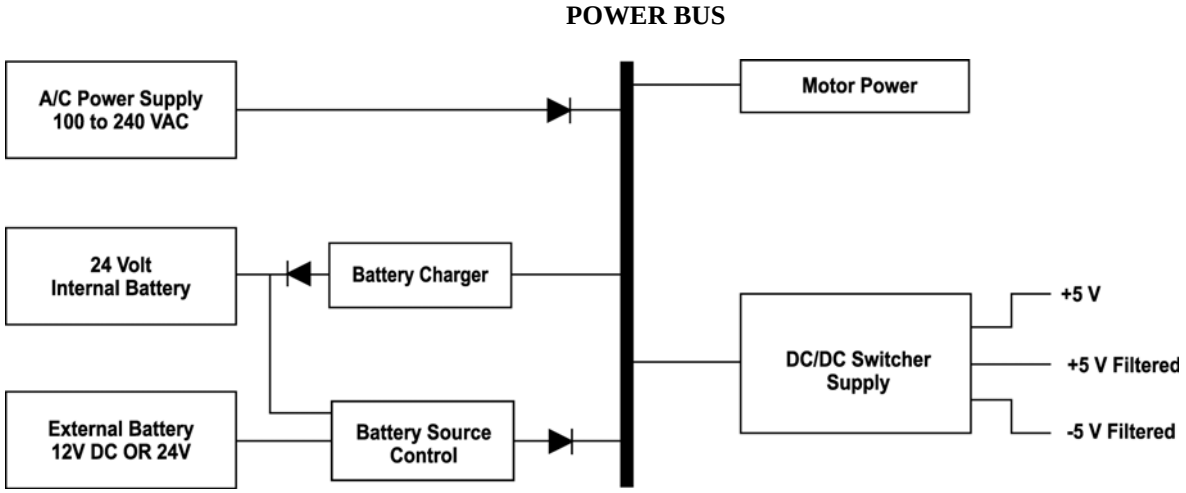


Figure 4-3: Power supply inputs

Table 4-1: Power sources and priority levels

Power Source	Priority	Voltage/Frequency Range
AC Line Power or a DC to AC Power Inverter	1	100 to 240V AC / 50 to 60 Hz (No switch setting or jumpers required)
External DC Power	2	See your ventilator's back panel for specific voltage ranges.
Internal Battery	3	23.2 to 29.0V DC / NA

The Achieva will operate properly when all three sources are connected simultaneously and will switch automatically between the three power sources. Switching will occur according to availability and priority of the power source and will not cause an interruption in ventilator operation.

The ventilator will operate from the external power source until the external power source is no longer within the operating range.

The ventilator will operate from an external power source (AC/DC Power Supply or External DC Power Source) when the internal battery is completely depleted or absent.

There is no on/off switch for the AC input. Plugging and unplugging the AC power cord is the correct way to connect/disconnect AC power. The AC power lines are fused with “Slo-Blow” type fuses rated at 3.15 amperes. The AC supply output voltage is 24V DC. The power supply is protected from short circuits on the output—no damage will result when a dead short is applied to the output.

Natural convection and heat-sinking are used to cool the power system.

External DC Input — The ventilator will accept an input of 11 to 32V DC through a separate input connector. The unit will start up if the input voltage is at least 12.7 ±.2V DC, and it will operate down to 11.8V DC. (*See your ventilator’s back panel for specific voltage ranges*.)

While the unit is capable of withstanding typical automotive transients, it may not withstand automotive start up transient conditions.

The peak input current when operating at 12V DC is 6 Amps. The external DC input is fused with a “Fast-Blow” type fuse.

The power system senses the external DC input voltage polarity and protects itself from damage. If battery polarity is reversed, no damage to the system will occur. The power system will disconnect the External DC Source from the system.

Internal Battery Input — The internal battery is rated at 24 volts. It will operate the ventilator, provided no other power source is available, until its voltage drops to about 11V. The peak input current when operating at 24.0V DC is 5.5 Amps. The internal battery input is fused with a “Fast-Blow” type fuse.

Power Distribution — The Main Power Bus supplies power for the motor power drive, the auxiliary DC/DC power supplies, and the internal battery charger. The Main Power Bus voltage will be at the voltage level of the active power source. The maximum voltage is 32V DC, and the minimum operating voltage is about 10.6V DC. The Main Power Bus is capable of distributing a maximum of 6 amps.

The Internal Battery Charger — The Internal Battery Charger is operational when the power source to the ventilator is either the External DC Source or the AC/DC Power Supply. The Battery Charger is capable of providing a bulk charge voltage level of 29.0V DC and a trickle charge voltage level of 27.6V DC. The battery charger is current-limited to 0.4 amp. The Battery Charger is capable of fully charging the internal battery within twelve hours. The Battery Charger is automatically disabled when the ventilator is operating from the internal battery.

Power system control

Front panel control — The ventilator sequence and the START/ENTER and STANDBY keys are capable of turning system power on and off as described below.

External battery voltage indicator — The power system provides a signal to the micro-controller that indicates whether the External DC Power Source is nominally rated at 12V DC or 24V DC. *See also your ventilator's back panel for specific voltage information*.

Watchdog turn off control — The power system includes an input that is used by the hardware Watchdog Timer, in conjunction with the STANDBY key, to provide a means to remove power from the system when the micro-controller has failed, and system power is latched on. If the system is operating from either the internal battery or an external DC source, and a watchdog failure activates the Watchdog Turn Off Control, pressing the STANDBY key for a period greater than three seconds will cause system power to be removed. If a watchdog failure is not present, pressing the STANDBY key for a period greater than three seconds will have no effect other than switching the ventilator to Standby Mode.

Alarm power — Alarm power is derived from one of two power sources:

- unfiltered 12V DC/DC switcher voltage
- unfused internal battery voltage.

The higher voltage is automatically selected. Power to the alarm is controlled in such a manner that if the system power is lost without being under micro-controller control, the audible alarm is activated.

(This page intentionally blank.)

Chapter 5: Maintenance

This chapter provides cleaning and maintenance information, a maintenance schedule, and replacement procedures for the inlet filter and fuses.

Cleaning ventilator surfaces

This section contains instructions for maintaining and cleaning the ventilator. You must also consult the corresponding cleaning instructions for the various accessories used with the ventilator.

Warning

A ventilator patient is highly susceptible to respiratory infections. Dirty or contaminated equipment may be a source of infection. Clean equipment is essential for successful ventilation. Be sure to wash your hands thoroughly before and after cleaning the ventilator or accessories.

Caution

Do not sterilize the ventilator with ethylene oxide (ETO) or steam. Doing so may damage the ventilator.

Caution

Do not use methyl ethyl ketone (MEK), trichloroethylene, or alcohol to clean the ventilator. Doing so may damage the unit’s surfaces.

Frequency

Clean as often as the surface becomes soiled.

Supplies

Use a mild soap solution and a damp cloth.

Procedure

1. Clean with a mild soap solution and a damp cloth. Squeeze the cloth thoroughly before applying it to the unit’s surface.
2. Do not allow liquids to enter the ventilator.

Caution

Never allow liquids to contact internal ventilator components. Moisture will damage the ventilator.

Note

Contact Puritan Bennett for alternate cleaning methods.

Replaceable parts

Caution

Failure to change a dirty filter may damage the ventilator and can void the warranty. A blocked inlet filter may cause a setting-error alarm.

Caution

Do not operate the ventilator without an inlet air filter. Using the ventilator without a filter may damage the ventilator. Use only filters supplied by Puritan Bennett.

Flatpak filter

The model Y-6109 Inlet Filter (Flatpak) is a replacement part for the ventilator. Inspect the filter monthly (weekly if used outdoors, in transport, or in a dusty atmosphere). Replace with a new filter when it shows signs of discoloration. The Flatpak filter is disposable; discard after removal. Do not attempt to wash or otherwise clean it. Do not reuse filters.

1. Twist off the retainer ring of the inlet filter (Flatpak) from the back panel of the ventilator and replace the Flatpak filter cartridge.
2. Reassemble the O-ring, Flatpak filter, and Retainer Ring as shown:

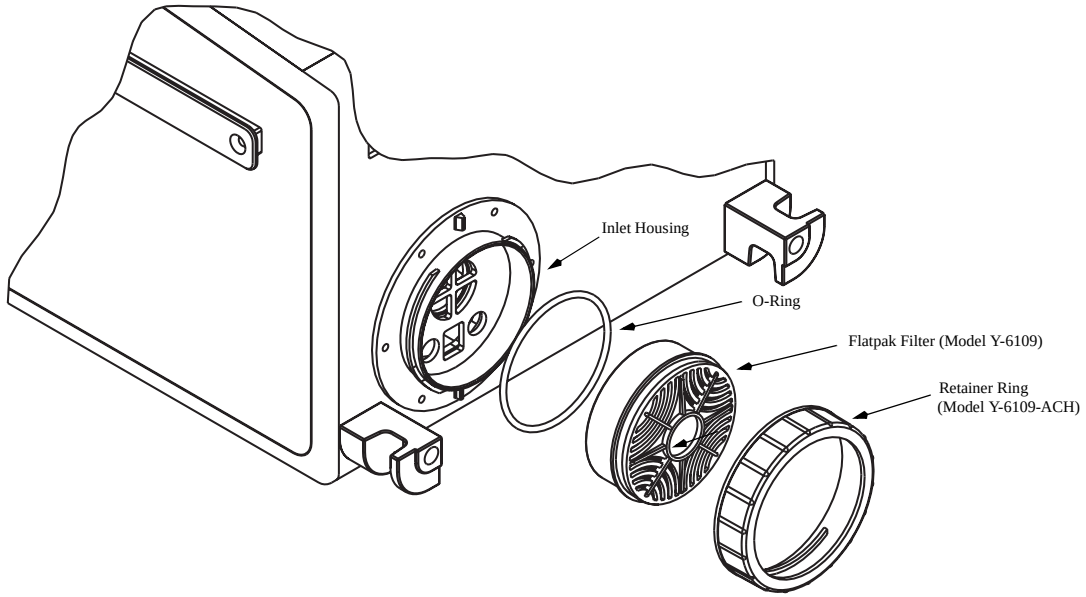


Figure 5-1: Replacing Flatpak filter

Changing the fuses

A fuse may need to be replaced if the ventilator is plugged into an electrical outlet, but the charging light is not illuminated.

The fuses for the ventilator are rated at 250V, 3.15A, 5 x 20 mm, slow blow. Replacement fuses are available from your equipment supplier or Puritan Bennett.

For continued protection against fire hazard, replace only with identically rated fuses.

Caution

Before changing the fuse, unplug the power cord.

Warning

The fuse holder is located above the power cord connector.

To remove the fuse holder:

1. Unplug the power cord.
2. Insert a small screwdriver into the small slot on the under side of the fuse holder.

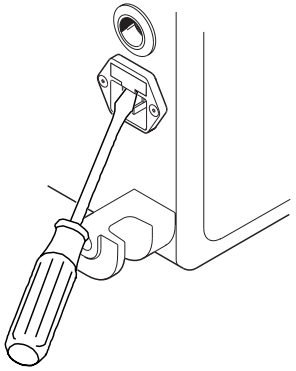


Figure 5-2: Removing fuse holder

3. Pull upward with the screwdriver.
4. The fuse holder should pop out slightly.
5. Pull the fuse holder out.

6. Remove the fuses.

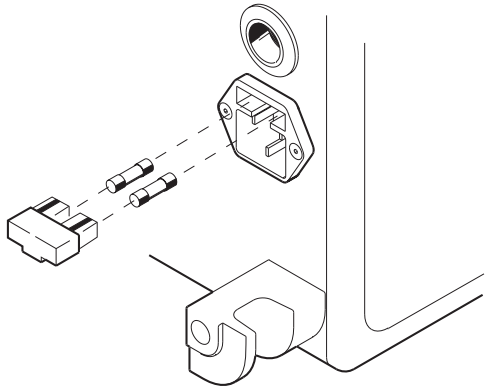


Figure 5-3: Replacing fuses

7. Place the new fuses directly into the fuse holder.
8. Replace the fuse holder in the ventilator. You should feel a click when it is secure.
9. Reconnect the power cord.

Periodic maintenance

The ventilators require preventive maintenance at a minimum of once every 6000 operating hours, or recertification every twelve (12) months (whichever occurs first) by Puritan Bennett's qualified service personnel. The ventilator is intended to function within its specified standards if the service schedule is followed.

To display the ventilator operating hours:

10. Press the MENU/ESC key.

11. Press the up or down arrow key until the display screen says:

    Ventilating hours since
    last maintenance: XXXXX

Achieva ventilators are warranted against defects in workmanship and materials. The full warranty provides details. Do not make any service repairs on this equipment during the stated warranty period. Any unauthorized work immediately voids the warranty. If you need information or assistance, or if the information in this manual is insufficient, contact Puritan Bennett at this number:

800.255.6774

Puritan Bennett does not recognize the owner of a ventilator as an authorized service representative. Puritan Bennett will not be liable for any repairs attempted by the owner. Any such attempted repairs, other than specified non-warranty repairs, void the warranty. Parts and labor costs incurred by the owner will not be reimbursed by Puritan Bennett.

Before returning any device to Puritan Bennett, you must obtain a Return Authorization Number by calling Puritan Bennett at the number listed above.

Chapter 6: Schematics

This chapter provides the schematic diagrams for the logic board and the power board, and assembly drawings.

Schematic 6-1: Logic board—notes for schematics

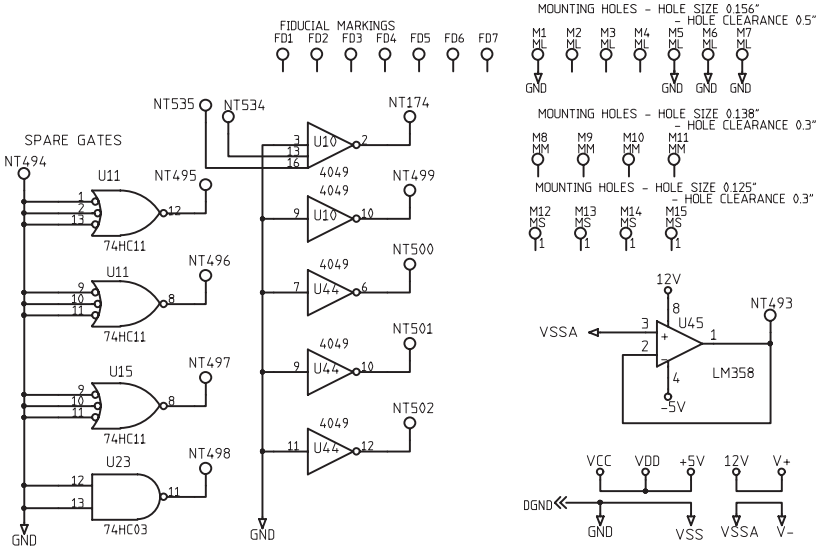
6-2

HIGHEST REFERENCE DESIGNATIONS USED
BT1 C340 D13 EMC1 F34 JP5 J32 L12 ISO4 Q13 R330 TP4 U48 Y1 NT587 FD7 M15 S1

REFERENCE DESIGNATIONS NOT USED
C90, 102, 108, 116, 119, 121, 150 C153-155, 158-194, 201-205, 209-212, 217-235 C250-253, 301-303,315 D3 F7, 13, 14, 16-22, 28-31 J2, 5-8, 11-13, 15-17, 19, 21 JP1, 2 L3, 4, 9, 10 Q1-4, R26-28, 62, 63, 122, 125, 126, 131-143, 145-219 RZZZ, 226, 227, 277, 285-287 TP2 U33 NT26, 57-59, 62, 77, 107, 152, 211, 238, 239, 275, 280, 297 NT312, 327, 332, 333, 342, 363, 384, 407, 409,410, 412-414 NT445, 448, 472, 474, 476, 477, 503, 504, 506,556, 577

IC VOLTAGE PIN TABLE				
		PWR	GND
U6	74HC390	16	8
U8	74HC138	16	8
U10	MC14049	1	8
U11	74HC11	14	7
U12	74HC03	14	7
U14	74HC273	20	10
U15	74HC11	14	7
U16	74HC541	20	10
U17	74HC541	20	10
U18	74HC541	20	10
U21	74HC273	20	10
U22	74HC273	20	10
U23	74HC03	14	7
U44	MC14049	1	8
U19	SP720	20	10
U13	LM393	8	4
U24	MAX706	2	3
U43	MAX505	22	3

VOLTAGE DEFINITION TABLE	
DIGITAL SYSTEM	
VCC	DIGITAL LOGIC +5V
VDD	DIGITAL LOGIC +5V
+5V	DIGITAL LOGIC +5V
GND	DIGITAL LOGIC GROUND
DGND	DIGITAL LOGIC GROUND
VSS	DIGITAL LOGIC GROUND
VEE	DIGITAL LOGIC GROUND
ANALOG SYSTEM	
VDDA	ANALOG CKTS +5V
12V	ANALOG CKTS FILTERED 12V
V+	ANALOG CKTS FILTERED 12V
-5V	ANALOG CKTS FILTERED -5V
VSSA	ANALOG GND
V-	ANALOG GND
POWER SYSTEM	
PGND	POWER ENTRY GROUND
SGND	SWITCHER SUPPLY GROUND
+4V_INT	ALWAYS ACTIVE 4 VOLTS
12V_UNFIL	DC-DC 12V OUTPUT

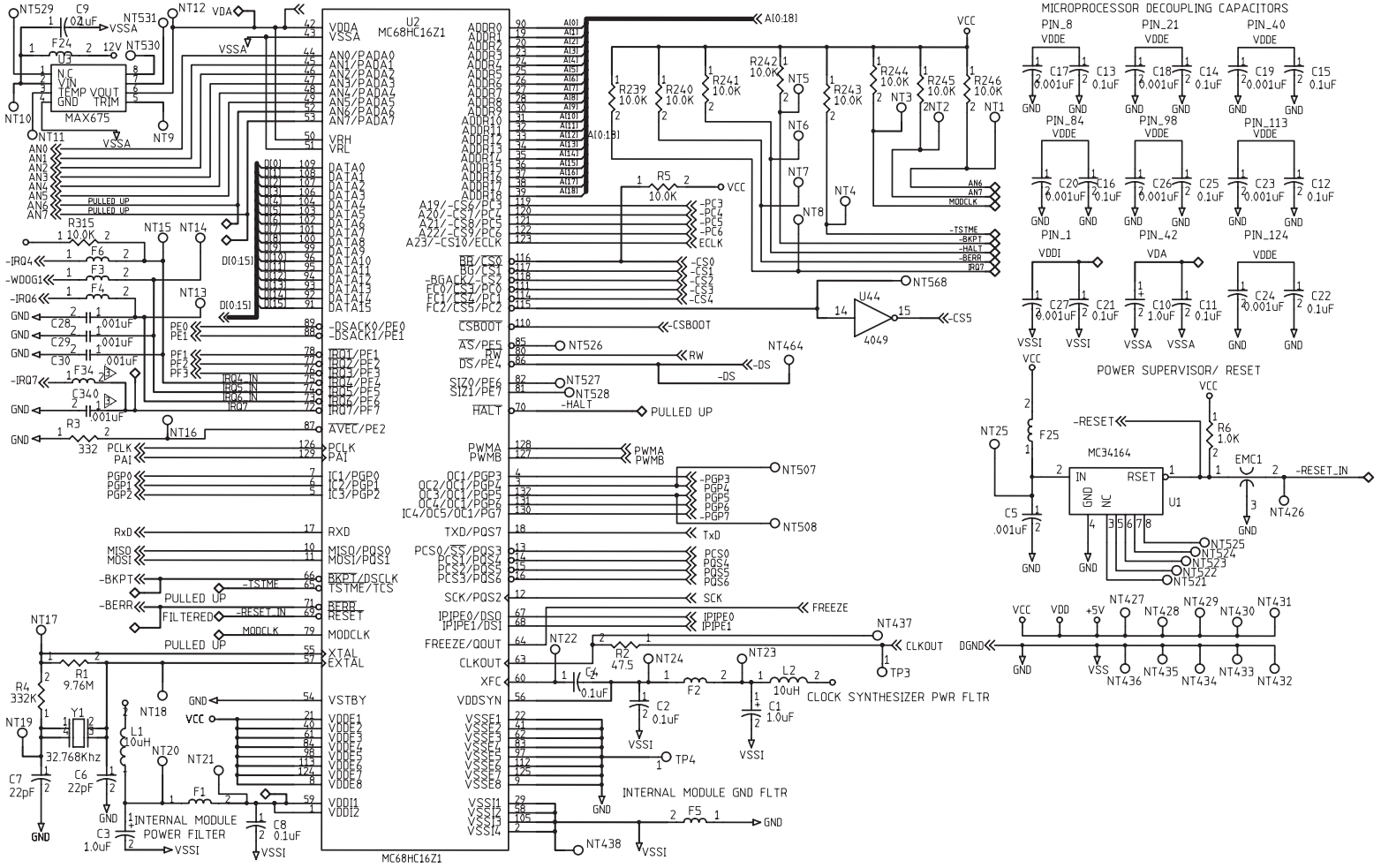


NOTES:

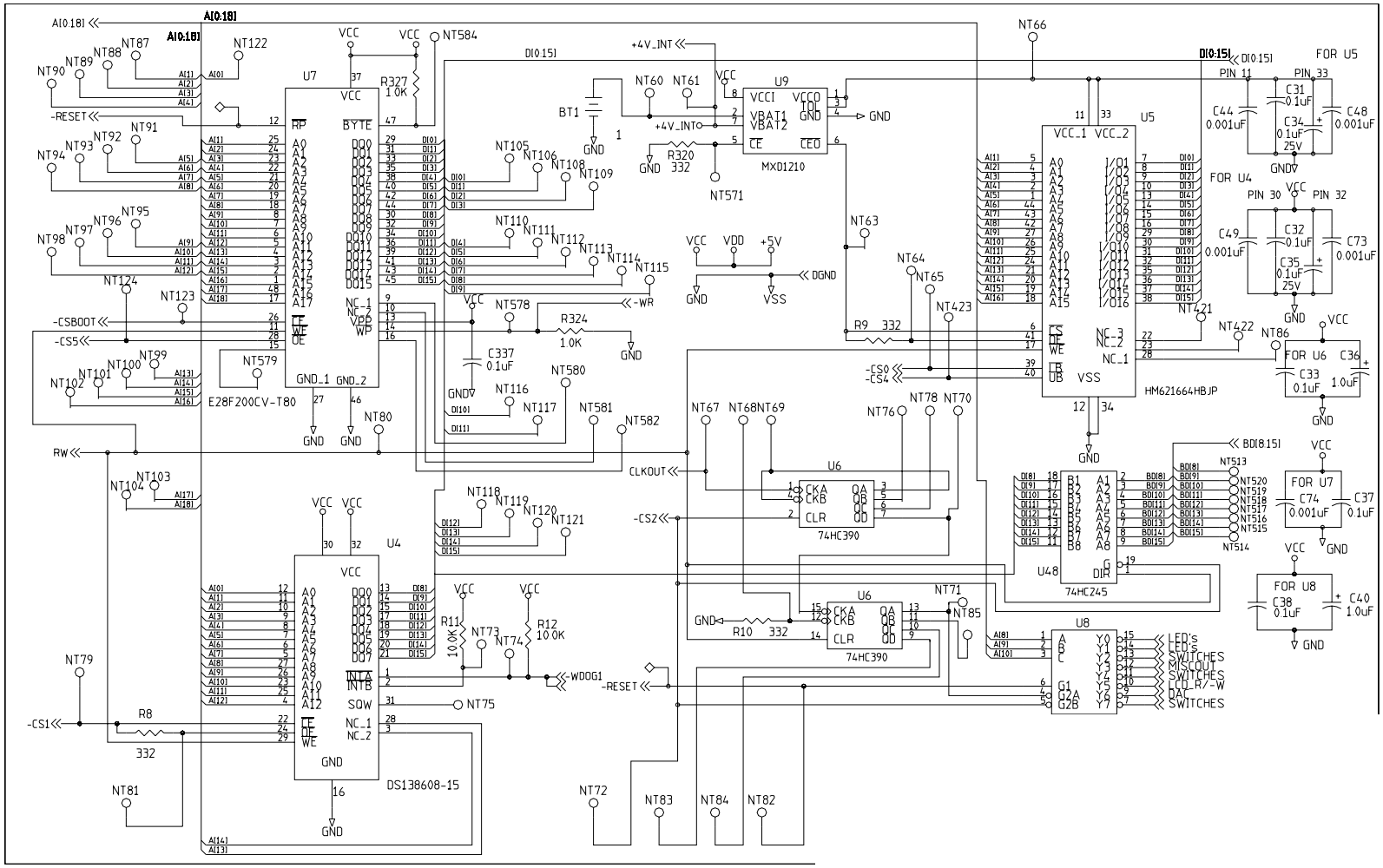
1. RESET CIRCUIT THRESHOLD VCC=4.6V
2. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHMS, 1/10W, 1%
   ALL CAPACITORS ARE IN MICROFARADS

DO NOT INSERT F34 OR C340

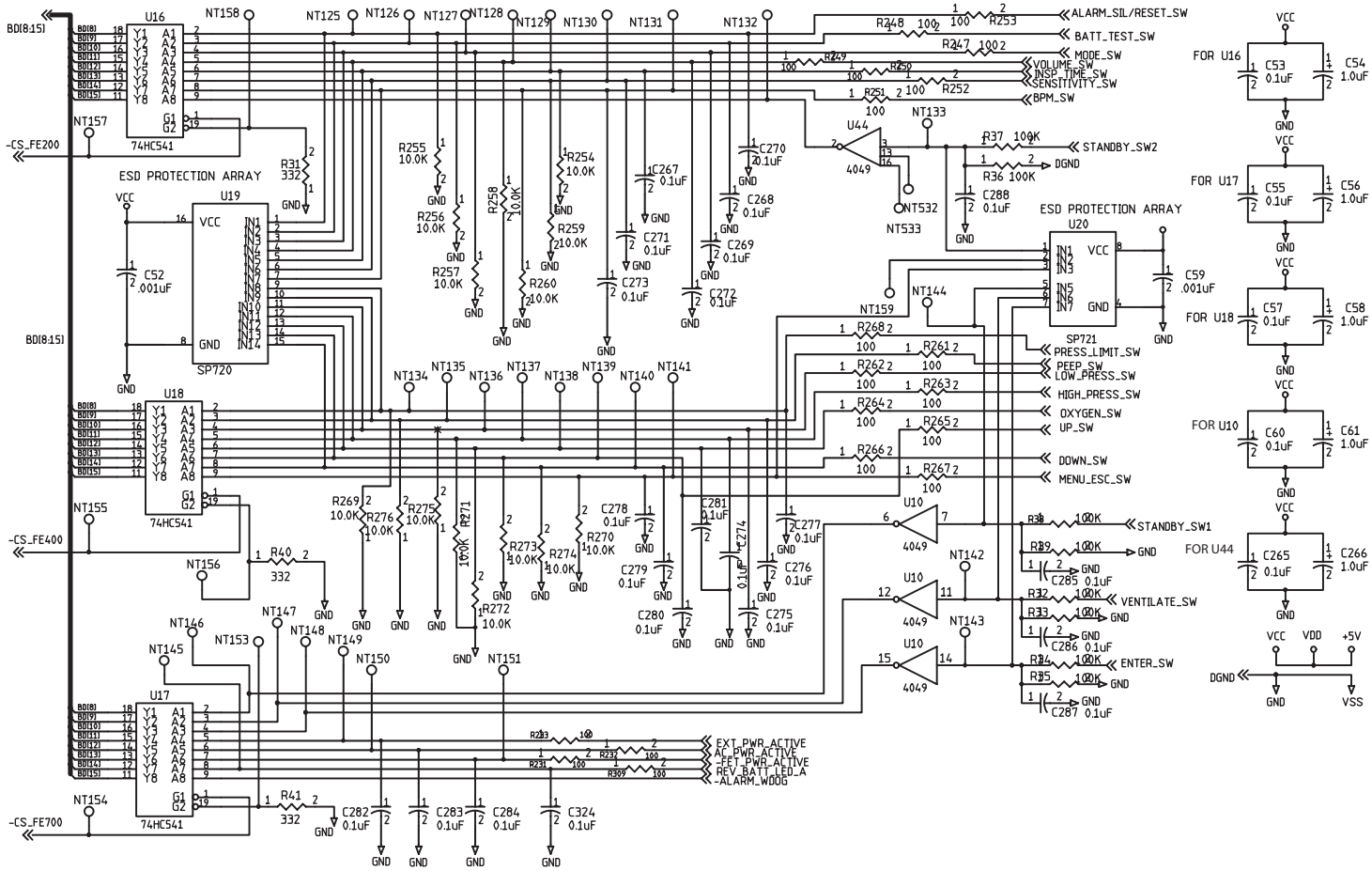
Schematic 6-2: Logic board—microprocessors



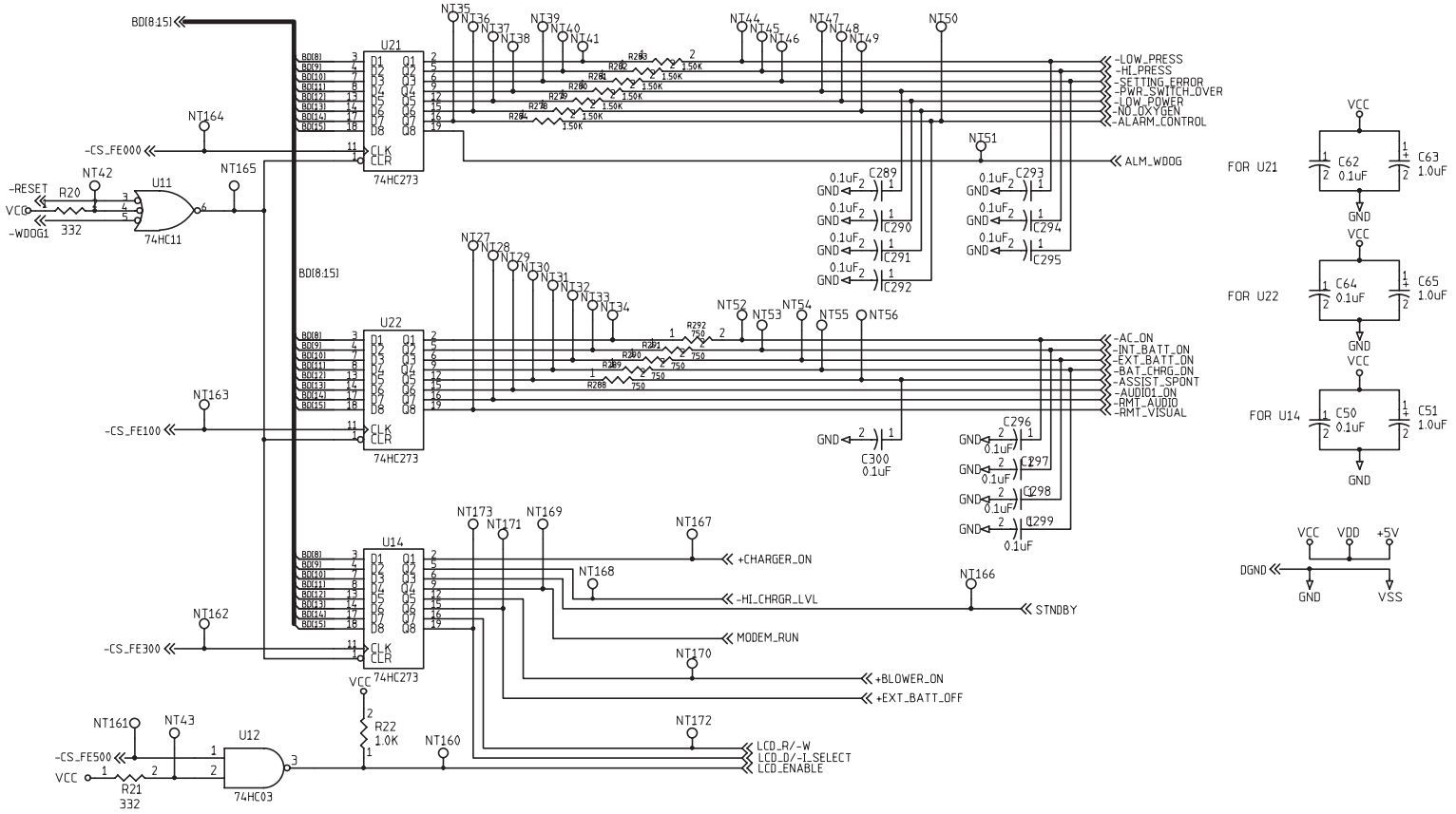
Schematic 6-3: Logic board—memory/address select



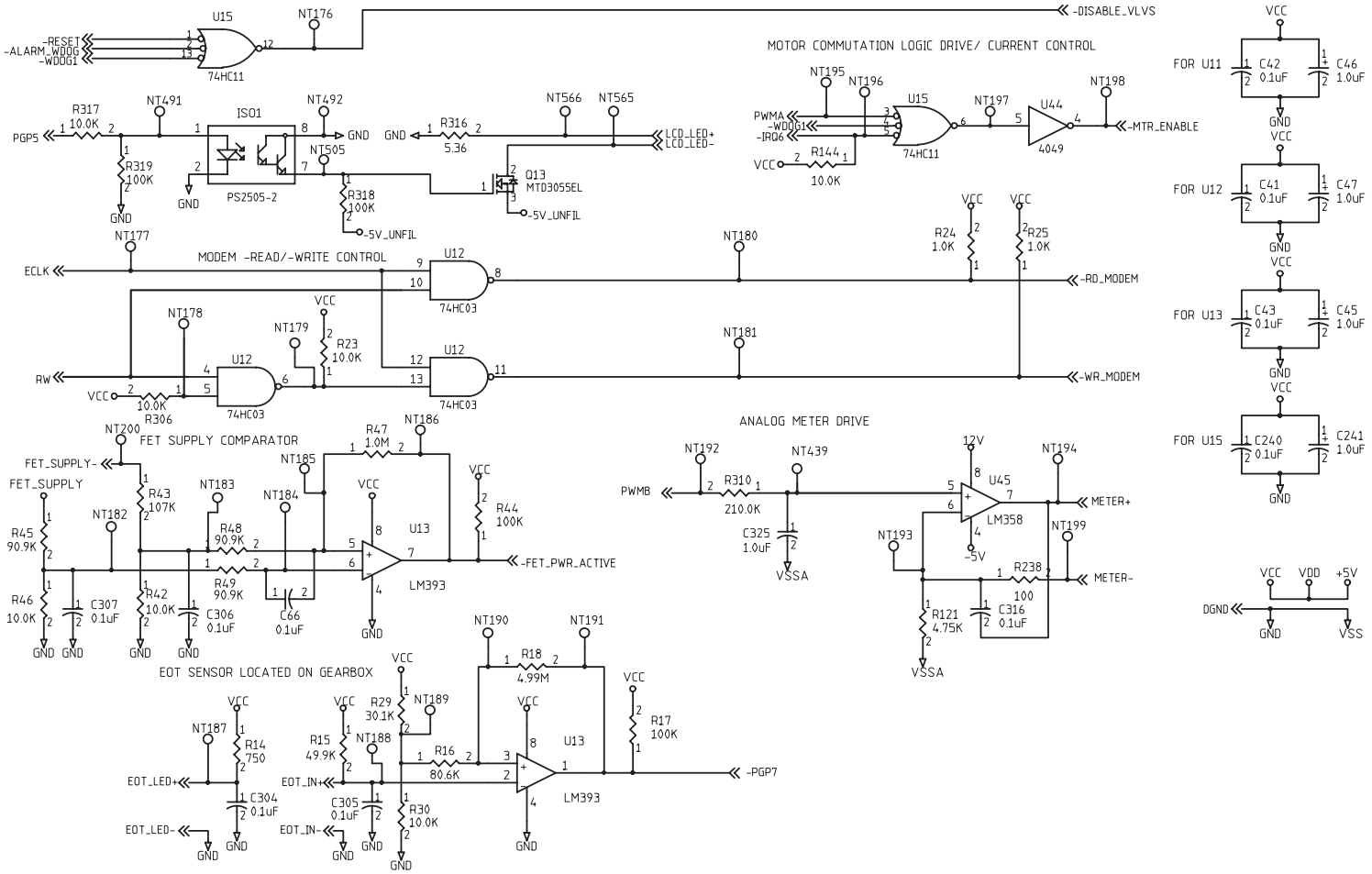
Schematic 6-4: Logic board—switch inputs



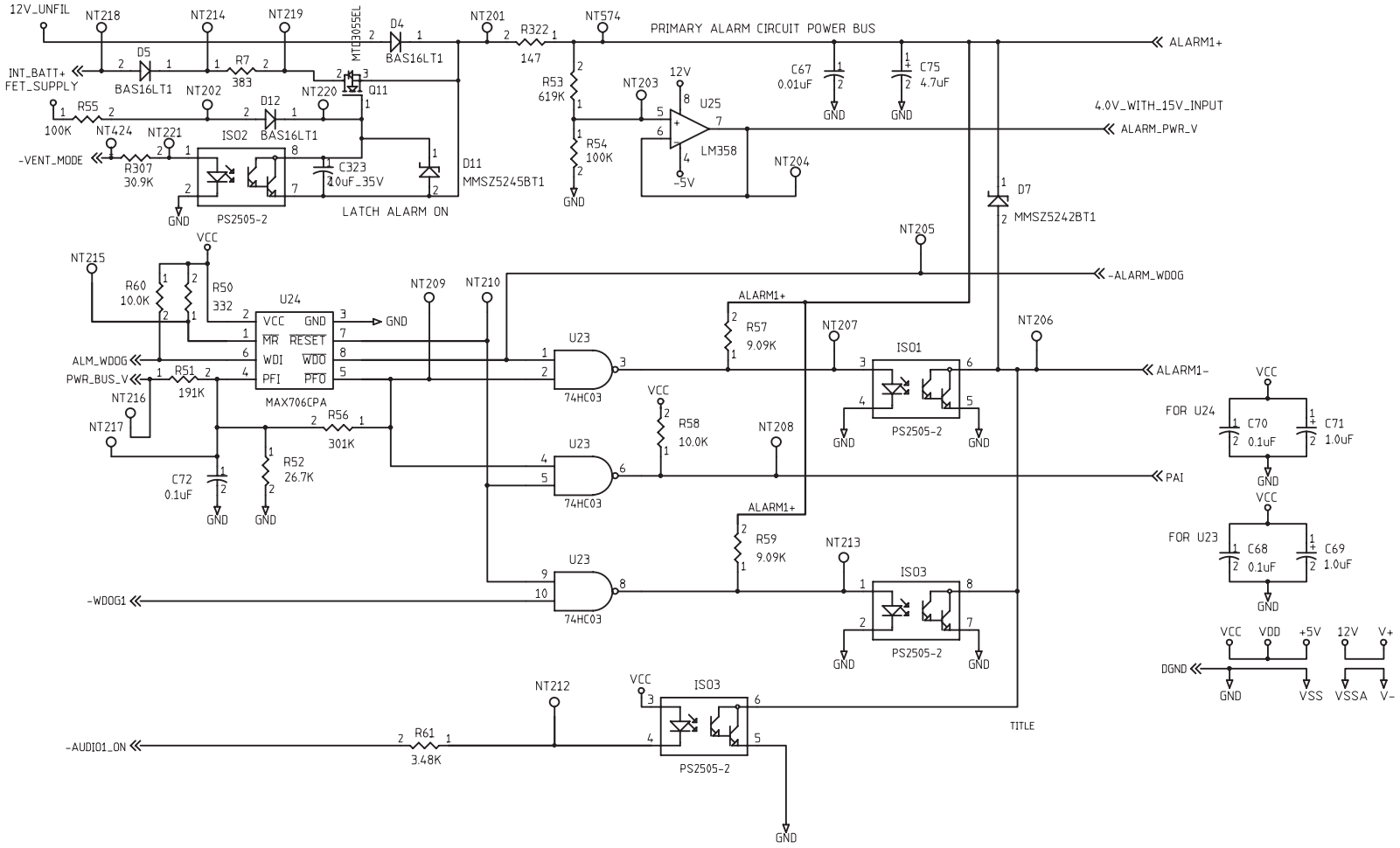
Schematic 6-5: Logic board—LED indicators/controls



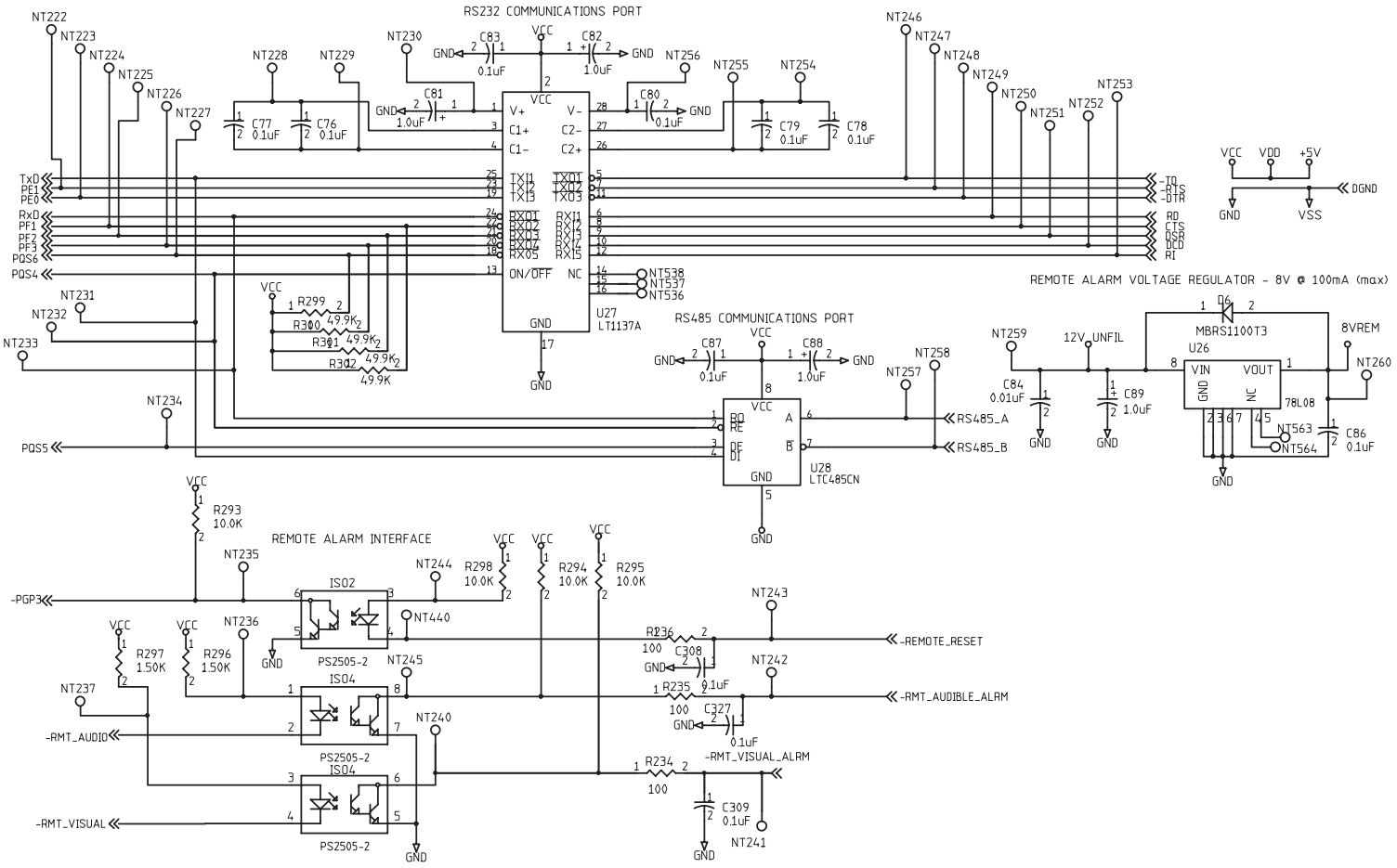
Schematic 6-6: Logic board—miscellaneous digital I/O



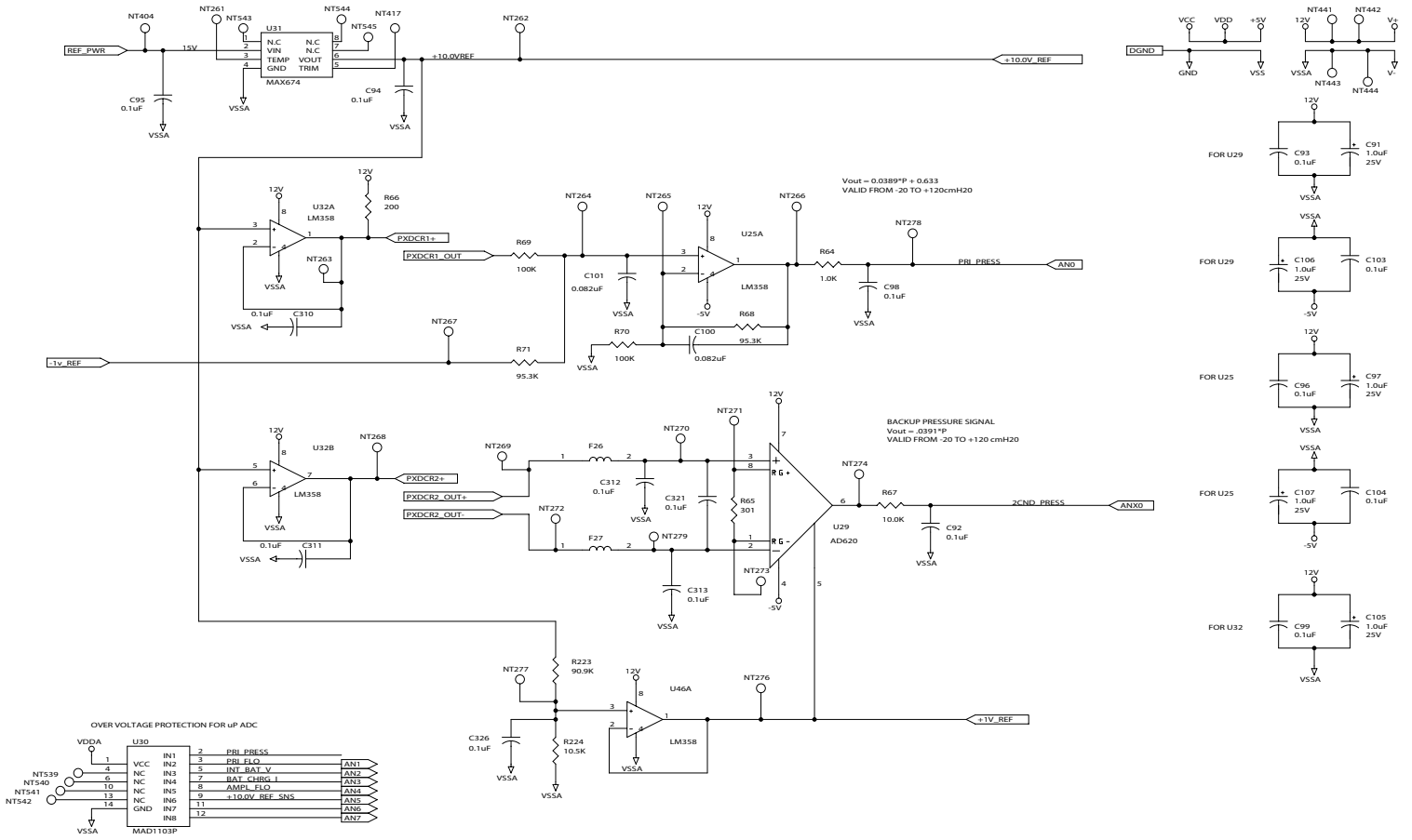
Schematic 6-7: Logic board—alarm and monitor circuits



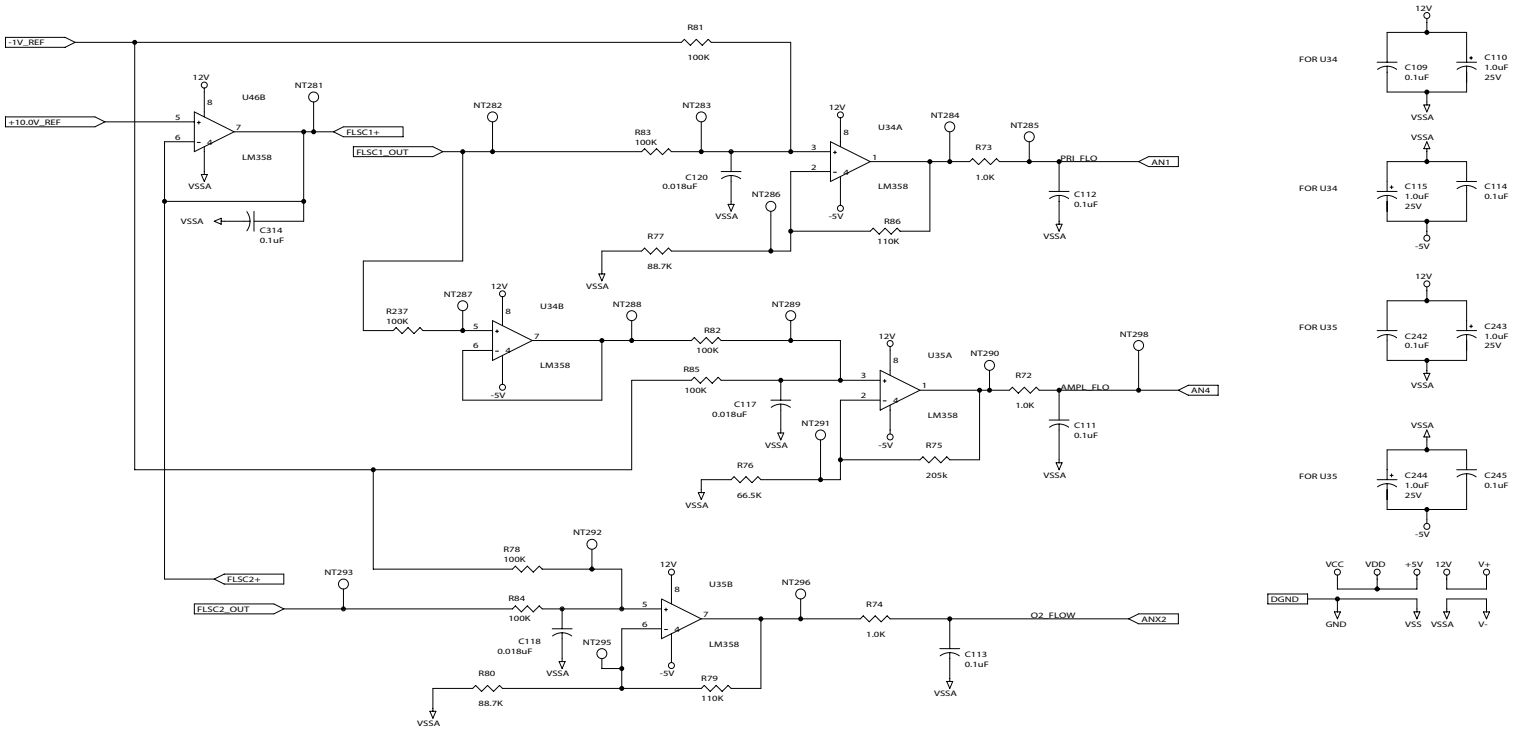
Schematic 6-8: Logic board——communications driver



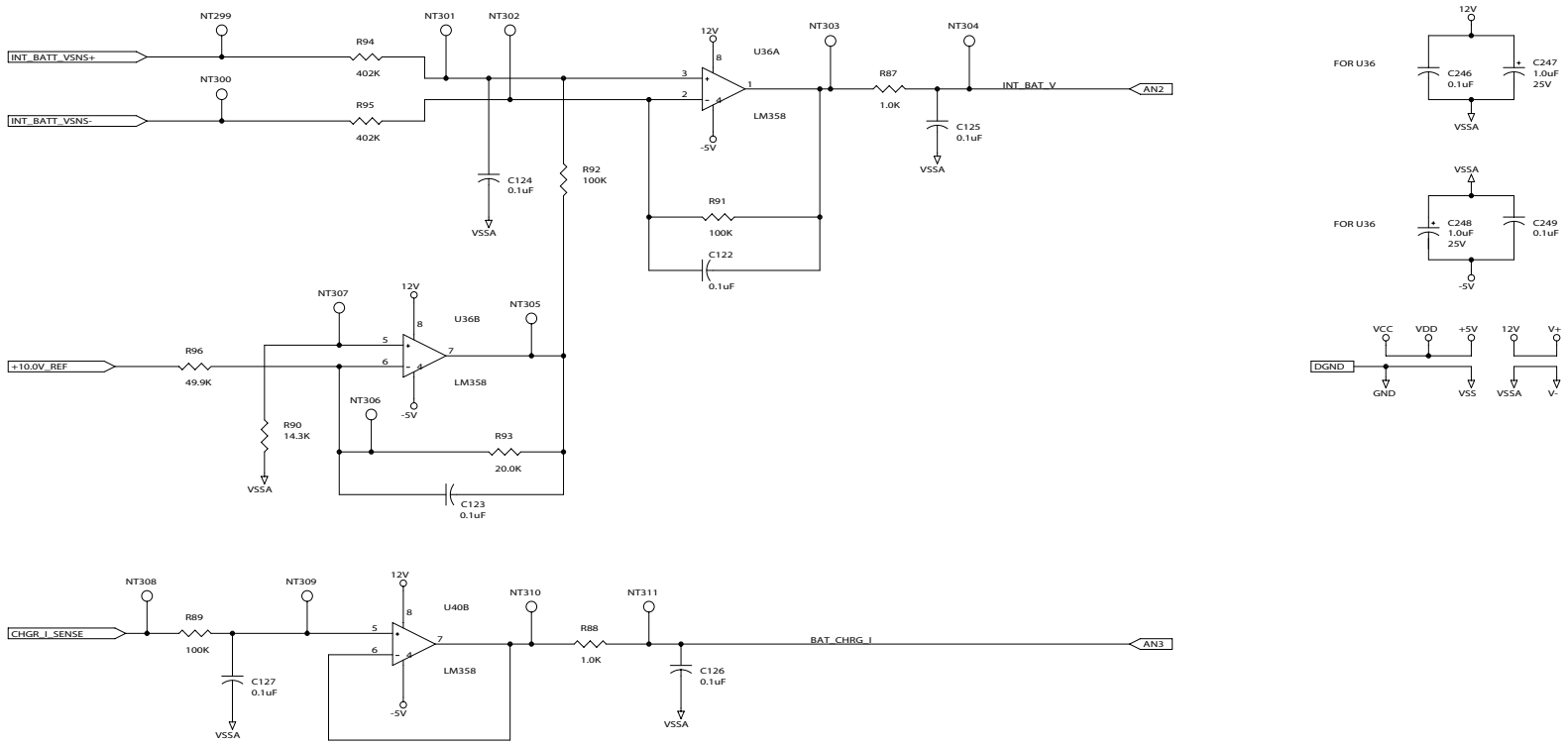
Schematic 6-9: Logic board—pressure sensor circuits



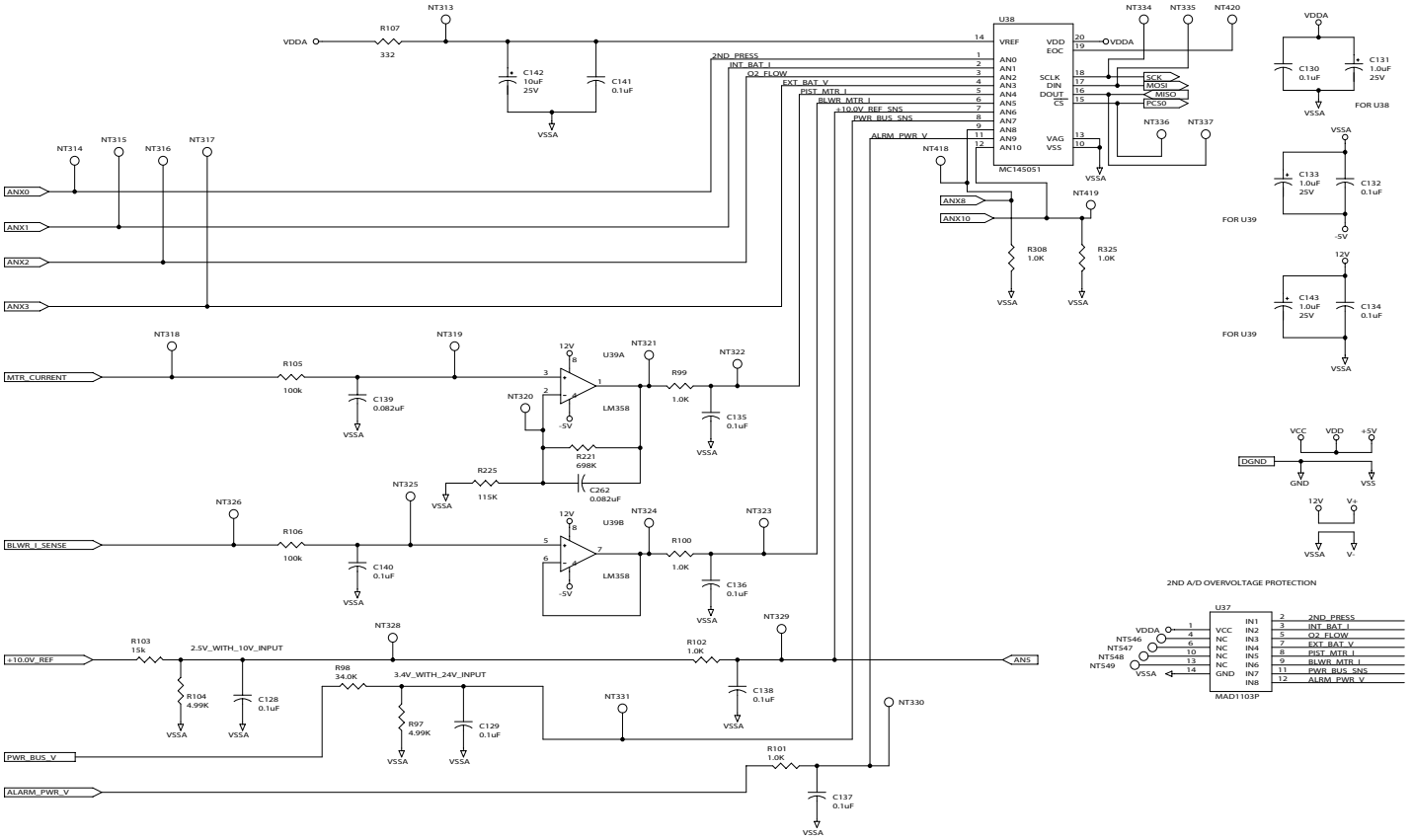
Schematic 6-10: Logic board—flow sensor circuits



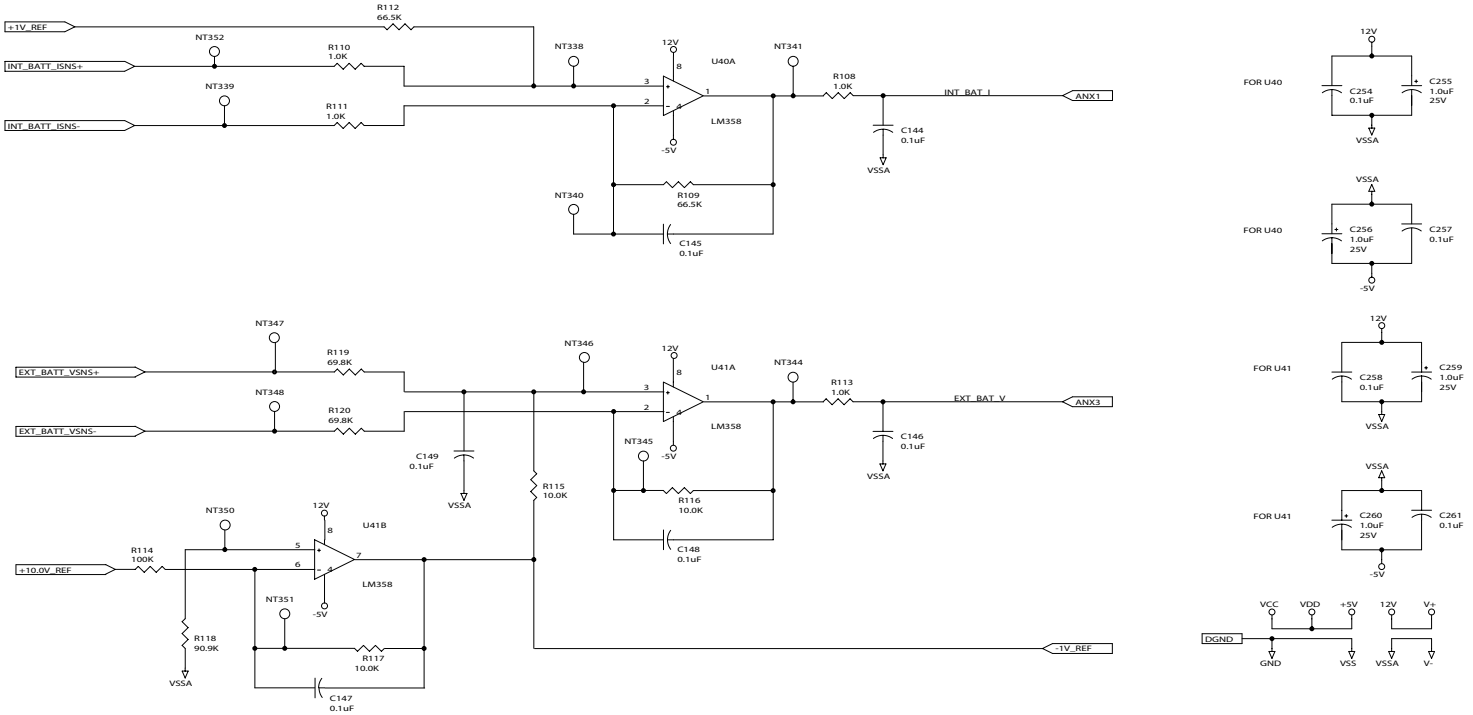
Schematic 6-11: Logic board—primary ADC circuits



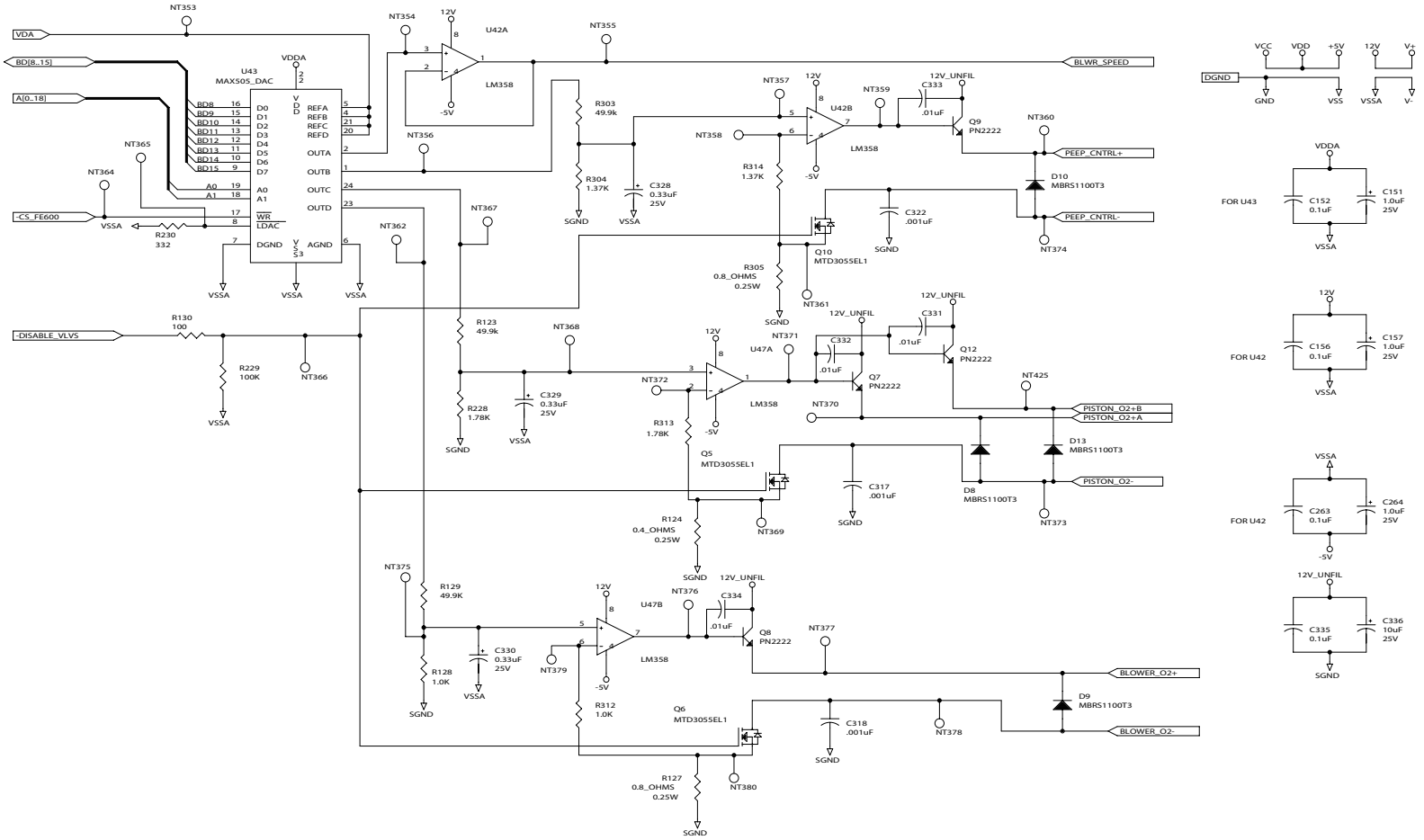
Schematic 6-12: Logic board—serial ADC



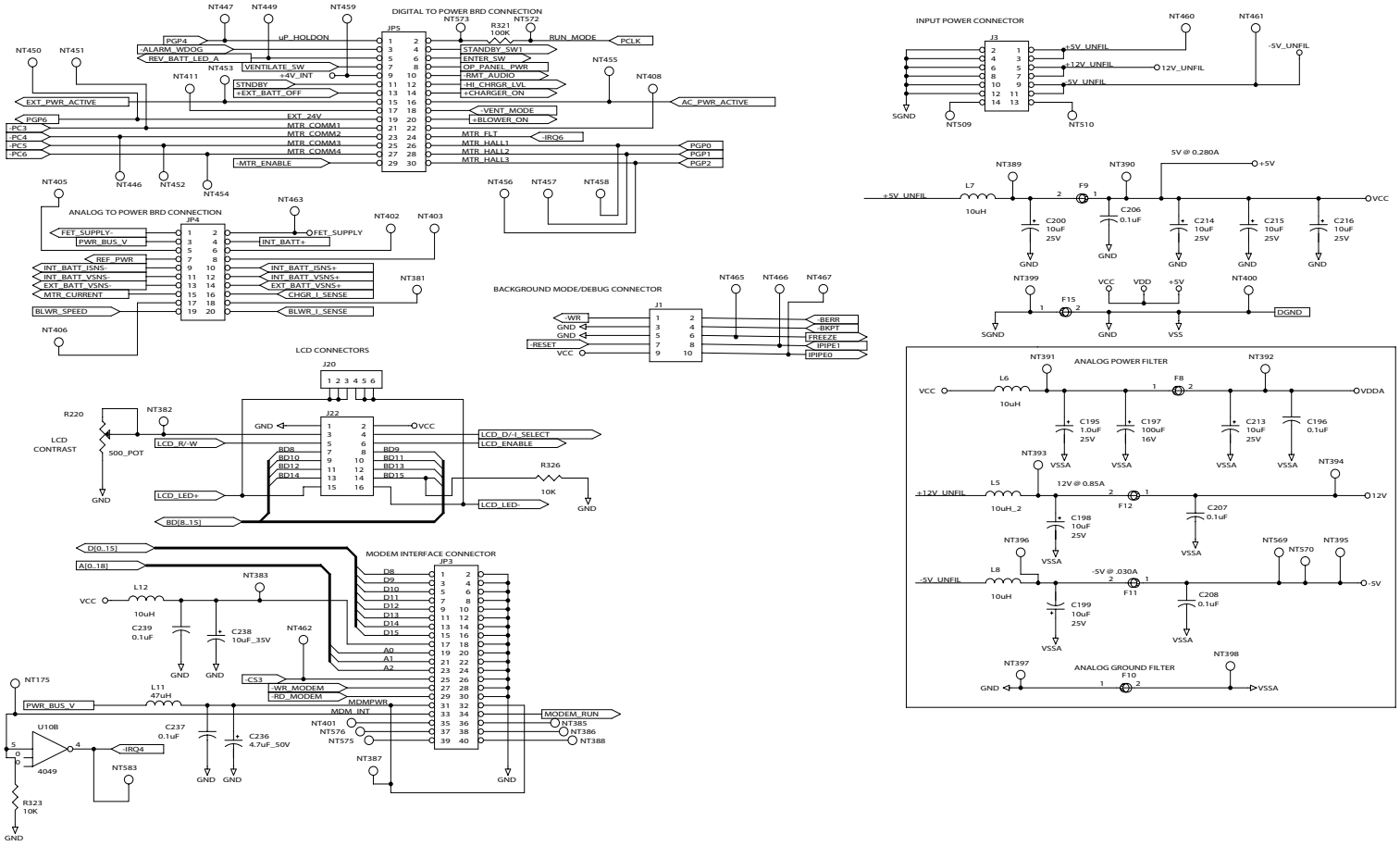
Schematic 6-13: Logic board—serial ADC circuits



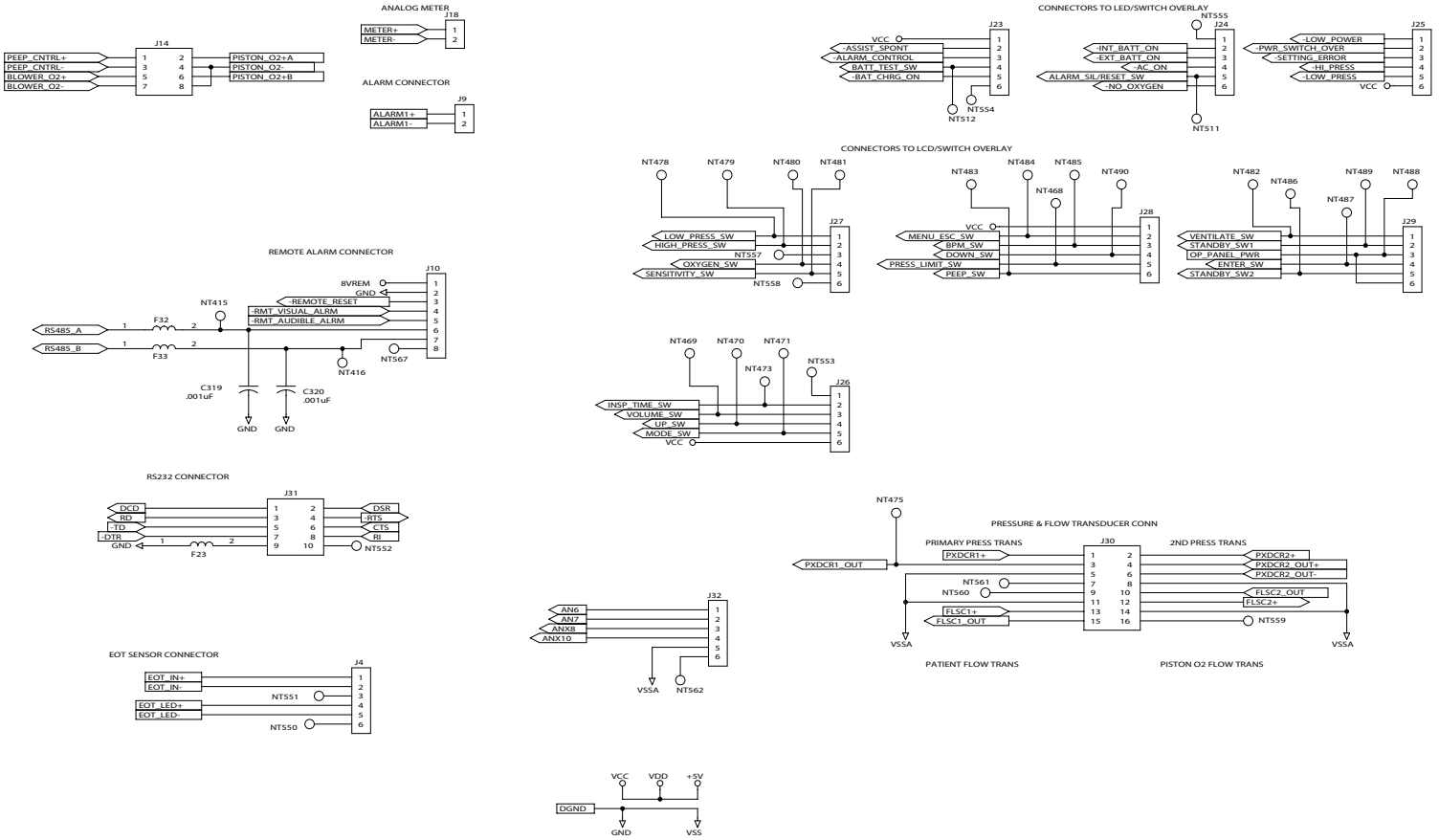
Schematic 6-14: Logic board—DAC circuits



Schematic 6-15: Logic board—connectors and EMI filters



Schematic 6-16: Logic board—connectors and modem port



Schematic 6-17: Power board schematic notes

VOLTAGE DEFINITION TABLE

DIGITAL SYSTEM

- VCC DIGITAL LOGIC +5V
- VDD DIGITAL LOGIC +5V
- +5V DIGITAL LOGIC +5V
- GND DIGITAL LOGIC GROUND
- DGND DIGITAL LOGIC GROUND
- VSS DIGITAL LOGIC GROUND
- VEE DIGITAL LOGIC GROUND

ANALOG SYSTEM

- VDDA ANALOG CKTS +5V
- 12V ANALOG CKTS FILTERED 12V
- V+ ANALOG CKTS FILTERED 12V
- -5V ANALOG CKTS FILTERED -5V
- VSSA ANALOG GND

POWER SYSTEM

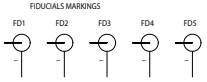
- PGND POWER ENTRY GROUND
- SGND SWITCHER SUPPLY GROUND
- MGND MOTOR GROUND
- MPWR MOTOR POWER
- +4V_INT ALWAYS ACTIVE 4 VOLTS
- 12VUNFIL DC-DC 12V OUTPUT

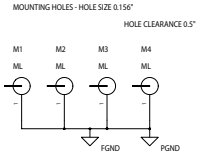
REFERENCE DESIGNATORS NOT USED

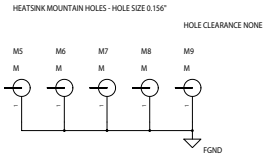
D16, 21, 47, 55, 57

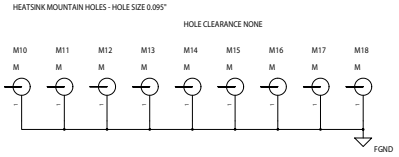
F1

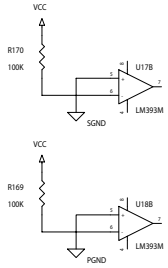
C75, 76, 77, 78, 79

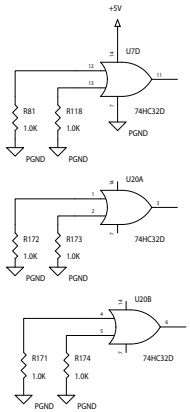


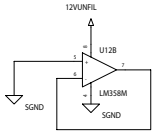


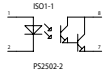












5. SWITCHING FREQUENCY = 52KHz

4. RELATIONSHIP BETWEEN HALL SENSORS AND STATOR PHASING

S3	S2	S1	PH_A	PH_B	PH_C	SINK	SOURCE
0	1	1	0	-	+	1	3
0	0	1	-	0	+	2	3
1	0	1	-	+	0	2	1
1	0	0	0	+	-	3	1
1	1	0	+	0	-	3	2
0	1	0	+	-	0	1	2

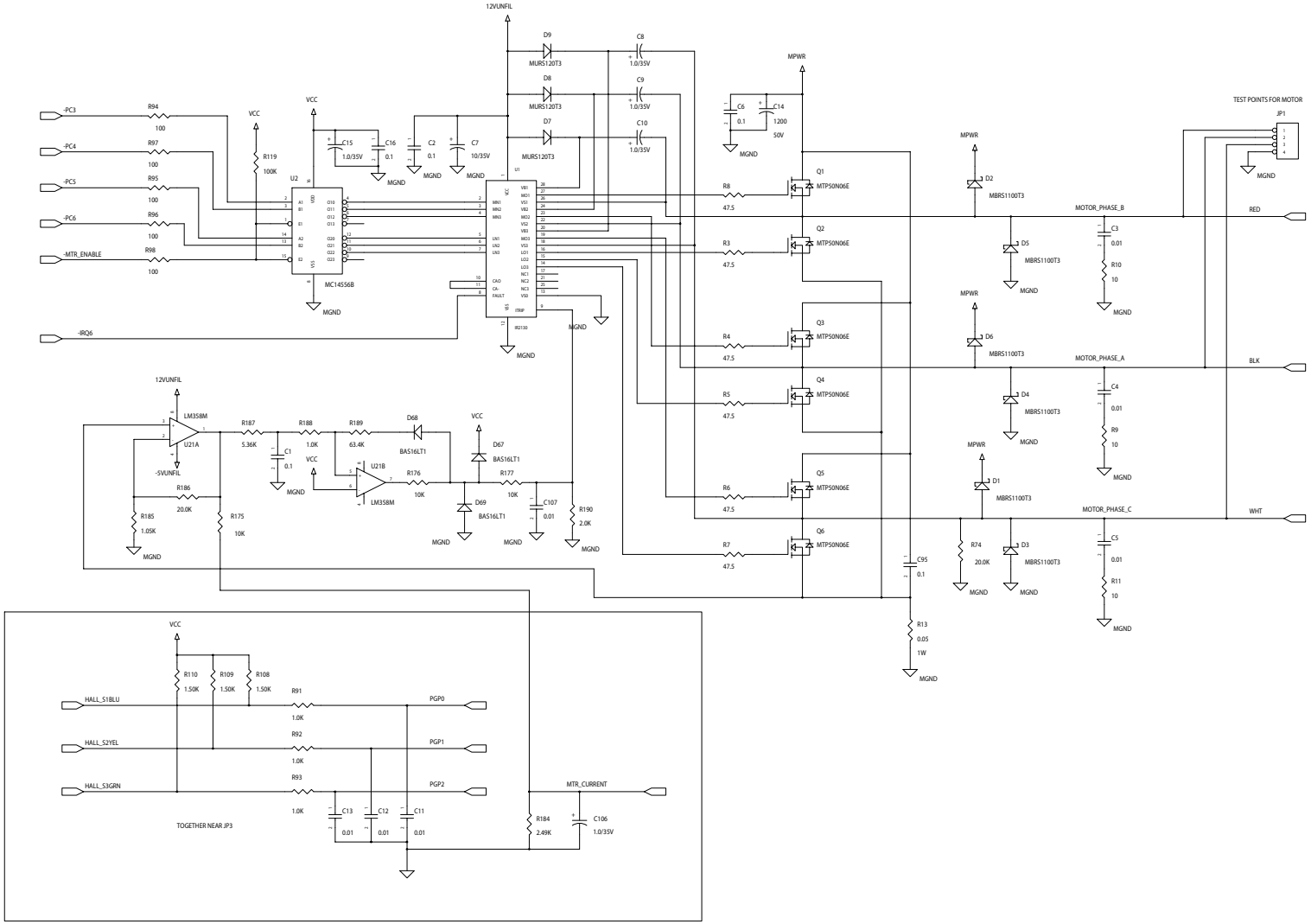
3. 332 OHMS RESISTORS USED TO IMPROVE TESTABILITY COVERAGE

2. INTERNAL +4V POWER SUPPLY IS ACTIVE AS LONG AS INTERNAL BATTERY IS PRESENT

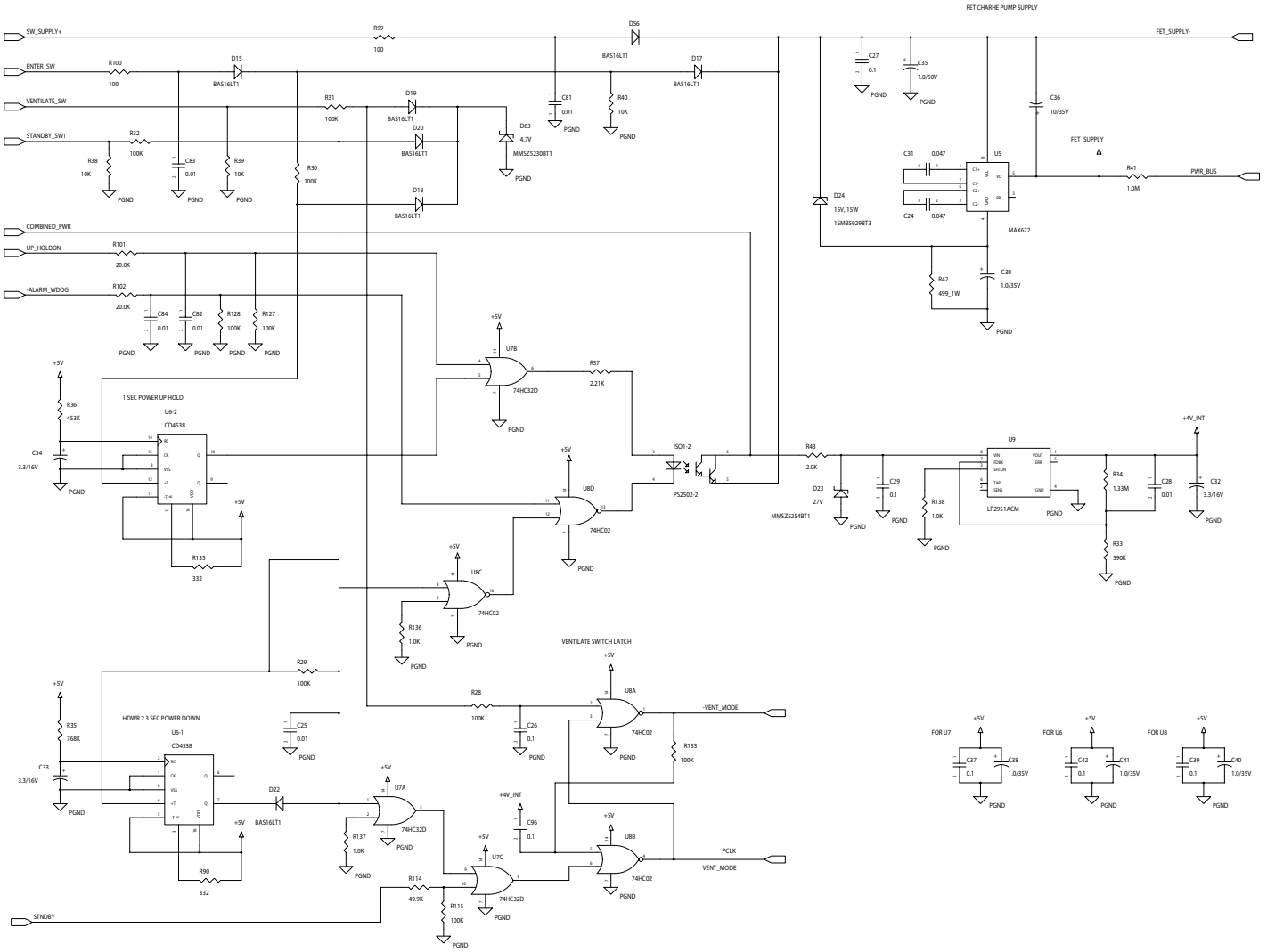
1. ALL RESISTORS ARE IN OHMS, 1/10W, 1%
ALL CAPACITORS ARE IN MICROFARADS

NOTES: UNLESS OTHERWISE SPECIFIED

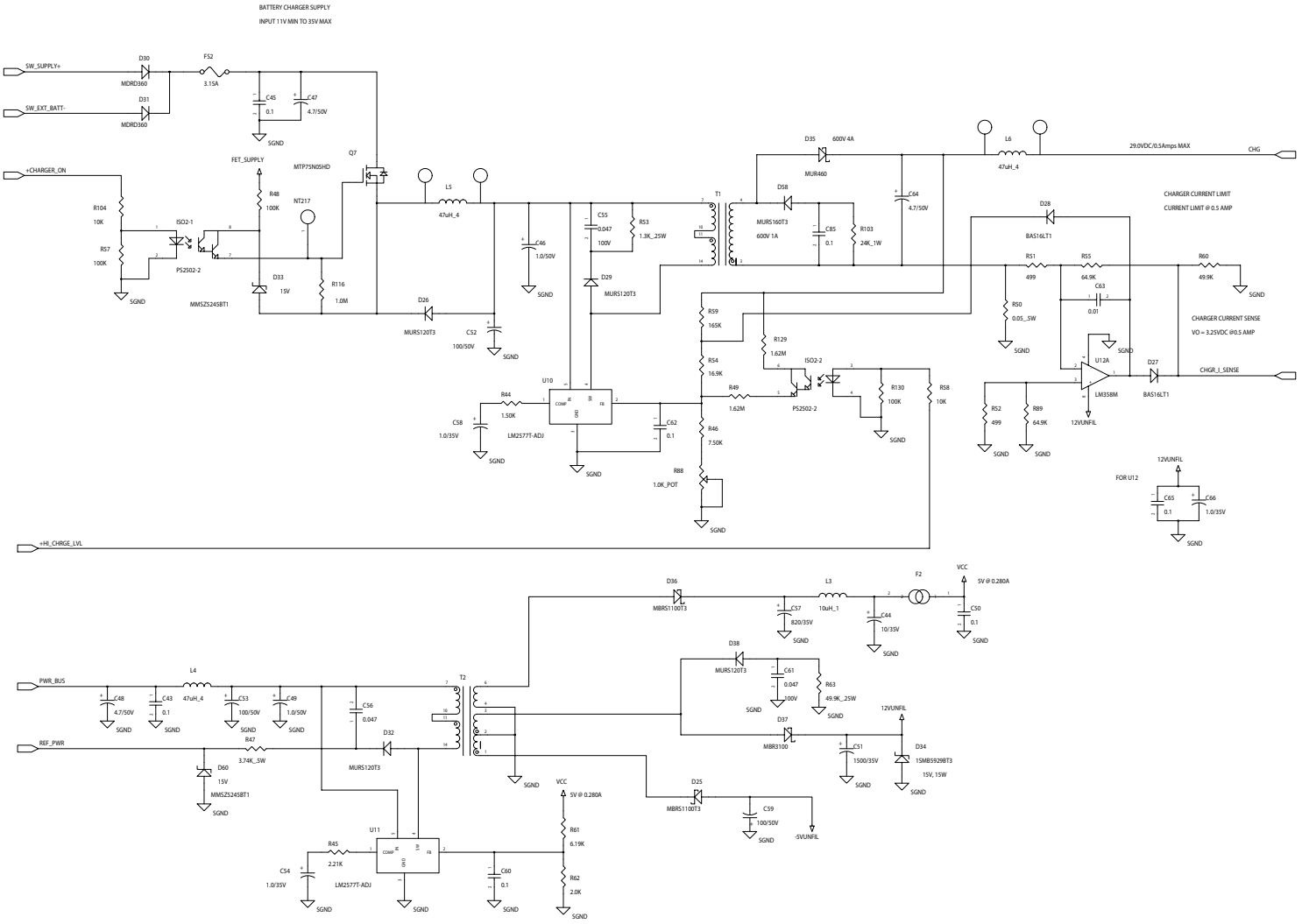
Schematic 6-18: Power board—motor drive



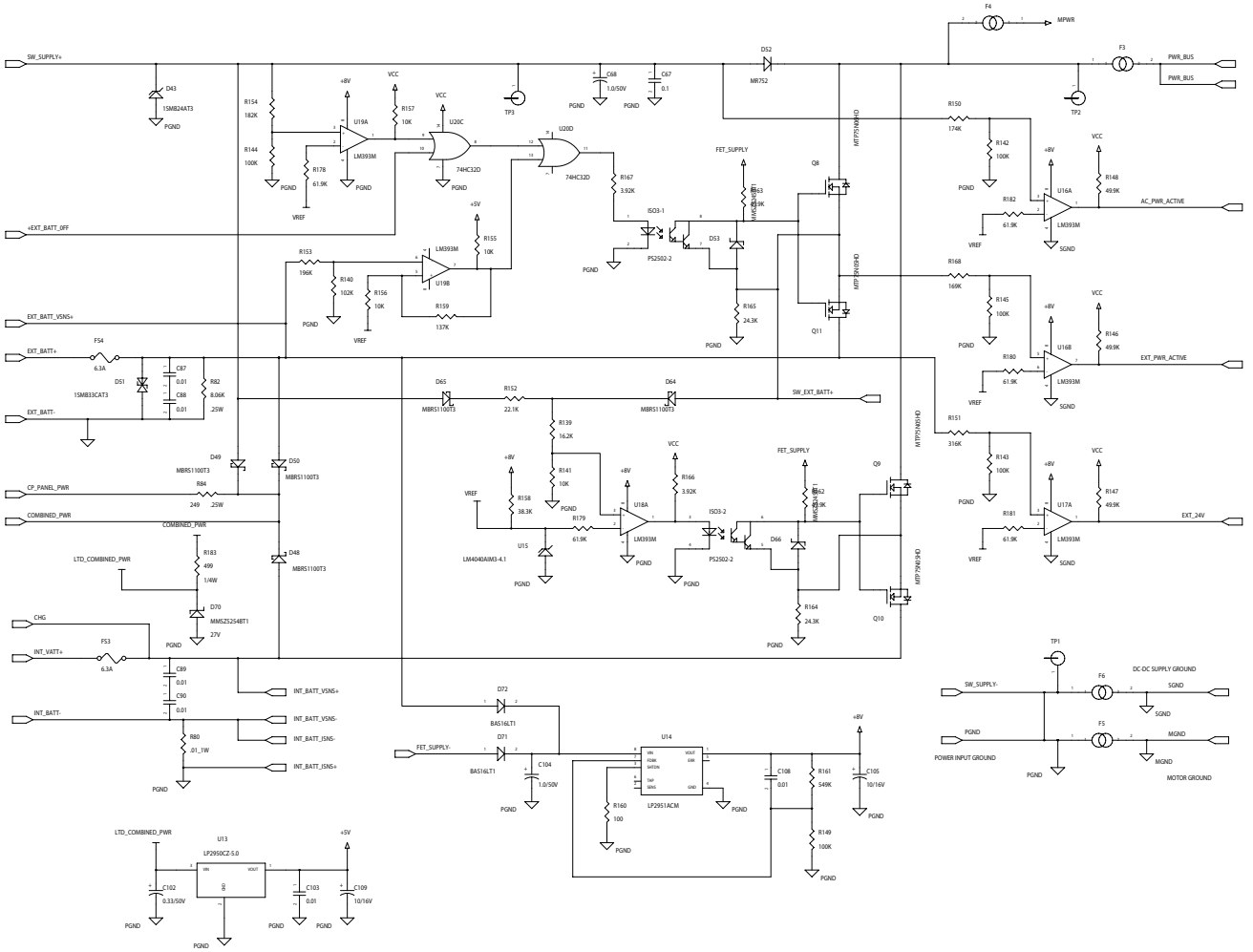
Schematic 6-19: Power board—power On/Off circuits



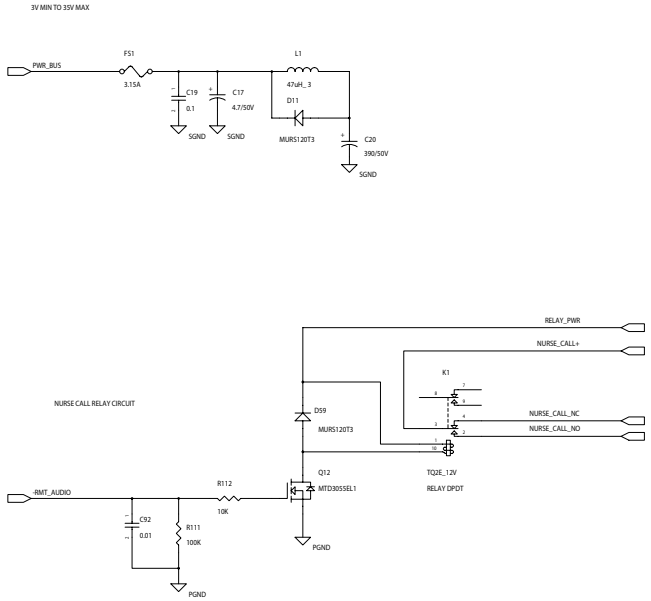
Schematic 6-20: Power board—switching power supplies



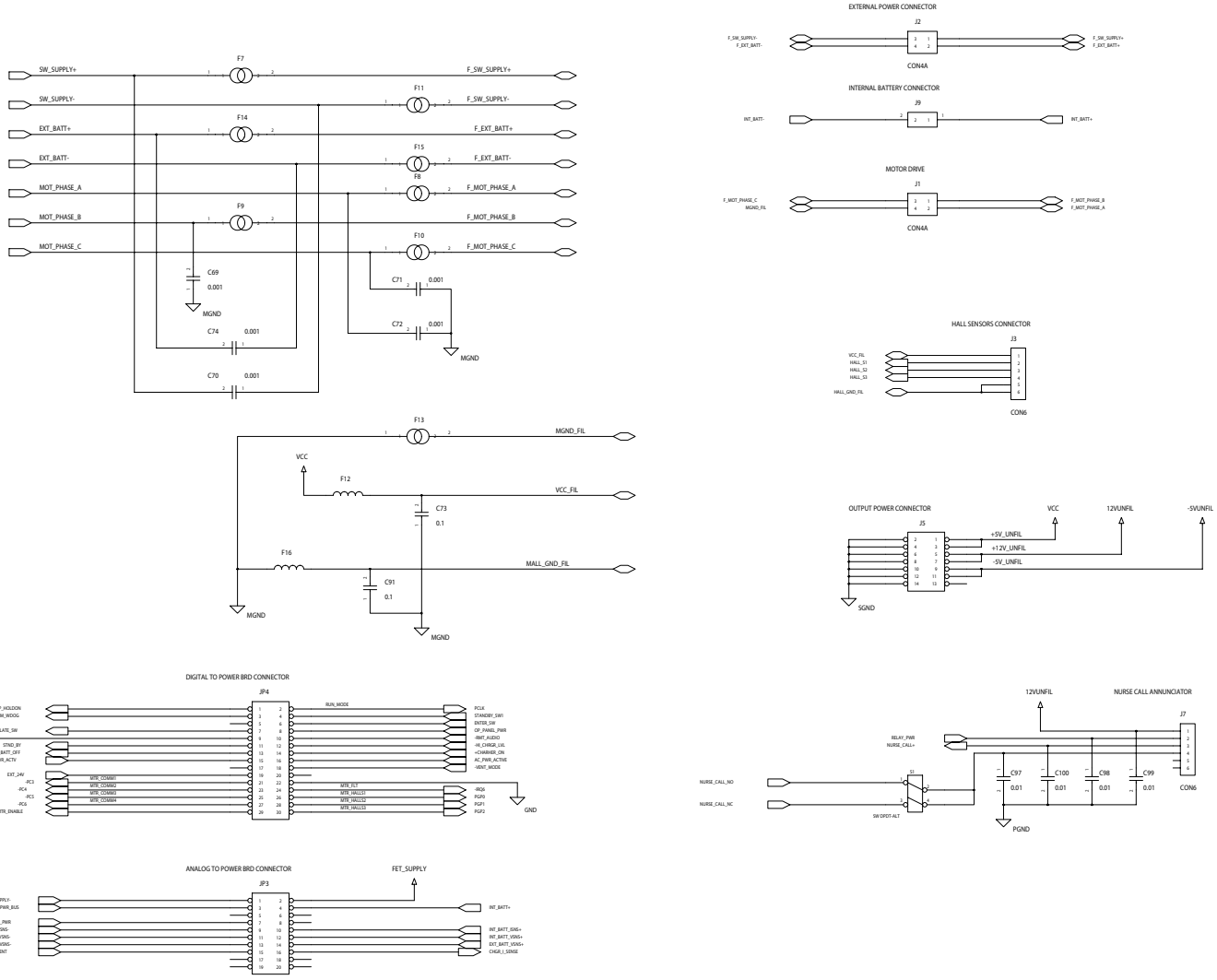
Schematic 6-21: Power board—system power entry



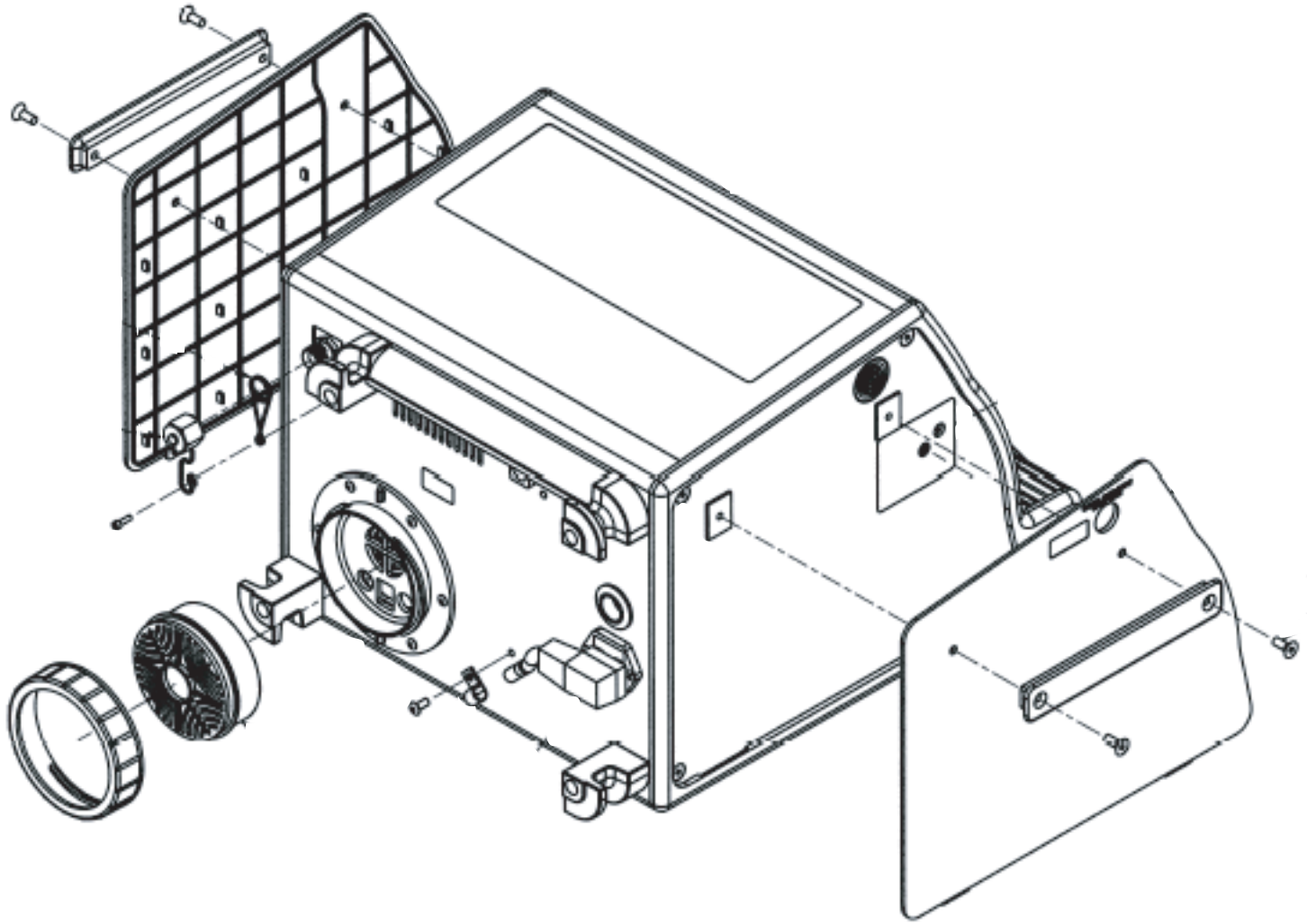
Schematic 6-22: Miscellaneous Circuitry



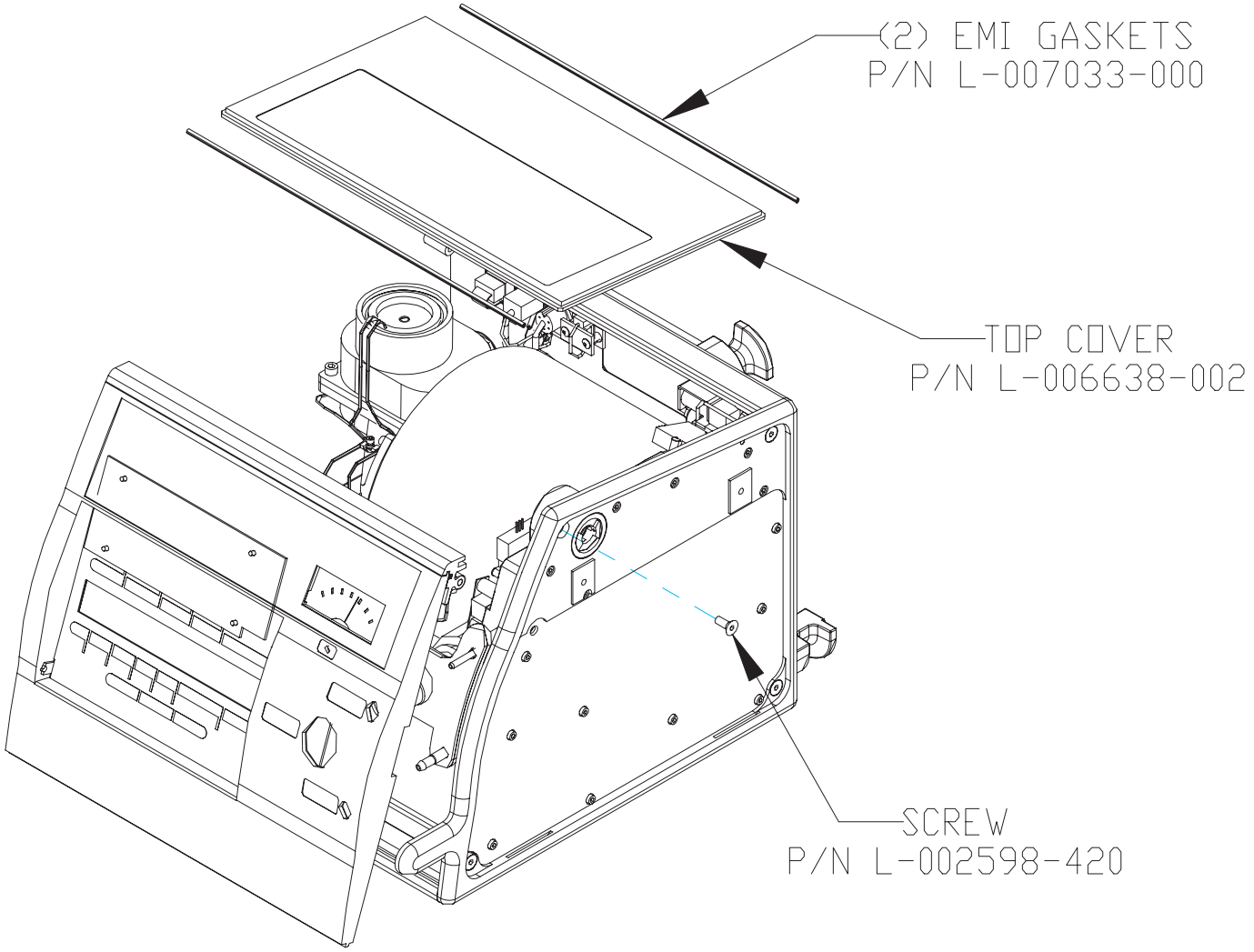
Schematic 6-23: Power board—connectors and EMI filters



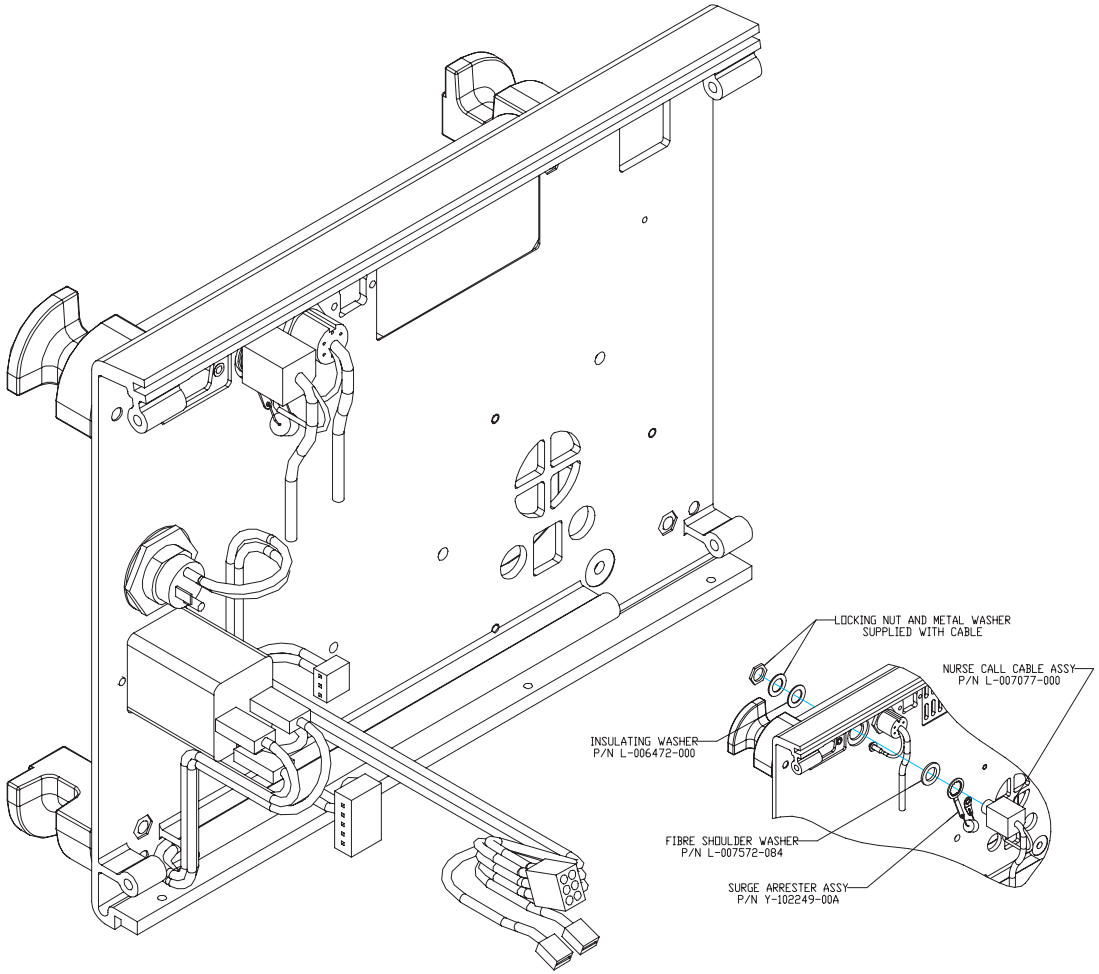
Drawing 6-1: Ventilator assembly drawing



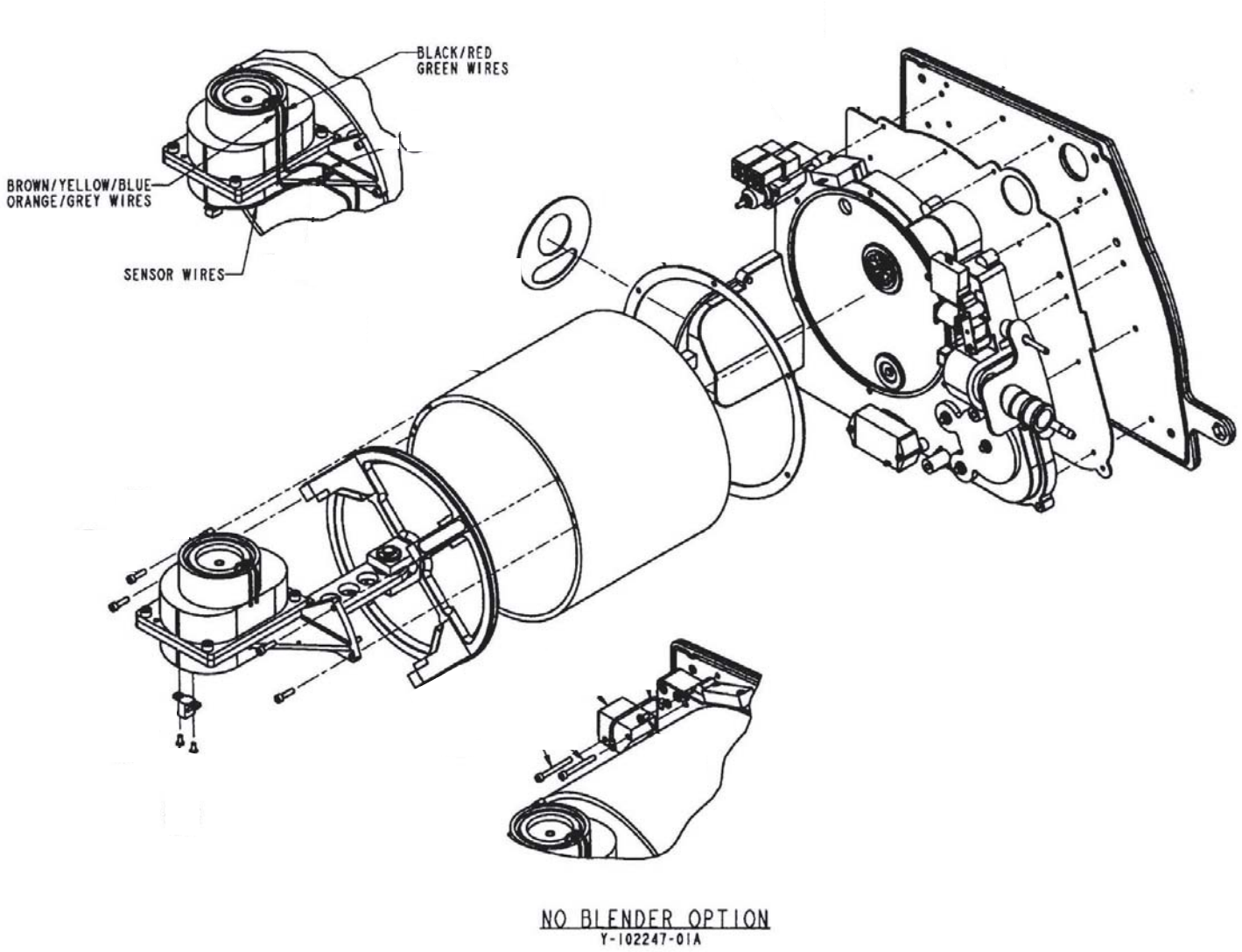
Drawing 6-2: Ventilator assembly drawing



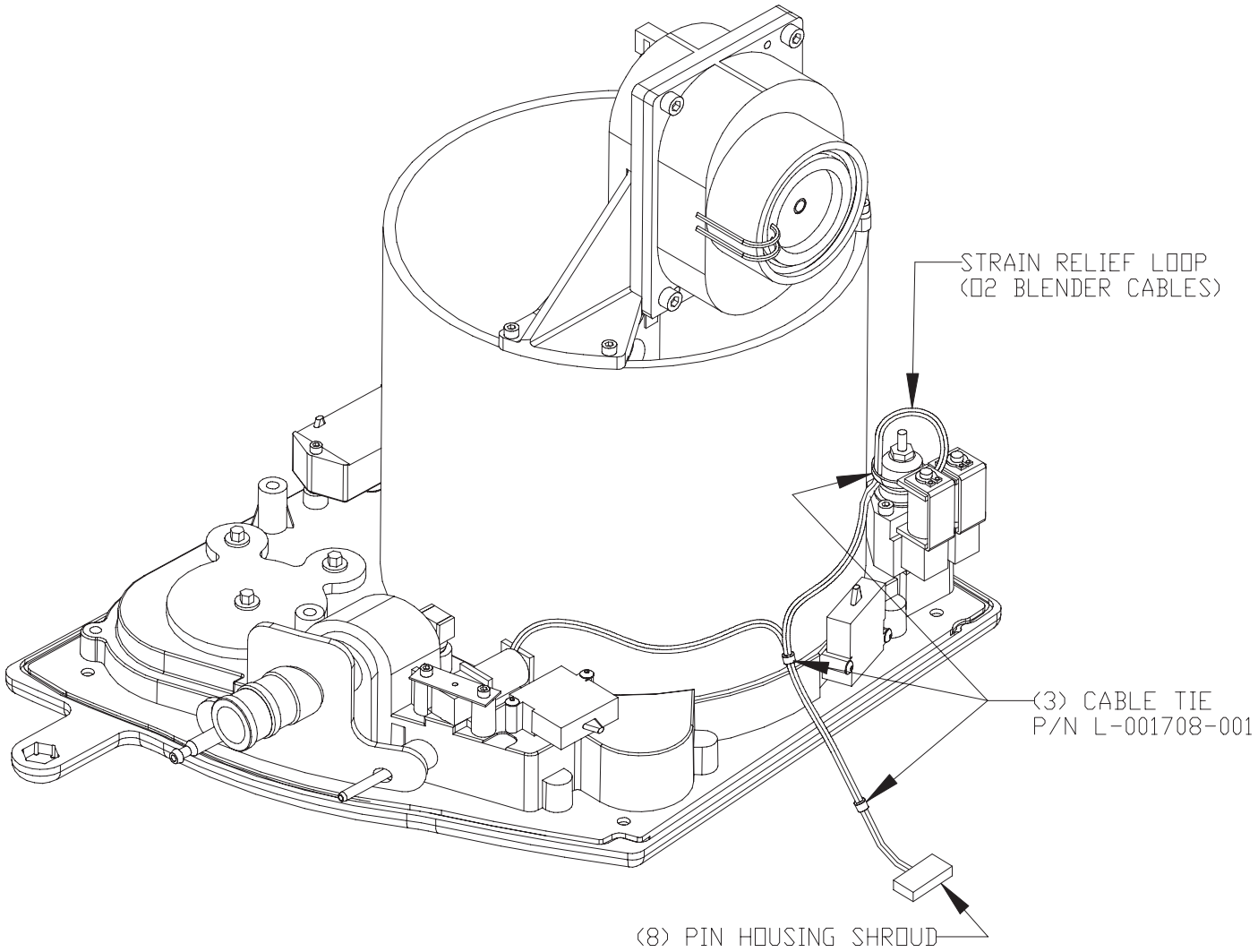
Drawing 6-3: Rear panel assembly drawing



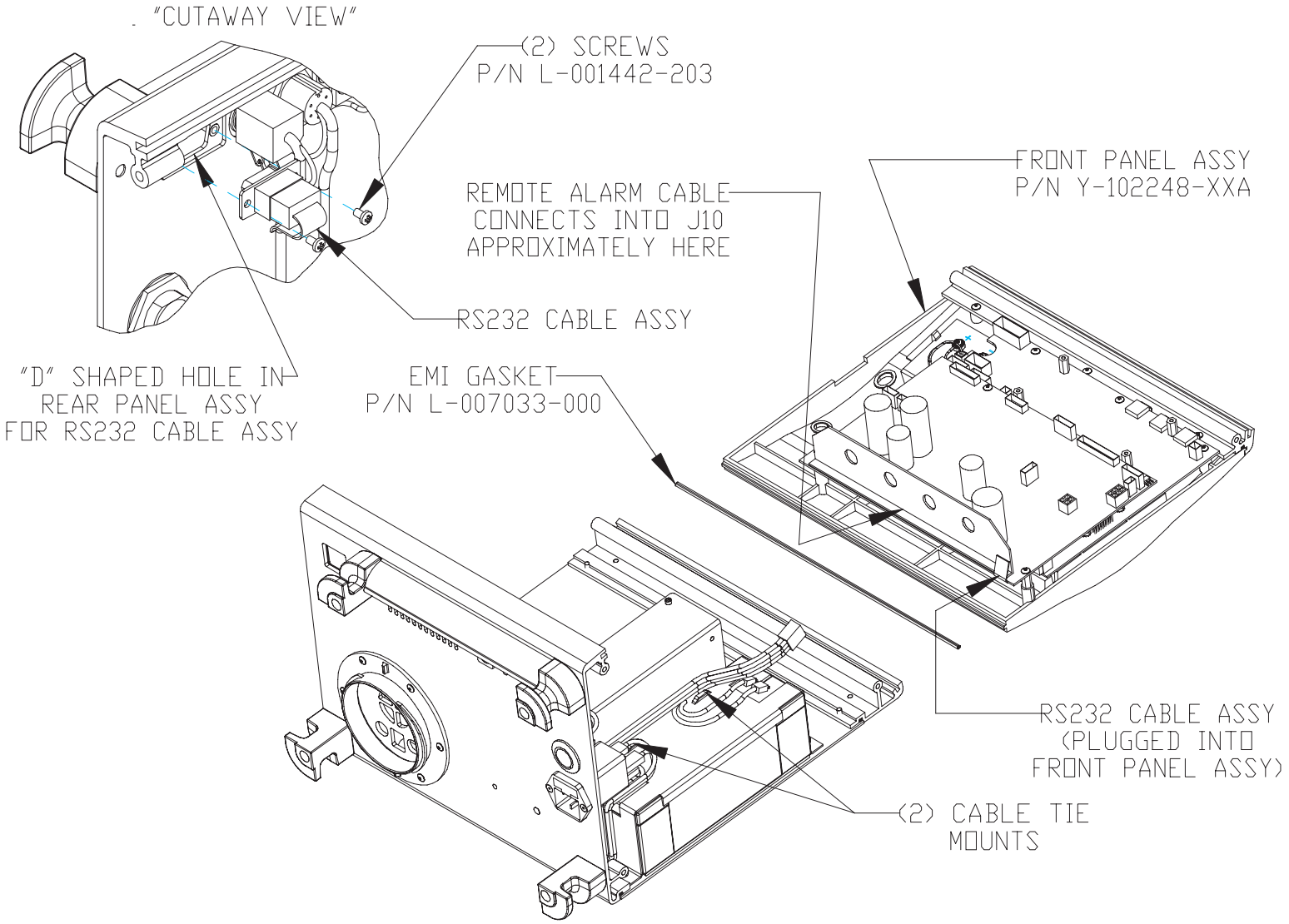
Drawing 6-4: Right end assembly drawing



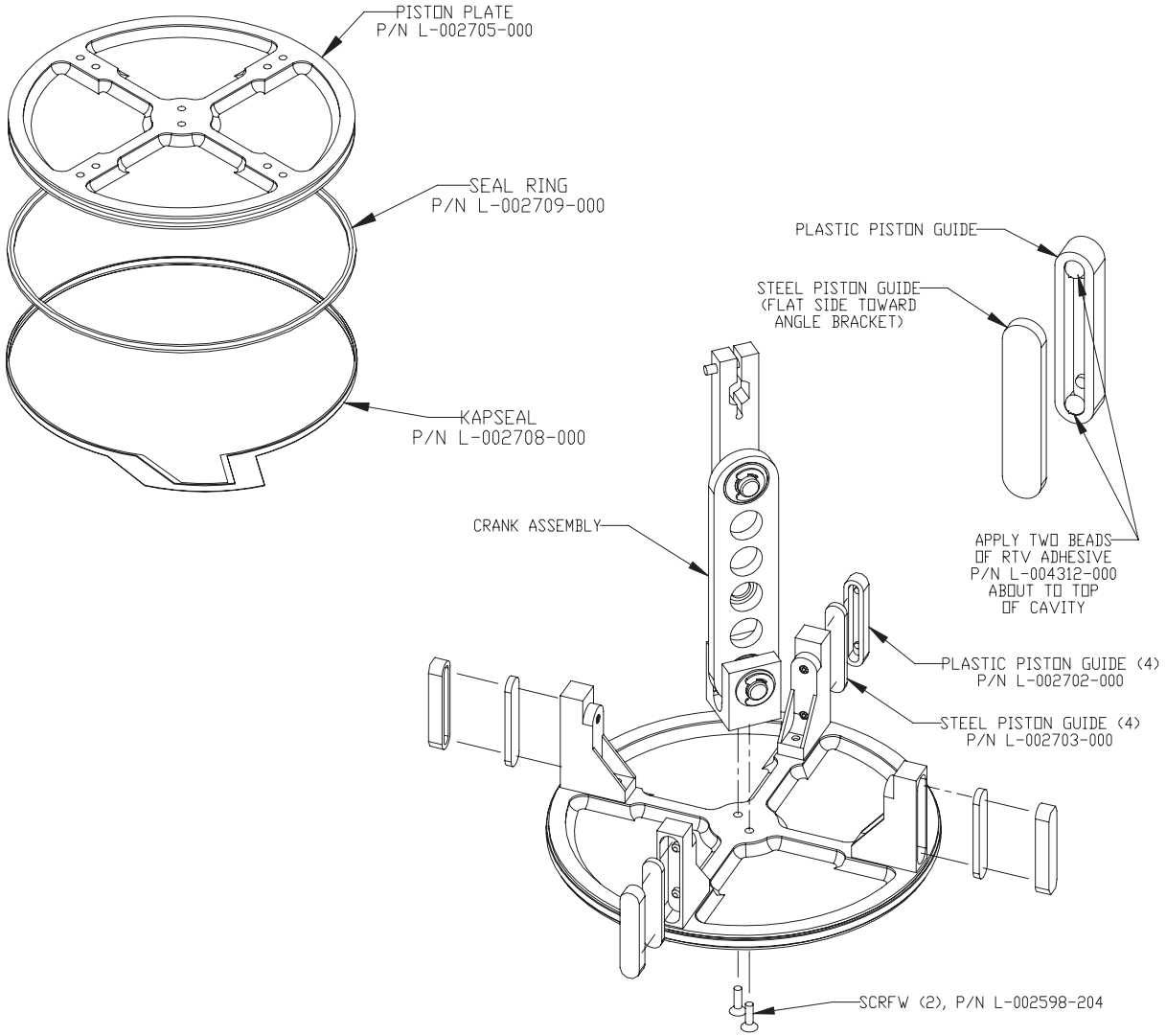
Drawing 6-5: Right end assembly drawing



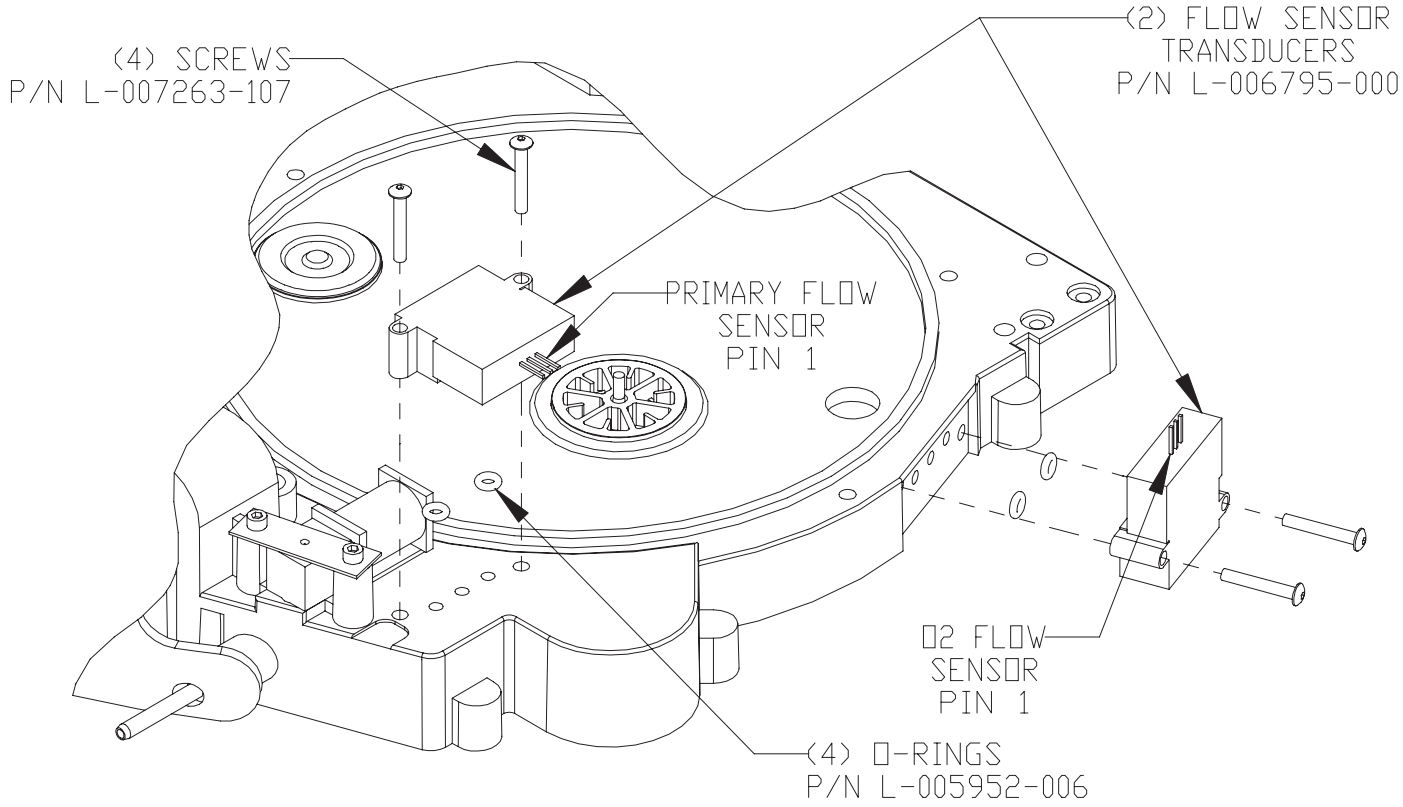
Drawing 6-6: Front panel assembly drawing



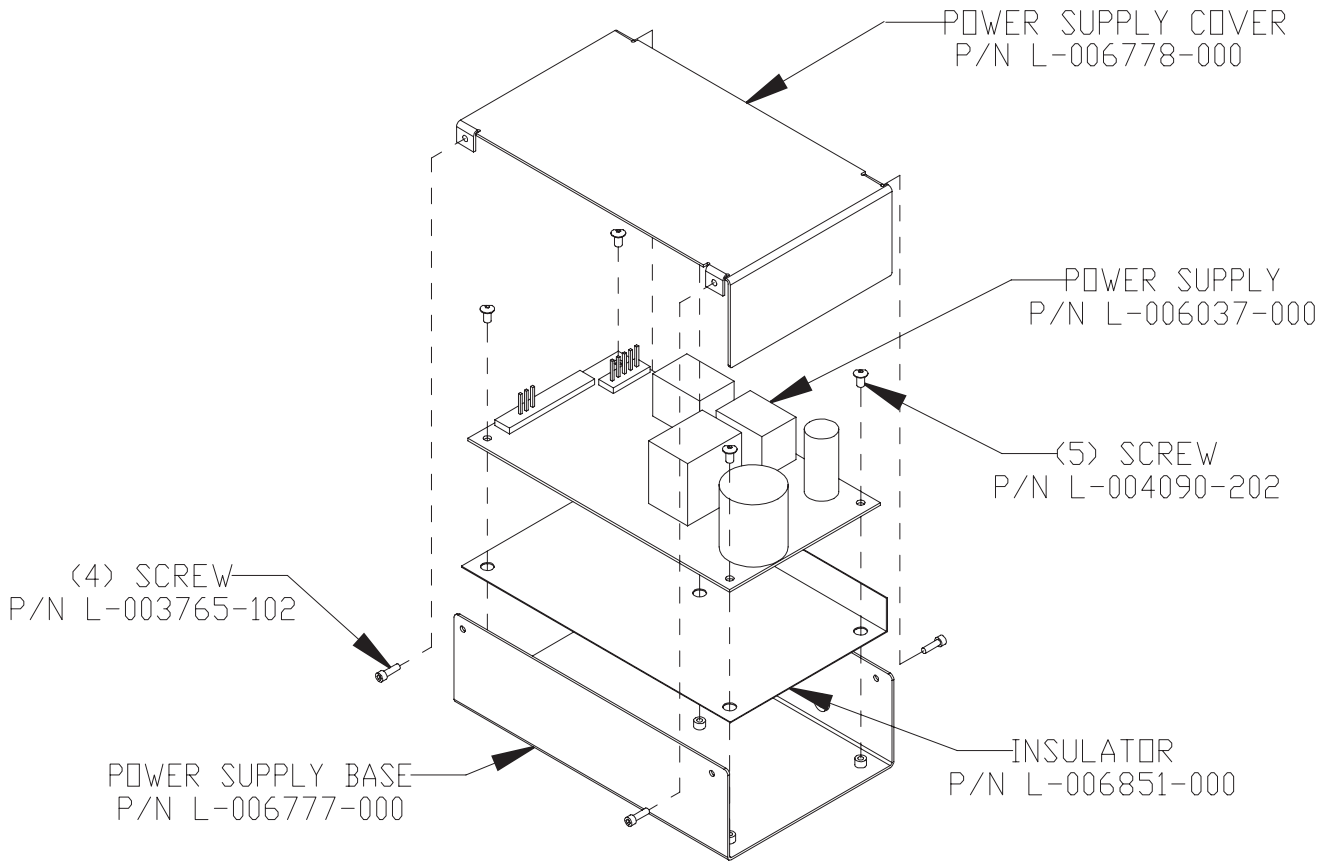
Drawing 6-7: Piston assembly drawing



Drawing 6-8: Manifold assembly drawing



Drawing 6-9: Power supply assembly drawing



(This page intentionally blank.)

Chapter 7: Service

This chapter provides service information and the limited warranty.

Service information

Achieva ventilators are warranted against defects in workmanship and materials. The full text of the warranty provides the details. Do not make any service repairs on this equipment during the stated warranty period. Any unauthorized work immediately voids the warranty. If you need information or assistance, or if the information in this manual is insufficient, contact Puritan Bennett at: 1.800.255.6774

Puritan Bennett does not recognize the owner of a ventilator as an authorized trained service representative. Puritan Bennett will not be liable for any repairs attempted by the owner. Any such attempted repairs other than specified non-warranty repairs void the warranty. Parts and labor costs incurred by the owner will not be reimbursed by Puritan Bennett. Puritan Bennett will make available on request: diagrams, component parts lists, descriptions, calibration procedures and instructions to assist in the repair of parts classified by Puritan Bennett as repairable.

Before returning any device to Puritan Bennett you must get a Return Authorization Number by calling Puritan Bennett at the number listed above.

Limited warranty

Puritan Bennett warrants to the owner that the Achieva ventilators, exclusive of expendable parts and other accessories, shall be free from defects in material and workmanship for twenty-four months from the original date of sale. Puritan Bennett's sole obligation, with respect to any such defect, is limited to the repair or, at Puritan Bennett's option, replacement of the ventilator. Purchaser pays return freight charges.

This warranty is made on the condition that prompt notification of a defect is given to Puritan Bennett within the warranty period, and that Puritan Bennett has the sole right to determine whether a defect exists.

This warranty is conditional on the performance of Preventive Maintenance at a minimum of once every 6000 operating hours, or recertification every twelve (12) months (whichever occurs first) by service personnel qualified by Puritan Bennett. The warranty does not apply to ventilators that have been partially or completely disassembled; altered; subjected to misuse, negligence, or accident; or operated other than in accordance with the instructions provided by Puritan Bennett. This includes repair by trained personnel.

This warranty represents the exclusive obligation of Puritan Bennett and the exclusive remedy of the purchaser regarding defects in the ventilator.

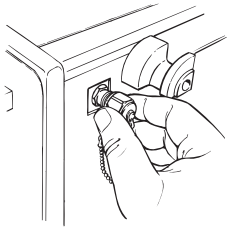
THIS WARRANTY IS GIVEN IN LIEU OF ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

No person is authorized to modify, in any manner, Puritan Bennett's obligation as described above.

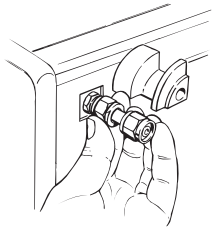
Appendix: Oxygen Adapter Assembly

Canadian

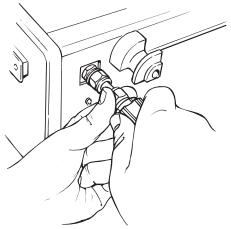
1. Remove the cover from the oxygen port (on the rear panel).



2. Attach the adapter to the oxygen port.

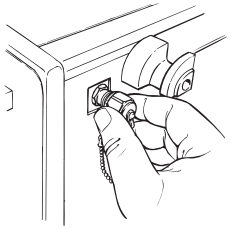


3. Attach the hose to the adapter.

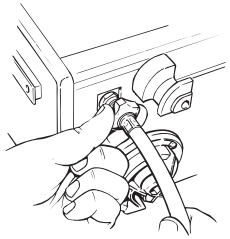


Dräger

1. Remove the cover from the oxygen port (on the rear panel).

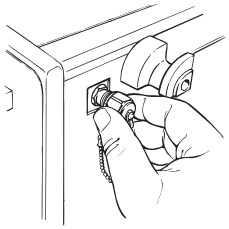


2. Attach the hose to the port.

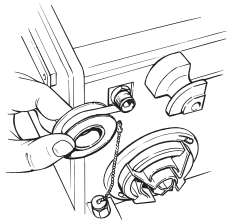


Australian

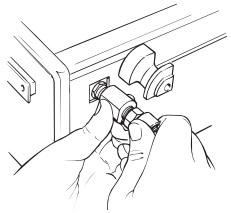
1. Remove the cover from the oxygen port (on the rear panel).



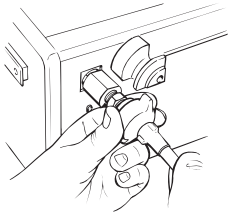
2. Apply PTFE thread sealing tape to the threads on the oxygen port. Do not apply tape to the two threads closest to the end of the port. Wrap the tape clockwise around the oxygen port. Wrap the tape around the port five full turns.



3. Attach the adapter to the oxygen port.

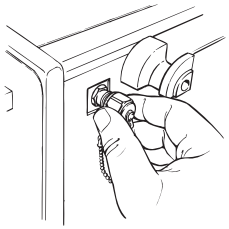


4. Attach the hose to the adapter.

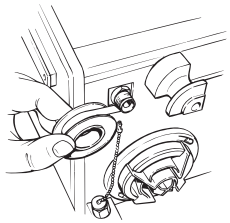


NIST

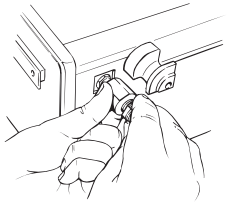
1. Remove the cover from the oxygen port (on the rear panel).



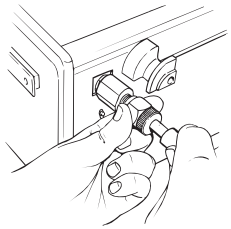
2. Apply PTFE thread sealing tape to the threads on the oxygen port. Do not apply tape to the two threads closest to the end of the port. Wrap the tape clockwise around the oxygen port. Wrap the tape around the port five full turns.



3. Attach the adapter to the oxygen port.

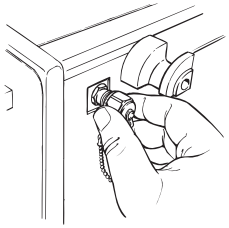


4. Attach the hose to the adapter.

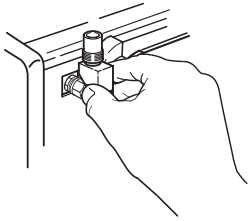


UK

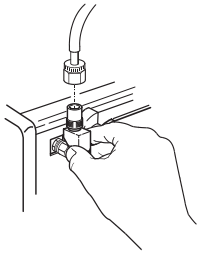
1. Remove the cover from the oxygen port (on the rear panel).



2. Attach the adapter to the oxygen port.

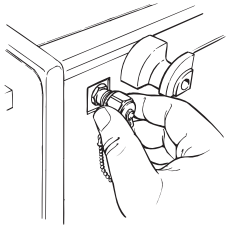


3. Attach the hose to the adapter.

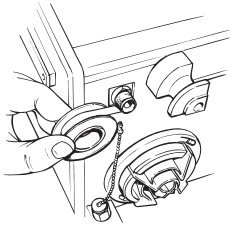


French

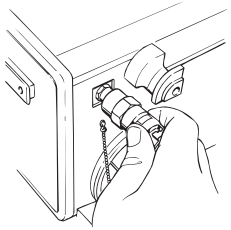
1. Remove the cover from the oxygen port (on the rear panel).



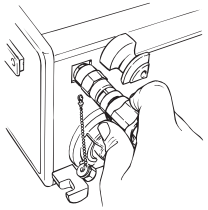
2. Apply PTFE thread sealing tape to the threads of the oxygen port. Do not apply tape to the two threads closest to the end of the port. Wrap the tape clockwise around the oxygen port. Wrap the tape around the port five full turns.



3. Attach the adapter to the oxygen port.



4. Attach the hose to the adapter.



Index

A

AC line power 2-2
AC power 3-4
Accessories 5-1
Alarm
    Low pressure 2-11
    Power 4-13
    Setting error 3-13
    Sounds 3-13
Alarm control light 2-6
Alarm lights 2-5
Alarms
    Internal battery 2-30
Alcohol 5-1
Arrow keys, up and down 2-8
Assist/Control Mode 2-19
Assist/Control mode 2-15
Assist/Spontaneous light 2-6
Assisted breath 2-10
Audible alarm 3-16, 3-17
Audible alarms 2-30

B

Back and sides of ventilator case 2-13
Bacteria filter 3-2
Battery 2-2
    Charging 2-2
    External 2-2, 3-5
    Internal 2-2, 3-10
Breath rate 2-10
Breath Rate setting 2-17

C

Calibration and testing 3-1
Caregiver 2-2
Caution, explanation of 1-2
Cleaning and sterilization 5-1
Components 4-1
Components, operation 4-3
Connectors specifications 2-32
Continuous Positive Airway Pressure 2-27
Contra-Indications 2-1
Contra-indications 2-4
Controls 2-1
Controls specifications 2-31
Conventions 1-3
CPAP 2-27

D

Data
    Storage of 4-5
DC power 2-33
Description 1-1, 2-1, 3-1
Display and controls, ventilator 2-2

E

Ethylene oxide 5-1
ETO 5-1
expiratory sensitivity level 2-19
External battery 3-4
External power source 4-11

F

FCC Part 68 Information 2-35
Features 2-3
Features of Achieva ventilators 2-1
Flow 2-12

Flow and valves 4-1
Front panel 2-4
Fuse, changing 5-5

H

High pressure 3-4

I

Indications for use 2-1
Input, external DC 4-12
Input, internal battery 4-12
Inputs, digital 4-8
Inspiratory 3-13
Inspiratory flow acceleration 2-19
inspiratory pressure 2-19
Inspiratory times 3-4
Intended use 2-1
Internal Battery 2-30
Internal battery charger 4-12
Internal battery operation 4-11
Invalid I/E ratio 2-30

L

Lights
    Alarm control 2-6
    Assist/Spontaneous 2-6
Logic board
    Alarm and monitor circuits 6-8
    DAC circuits 6-15
    Flow sensor circuits 6-11
    LED indicators/controls 6-6
    Memory/address select 6-4
    Miscellaneous digital I/O 6-7
    Notes for schematics 6-2
    Pressure sensor circuits 6-10
    Primary ADC circuits 6-12
    Serial ADC 6-13
    Switch inputs 6-5
Low internal battery alarm 2-30
Low pressure 2-11
Low pressure alarm 2-11

M

Maintenance 5-1
Maintenance, periodic 5-7
Maintenance, tools and equipment 1-4
Mandatory volume breaths 2-21
MEK 5-1
Menu
    Options 2-8
    Selections 3-6
Meter, battery charge level 2-2
Meter, patient pressure 2-6
Micro-controller 4-4
Micro-controller I/O ports 4-9
Miscellaneous specifications 2-34
Mode 3-10
Modem
    External 2-14
Modem connector 2-14
Modem controller 4-8
Modem, FCC and telephone company 2-35
Motor drive control 4-5

N

Nonlatching 2-30
Note, explanation of 1-3

O

O2 fail alarm 4-3

O2 Level 2-32
Outputs, digital 4-8
Oxygen 4-3
Oxygen adapters A-1
Oxygen alarm 4-3

P

Panel, front 2-4
Patient circuit 3-1, 3-2, 3-7
Patient circuit and equipment 3-8
Patient pressure meter 2-6
Patient pressure tube 2-33
PEEP 2-10
Periodic maintenance 5-1, 5-7
Pneumatic diagram 4-2
Pneumatic test 3-6
Power
    AC
        DC 4-11
Power board
    Connectors and EMI filters 6-24
    Motor drive 6-19
    Notes ventilator schematic 6-18
    Power on/off circuit 6-20
    Switching power supplies 6-21
    System power entry 6-22
Power cord 5-5
Power cord connector 5-5
Power distribution 2-2, 4-12
Power lights 2-6
Power system 2-2
Power system control 4-13
Power, system 4-9
Presilence audible alarm 2-6
Pressure control 2-3, 2-10
Pressure support 2-10, 3-16, 3-17
Pressure trigger 2-10
Pressure-supported breaths 2-25

R

Real-time clock 4-5
REN 2-35
Right end assembly drawing 6-28
Ringer equivalence number (REN) 2-35

S

Self-test 3-6
Service information 7-1
SIMV mode 2-21, 2-23, 3-14
Specifications 2-29
Spontaneous mode 2-25
Standard compliance 2-35
Sterilization 5-1
Supplemental 4-3
System analog control 4-7
System analog monitoring circuitry 4-6
System memory 4-5

T

Telephone company and modem 2-36
Telephone cord 2-36
Theory of operation 4-1
Trichloroethylene 5-1

U

Up and down keys 2-31
User
    Self-test 1-1, 2-30
USOC jack 2-35

V

Ventilator
    Mode 3-4
Ventilator mode 3-1
Ventilator modes and apnea 3-13, 3-15
Ventilator operation 3-1
Visual alarm 3-10
Volume breaths 3-12–3-13
Volume change 3-11
Volume error alarm 3-12

W

Warning, convention 1-3
Warranty 7-1
Warranty considerations 1-3
Waveforms 2-15–2-27

Tyco Healthcare Group LP
Nellcor Puritan Bennett Division
4280 Hacienda Drive
Pleasanton, CA 94588
Toll Free: 1.800.NELLCOR

Authorized Representative:
Tyco Healthcare UK LTD
154 Fareham Road
Gosport PO13 0AS, U.K.

CE
0123

tyco
Healthcare

PURITAN
BENNETT

Rx ONLY

 066477A-0204