

Philips Respironics V60/V60 Plus Ventilator

Service Manual

For technical support and customer service, contact:

USA and Canada: 1-800-722-9377

International: www.healthcare.philips.com.

Select your location to access contact information.

Philips Healthcare is a part of Royal Philips

© Koninklijke Philips N.V. 2009-2022

All Rights are reserved. Reproduction in whole or in part in any form or by any means, electrical, mechanical or otherwise is prohibited without the written consent of the copyright holder. Unauthorized copying of this publication may infringe copyright and reduce the ability of Philips to provide accurate and up-to-date information to users. Non Philips product names may be trademarks of their respective owners.



Manufacturer

Respironics California, LLC

2271 Cosmos Court

Carlsbad, California 92011

USA

Respironics California, LLC. reserves the right to make changes to both this service manual and to the product it describes. Product specifications are subject to change without notice. Nothing contained within this service manual is intended as any offer, warranty, promise or contractual condition, and must not be taken as such.

Table of Contents

1	Introduction and Intended Use	9
1.1	Intended Use	10
1.2	Recommended Test Equipment, Tools, and Supplies	11
1.3	Symbols	15
1.4	Where to Go for Help	20
2	Warnings, Cautions, and Notes	21
2.1	General	22
2.2	Preparing for Ventilation	26
2.3	Operation	29
2.4	Operation in High Flow Therapy (HFT)	30
2.5	Alarms and Messages	30
2.6	Care and Maintenance	31
2.7	Internal Battery	32
2.8	First-Time Installation	33
2.9	Communications Interface	34
2.10	Diagnostic Mode	34
3	Theory of Operation	35
3.1	Pneumatics	36
3.1.1	Air Inlet	37
3.1.2	Air Inlet Filter	37
3.1.3	Air Flow Sensor	38
3.1.4	Machine and Proximal Pressure Transducers	38
3.1.5	Barometric Pressure Transducer	38
3.1.6	O ₂ Pressure Transducer	38
3.1.7	Manifold, O ₂ Inlet Filter, Filter Element	39
3.1.8	O ₂ Solenoid Valve	39
3.1.9	O ₂ Flow Sensor	39
3.1.10	Blower	39
3.1.11	Solenoid Valves	40
3.2	Electronics	41
3.2.1	Power Management (PM) PCBA	41
3.2.2	Power Supply	42
3.2.3	Internal Battery	42
3.2.4	CPU PCBA	43
3.2.5	Motor Controller (MC) PCBA	46
3.2.6	Data Acquisition (DA) PCBA	46
3.2.7	Primary Speakers	46
3.2.8	Flow Sensors	47
3.2.9	User Interface (UI)	47
3.2.10	LCD Assembly	47

3.2.11	Backlight Inverter PCBA	48
3.2.12	Touchscreen Assembly	48
3.2.13	Nav-ring Assembly/Accept Button	48
3.2.14	Power Switch Overlay	49
3.2.15	Switch PCBA	49
3.2.16	UI PCBA	49
3.3	Electronic Signal Paths	50
4	Installation	61
4.1	Assembly and Installation	62
4.2	Record Ventilator Information	63
4.3	Electrical Safety	64
4.4	Preoperational Check	64
4.5	Preparing the Ventilator for Use	66
4.6	Electrical Safety/Preoperational Check Form	67
5	Maintenance	69
5.1	Exterior and Touchscreen Cleaning	72
5.1.1	Approved Cleaning Agents	72
5.1.2	Cleaning Instructions	72
5.2	Exterior and Touchscreen Disinfection	73
5.2.1	Approved Disinfecting Agents	73
5.2.2	Disinfecting Instructions	73
5.3	Annual Preventive Maintenance Instructions	74
6	Diagnostic Mode and Troubleshooting	79
6.1	System Settings	81
6.1.1	Selecting a Language	82
6.1.2	Setting Date and Time	84
6.1.3	Restoring Default Settings	85
6.1.4	Selecting Pressure Units	86
6.1.5	Enabling Software Options	87
6.1.6	Baud Rate	88
6.1.7	Alarm Volume Escalation	89
6.2	Service	90
6.2.1	Viewing Ventilator Information	90
6.2.2	Pneumatic Controls	91
6.2.3	Output Controls	93
6.2.4	Miscellaneous	94
6.3	Touchscreen Calibration	98
6.4	Diagnostic Codes, Alarms, and Troubleshooting	99
6.5	Symptom-Based Troubleshooting	113
6.6	Miscellaneous Troubleshooting Tips	114
6.7	Battery Troubleshooting Tips	118

7	Reports and Software Downloads	119
7.1	Setting Up the Service PC	120
7.2	Generating a Diagnostic Report (DRPTA)	128
7.3	Generating a Flow Sensor Zero Calibration Report (FSZR)	130
7.4	Clearing the Significant Event Log	131
7.5	Downloading Ventilator Software	132
7.5.1	Downloading Software from InCenter	132
7.5.2	Downloading Software to the Ventilator	137
7.6	Programming the Ventilator Serial Number and Power-On Hours	140
7.6.1	Programming the Ventilator Serial Number	140
7.6.2	Programming Ventilator Power-On Hours	141
7.7	Upgrading PM PCBA PMC (PIC) Firmware	141
8	Removal and Installation	143
8.1	Repacking and Shipping	145
8.2	Disconnecting All Power	146
8.3	Air Inlet Filter	147
8.4	Internal Battery	148
8.5	Top Cover	150
8.6	AC Inlet	151
8.7	Fan	152
8.8	O ₂ Inlet Fitting	153
8.9	DA PCBA to MC PCBA Cable	154
8.10	MC PCBA Retention Bracket	155
8.11	Motor Controller (MC) PCBA	156
8.12	Separating the UI from the Base	158
8.13	Front Panel	159
8.14	Gas Outlet Port	160
8.15	UI Retainer	160
8.16	Proximal Pressure Port	161
8.17	Alarm Speakers	162
8.18	Power Management (PM) PCBA	163
8.19	Power Supply	165
8.19.1	1st Generation Power Supply and Shroud	166
8.19.2	2nd Generation Power Supply and Shroud	167
8.20	CPU PCBA	169
8.21	Real-Time Clock Battery	170
8.22	Left Side Wall	171
8.23	Gas Delivery Subsystem (GDS)	172
8.24	Right Side Wall	174
8.25	O ₂ Inlet Filter	175
8.26	Data Acquisition (DA) PCBA	176
8.27	O ₂ Solenoid Valve	178
8.28	Air and O ₂ Flow Sensor Assembly	179
8.29	Solenoid Valves	181
8.30	Blower	182
8.31	Opening the User Interface (UI)/Rear Bezel	183
8.32	Power Switch Overlay	184

8.33	Switch PCBA	185
8.34	Front Bezel, Touchscreen	186
8.35	LCD	188
8.35.1	Original (HYDIS) LCD	188
8.35.2	2nd-Generation (NEC) LCD	190
8.36	User Interface (UI) PCBA	192
8.36.1	Original UI PCBA	192
8.36.2	2nd-Generation UI PCBA	193
8.37	Backlight Inverter PCBA	194
8.38	LCD Tray	194
8.39	Bottom Feet	195
8.39.1	Removing Bottom Feet Configured for the Universal Stand	195
8.39.2	Converting Ventilator Feet (Universal Stand to V60/V60 Plus Stand)	196
8.40	Labels	197
8.41	Component Replacement Data Form	202
9	Performance Verification	203
9.1	Performance Verification Tests	204
9.2	Pneumatic Calibration Analyzer Setup	209
9.2.1	Measurement Selection Screen	209
9.2.2	Averaging Setup Menu	211
9.2.3	Trigger Options	212
9.2.4	Configurations	213
9.3	Preliminary Procedures	216
9.3.1	Cleaning and Inspection	216
9.3.2	Touchscreen Calibration	216
9.3.3	Record Ventilator Information	217
9.4	Test 1: Electrical Safety	219
9.5	Test 2: Leak Tests	221
9.5.1	High Pressure Leak Test	221
9.5.2	System Leak Test	223
9.6	Test 3: Controls	225
9.7	Test 4: Pressure Accuracy	227
9.7.1	Pressure Accuracy Test Example	230
9.8	Test 5: Air Delivery	232
9.9	Test 6: Flow Sensor Zero Calibration	236
9.10	Test 7: Air Flow Accuracy	238
9.11	Test 8: O ₂ Flow Accuracy	241
9.12	Test 9: O ₂ Mix Accuracy	244
9.13	Test 10: S/T Performance	248
9.14	Test 11: Alarms	250
9.15	Test 12: Power Fail	252
9.15.1	Power Fail Test - Internal Battery Installed	252
9.15.2	Power Fail Test - Internal Battery Not Installed	254
9.16	Test 13: Internal Battery	255
9.17	Preparing the Ventilator for Use	257

9.18	Performance Verification Troubleshooting/Repair	259
9.18.1	Test 1: Electrical Safety	259
9.18.2	Test 2: Leak Tests	260
9.18.3	Test 3: Controls	260
9.18.4	Test 4: Pressure Accuracy	261
9.18.5	Test 5: Air Delivery	261
9.18.6	Test 6: Flow Sensor Zero Calibration	261
9.18.7	Test 7: Air Flow Accuracy	261
9.18.8	Test 8: O ₂ Flow Accuracy	262
9.18.9	Test 9: O ₂ Mix Accuracy	262
9.18.10	Test 10: S/T Performance	262
9.18.11	Test 11: Alarms	263
9.18.12	Test 12: Power Fail	263
9.18.13	Test 13: Internal Battery	263
9.19	Electrical Safety Data Form	265
9.20	Performance Verification Data Form	267
A	Replacement Parts	275
A.1	Complete Parts List	277
A.2	Recommended Inventory Parts List	285
A.3	Accessory Part Numbers	297
A.4	O ₂ Manifolds and Hoses	298
A.5	Universal Stand	299
A.6	V60 Stand	302
B	Specifications	305
B.1	Control Settings	306
B.2	Controls Active in V60/V60 Plus Ventilation Modes	307
B.3	Patient Data	308
B.4	Alarms	309
B.5	Alarm-Related Specifications	310
B.6	Menu Window Settings	311
B.7	Operator-Accessible Diagnostic Mode Functions	312
B.8	Physical Characteristics	313
B.9	Environmental Specifications	314
B.10	Pneumatic Specifications	315
B.11	Accessory Requirements	316
B.12	Electrical Specifications	317
B.13	Other Specifications	318
C	Service Bulletins	319
C.1	Downloading Bulletins from InCenter	319
	Index	321

1 Introduction and Intended Use

1.1	Intended Use	10
1.2	Recommended Test Equipment, Tools, and Supplies	11
1.3	Symbols	15
1.4	Where to Go for Help	20

The Philips Respironics V60/V60 Plus ventilator is a microprocessor-controlled, positive pressure ventilator assist system. The ventilator provides noninvasive and invasive ventilatory support for spontaneously breathing adult and pediatric patients.

The ventilator has a variety of modes and monitoring capabilities to assist in assessing performance and patient-to-ventilator synchrony. Safety features include in-depth alarms and a variety of integrated safety and self-diagnostic features. The ventilator automatically checks many system functions at startup and during operation.

The ventilator includes a touchscreen user interface (UI) that lets the operator select ventilator and alarm settings and displays of ventilator and patient data.

The ventilator is designed to be upgradeable, and features communications capabilities and an internal backup battery.

Read this manual thoroughly before performing service or maintenance on the ventilator. This manual includes advanced troubleshooting, calibration, and maintenance instructions for the ventilator. All maintenance and repair work should be performed by qualified biomedical technicians who have appropriate training and authorization to provide maintenance, repair, and service for the ventilator.

Review the operating instructions for the ventilator before running tests, checking operational readiness, or initiating patient use. These instructions include important information about ventilator safety and operation.

For additional information about accessories or related equipment, such as humidifiers and remote alarm systems, refer to the appropriate instruction manual prior to operating the ventilator. Review the applicable warnings and cautions in the ventilator user manual before operating the ventilator.

1.1 Intended Use

The V60/V60 Plus ventilator is an assist ventilator and is intended to augment patient breathing. In high flow therapy (HFT), the ventilator can also provide respiratory support. the ventilator is intended for spontaneously breathing individuals who require mechanical ventilation and respiratory support: patients with respiratory failure, chronic respiratory insufficiency, or obstructive sleep apnea in a hospital or other institutional settings under the direction of a physician.

The ventilator is intended to support pediatric patients weighing 20 kg/44 lb or greater to adult patients. It is also intended for intubated patients meeting the same selection criteria as the noninvasive applications. The ventilator is intended to be used by qualified medical professionals such as physicians, nurses, and respiratory therapists. The ventilator is intended to be used only with various combinations of Philips-recommended patient circuits, interfaces (masks), humidifiers, and other accessories.

1.2 Recommended Test Equipment, Tools, and Supplies

Table 1-1 (V60 ventilator service kit) and Table 1-2 (other equipment and supplies) summarize the test equipment required to service the ventilator. Check the calibration status of all test equipment before use.

NOTE:	The following items are not included in the service kit and must be ordered separately (see Table 1-2):
	- Breathing circuit, single-limb with DEP - Exhalation port, Whisper Swivel II, reusable - O₂ hose kit - Test lung, hard-sided

Table 1-1: V60 Ventilator Service Kit Contents

Description	Part number	Order number
V60 ventilator service kit:	1054291	453561512121
Adapter, 22-mm to 22-mm	1002505	453561506281
Adapter, remote alarm test cable	1027817	453561507991
Adapter, test, 0.25-in.	332353	453561517281
Adapter, torque, GDS air inlet collar	1111163	453561531671
Adapter, USB to serial	1022895	989805643371
Cable, HIS/EMR null modem	1080588	989805629921
Cable, remote alarm test	1027818	453561508001
Cable, TTL communications	1058778	453561512951
Coupling, straight silicone	500-1000-43	453561505771
Forceps, locking, plastic	1058432	453561512941
O ₂ regulator/shut-off valve (requires O ₂ hose kit)	1122489	989805654391
Plug, low-pressure	1058270	453561512911
Plug, tapered, $\frac{23}{32}$ - $\frac{61}{64}$ in., silicone	1055322	453561512731
Plug, tapered, 9/16 - 3/4 in., silicone	1055323	453561512741
Pressure pick-off assembly	--	--
Pressure pick-off port (O ₂ enrichment attachment)	312710	989805609421
Pressure pick-off tubing	--	--
Syringe, system leak test	1058271	453561512921
Tubing, 18-in. smooth-bore, package of 2	1003660	453561507701
Valve, ball	1058431	453561512931

				
Adapter, 22-mm to 22-mm	Adapter, remote alarm test cable	Adapter, test, 0.25-in.	Adapter, torque, GDS air inlet collar	Adapter, USB to serial
				
Cable, HIS/EMR null modem	Cable, remote alarm test	Cable, TTL communications	Coupling, straight silicone	Forceps, locking, plastic
				
O ₂ regulator/shut-off valve	Plug, low-pressure	Plug, tapered, 22/32 - 61/64 in. ID, silicone	Plug, tapered, 9/16 - 3/4-in., silicone	Pressure pick-off assembly
				
Pressure pick-off port	Pressure pick-off tubing	Syringe, system leak test	Tubing, 18-in. smooth-bore, package of 2	Valve, ball

Table 1-2: Other Equipment and Supplies

Description	Part number	Order number
Test equipment:		
Digital multimeter (DMM) accurate to three decimal places	Local supplier	
Electrical safety analyzer, Fluke ESA620 or equivalent	Local supplier	
Pneumatic calibration analyzer (measures flow, barometric and ventilator pressures, O ₂ %, and frequency), TSI Certifier FA Plus System or equivalent, including:		
NOTE The Certifier FA Plus System is only available through the commercial channel or your local supplier.		
• Controller (TSI model no. 4089)	1154171	989805689961
• High-flow module (TSI model no. 4081)	1037696	989805612971
• O ₂ sensor kit (TSI model no. 4073)	1037156	989805612921
Temperature/humidity monitor, capable of measuring: - Relative humidity: 25% to 98%; resolution: 1%; accuracy: ± 3.5% (midrange) to ± 5.5% (outside midrange). - Temperature: 0.0°C to 50.0°C (32.0°F to 122.0°F); resolution ± 0.1°C; accuracy: ± 1°C (± 1.8°F).	Local supplier	
Test lung, 1-L, IngMar QuickLung or equivalent, capable of compliance and resistance: - C20 (C6) 0.2 (0.06) L/kPa ± 10% at 500 (200) mL tidal volume. - Rp20 K 17.61 ± 20% (equivalent orifice size = 5.31 mm) pressure drop 17.61 cmH₂O at 1 L/s.	Local supplier	
Timer	Local supplier	
Service tools and supplies:		
Breathing circuit, single-limb with DEP	582072	989805609601
Exhalation port, Whisper Swivel II, reusable	332113	989805617951
Fitting, system leak test syringe (replacement)	1060263	453561512961
Isopropyl alcohol, 70%	Local supplier	
Label, electrical safety (x20)	1098020	453561528311
Label, preventive maintenance (x20)	1098019	453561528301
Lubricant, Dupont, KRYTOX GPL 226	1101835	453561529261
Hex drivers (rounded ends), 1.5 to 4 mm	Local supplier	

Table 1-2: Other Equipment and Supplies

Description	Part number	Order number
O ₂ hose kit Use one hose kit with the O ₂ /regulator shut-off valve (hose kits are not included in the V60 service kit)		
• Hose kit, O ₂ , DISS female x DISS female (US)	1122456	989805654361
• Hose kit, O ₂ , DISS female x NIST socket, DISS female x NIST probe (EMEA)	1122488	989805654381
• Hose kit, O ₂ , DISS male x DISS male, DISS male x DISS female (Canada)	1123977	989805654401
• Hose kit, O ₂ , DISS female x SIS socket, DISS female x NIST probe (Australia)	1122457	989805654371
PC or laptop (required for downloading software and capturing diagnostic codes), Windows 7 or newer operating system with serial or USB ports	Local supplier	
Pliers, channel lock	Local supplier	
Pliers, needle-nose	Local supplier	
Screwdriver, #0 Phillips	Local supplier	
Screwdriver, #1 Phillips	Local supplier	
Socket, deep, 7-mm	Local supplier	
Socket, deep, 3/16-in., 1/4-in., 5/16-in., 3/8-in., 9/16-in., and 9-32-in.	Local supplier	
Test lung, hard-sided	1021671	989805611871
Tool, plug, blockout, RJ45	1116109	453561533851
Torque driver, capable of (8.5 to 203.4 N-cm) (0.75 to 18 in.-lb)	Local supplier	
Torque driver, capable of (361.6 to 621.4 N-cm) (32 to 55 in.-lb)	Local supplier	
Tubing, Tygon, ID 1/8 in., OD 1/4 in., 5 ft L	1121145	453561535011
Vacuum, ESD-safe, 3M Model 497-AJM or equivalent	Local supplier	
Workstation, antistatic, 3M Model 725 or equivalent	Local supplier	
Wrench, roll stand caster, 17-mm thin	1096352	453561528181

1.3 Symbols

Refer to these tables to interpret symbols used on the ventilator labels, backup battery labels, and packaging. In addition, Philips provides a Symbol Library at: <http://symbols.philips.com>. To interpret symbols pertaining to accessories, refer to their instructions for use.

Table 1-3: Symbols Used on Ventilator Labels, Battery, and Packaging

Symbol	Description
	Warning: Risk of explosion. Do not use in the presence of flammable anesthetics.
	Attention, consult the accompanying documents.
	Read the user manual before using the ventilator. Symbol may be accompanied by the web address www.Philips.com/IFU to indicate access to electronic IFUs.
	Electronic instructions for use. Indicates that relevant information for use of the product is available in electronic form.
	(Blue) It is mandatory for the operator to consult the accompanying documents.
	Protective earth (ground)
	Medical device
	Unique device identifier
	Distributor. Symbol accompanied by address
	Importer. Symbol accompanied by address
	This medical device contains substances that can be carcinogenic, mutagenic, reprotoxic (CMR), or substances with endocrine-disrupting properties.
	Fragile

Table 1-3: Symbols Used on Ventilator Labels, Battery, and Packaging

Symbol	Description
	Keep dry
	Stacking limit by number
	This end up
	Type B applied part, which is equipment that provides a particular degree of protection against electric shock, particularly in regard to allowable leakage current and of the protective earth connection
	Requires alternating current (AC)
IPX1	Degree of fluid ingress protection provided by the enclosure (drip-proof)
IP21	Degree of solid object protection and fluid ingress protection provided by the enclosure (drip-proof)
Rx ONLY	Caution: Federal law restricts this device to sale by or on the order of a physician
	Alarm and remote alarm
	Two states of control: ON and Shutdown
	Battery
CE 2797	European Conformity. Symbol is on rear panel of ventilator.
Segurança   	Brazilian Conformity. Certification by INMETRO (National Institute of Metrology, Standardization and Industrial Quality)/SGS (Societe Generale de Surveillance). One of these three symbols, depending upon available space.
EAC	EurAsian Conformity mark - EAC

Table 1-3: Symbols Used on Ventilator Labels, Battery, and Packaging

Symbol	Description
	Date of manufacture. Symbol accompanied by date.
	Country of Manufacture. Symbol accompanied by country code (and optionally manufacture date and/or manufacturer's name and address).
	Manufacturer. Symbol accompanied by manufacturer's name and address.
	EC representative
	Indicates a medical device that contains substances that can be carcinogenic, mutagenic, reprotoxic (CMR), or substances with endocrine disrupting properties.
	Serial number
	Order number
	Lot or batch number
	Model number
	Use by date
	RS-232 serial input/output
	USB port
	Oxygen
	(Yellow) Warning
	Ethernet connection
	Accept button. If the nav-ring is present, the Accept button is on the nav-ring.

Table 1-3: Symbols Used on Ventilator Labels, Battery, and Packaging

Symbol	Description
	Adjustment direction on the nav-ring (if present)
	ETL certification mark
	Do not disassemble. Refer to authorized service personnel.
	Product must be disposed of in accordance with the WEEE directive.
	Noninvasive ventilation (patient with mask)
	Invasive ventilation (intubated patient)
	The ventilator is MR Unsafe and presents a projectile hazard. Keep the ventilator outside MRI scan room (Zone IV).
	Do not block the cooling fan Inlet (at the rear of the ventilator).
	Used in conjunction with the blue “consult accompanying documents” symbol to indicate “Do not block the cooling fan Inlet.”
	No pushing. Do not push on the ventilator screen. Tipping hazard.

Table 1-3: Symbols Used on Ventilator Labels, Battery, and Packaging

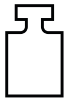
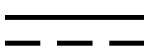
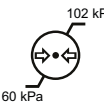
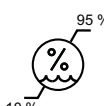
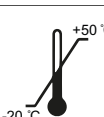
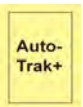
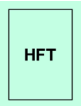
Symbol	Description
	Total mass (weight). See section B.8 for details on physical characteristics of the ventilator, stand, and accessories.
 (On power cord)	Hospital-grade
	Packaging unit. Symbol accompanied by a number (indicating the number of pieces in the package).
	Recycle
	Recycle (Taiwan)
	RoHS (China). Administrative Measure on the Control of Pollution Caused by Electronic Information Products. Contains RoHS substances with 50 years environmentally friendly use period (EFUP).
	uR UL recognition symbol
	Direct current (DC). Symbol is on backup battery.
	Battery check.
	Rechargeable battery. Symbol is on backup battery.
	Lithium-ion battery. Battery must be recycled or disposed of properly. Symbol is on backup battery.
	Barometric pressure limitation. Indicates the acceptable upper and lower limits of barometric pressure for transport and storage.
	Humidity limitation. Indicates the acceptable upper and lower limits of relative humidity for transport and storage.
	Temperature limit. Indicates the maximum and minimum temperature limits at which the item shall be stored or transported.

Table 1-3: Symbols Used on Ventilator Labels, Battery, and Packaging

Symbol	Description
	Battery included
	C-Flex feature
	AVAPS mode (included)
	PPV software option
	Auto-Trak+ software option
	High flow therapy (may be accompanied by a numerical value indicating maximum flow in L/min during HFT).

1.4 Where to Go for Help

Call the Response Center nearest you or visit Philips' website below.

- In the United States call: 1-800-722-9377.
- For other telephone numbers worldwide, go to:
www.healthcare.philips.com

1. Select your location and language.
2. Click the **About** drop-down menu.
3. Select **Contact**.

2 Warnings, Cautions, and Notes

2.1	General	22
2.2	Preparing for Ventilation	26
2.3	Operation	29
2.4	Operation in High Flow Therapy (HFT)	30
2.5	Alarms and Messages	30
2.6	Care and Maintenance	31
2.7	Internal Battery	32
2.8	First-Time Installation	33
2.9	Communications Interface	34
2.10	Diagnostic Mode	34

Before servicing the V60/V60 Plus ventilator, read and understand this service manual, especially safety considerations. These safety considerations are for reference only, and are not intended to supersede your institution's protocol for service or safe use of noninvasive ventilation.

The instructions in this manual are primarily reserved for use by an authorized service technician.

WARNING

Alerts the user to the possibility of injury, death, or other serious adverse reactions associated with the use or misuse of the device.

CAUTION

Alerts the user to the possibility of a problem with the device associated with its use or misuse, such as device malfunction, device failure, damage to the device, or damage to other property.

NOTE

Emphasizes information of particular importance.

2.1 General

WARNING

- Always have immediate access to an alternative means of ventilation. If there is a ventilator failure, immediately remove the ventilator from use and secure an alternative means of ventilation, such as a self-inflating, manually powered resuscitator and mask. Failure to do so can result in patient injury or death.
- Use the ventilator on spontaneously breathing patients only. It is an assist ventilator and is intended to augment the ventilation of a spontaneously breathing patient. It is not intended to provide the total ventilatory requirements of the patient.
- We do not recommend using the ventilator on patients who require ventilation at predetermined tidal volumes. The ventilator provides CPAP and positive pressure ventilation (S/T, PCV, and AVAPS) and is indicated for assisted ventilation only. These modes do not provide ventilation with guaranteed tidal volume delivery.
- We do not recommend using AVAPS on patients who require rapid and frequent IPAP adjustments to maintain a consistent tidal volume. AVAPS, a volume targeted mode, changes the IPAP setting in order to achieve the target tidal volume. During AVAPS setup, there may be a period of time before the target tidal volume is achieved. AVAPS is ideal for more stabilized patients.

WARNING

- To reduce the risk of CO₂ rebreathing, make sure that EPAP pressures and exhalation times are sufficient to clear all exhaled gas through the exhalation port. In noninvasive ventilation continuous air flow through the port flushes exhaled gases from the circuit. The ability to completely exhaust exhaled gas from the circuit depends on the EPAP setting and I:E ratio. Higher tidal volumes further increase the volume of CO₂ that the patient rebreathes. Note: this may occur if exhalation time is insufficient.
- To reduce the risk of CO₂ rebreathing, monitor the patient for changes in respiratory status at the start of ventilation and with each change in ventilator settings, circuit configuration, or patient condition. Pay attention to ventilator alarms that warn of increased CO₂ rebreathing risk.
- To ensure accuracy of O₂ administration and to monitor for the presence of contamination (incorrect gas connected), use an external O₂ monitor to verify the O₂ concentration in the delivered gas.
- To reduce the risk of fire, use the ventilator in well-ventilated areas away from flammable anesthetics. Do not use in a hyperbaric chamber or other similarly O₂-enriched environments. Do not use near an open flame.
- To reduce the risk of electric shock from liquid entering the device, do not put a container filled with a liquid on the ventilator.
- To reduce patient risk of O₂ toxicity, keep free-flowing O₂ away from the air inlet of the ventilator.
- The remote alarm should be considered a backup to the ventilator's primary alarm system.
- Set the alarm loudness above the ambient level. Setting the alarm loudness too low may prevent recognition of alarm conditions.
- Avoid blocking the alarm speakers beneath the ventilator.
- Do not leave the ventilator unattended when stationed on an incline.
- The ventilator may cause radio interference or may disrupt the operation of nearby equipment. It may be necessary to take mitigation measures, such as re-orienting or relocating the ventilator or shielding the location.
- The ventilator is designed to comply with IEC 60601-1-2. The ventilator generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with instructions, may cause harmful interference to other devices in the vicinity. However, there is no guarantee that interference will not occur in a particular installation. Harmful interference to other devices can be determined by turning this equipment ON and OFF. Try to correct the interference using one or more of the following:
 - Reorient or relocate the receiving device
 - Increase the separation between the equipment
 - Connect the equipment to an outlet on a different circuit from that to which the other device(s) are connected and consult the Philips service technician for help
 - Consult the Philips service technician for help.

WARNING

- Use of non-approved accessories, transducers or cables may increase EMC emissions or decrease the EMC immunity performance of the equipment.
- Do not use the ventilator in an MRI environment. The V60/V60 Plus ventilator is MR Unsafe. Keep it outside the MRI scan room (Zone IV). It represents a projectile hazard.
- Use portable radio-frequency (RF) communications equipment (including peripherals such as antenna cables and external antennas) no closer than 30 cm (12 in.) to any part of the ventilator system, including cables specified for use with the ventilator. Otherwise, equipment performance can be degraded. If higher immunity test levels than those specified in IEC 60601-1-2:2014, Table 9, are used, the minimum separation distance may be lowered. Lower minimum separation distances shall be calculated using the equation specified in chapter 8.10 of the standard.
- Do not use the ventilator near radio-frequency identification (RFID) or electromagnetic security systems. The ventilator may disrupt the operation of this equipment.
- Do not use the ventilator near active high frequency (HF) surgical equipment, medical devices such as X-ray devices and diathermy, or in an RF-shielded room of medical equipment or system for magnetic resonance imaging, where the intensity of electromagnetic (EM) disturbances is high. These devices may degrade the performance of the ventilator.

CAUTION

- Federal law (USA) restricts this device to sale by or on the order of a physician.
 - The ventilator is designed to operate in the temperature range of 5°C to 40°C (41°F to 104°F). To minimize the risk of overheating the device, do not operate adjacent to heaters or other heat sources.
-

NOTE

- *The displays shown in this manual may not exactly match what you see on the ventilator.*
- *Pressures are indicated on the ventilator in cmH₂O. Millibars and hectopascals (hPa) are used by some institutions instead. Since 1 millibar equals 1 hPa, which equals 1.016 cmH₂O, the units may be used interchangeably.*
- *The ventilator is not intended for use as an ambulance transport ventilator or as an Automatic Transport Ventilator as described by the American Hospital Association and referenced by the FDA. It is intended for to allow the patient to be transported within the hospital setting using a stand to move the ventilator.*
- *When attachments or other components or subassemblies are added to the ventilator breathing system, the pressure gradient across the ventilator breathing system, measured with respect to the ventilator outlet, may increase.*
- *To ensure the correct performance of the ventilator and the accuracy of patient data, use only Philips-approved accessories with the ventilator. See the user manual for more information.*

- *The ventilator and its recommended accessories that have patient contact are not made of natural rubber latex.*
- *If an alarm persists for no apparent reason, discontinue ventilator use and contact Philips.*
- *In case of any unexplained changes in the performance or visual displays of the ventilator, discontinue ventilator use and contact Philips.*
- *The ventilator does not support automatic record keeping.*
- *All ventilator mode and alarm settings, alarm messages and significant events are retained and automatically logged, even when power is lost.*
- *Any serious incident that has occurred in relation to this device should be reported to Philips and the competent authority of the country in which the user and/or patient is established.*
- *A patient alarm is an alarm triggered by physiological changes in the patient or by variation in measured parameters that reflect patient status. Patient alarms include those related to tidal volume, respiratory rate, pressure, minute volume, and other such alarms. See the V60/V60 Plus Ventilator User Manual for more information on ventilator alarms, including patient alarms.*

2.2 Preparing for Ventilation

WARNING

- Connect the ventilator only to an appropriate medical-grade O₂ source.
- To reduce the risk of hypoxia, connect only O₂ to the high-pressure connector at the rear of the ventilator.
- The ventilator can be used as a high-flow device. Connect it only to a gas supply system that can provide adequate flow to all terminal outlets. Connecting the ventilator to an adequate gas supply system helps ensure that the ventilator and other connected devices perform to their specifications.
- To reduce the risk of fire, do not use a high-pressure O₂ hose that is worn or contaminated with combustible materials like grease or oil.
- The ventilator is designed to use ambient air and high pressure 100% O₂. No other gases should be used.
- Do not use the ventilator with helium or helium mixtures. The ventilator is not intended to be used with helium or heliox. Connecting helium to the ventilator may affect ventilator performance, gas mixtures, and measurements due to the lower density of helium.
- Do not use the V60/V60 Plus ventilator with nitric oxide. The ventilator is not validated for use with nitric oxide.
- To prevent possible asphyxia and to reduce the risk of CO₂ rebreathing, take these precautions with respect to mask and exhalation port use:
 - Use only an oro-nasal mask with an anti-asphyxia valve or a nasal mask for noninvasive ventilation.
 - Do not occlude the exhalation port.
 - Turn on the ventilator and verify that the port is operational before application. Pressurized gas from the ventilator should cause a continuous flow of air to exhaust from the leak port, flushing exhaled gas from the circuit.
 - Never leave the mask on the patient while the ventilator is not operating. When the ventilator is not operating, the exhalation port does not let sufficient exhaust eliminate CO₂ from the circuit. Substantial CO₂ rebreathing may occur.
- The patient's exhaled volume can differ from the measured exhaled volume due to leaks around the mask during noninvasive ventilation.
- To ensure normal air circulation and exchange, do not cover or block the ports on the ventilator. Do not block the air inlet panel on the right side of the ventilator.
- Do not cover or position the ventilator so as to adversely affect its operation or performance. For example, positioning the ventilator next to a curtain blocks the flow of cooling air and can cause the equipment to overheat. Use the ventilator in an upright position that does not block the air inlet.
- Do not block the air intake. Blocking the intake can impair ventilator performance and result in patient injury.
- To reduce the risk of the device overheating and possible burn injury, do not block the fan intake at the rear of the ventilator.
- To prevent possible patient injury and possible water damage to the ventilator, make sure the humidifier is set appropriately.

WARNING

- When using a humidifier, always use either a circuit with a water trap or a heated wire circuit to minimize patient risk from condensate in the circuit.
- To prevent the possibility of inadequate humidification, pay close attention to the humidifier's functioning when operating the ventilator at an ambient temperature > 30°C (86°F). The ventilator warms the air delivered to the patient above ambient temperature, which may impair the humidifier's performance.
- To reduce the risk that the patient will aspirate condensed water from the breathing circuit, position any humidifier lower than both the ventilator and the patient.
- To prevent possible patient injury and equipment damage, do not turn the humidifier on until the gas flow has started and is regulated. Starting the heater or leaving it on without gas flow for prolonged periods may result in heat build-up, causing a bolus of hot air to be delivered to the patient. Circuit tubing may melt under these conditions. Turn the heater power switch off before stopping gas flow.
- To reduce the risk of fire, use only patient circuits intended for use in O₂-enriched environments. Do not use antistatic or electrically conductive tubing.
- To prevent patient or ventilator contamination, always use a main flow bacteria filter on the patient gas outlet port. Filters not approved by Philips may degrade system performance.
- During ventilation, patient exhalate is released into room air. Use of a patient circuit with a filter on its exhalation port is recommended.
- Avoid adding any components to the patient circuit that are not absolutely necessary. Additional components installed in the patient circuit can change the pressure gradient across the ventilator breathing system, increase dead space, and adversely affect the ventilator performance.
- To reduce the risk of bacterial contamination or damage, handle bacteria filters with care.
- Any additional accessories in the patient circuit may substantially increase flow resistance and impair ventilation.
- Avoid adding resistive circuit components on the patient side of the proximal pressure line. Such components may defeat the disconnect alarm.
- To reduce the risk of strangulation from patient tubing, use a tubing support arm and secure the proximal pressure line with clips.
- To reduce the risk of electric shock, connect the ventilator to an AC supply mains with protective earth only.
- Do not use extension cords, adapters, or power cords with the ventilator that are not approved by Philips.
- To prevent unintentional disconnection of the power cord, always use the correct, Philips-supplied power cord and lock it into place with the power cord retainer before switching the ventilator on. The retainer is designed to hold the connector end of the Philips-supplied cord securely in place.

WARNING

- Do not position the V60/V60 Plus ventilator in a way that makes it difficult to disconnect from mains power if necessary. Disconnect from supply mains by removing the power cord from the wall outlet. The AC mains plug is used as a disconnection device.
- To reduce the risk of electric shock, regularly inspect the AC power cord and verify that it is not frayed or cracked.
- To reduce the risk of strangulation, route the power cord to avoid entanglement.
- To reduce the risk of power failure to the ventilator, pay close attention to the battery's charge level. The battery's operation time is approximate and is affected by ventilator settings, discharge and recharge cycles, battery age, and ambient temperature.
- Always check the status of the O₂ cylinders before using the ventilator during transport.
- Provide external O₂ monitoring to minimize patient risk in case of O₂ supply loss or ventilator failure.
- Always verify ventilator operation as described in the user manual before using the ventilator on a patient. If the ventilator fails any tests, remove it from clinical use immediately. Do not use the ventilator until necessary repairs are completed and all tests have passed.
- To prevent possible patient injury due to nonannunciating alarms, verify the operation of any remote alarm device before use.
- To prevent possible patient injury, always return alarm settings to hospital-standard values after verifying ventilator operation.
- Manufacturer default settings are not appropriate for all patients. Prior to using the ventilator, verify that the current alarm settings or defaults are appropriate for each particular patient.

CAUTION

- To prevent possible damage to the ventilator, ensure that the connection to the O₂ supply is clean and unlubricated, and that there is no water in the O₂ supply gas.
- Equipment, grounding reliability can only be achieved when it is connected to an equivalent receptacle marked "hospital only" or "hospital grade."
- O₂ hose configurations using SIS connectors generate higher resistance to flow. Therefore, a supply pressure of 53 to 87 psig is recommended when adding supplemental O₂ accessories with SIS adapters such as the O₂ transport manifold.

NOTE

The V60/V60 Plus ventilator is a single-limb device with substantial intentional and unintentional leak in the ventilator breathing system. Under those conditions, CO₂ cannot be measured accurately. Therefore, we do not recommend the use of CO₂ monitoring.

2.3 Operation

WARNING

- To prevent possible patient injury, avoid setting alarm limits to extreme values, which can render the alarm system useless.
- PPV limits are not intended to be the primary ventilator alarms and should not be substituted for the alarms found in the Alarm Settings window.
- To prevent the delivery of excessive pressure or volume, set the PPV limits appropriately. Delivery of excessive pressure or volume can occur from a sudden increase in mask leak, inappropriate settings, or a plugged or kinked proximal pressure line. Conversely, insufficient treatment may result if limits are set too low.
- Nebulization or humidification can increase the resistance of breathing system filters. When using a nebulizer or humidifier, monitor the breathing system filter frequently for increased resistance and blockage.
- Using a jet nebulizer can cause inadvertent alarms and affect the accuracy of delivered FiO₂. To reduce patient risk, use only a Philips-approved nebulizer.

2.4 Operation in High Flow Therapy (HFT)

WARNING

- When transitioning from an high flow interface to an NIV mask, ensure that an exhalation port is placed in the circuit and is unobstructed to reduce the risk of CO₂ rebreathing.
- When transitioning from ventilation to HFT, remove the NIV mask and use only a Philips-approved HFT interface to minimize pressure buildup and patient discomfort.
- When transitioning from HFT to ventilation, remove the high flow nasal cannula as it is restrictive and may defeat alarms such as patient disconnect. Using a high flow nasal cannula in an NIV mode may lead to hypercarbia due to the inability to provide pressure support.
- Patient alarms are not available during HFT, as the therapy uses an open system. A high flow nasal cannula occupies only a portion of the nares and a patient can breathe through the mouth, which prevents estimation of patient parameters such as tidal volume, respiratory rate, pressure, and minute ventilation. Provide external monitoring, including oximetry, to inform the clinician of a change in the patient's condition.
- During HFT, the clinician should closely monitor the patient, and continuously monitor the patient's SpO₂. Respond to all alarms in HFT urgently, regardless of alarm priority.
- During HFT, verify that an occlusive patient interface is not being used. Occlusive patient interfaces include a cannula fully sealed within the nares, an NIV mask, or a direct connection to a tracheostomy tube or endotracheal tube. Remove any occlusive interface immediately as this may expose the patient to unintended high pressures.
- The high flow tracheostomy interface (F&P OPT970) is not an occlusive interface. Although the interface is directly connected, it is not fully sealed.

2.5 Alarms and Messages

WARNING

If AC power fails and the backup battery is not installed or is depleted, an audible and visual alarm annunciates for at least 2 minutes. Immediately discontinue ventilator use and secure an alternative means of ventilation. As in most ventilators with passive exhalation ports, when power is lost, sufficient air is not provided through the circuit and exhaled air may be rebreathed.

2.6 Care and Maintenance

WARNING

- To reduce the risk of electric shock, power down the ventilator and disconnect it from AC power before cleaning, disinfecting, or servicing it.
- Turn off the ventilator and disconnect it from the AC mains outlet before performing decontamination or maintenance procedures. Failure to do so may result in electric shock.
- To prevent patient or ventilator contamination, inspect and replace the main flow bacteria filter between patients and at regular intervals (or as stated by the manufacturer).
- To prevent possible patient injury, inspect and verify the proper operation of the exhalation port regularly during use.
- To reduce the risk of fire, explosion, leakage, or other hazard, take these precautions with respect to the battery:
 - Do not attempt to disassemble, open, drop, crush, bend or deform, insert foreign objects into, puncture, or shred the battery pack; modify or remanufacture it; immerse or expose it to water or other liquids; expose it to fire, excessive heat (including soldering irons); or put it in a microwave oven.
 - Replace the battery only with another Philips-approved battery.
 - Follow all instructions for proper use of the battery.
 - Do not short-circuit the battery or let metallic or conductive objects contact the battery connector housing.
 - Use the battery with the V60/V60 Plus ventilator only.
- Modification of the ventilator and associated equipment is not permitted and may compromise ventilator operation and patient safety. Service should only be performed by qualified service personnel.
- Only authorized service personnel should replace parts within the ventilator or perform other service activities. Unauthorized personnel without proper training are at risk of electric shock.
- This product consists of devices that may contain mercury, which must be recycled or disposed of in accordance with local, state, or federal laws. (Within this system, the backlight lamps in the monitor display contain mercury.)

CAUTION

- Do not attempt to sterilize or autoclave the ventilator.
 - To prevent possible damage to the ventilator, use only those cleaning agents listed in this manual.
 - To prevent possible damage to the ventilator, do not drip or spray any liquids directly onto any surface, including the front panel, touchscreen, navigation ring (if present), and Accept button.
 - Never clean the touchscreen with an abrasive brush or device, since this will cause irreparable damage.
 - To avoid introducing foreign matter into the ventilator and to ensure proper system performance, change the air inlet filter at regular intervals (or as stipulated by your institution).
 - To ensure proper system performance, use a Philips-approved air inlet filter.
 - Because some environments cause a quicker collection of lint and dust than others, inspect the filters more often when needed. The air inlet filter should be replaced; the cooling fan filter should be cleaned.
 - To prevent possible damage to the ventilator, always ship it with the original packing material. If the original material is not available, contact Philips to order replacements.
-

2.7 Internal Battery

WARNING

Installation or replacement of lithium batteries by inadequately trained personnel could result in a hazard.

CAUTION

- Avoid allowing the ventilator battery to become completely discharged. Otherwise, the battery may become over-discharged and require long recharge times of up to 16 hours or more. The over-discharged condition may permanently damage the battery so that it is unable to recharge. To prevent the occurrence of a non-recoverable over-discharged battery, always keep the ventilator connected to an AC outlet. Schedule regular preventive maintenance to ensure battery health.
 - If the ventilator battery becomes completely discharged (non-recoverable), the ventilator stops charging the battery after one hour.
-

NOTE

- *The backup battery is intended for short-term use only. It is not intended to be a primary power source.*
- *Philips recommends that the ventilator battery is fully charged before ventilating a patient. If the batteries are not fully charged and AC power fails, always pay close attention to the level of battery charge.*
- *Install and charge a new backup battery within one year of the date of manufacture identified on the battery and on the shipping box.*
- *Storing the battery for an extended period of time after its manufacture date without being put into service, or at temperatures that exceed its limits, increases the risk of discharge whereby the battery is unable to be recharged by the ventilator.*
- *Batteries that are not installed in the ventilator should be stored at -20°C to 25°C and charged at least once per year.*
- *Lithium ion batteries are shipped with a charge level of under 30%, which may further impact the time until the battery is charged and discharged.*
- *The battery charge level displays within about a minute of power on.*
- *A new battery must be charged for at least 5 hours before being placed into service. Based on the age and state of the battery, it may take up to 16 hours or more to fully charge the battery.*

2.8 First-Time Installation

WARNING

Never attempt to disconnect or reconnect the battery during operation.

CAUTION

To prevent possible damage to the ventilator, always secure it to its stand or securely place it on a flat, stable surface that is free of dirt and debris. Do not use the ventilator adjacent to, or stack it with, other equipment.

2.9 Communications Interface

WARNING

- Connect to the ventilator only items that are specified as part of or compatible with the ventilator system. Additional equipment connected to medical electrical equipment must comply with the respective IEC or ISO standards. Furthermore, all configurations shall comply with the requirements for medical electrical systems (see IEC 60601-1-1 or clause 16 of edition 3 of IEC 60601-1, respectively). Anybody connecting additional equipment to medical electrical equipment configures a medical system and is therefore responsible for ensuring that the system complies with the requirements for medical electrical systems. Also be aware that local laws may take priority over the above mentioned requirements. If in doubt, consult Philips.
- The USB port is not currently available for use. DO NOT connect or attempt to power any equipment from the USB port.
- It is the responsibility of the end user to validate the compatibility and use of information transmitted from the ventilator with the device to be connected to the ventilator.
- The data provided through the communications interface is for reference only. Decisions for patient care should be based on the clinician's observations of the patient.
- To prevent possible patient injury due to nonannunciating alarms, verify the operation of any remote alarm device before use.
- To ensure the functionality of the remote alarm, connect only Philips-approved cables to the remote alarm port.

CAUTION

The remote alarm port is intended to connect only to an SELV (safety extra-low voltage) and ungrounded system with basic insulation to ground, in accordance with IEC 60601-1. To prevent damage to the remote alarm, make sure the signal input does not exceed the maximum rating of 24 VAC or 36 VDC at 500 mA with a minimum current of 1 mA.

2.10 Diagnostic Mode

WARNING

To prevent possible patient injury, do not enter the diagnostic mode while a patient is connected to the ventilator. Verify that the patient is disconnected before proceeding.

3 Theory of Operation

3.1	Pneumatics	36
3.1.1	Air Inlet	37
3.1.2	Air Inlet Filter	37
3.1.3	Air Flow Sensor	38
3.1.4	Machine and Proximal Pressure Transducers	38
3.1.5	Barometric Pressure Transducer	38
3.1.6	O ₂ Pressure Transducer	38
3.1.7	Manifold, O ₂ Inlet Filter, Filter Element	39
3.1.8	O ₂ Solenoid Valve	39
3.1.9	O ₂ Flow Sensor	39
3.1.10	Blower	39
3.1.11	Solenoid Valves	40
3.2	Electronics	41
3.2.1	Power Management (PM) PCBA	41
3.2.2	Power Supply	42
3.2.3	Internal Battery	42
3.2.4	CPU PCBA	43
3.2.5	Motor Controller (MC) PCBA	46
3.2.6	Data Acquisition (DA) PCBA	46
3.2.7	Primary Speakers	46
3.2.8	Flow Sensors	47
3.2.9	User Interface (UI)	47
3.2.10	LCD Assembly	47
3.2.11	Backlight Inverter PCBA	48
3.2.12	Touchscreen Assembly	48
3.2.13	Nav-ring Assembly/Accept Button	48
3.2.14	Power Switch Overlay	49
3.2.15	Switch PCBA	49
3.2.16	UI PCBA	49
3.3	Electronic Signal Paths	50

The Philips Respironics V60/V60 Plus ventilator is a microprocessor-controlled gas flow control and monitoring system that can deliver air and O₂ to augment or replace the work normally performed by the patient's respiratory system. The ventilator uses electromechanical control circuits, flow and pressure monitors, and software programs to deliver pressure controlled breaths.

The ventilator includes a user interface (UI), internal blower, and gas delivery subsystem (GDS) that mixes air and O₂. The ventilator can operate from a 40 to 87 psig (276 to 600 kPa) medical grade O₂ source for enriched O₂ operation. The internal power supply that can operate from mains (100 to 240 V AC 50/60 Hz) or internal battery (14.4 V DC) power. The ventilator also includes several communications interfaces.

The ventilator uses AC mains as its primary power source. If AC power fails, the ventilator automatically switches to operation on backup battery without interrupting ventilation. The battery powers the ventilator until AC power is connected or the battery is depleted.

Ventilator schematic diagrams are available upon request.

3.1 Pneumatics

The pneumatic subsystem delivers and monitors pressurized gas to the patient in response to commands from the CPU subsystem. The pneumatic subsystem includes these components:

- Manifold
- Blower
- Oxygen solenoid valve
- Air and O₂ flow sensors
- Pressure transducers
- Solenoid valves
- Motor controller (MC) PCBA
- Data acquisition (DA) PCBA

The ventilator uses ambient air and high-pressure O₂. Air enters through an inlet filter. O₂ enters through a high-pressure inlet, and a proportional valve provides the operator-set concentration. The system mixes the air and O₂, pressurizes it in the blower, and then regulates it to the user-set pressure. To do this, the ventilator compares the proximal (patient) pressure measurement with the ventilator outlet (machine) pressure, and adjusts the machine pressure to compensate for the pressure drop across the inspiratory filter, patient circuit, and humidifier. This helps ensure accurate and responsive pressure delivery and leak compensation.

The ventilator delivers gas to the patient through a main flow (inspiratory) bacteria filter, a single-limb patient breathing circuit, a humidification device (optional), and a patient interface such as a mask, high flow nasal cannula, or ET tube. A pressure tap proximal to the patient is used to monitor patient pressure. The internal exhalation port continually clears gas from the ventilator airway to ensure delivery of an accurate O₂ mixture.

Figure 3-1 shows the ventilator pneumatic schematic.

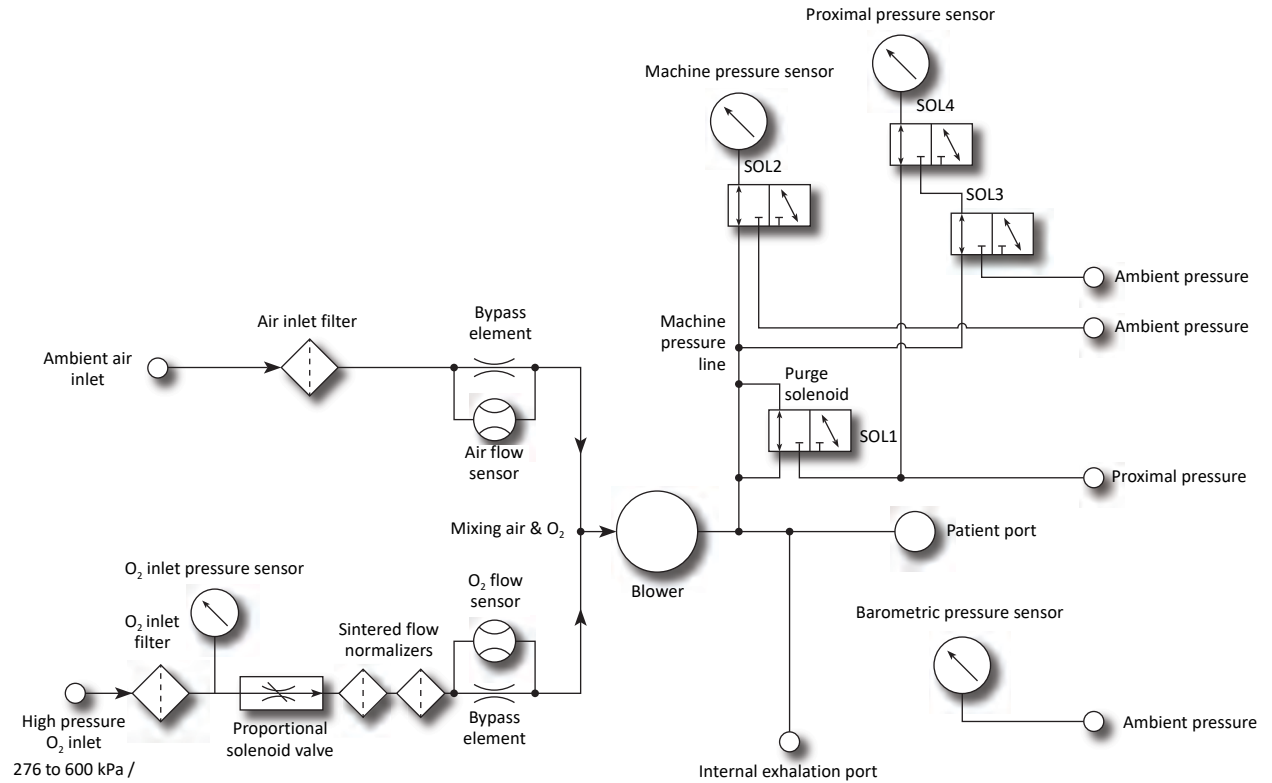
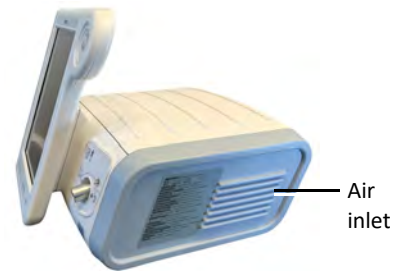


Figure 3-1: Ventilator Pneumatic Subsystem Schematic

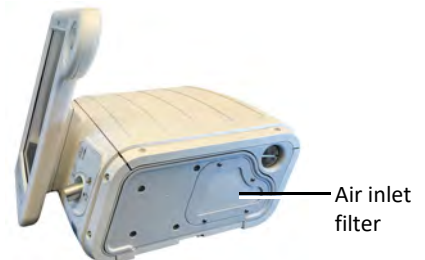
3.1.1 Air Inlet

Ambient air is entrained through the *air inlet*.



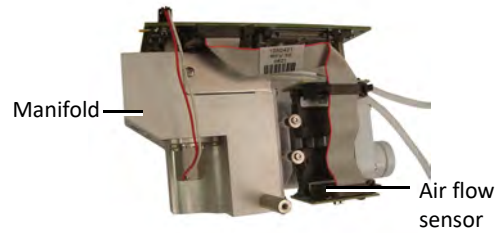
3.1.2 Air Inlet Filter

The *air inlet filter* is designed to filter 5-micron particles at 70% efficiency at 150 SLPM flow.



3.1.3 Air Flow Sensor

The *air flow sensor* measures a subset (bypass flow) of total flow in the pneumatic air path and interpolates the measurements according to constants that are calculated during gas delivery subsystem (GDS) calibration. The air flow sensor also helps provide closed-loop control of gas flow during O₂ blending.



3.1.4 Machine and Proximal Pressure Transducers

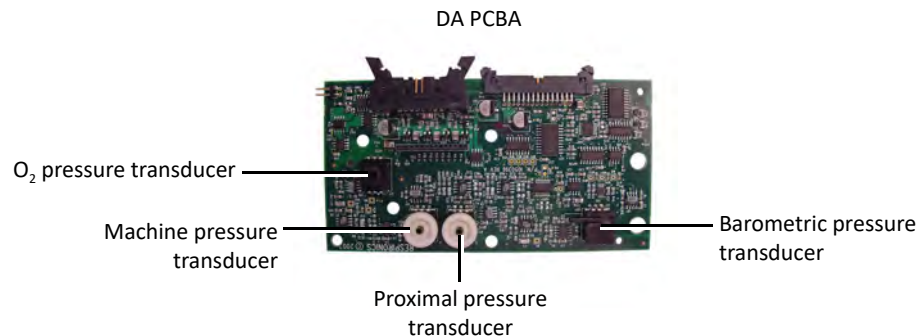
The *machine and proximal pressure transducers* on the DA PCBA measure the machine and proximal pressure over a range of -20 to +65 cmH₂O.

3.1.5 Barometric Pressure Transducer

The *barometric pressure transducer* on the DA PCBA measures barometric pressure over a range of 525 to 850 mmHg.

3.1.6 O₂ Pressure Transducer

The O₂ pressure transducer on the DA PCBA can measure accurate inlet pressures over a range of 0 to 100 psig. An alarm results if O₂ supply pressure is below 40 psig (276 kPa) or above 92 psig (634 kPa).

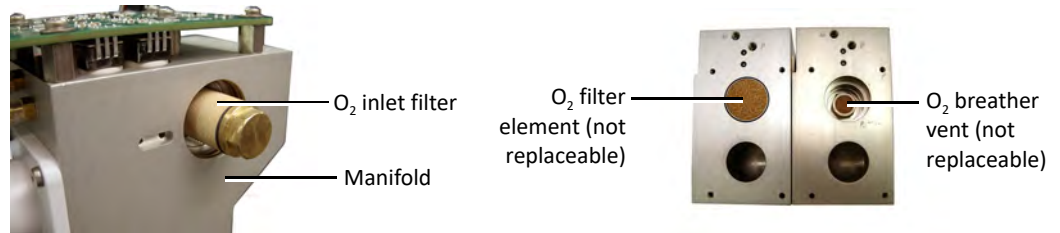


3.1.7 Manifold, O₂ Inlet Filter, Filter Element

The *manifold* includes a connection for the O₂ inlet fitting to accommodate country-specific O₂ connections. The manifold provides the pneumatic interfaces to the air inlet, O₂ inlet, blower inlet, and proximal and machine pressure lines.

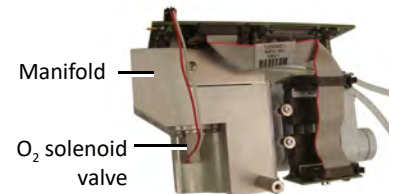
The *O₂ inlet filter* removes 5-micron particles from the O₂ gas supply.

A 40-micron sintered bronze *filter element* acts to reduce turbulence in the O₂ flow. The 40-micron O₂ breather vent reduces noise in the O₂ flow.



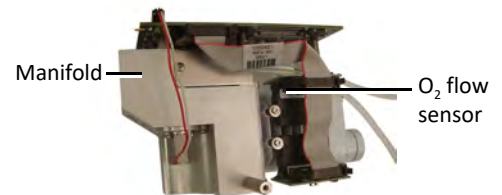
3.1.8 O₂ Solenoid Valve

The *O₂ solenoid valve* and valve driver circuitry control the flow of O₂ according to the set O₂ and flow. The O₂ solenoid valve is closed when there is a loss of power or system reset.



3.1.9 O₂ Flow Sensor

The *O₂ flow sensor* measures a subset (bypass flow) of the total flow. These measurements are interpolated according to constants that are calculated during GDS calibration. Together, the O₂ solenoid valve and flow sensor provide closed-loop control for delivered O₂ flow.



3.1.10 Blower

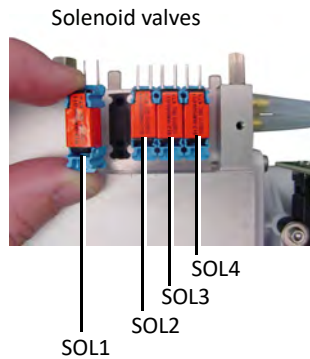
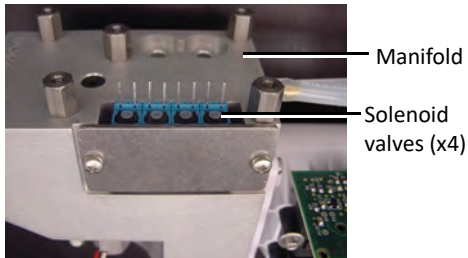
The *blower* is controlled by the MC PCBA, and generates flow and pressure for the system. The blower includes an impeller, housing, and a three-phase brushless DC motor. The blower delivers a maximum pressure of less than 125 cmH₂O in a dead-head condition, can accelerate from 10,000 to 22,500 revolutions per minute (RPM) in 120 msec from a nominal 5- to 25-cmH₂O pressure rise.

Maximum motor speed is approximately 40,000 RPM. The blower motor has internal Hall Effect sensors that are monitored by the MC PCBA and measure impeller speed.



3.1.11 Solenoid Valves

Four *solenoid valves* are mounted on the manifold and controlled by the DA PCBA. These three-way autozero solenoids include SOL1 (purge solenoid), SOL2 and SOL4 (machine pressure autozero solenoids), and SOL3 and SOL4 (proximal pressure autozero solenoids).



SOL1: Purge solenoid, uses the machine pressure line to purge the proximal pressure line.

SOL2 + SOL4: Machine pressure autozero solenoids.

SOL3 + SOL4: Proximal pressure autozero solenoids.

SOL4: Connects machine pressure to the proximal pressure transducer during autozero.

3.2 Electronics

The electronics system provides software-based control and monitoring, power management, user input, display, subsystem I/O, external communication, and alarms. The electronics system includes a microcontroller for control and monitor processing.

Control tasks include breath delivery, patient data calculation, and alarm detection/response. Monitoring tasks include controlling the LCD, front panel keys and indicators, inputs, and primary alarm output. An independent watchdog control provides safety monitoring.

The electronics system includes:

- Power management (PM) PCBA
- Power supply
- Internal battery
- CPU PCBA
- Motor controller (MC) PCBA
- Data acquisition (DA) PCBA
- Flow sensors
- User interface
- Liquid crystal display (LCD)
- Backlight inverter PCBA
- Touchscreen assembly
- Nav-ring assembly/Accept button
- Power switch overlay
- Switch PCBA
- User interface (UI) PCBA

3.2.1 Power Management (PM) PCBA

- Battery charging and management circuitry.
- Internal supply voltages (supply voltages: 3.3 V, 5 V, 12 V, 35 V).
- Fan power and tachometer monitoring.
- Backup alarm control circuitry, including power fail detection.
- Power switch control circuitry.
- System alarm and reset management.
- Electrical interfaces between the CPU PCBA, LCD, and the user interface (UI) PCBA.
- Includes an EEPROM for programmed data, board identification information, and PM PCBA power-on hours.
- The battery can become so discharged that it can only accept a trickle charge of approximately 10 to 100 mA. At this point the battery processor turns on the charger (and fan) every 4 seconds, then turns off the charger and fan after 2 seconds if charger current is insufficient. Once the battery voltage is above the internal circuit cutoff voltage, the battery can then accept the full charging current of 3.5 A. A seriously-depleted battery may require days of trickle-charging before it can again accept full charging current.



PM PCBA

3.2.2 Power Supply

- Provides ventilator and battery recharging power from AC line voltage.
- Converts AC line voltage (90 to 264 VAC, 50 to 60 Hz) into 24 VDC power.
- Includes input over-current, output over-voltage, and output current-limiting protection.



Power supply

3.2.3 Internal Battery

- 14.4-V, 11.0-Ah lithium-ion battery has a run-time of six hours under normal conditions.
- Provides operating power when AC power is not available.
- Provides charge and temperature status to the PM PCBA.
- Internal circuitry monitors battery status, provides self-contained fault control features, and communicates this information to the PM PCBA.
- Recharges in approximately 5 hours.
- Replace every 5 years based on the date of manufacture recorded on the battery label (also viewable on the Ventilator Information screen in Diagnostic mode).



Internal battery

NOTE

If the battery becomes discharged to the point that it will only allow a trickle charge (approximately 10 mA to 100 mA), the battery processor turns on the charger and fan every 4 seconds. After 2 seconds, if the battery processor determines that insufficient charger current is flowing, it turns off the charger and fan. This process continues until the battery voltage is charged above the battery internal circuit cutoff voltage, after which the battery accepts full charging current (3.5 A). It can take days of trickle-charging to charge a seriously-depleted battery to the point when it can accept full charging current.

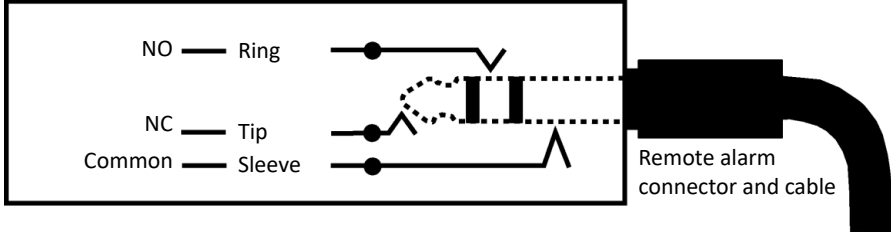
3.2.4 CPU PCBA

- Microprocessor: once in a run state, the microprocessor can only be reset by a watchdog timeout or out-of-specification power condition. Monitors operation of the ventilator and controls delivery of air and O₂ to the patient. Verifies safe ventilator operation.
- Flash memory: 8 MB program storage.
- RAM: 8 MB for program execution and volatile data storage.
- EEPROM: 4 KB of storage for board-specific information (including operating hours, time since last service, serial numbers, part numbers, and software and hardware revisions).
- Watchdog timer: disables the blower and O₂ flow if not strobed by software within a predefined time window that is independent of the CPU master clock. In addition, ensures that software is operating.
- Real-time clock (RTC): a time of day clock that provides the date and time to the ventilator, and is powered by a dedicated 3-V lithium coin cell battery.
- LCD interface supports a display of 1024 horizontal x 768 vertical pixels in 256 colors with a refresh rate of at least 50 Hz. The CPU PCBA controls LCD brightness by varying a control voltage over a range of 0 to 3.5 V (minimum to maximum brightness).
- Touchscreen interface supports a five-wire type touchscreen.
- Nav-ring rotary adjustment interface (if present) with a minimum resolution of 24 ticks per revolution.
- User key switches: interfaces to front panel keys.
- Alarm subsystem: includes a speaker driver circuit for the two main speakers, a backup piezo alarm (soldered to the CPU PCBA), and a three-wire relay-controlled remote alarm interface (normal open, NO, or normal closed, NC) on the ventilator back panel. Table 3-1 summarizes the characteristics of the remote alarm interface.
- Blower speed monitor measures blower speeds from 3,000 to 50,000 RPM with 2% accuracy.
- Electrical interfaces to the power management (PM) and motor controller (MC) PCBAs.
- Two USB ports and an Ethernet connection are reserved for future use.
- RS-232 serial connector (female DB-25). Connects to hospital information systems and other serial devices. Table 3-2 summarizes hospital information system (HIS) RS-232 port pinout.



CPU PCBA

Table 3-1: Remote Alarm Interface

Component	Description
	
NO contact	Normally open (NO) relay contact. An open contact indicates that a high-priority alarm is not active. A closed contact indicates that a high priority alarm is active.
NC contact	Normally closed (NC) relay contact. A closed contact indicates that a high-priority alarm is not active. An open contact indicates that a high priority alarm is active.
Common contact	Used with both NO and NC protocols.
Remote alarm connector	Standard 1/4-inch female audio (ring, tip, sleeve) connector.
Remote alarm description	The remote alarm port allows high-priority alarm conditions to be annunciated away from the ventilator (for example, when the ventilator is in an isolation room). The ventilator sends alarm signal to a remote alarm through the remote alarm connector at the back of the ventilator.

WARNING

- To prevent possible patient injury due to nonannunciating alarms, verify the operation of any remote alarm device before use.
- To ensure the functionality of the remote alarm, connect only Philips-approved cables to the remote alarm port.

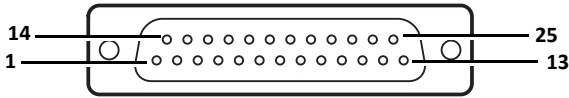
CAUTION

The remote alarm port is intended to connect only to an SELV (safety extra-low voltage) and ungrounded system with basic insulation to ground, in accordance with IEC 60601-1. To prevent damage to the remote alarm, make sure the signal input does not exceed the maximum rating of 24 VAC or 36 VDC at 500 mA with a minimum current of ≥ 1 mA.

NOTE

Selecting **Alarm Silence** deactivates the remote alarm.

Table 3-2: Ventilator HIS Serial Communications Port Pinout

Pin	Signal	I/O	Description
			
1	HIS_RS232_SHLD	Power	HIS RS232 cable shield
2	HIS_RS232_TxD	Output	HIS RS232 transmit data output
3	HIS_RS232_RxD	Input	HIS RS232 receive data input
4	HIS_RS232_RTS	Output	HIS RS232 ready to send
5	HIS_RS232_CTS	Input	HIS RS232 clear to send
6	HIS_RS232_DSR	Input	HIS RS232 data set ready
7	HIS_SIG_RTN	Power	HIS RS232 signal common
8	PULSE_OX_IN	Input	Pulse oximeter analog Input
9	HIS_DIG_IN0	Input	HIS digital input #0, 0-3.3 V digital logic level (0-5 V tolerant)
10	HIS_DIG_IN1	Input	HIS digital input #1, 0-3.3 V digital logic level (0-5 V tolerant)
11	HIS_ANALOG_IN00	Input	HIS analog input #0, 0-5.0 V analog voltage level
12	HIS_ANALOG_IN01	Input	HIS analog input #1, 0-5.0 V analog voltage level
13	HIS_SIG_RTN	Power	HIS RS232 signal common
14	HIS_DIG_IN2	Input	HIS digital input #2, 0-3.3 V digital logic level (0-5 V tolerant)
15	HIS_DIG_IN3	Input	HIS digital input #3, 0-3.3 V digital logic level (0-5 V tolerant)
16	HIS_DIG_OUT0	Output	HIS digital output #0, 0-3.3 V digital logic level
17	HIS_DIG_OUT1	Output	HIS digital output #1, 0-3.3 V digital logic level
18	HIS_DIG_OUT2	Output	HIS digital output #2, 0-3.3 V digital logic level
19	HIS_DIG_OUT3	Output	HIS digital output #3, 0-3.3 V digital logic level
20	HIS_RS232_DTR	Output	HIS RS232 data terminal ready
21	HIS_SIG_RTN	Power	HIS RS232 signal common
22	nHIS_BOOT_SEL	Input	Boot select signal: 0 = download, 1 = flash
23	HIS_ANALOG_OUT0	Output	HIS analog output #0, 0-5.00 V analog voltage level
24	HIS_ANALOG_OUT1	Output	HIS analog output #1, 0-5.00 V analog voltage level
25	HIS_ANALOG_OUT2	Output	HIS analog output #2, 0-5.00 V analog voltage level
SHLD	Chassis	Power	Cable shield

Supported communication protocols

The ventilator supports these communication protocols:

- Philips IntelliBridge (VueLink): Use for connecting to Philips monitors, refer to the V60/V60 Plus Ventilator *Connectivity Guide* (1149120MC).
- Legacy (VRPT/SNDA): Fixed text-based protocol (not to be used for developing new driver interfaces). For this protocol specification, refer to the *V60/V60 Plus Developers Guide: Communications Interface for VRPT/SNDA* (1147828MC).
- PVOI (Philips Ventilator Open Interface): Use for interfacing with non-Phillips monitors or devices.

3.2.5 Motor Controller (MC) PCBA

- Controls the blower motor according to speed or current as commanded by ventilator software.
- Provides electrical interfaces to the DA PCBA, O₂ and air flow sensors, fan, and primary speaker.
- Includes monitoring of an embedded temperature sensor in the blower motor.
- Includes analog to digital converters (ADCs) and digital to analog converters (DACs) for flow control and monitoring.
- Includes two energy storage capacitors that increase motor power usage efficiency and power a backup audible alarm (a piezo alarm) and Alarm LED for at least two minutes.
- Includes EEPROM for calibration data, board identification information, and MC PCBA power-on hours.



MC PCBA

3.2.6 Data Acquisition (DA) PCBA

- Provides precision measuring and signal conditioning.
- Includes analog-to-digital converters (ADCs) and digital-to-analog converters (DACs) for flow and pressure monitoring signals.
- Controls the O₂ solenoid valve with 12-bit accuracy.
- Includes barometric (measurement range 525 to 850 mmHg) and O₂ pressure (measurement range 0 to 100 psig) transducers.
- Includes individual patient proximal and machine pressure transducers (measurement range -20 to +65 cmH₂O).
- Includes EEPROM for calibration data, board identification information, and DA PCBA power-on hours.
- Drives the solenoid valves mounted to the manifold.
- Interfaces to the air and O₂ flow sensors.



DA PCBA

3.2.7 Primary Speakers

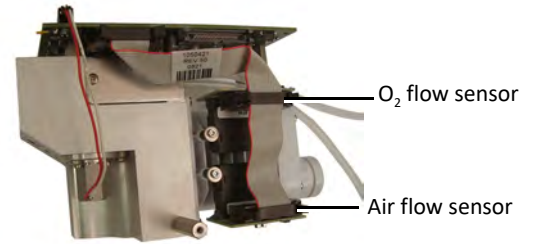
- The primary audio alarm includes two alarm speakers in the base unit (adjustable from 60 to 95 dBA at 1 m), one connected through the PM PCBA, and one connected through the MC PCBA.



Speaker assembly

3.2.8 Flow Sensors

- Calibrated to the specific gas (air or O₂).
- Provides the signal source for the O₂ and air flow signals. Converts manifold gas flow into an analog signal, which is sent to DA PCBA for filtering and conversion.
- Air flow sensor measures flows from -240 to 240 SLPM. O₂ flow sensor measures flows from 0 to 240 SLPM.
- Includes EEPROM for calibration data, board identification information, and power-on hours for each flow sensor.



3.2.9 User Interface (UI)

- Includes indicators and controls for setting and monitoring parameters.
- Includes LCD, backlight inverter PCBA, touchscreen, power switch overlay, Accept button or rotary adjustment (nav-ring) assembly, UI PCBA, and switch PCBA.
- Audible alarms: Primary audio alarm includes two alarm speakers in the base unit (adjustable from 60 to 95 dBA at 1 m), one connected through the PM PCBA, and one connected through the MC PCBA. Backup audio alarm (piezo alarm) mounted on the CPU PCBA.



User interface

3.2.10 LCD Assembly

- 12.1-in. diagonal flat panel, 768 x 1024 pixels with 6-bit color.
- Connects to backlight inverter PCBA and CPU PCBA through the PM PCBA.
- HYDIS LCD: Cold cathode fluorescent lamp (CCFL) backlight with 10,000-hour minimum life (half initial brightness).
- NEC LCD: CCFL backlight with 50,000-hour minimum life (half initial brightness).



LCD assembly

3.2.11 Backlight Inverter PCBA

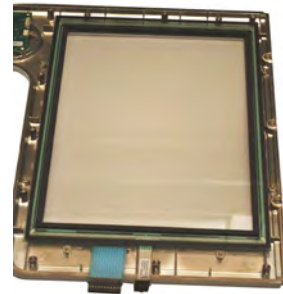
- Provides an adjustable backlight drive voltage.
- Backlight dimming capability using a 0 to 3.5-V control voltage from the CPU PCBA through the PM PCBA.



Backlight inverter PCBA

3.2.12 Touchscreen Assembly

- Uses a robust five-wire resistive panel.
- Resolves touches in a configuration 0.3 x 0.3-in. matrix.



Touchscreen assembly

3.2.13 Nav-ring Assembly/Accept Button

- All ventilators use touchscreen controls to change setting values and an Accept button to apply setting values.
- Older ventilators also include a nav-ring, a rotary adjustment is used to change setting values.
- Newer ventilators include the Accept button only.
- The Accept button contacts the switch PCBA.



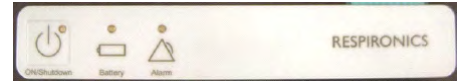
Older ventilators:
nav-ring assembly
with Accept button



Newer ventilators:
Accept button
without nav-ring

3.2.14 Power Switch Overlay

- Includes the power switch, and embedded indicators for power status, battery charge status, and alarms.



Power switch overlay

3.2.15 Switch PCBA

- Interconnects between the nav-ring (if present) and the UI PCBA and CPU PCBA.
- Provides a center push button (the Accept button) and interface to nav-ring (if present).
- Connects to UI PCBA.



Switch PCBA

3.2.16 UI PCBA

- Provides a connection for backlight PCBA, touchscreen, switches, and switch PCBA to PM PCBA.
- Mounts behind the LCD and provides connectors to the backlight inverter PCBA, power switch overlay, switch PCBA, and touchscreen.
- Connects to the PM PCBA.



UI PCBA

3.3 Electronic Signal Paths

Table 3-3 summarizes the electronic signal paths for ventilator components.

Table 3-3: Ventilator Signal Paths

Component	Signal Path Sequence
Air flow sensor	DA PCBA, MC PCBA, CPU PCBA
Alarm indicator	Power switch overlay, UI PCBA, PM PCBA, CPU PCBA
Backlight inverter PCBA	Input: UI PCBA, PM PCBA, CPU PCBA Output: LCD CCFL
Barometric pressure transducer	DA PCBA, MC PCBA, CPU PCBA
Battery indicator	Power switch overlay, UI PCBA, PM PCBA, CPU PCBA
Blower motor	MC PCBA
CPU PCBA DAC	CPU PCBA
DA PCBA ADC	DA PCBA, MC PCBA, CPU PCBA
DA PCBA DAC	DA PCBA, MC PCBA, CPU PCBA
Ethernet connector	CPU PCBA
Fan	MC PCBA, CPU PCBA, PM PCBA
LCD	Power: PM PCBA. Signal: PM PCBA, CPU PCBA. CCFL: Backlight inverter PCBA
Internal battery	PM PCBA
Speaker #1	MC PCBA, CPU PCBA
Speaker #2	PM PCBA, CPU PCBA
MC PCBA ADC	MC PCBA, CPU PCBA
MC PCBA DAC	MC PCBA, CPU PCBA
Nav-ring assembly/Accept button	Switch PCBA, UI PCBA, PM PCBA, CPU PCBA
Remote alarm connector	CPU PCBA
O ₂ flow sensor	DA PCBA, MC PCBA, CPU PCBA
O ₂ inlet pressure sensor	DA PCBA, MC PCBA, CPU PCBA
O ₂ solenoid valve	DA PCBA
Power indicator	Power switch overlay, UI PCBA, PM PCBA, CPU PCBA
Power supply	Input: AC inlet. Output: PM PCBA.
Power switch	Power Switch Overlay, UI PCBA, PM PCBA, CPU PCBA
Proximal pressure sensor	DA PCBA, MC PCBA, CPU PCBA
Solenoid valves	DA PCBA
Switch PCBA	UI PCBA, PM PCBA, CPU PCBA
Touchscreen	UI PCBA, PM PCBA, CPU PCBA
USB device connector	CPU PCBA
USB host connector	CPU PCBA

Figure 3-2 shows a wiring diagram for the main assembly.

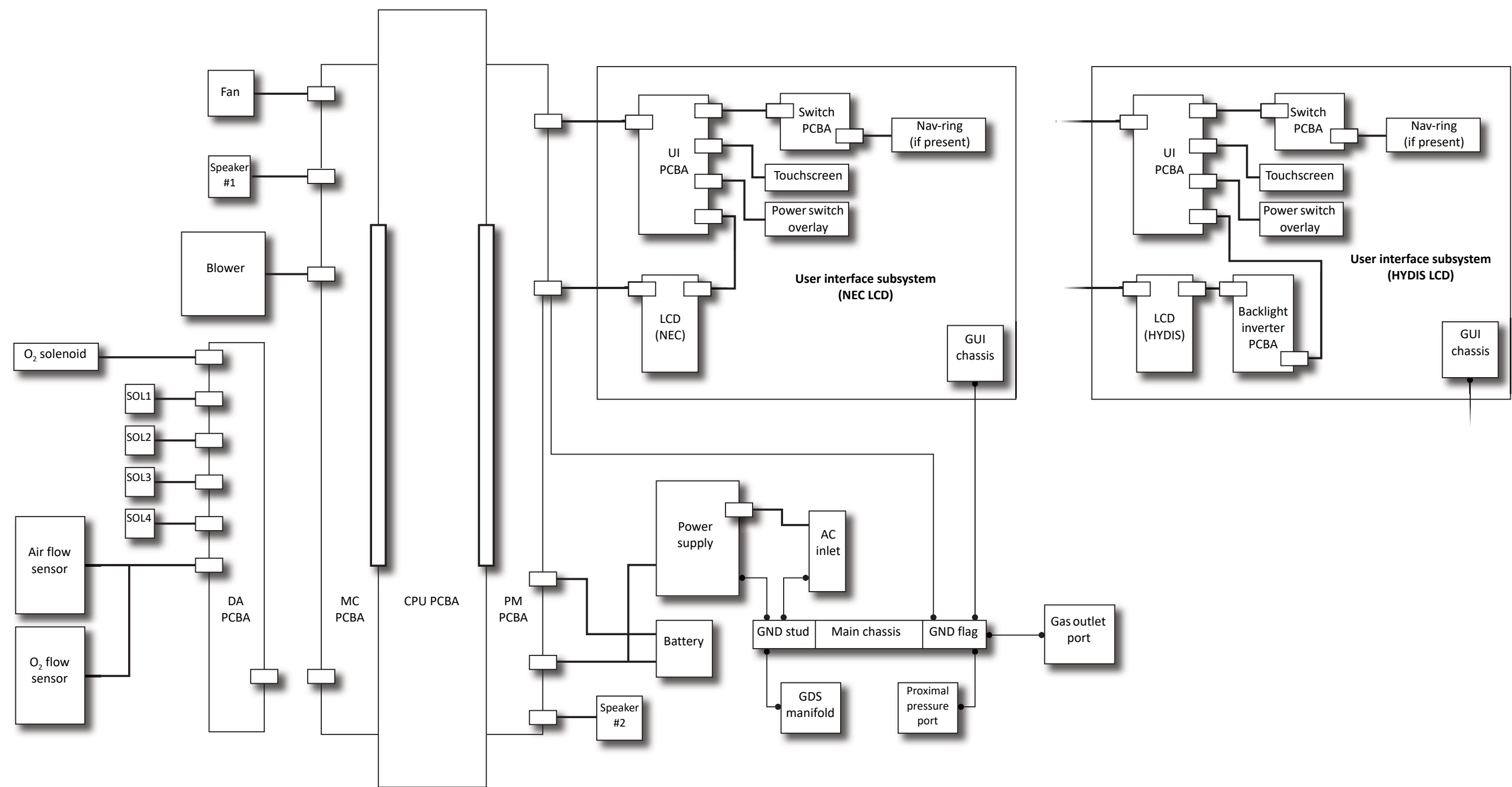


Figure 3-2: Main Assembly Wiring Diagram

Figure 3-3 shows a wiring diagram for the UI subsystem.

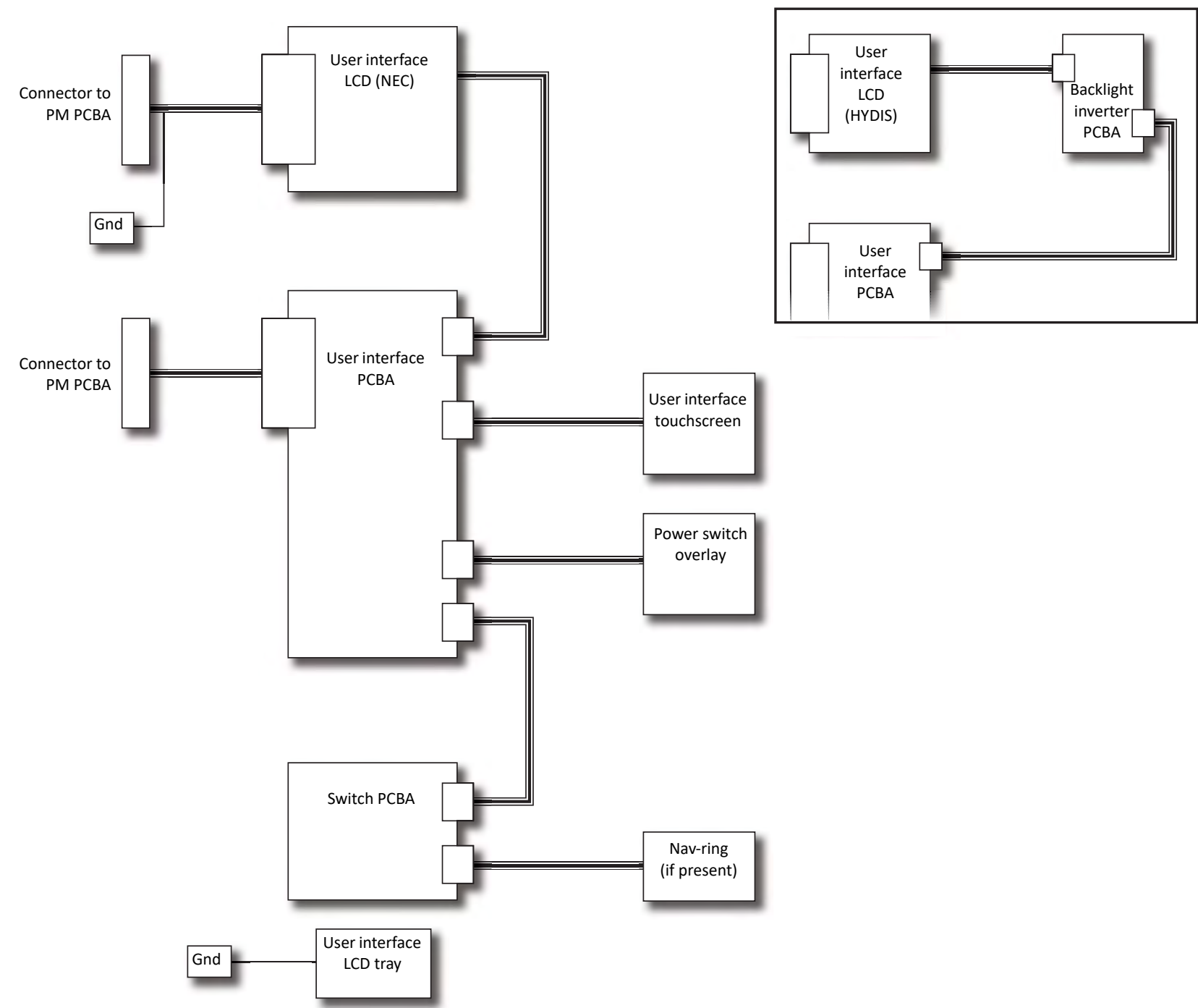


Figure 3-3: UI Assembly Wiring Diagram

Figure 3-4 shows a block diagram of the ventilator voltages.

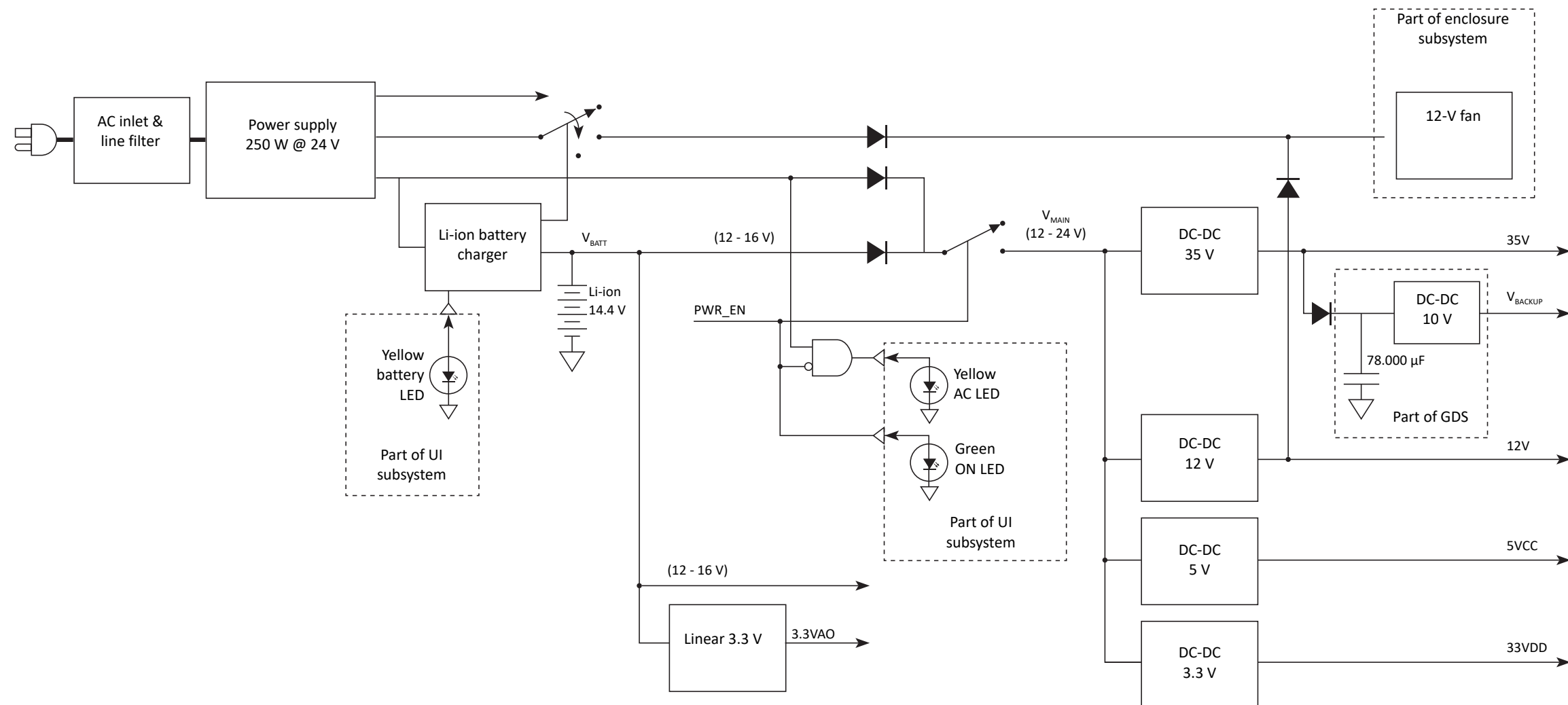


Figure 3-4: Ventilator Voltages Block Diagram

Figure 3-5 shows a block diagram of the PM PCBA.

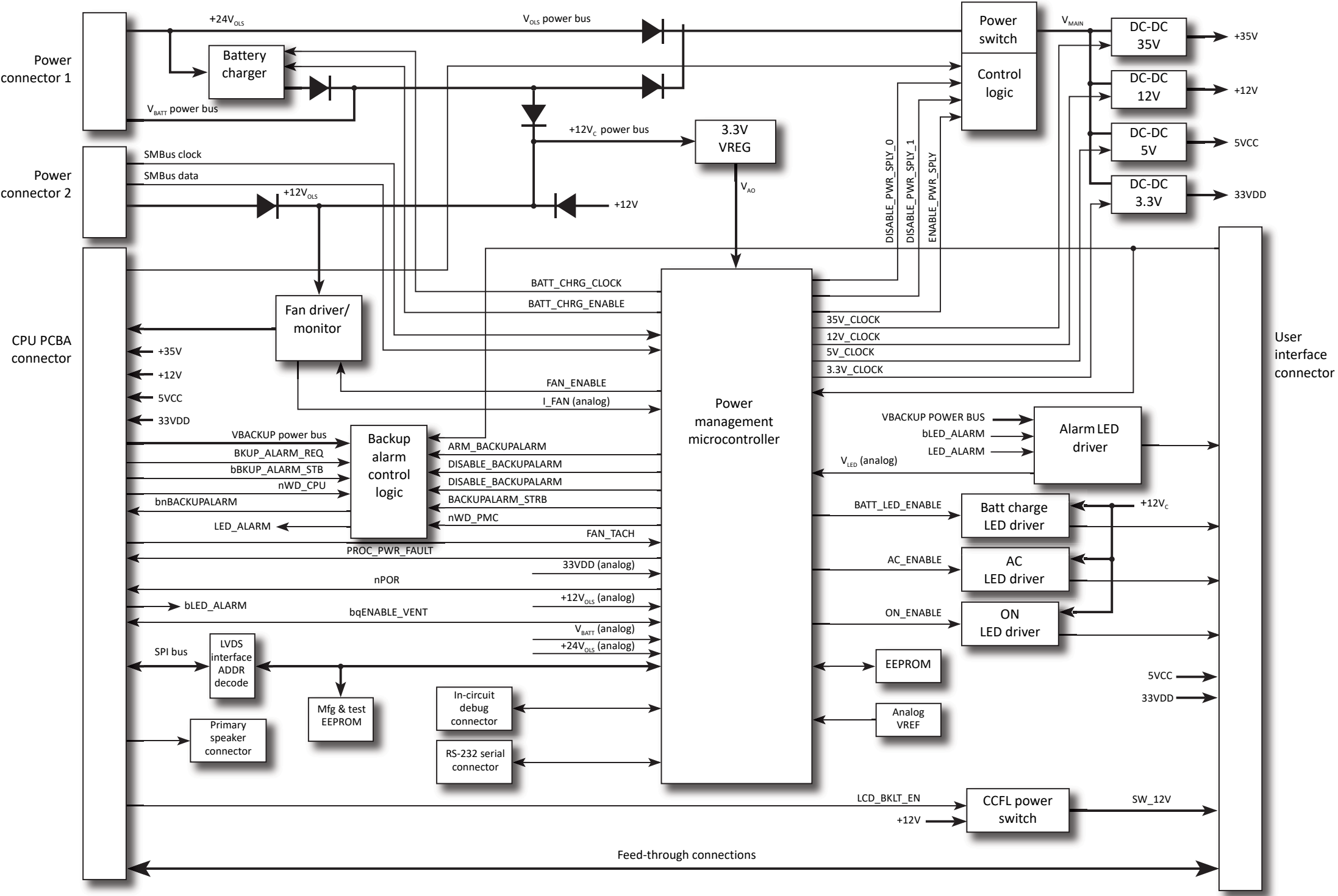


Figure 3-5: Power Management (PM) PCBA Block Diagram

Figure 3-6 shows a block diagram of the MC PCBA.

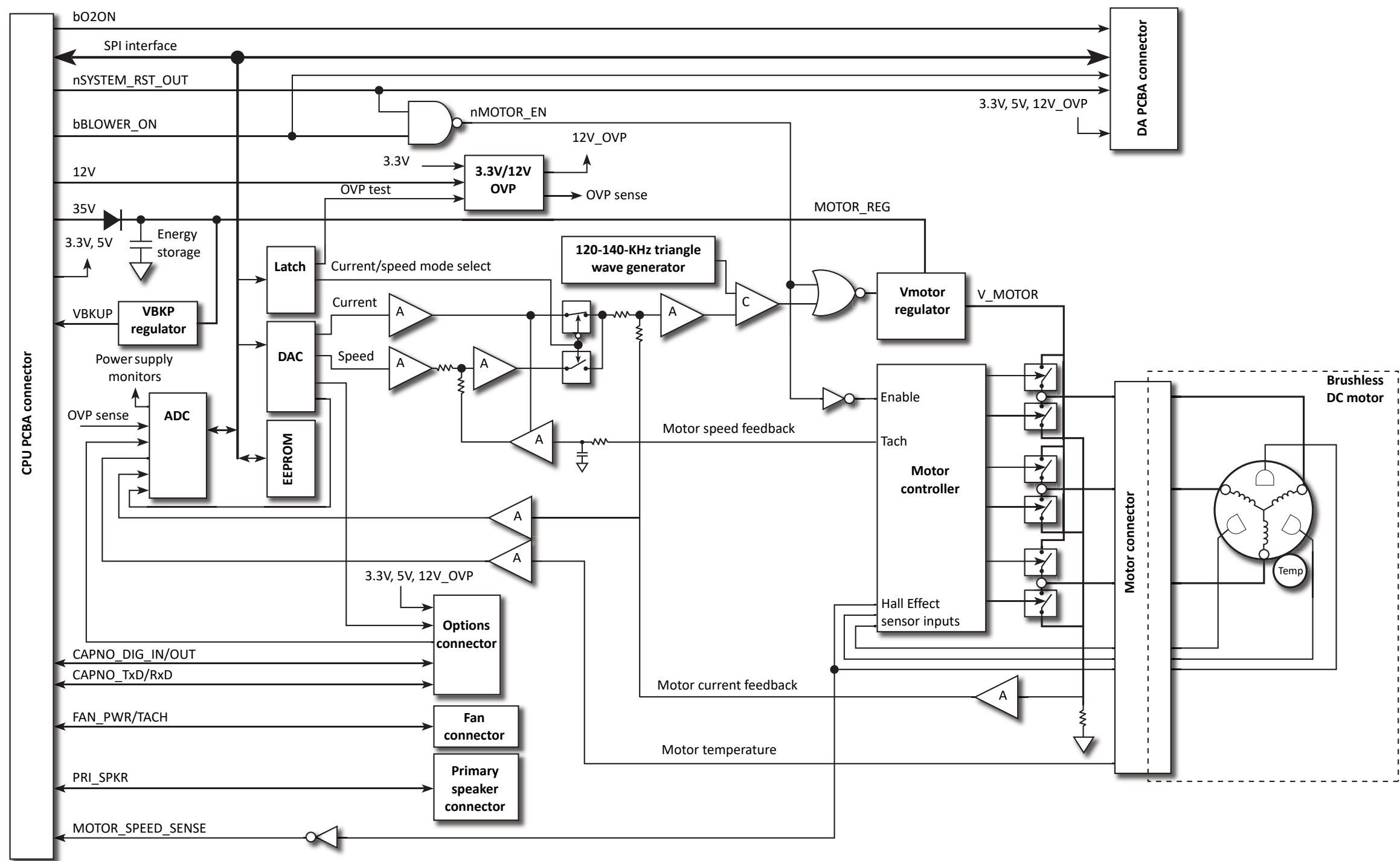


Figure 3-6: Motor Controller (MC) PCBA Block Diagram

4 Installation

4.1	Assembly and Installation	62
4.2	Record Ventilator Information	63
4.3	Electrical Safety	64
4.4	Preoperational Check	64
4.5	Preparing the Ventilator for Use	66
4.6	Electrical Safety/Preoperational Check Form	67

This section outlines the steps required to install and test the V60/V60 Plus ventilator. Use the form at the end of the section to record all data.

NOTE

It is not required that Philips install the ventilator, but this option may be available at an additional cost.

4.1 Assembly and Installation

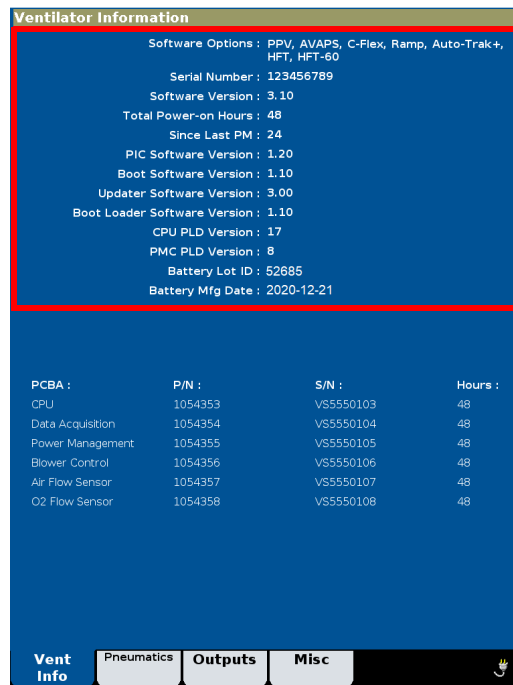
Assemble and install all items according to the IFU included with each accessory and as shown in the ventilator user manual.

The ventilator charges the battery whenever the ventilator is connected to AC power, with or without the ventilator switched on. The Battery (charged) LED flashes to show that the battery is charging. Check the battery charge level before putting a patient on the ventilator and before unplugging the ventilator for transport or other purposes. The power source symbol at the bottom-right corner of the screen shows the power source in use and, if the ventilator is running on battery, the level of battery charge.



4.2 Record Ventilator Information

1. Connect the ventilator to AC power.
2. If the ventilator is not already in Diagnostic mode, press and hold the Accept button, and press the On/Shutdown button on the user interface. Within 5 seconds of the power up, release and press the Accept button again to enter the Diagnostic menu.
3. Touch **Service** to display the Ventilator Information screen and record the following information on the Electrical Safety/Preoperational Check Data Form (section 4.6):
 - Software options
 - Ventilator serial number
 - Software version
 - Total power-on hours
 - Since last PM hours
 - PIC software version
 - CPU PLD version
 - PMC PLD version
 - Battery lot ID
 - Battery mfg date



4. Turn the ventilator off.

4.3 Electrical Safety

Perform the electrical safety test as described in section 9.4.

4.4 Preoperational Check

Required equipment (section 1.2):

Patient circuit (P/N 989805609611 or equivalent)
Test lung, 1-L (P/N 989805611871 or equivalent)

1. Connect the ventilator to AC power.
2. Connect an oxygen supply to the ventilator.
3. Connect the breathing circuit to the ventilator (see the ventilator user manual for circuit setup).
4. Attach the test lung to the end of the breathing circuit.
5. Press the On/Shutdown button to start the ventilator in normal ventilation mode.
6. Verify that both the backup alarm (high pitch) and the primary alarm (lower tone) sound momentarily during start up.
7. Verify the active mask and exhalation port in the Messages window is set to **Other**. If not see Selecting the Mask and Exhalation Port instructions in the User Manual. The window should display this information before proceeding:

Mask: Other, Exh Port: Other

Use Menu to change

8. Select these ventilator settings and alarm limits, reset any alarms if necessary:

Ventilator settings		Alarm limits	
Mode:	S/T	High Rate:	90 BPM
IPAP:	10 cmH ₂ O	Lo Rate:	1 BPM
EPAP:	6 cmH ₂ O	Hi V _T :	1500 mL
Rate:	4 BPM	Lo V _T :	Off mL
I-Time:	1.00 secs	HIP:	50 cmH ₂ O
Rise:	1	LIP:	Off cmH ₂ O
Ramp:	Off	Lo V _E :	Off L/min
O ₂ :	21%	LIP T:	20 secs

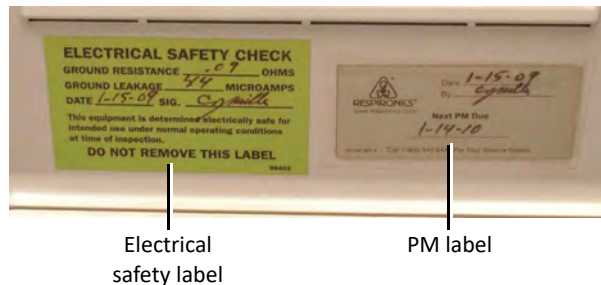
9. Verify that the test lung expands during inspiration, collapses during exhalation, and there is a continuous flow of gas from the exhalation port.

10. Disconnect the proximal line from the ventilator, verify that a Proximal Pressure Line Disconnect alarm is activated with the following results:
 - Audible alarm sounds
 - Alarm message appears
 - Alarm LED flashes
11. Reconnect the proximal line from the ventilator and verify that the audible alarm is automatically silenced.
12. Press the **Alarm Reset** button on the touchscreen to clear the alarm messages.
Go to step 16 if no internal battery is installed.
13. Disconnect the ventilator from AC power and verify the following:
 - Ventilator switches to internal battery
 - *Running on Internal Battery* appears in the Alarm window
 - *Battery in use* icon appears
 - ON/Shutdown LED remains green
 - Audible alarm sounds approximately every 30 seconds
14. Reconnect the ventilator to AC power and verify that the ventilator operation is uninterrupted, the AC icon is displayed and the *Battery In Use* icon turns off.
15. Verify that the Battery LED is on or flashing:
 - On = battery charge state is 90% to 100%,
 - Flashing = battery is being charged)
16. Turn the ventilator off.

The preoperational check is complete.

4.5 Preparing the Ventilator for Use

1. Remove all test equipment, tools and materials from the ventilator.
2. If the ventilator is not already in diagnostic mode, press and hold the Accept button, and press the On/Shutdown button on the user interface. Within 5 seconds of the power-up, release and press the Accept button again to enter the Diagnostic menu.
3. Touch **System Settings**, and then touch **Restore Default Settings**.
4. Touch **Date/Time** and verify that the date and time are correct, if not set appropriately.
5. Turn ventilator off.
6. Enter the required information on the electrical safety and PM labels.
7. Affix the labels to the ventilator, and apply a chemical-resistant label over the electrical safety and PM labels.



Installation is complete.

4.6 Electrical Safety/Preoperational Check Form

Complete this form for every ventilator installation or software-only update. Retain this form for your service records.

Customer information			
Facility name:			
Contact name:			
Address:			
City/State/Zip			
Phone:			
Email:			
Preliminary ventilator cleaning and inspection			Circle one
Cleaned ventilator exterior?	PASS	FAIL	
Inspected cooling fan filter?	PASS	FAIL	
Inspected air inlet filter?	PASS	FAIL	
Ventilator information			
Installed options (circle all that apply):	PPV	AVAPS	C-Flex
	RAMP	Auto-Trak+	HFT
Other: _____			
Serial number:		CPU PLD version:	
Software version:		PMC PLD version:	
Total power-on hours:		Battery lot ID:	
Hours since last PM:		Battery mfg date:	
PIC software version:			

Electrical safety (section 9.4)		Circle one
Verify cooling fan operation?	PASS	FAIL
Resistance and leakage current	Pass value	Fail value
Proximal pressure port GND resistance $\leq 200 \text{ m}\Omega$	$\text{m}\Omega$	$\text{m}\Omega$
Gas outlet port GND resistance $\leq 200 \text{ m}\Omega$	$\text{m}\Omega$	$\text{m}\Omega$
O ₂ fitting retainer screw GND resistance $\leq 200 \text{ m}\Omega$	$\text{m}\Omega$	$\text{m}\Omega$
Forward leakage current $\leq 280 \text{ }\mu\text{A}$	μA	μA
Reverse leakage current $\leq 280 \text{ }\mu\text{A}$	μA	μA

Preoperational check (section 4.4)		Steps	Circle one	
Audible alarms		6	PASS	FAIL
Inspiration/exhalation		9	PASS	FAIL
Proximal pressure line disconnect		10 - 11	PASS	FAIL
Internal battery (circle N/A if not installed)	N/A	13 - 15	PASS	FAIL
Did the electrical safety/preoperational check pass?			PASS	FAIL

Preparing the ventilator for use (section 4.5)		Steps	Circle one	
Restore default settings		3	YES	NO
Correct date/time		4	YES	NO

Technician name (print):		Date:
Technician signature:		

5 Maintenance

- 5.1 Exterior and Touchscreen Cleaning 72
 - 5.1.1 Approved Cleaning Agents 72
 - 5.1.2 Cleaning Instructions 72
- 5.2 Exterior and Touchscreen Disinfection 73
 - 5.2.1 Approved Disinfecting Agents 73
 - 5.2.2 Disinfecting Instructions 73
- 5.3 Annual Preventive Maintenance Instructions 74

WARNING

- To reduce the risk of electric shock, power down the ventilator and disconnect it from AC power before cleaning, disinfecting, or servicing it.
- This product consists of devices that may contain mercury, which must be recycled or disposed of in accordance with local, state, or federal laws. (Within this system, the backlight lamps in the monitor display contain mercury.)

NOTE

- *It is the user's responsibility to comply with the information provided in this section.*
- *Cleaning, disinfection and sterilization are most effective if soiling is not allowed to dry on a medical device.*
- *Disinfection and sterilization are most effective on medical devices that were previously cleaned.*
- *For all ventilator hardware accessories recommended by Philips, follow the cleaning and disinfection guidelines described in this section. For multi-patient interfaces and circuit accessories, consult the product instructions for use. For single patient use accessories, no cleaning and disinfection is needed.*

To ensure the safety and reliability of the ventilator, follow these maintenance procedures along with institutional policies for cleaning, disinfecting, and maintaining equipment.

The expected life of the V60/V60 Plus ventilator is 10 years. Ventilators in use beyond the expected service life may require more frequent maintenance and/or repair to maintain basic safety and essential performance.

Perform cleaning, sterilizing, and preventive maintenance procedures (summarized in Table 5-1) to ensure consistent ventilator operation. Hospital personnel can perform all maintenance tasks except the annual preventive maintenance procedures (the preventive maintenance procedures must be performed by a qualified service technician). The ventilator user manual also describes preventive care and maintenance procedures.

Table 5-1: Maintenance Schedule

Frequency	Component	Maintenance
Every month	Air inlet filter	Inspect and replace if needed.
	Cooling fan filter	Inspect for occlusions, dust, lint, or damage. If the filter is discolored or dirty, wash or rinse thoroughly, then allow the filter to dry completely before reinstalling.
	NOTE Some environments may require more frequent filter replacement.	
Every year (authorized service personnel only)	Ventilator	• Install the annual preventive maintenance kit. • Clean ventilator interior and exterior. • Inspect the O₂ inlet filter. • Perform the air and O₂ flow sensor zero calibration. • Complete performance verification procedure. • Philips recommends updating the operational software to the current version during this service.
Every 5 years	Backup battery	Replace the battery. Battery replacement is based on the date of manufacture. The date of manufacture is on the battery label and in Diagnostic mode on the Ventilator Information screen. The lithium ion battery cannot be recycled. Please contact customer service for safe disposal instructions.
CAUTION Only qualified service technicians are to install preventive maintenance kits or perform service procedures.		

Dispose of all parts removed from the device according to your institution's protocol. Follow all local, state, and federal regulations with respect to environmental protection, especially when disposing of the electronic device or parts of it (for example, oxygen cell, batteries).

Dispose of this device in accordance with local collections and recycling regulations. For more information, visit www.philips.com/recycling.

5.1 Exterior and Touchscreen Cleaning

CAUTION

- To prevent possible damage to the ventilator, use only those cleaning and disinfecting agents listed in this manual.
 - To prevent possible damage to the ventilator, do not drip or spray any liquids directly onto any surface including the front panel, touchscreen, and nav-ring (if present).
 - Never clean or disinfect the touchscreen with an abrasive brush or device, since this will cause irreparable damage.
 - Do not attempt to sterilize or autoclave the ventilator.
 - Use of non-approved cleaning and disinfecting agents may cause damage to the enclosure, touchscreen, or parts of the ventilator.
-

5.1.1 Approved Cleaning Agents

The following cleaning agent is acceptable for use on the touchscreen and exterior surfaces of the ventilator:

- Soapy water with Medivators Intercept detergent, per manufacturer's recommendation at 1/3 oz (10 mL) per gallon of warm tap water. (Benzalkonium chloride 4.8%, diethylene glycol monoethyl ether 4.8%, lactic acid 1.4%, alkyl polyglycoside 1.4%)

5.1.2 Cleaning Instructions

1. Verify that the ventilator is off and disconnected from AC power.
2. Apply cleaning agent to a soft lint-free cloth or use a disposable wipe. The cloth or wipe should be saturated but not dripping.
3. Wipe cleaning agent over the entire exterior surface and touchscreen of the ventilator.
4. Continue wiping until all visible contaminants and soiling are removed.
5. Rinse with a clean, water-dampened cloth and let dry completely before reuse.

5.2 Exterior and Touchscreen Disinfection

CAUTION

- To prevent possible damage to the ventilator, use only those cleaning and disinfecting agents listed in this manual.
- To prevent possible damage to the ventilator, do not drip or spray any liquids directly onto any surface including the front panel, touchscreen, nav-ring (if present), and Accept button.
- Never clean or disinfect the touchscreen with an abrasive brush or device, since this will cause irreparable damage.
- Do not attempt to sterilize or autoclave the ventilator.
- Use of non-approved cleaning and disinfecting agents may cause damage to the enclosure, touchscreen, or parts of the ventilator.

5.2.1 Approved Disinfecting Agents

The following disinfecting agents are acceptable for use on the touchscreen and exterior surfaces of the ventilator:

Disinfectant
Solution of 1 part 5% sodium hypochlorite (bleach) diluted in 9 parts deionized water.
3% hydrogen peroxide

5.2.2 Disinfecting Instructions

1. Verify that the ventilator is off and disconnected from AC power.
2. Ensure that ventilator and touchscreen are clean (section 5.1).
3. Apply cleaning agent to a soft lint-free cloth or use a disposable wipe. The cloth or wipe should be saturated but not dripping.
4. Wipe disinfecting agent over the entire exterior surface of the ventilator.
5. Let the disinfectant remain on the surface for the following contact times:
 - Bleach solution: 2 minutes
 - Hydrogen peroxide: 15 minutes
6. Rinse with a clean cloth dampened with water and let dry completely before reuse.

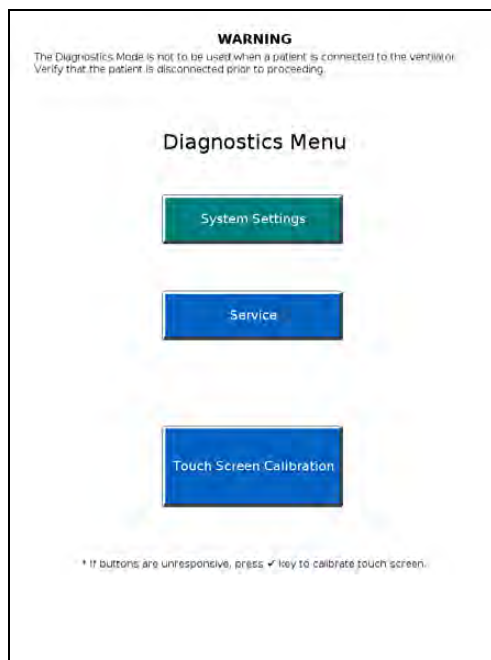
5.3 Annual Preventive Maintenance Instructions

Follow these steps to perform the annual preventive maintenance (PM) procedure on the ventilator.

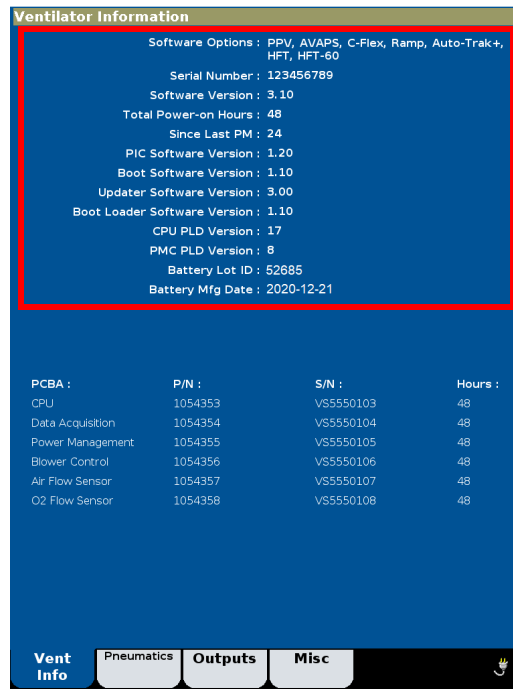
The annual PM procedure must be performed by a qualified service technician in an appropriate setting, such as a biomedical repair facility. Use a clean patient circuit and filters when performing any testing or operational checkout.

Philips recommends that the operational software be updated to the current version during the annual preventive maintenance.

1. Verify that the ventilator is off and disconnected from AC power.
2. Clean the exterior of the ventilator using universal precautions (including mask, gloves, eye protection) and following the instructions in section 5.1 and disinfect as needed using the instructions in section 5.2.
3. Verify that the ventilator is connected to an AC mains outlet.
4. Enter Diagnostic mode by pressing and holding the Accept button and turn on the ventilator by pressing the On/Shutdown button on the user interface. Within 5 seconds, press the Accept button again to enter Diagnostic mode. The Diagnostics Menu appears.

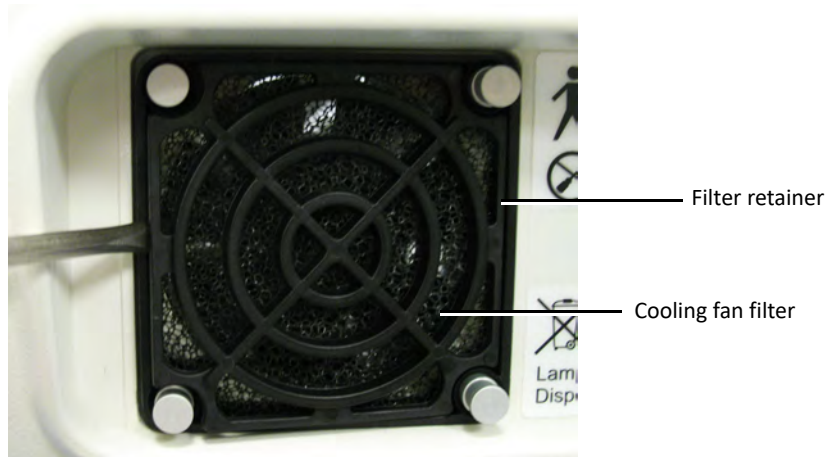


5. Touch **Service** to display the Ventilator Information screen.

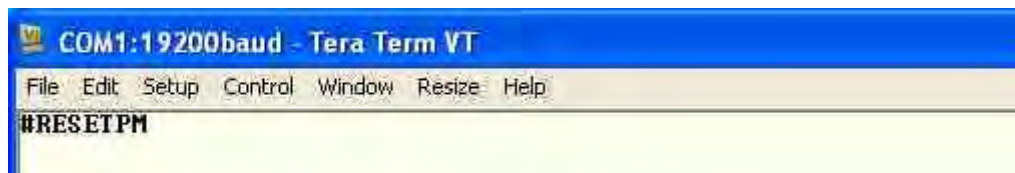


6. Record information on the Performance Verification Data Form (section 9.20):
 - Software options
 - Ventilator serial number
 - Software version
 - Total power-on hours
 - Hours since last PM
 - PIC software version
 - CPU PLD version
 - PMC PLD version
 - Battery lot ID
 - Battery mfg date
7. Generate a diagnostic report (DRPTA) for the ventilator (section 7.2).
8. Turn off the ventilator by pressing the On/Shutdown button.
9. Disconnect all power, remove the top cover, and remove the EMI shroud from the power supply (section 8.19).
10. Use an electrostatic discharge (ESD) safe vacuum to remove any accumulated dust and debris from the inside the ventilator enclosure.
11. Inspect all electrical and pneumatic connections.
12. Replace the air inlet filter (section 8.3).
13. Remove the O₂ filter cap from the GDS (section 8.25). Inspect the O₂ inlet filter for contamination or debris and verify that it is properly installed.

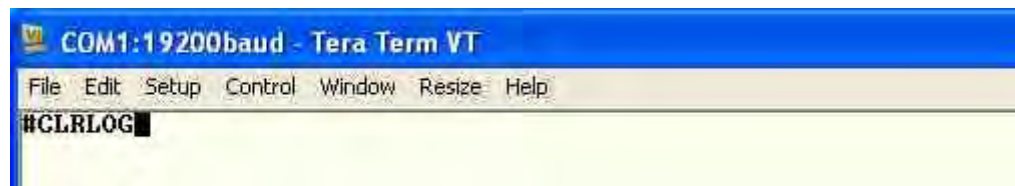
14. From outside the bottom enclosure, use a small screwdriver to remove the filter retainer, then replace the cooling fan filter.



15. Reassemble the ventilator.
16. Complete the performance verification (section 9).
17. If the ventilator is not already in diagnostic mode, press and hold the Accept button and turn on the ventilator by pressing the On/Shutdown button on the user interface. Within 5 seconds, release and press the Accept button again to enter Diagnostic mode.
18. Connect the 25-pin to 9-pin HIS/EMR null modem cable between the PC serial port and the ventilator.
19. Launch Tera Term to enable communication with the ventilator.
20. Type: **#RESETPM** (all caps) in the dialog box, and press Enter to reset hours since last PM to zero.



21. When the hours since last PM have been successfully reset, the dialog box displays:
?RESETPMOK
22. Type **#CLRLOG** (all caps) in the dialog box, and press Enter to clear the diagnostic log.



23. When the diagnostic log has been successfully cleared, the dialog box displays:
?CLRLOGOK

24. Select **System Settings**, and then **Restore Default Settings**.
25. Select **Date/Time** and correct the date and time if necessary.
26. Turn the ventilator off by pressing the On/Shutdown button.
27. Upon successful completion of the performance verification, hours reset, and restoring the default settings, enter the required information on the PM and electrical safety labels.
28. Affix the labels to the ventilator.



29. Apply a clear chemical-resistant label over the electrical safety and PM labels.
30. The annual PM is complete.

6 Diagnostic Mode and Troubleshooting

6.1	System Settings	81
6.1.1	Selecting a Language	82
6.1.2	Setting Date and Time	84
6.1.3	Restoring Default Settings	85
6.1.4	Selecting Pressure Units	86
6.1.5	Enabling Software Options	87
6.1.6	Baud Rate	88
6.1.7	Alarm Volume Escalation	89
6.2	Service	90
6.2.1	Viewing Ventilator Information	90
6.2.2	Pneumatic Controls	91
6.2.3	Output Controls	93
6.2.4	Miscellaneous	94
6.2.4.1	Significant Event Log	95
6.2.4.2	Download Mode	96
6.2.4.3	Touchscreen Diagnostics	97
6.2.4.4	High Pressure Leak Test	97
6.2.4.5	System Leak Test	98
6.2.4.6	Flow Sensor Zero Calibration	98
6.3	Touchscreen Calibration	98
6.4	Diagnostic Codes, Alarms, and Troubleshooting	99
6.5	Symptom-Based Troubleshooting	113
6.6	Miscellaneous Troubleshooting Tips	114
6.7	Battery Troubleshooting Tips	118

Use Diagnostic mode to perform these functions:

- System settings: language, ventilator date and time, pressure units, restore default settings, enable software options, and Baud rate.
- Service: ventilator information, pneumatics and outputs screens (for troubleshooting), and miscellaneous features (viewing the significant event log, downloading software, touchscreen diagnostics, high pressure leak test, and system leak test).
- Touchscreen calibration.

This section also provides detailed information on diagnostic codes and troubleshooting (section 6.4).

WARNING

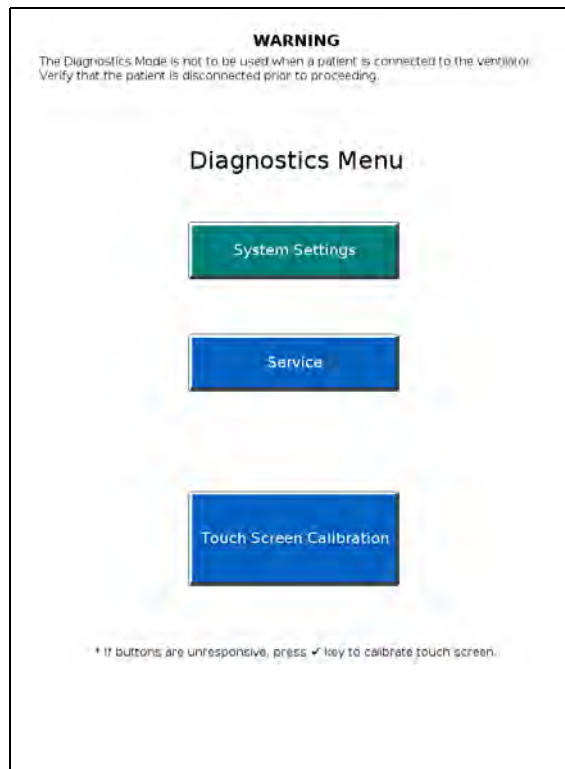
Do not enter Diagnostic mode while a patient is connected to the ventilator.

NOTE

This mode is primarily reserved for use by a qualified service technician.

To enter Diagnostic mode:

1. Press and hold the Accept button then press and release the ventilator On/Shutdown button on the user interface.
2. Within five seconds, press the Accept button again to enter the Diagnostics Menu.

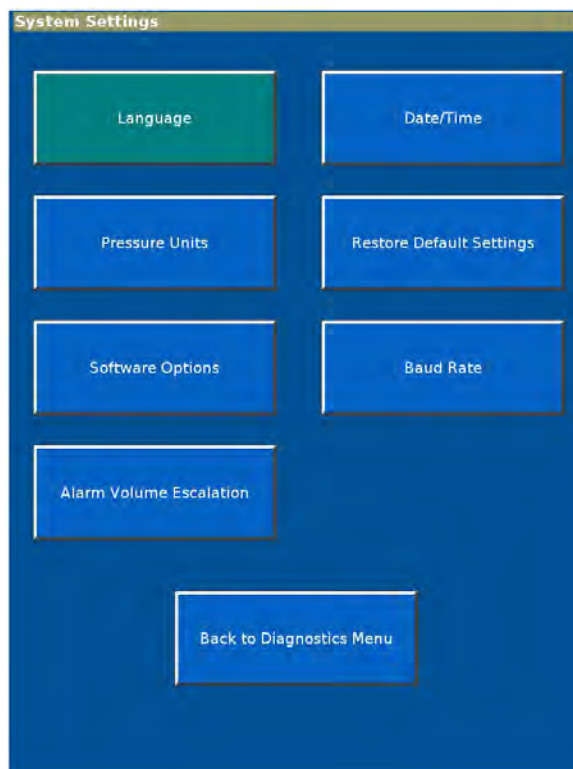


3. To exit Diagnostic mode at any time, press the On/Shutdown button.

6.1 System Settings

The **System Settings** button provides access to these function:

- Language (language button is a different color)
- Date/Time
- Pressure Units
- Restore Default Settings
- Software Options
- Baud Rate

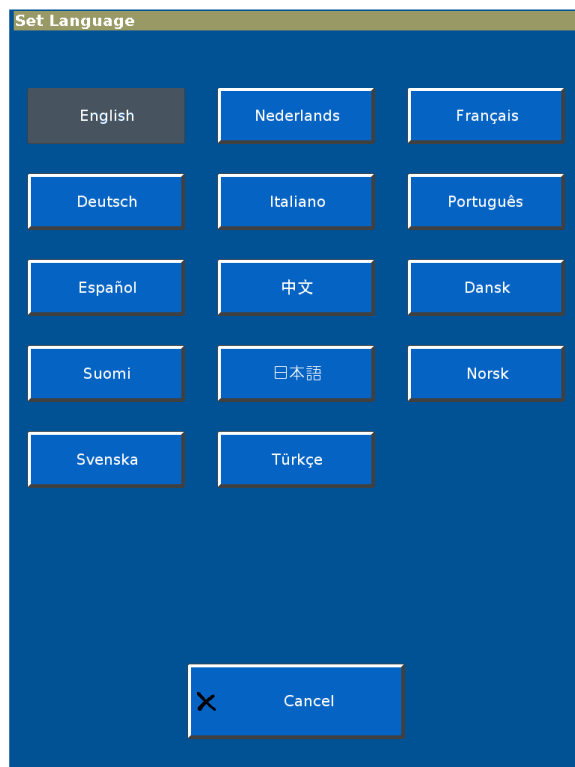


6.1.1 Selecting a Language

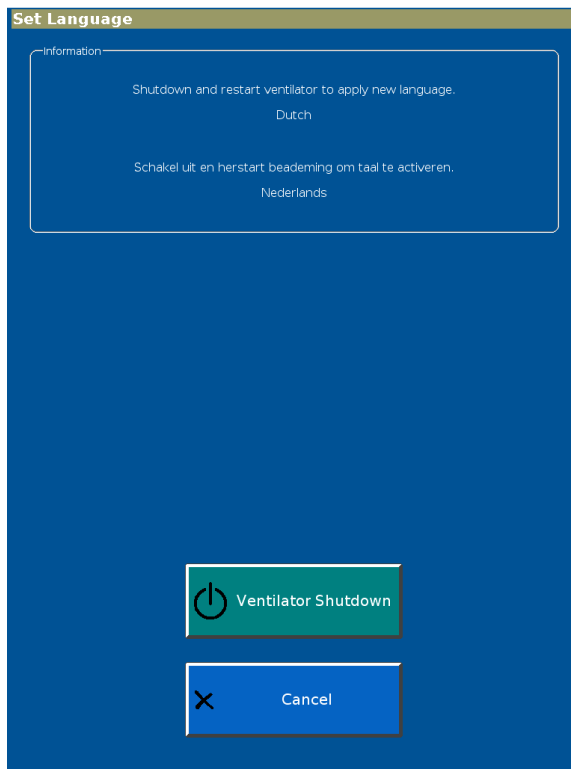
Use the Set Language screen to select the language displayed during ventilation mode.

Screens displayed after touching the **Service** button from the Diagnostics Menu appear in English, regardless of the selected language.

1. From the System Settings screen, select **Language**.
2. Touch the language button on the Set Language screen.



3. The screen shows the selected language.



4. To apply the new language, select **Ventilator Shutdown**. To exit without changing the language, select **Cancel**.

6.1.2 Setting Date and Time

Use the Set Date and Time screen to update the ventilator date and time. The ventilator uses these settings for the significant event log, and does *not* adjust settings for daylight savings.

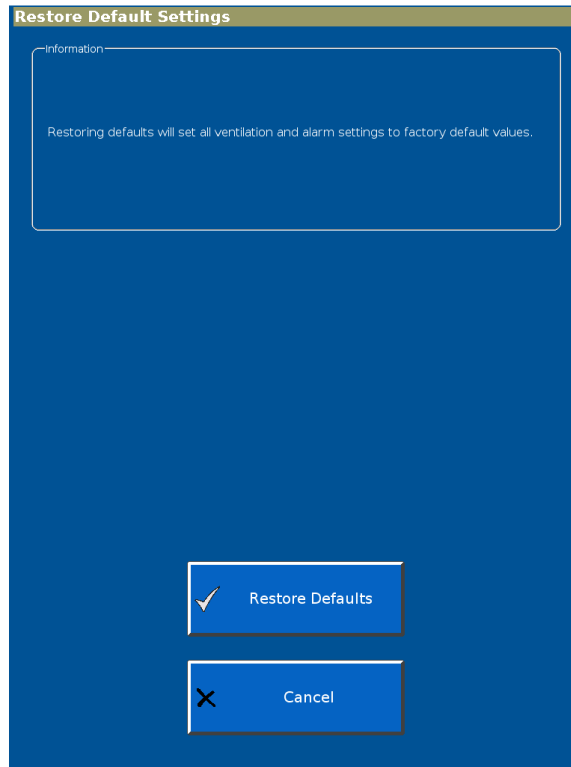
1. From the System Settings screen, touch **Date/Time**.
2. Enter the date and time, then touch **Accept**. To exit without changing the date and time, touch **Cancel**.

The screenshot shows the 'Set Date and Time' screen with a blue background. At the top, there is a title bar with the text 'Set Date and Time'. Below the title bar is a large empty rectangular box labeled 'Information'. Underneath this box are two sections for time and date settings. The first section is for 'Hours' and 'Minutes', each with a '+' button above a numeric display and a '-' button below it. The 'Hours' display shows '13' and the 'Minutes' display shows '53'. The second section is for 'Year', 'Month', and 'Day', each with a '+' button above a numeric display and a '-' button below it. The 'Year' display shows '2020', the 'Month' display shows '12', and the 'Day' display shows '8'. To the right of these settings are two buttons: 'Accept' with a checkmark icon and 'Cancel' with an 'X' icon.

6.1.3 Restoring Default Settings

Use the Restore Default Settings screen to restore ventilation and alarm settings to their default values. This function does *not* change other settings such as brightness, loudness, language, Baud rate, or pressure units.

1. From the System Settings screen, select **Restore Default Settings**.
2. Select **Restore Defaults** on the Restore Default Settings screen. To exit without restoring default settings, select **Cancel**.

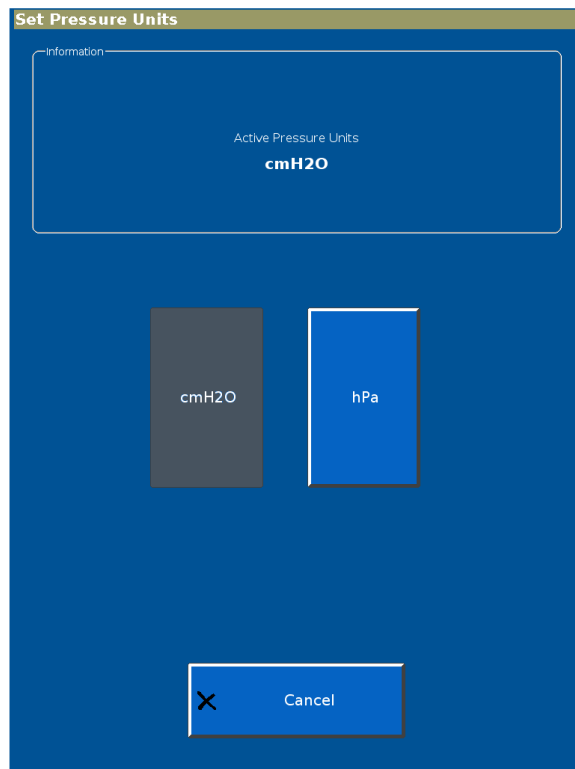


3. When all ventilator and alarm settings have been restored to factory default values, the screen displays:
Settings have been restored to factory defaults.

6.1.4 Selecting Pressure Units

Use the Set Pressure Units screen to select what unit of pressure the ventilator displays during ventilation and Diagnostic modes.

1. From the System Settings screen, touch **Pressure Units**.
2. Touch the selected pressure unit button on the Set Pressure Units screen.



3. The screen displays the selected pressure unit and this message:
Pressure units will apply after a ventilator shutdown and restart.
4. To apply the new unit of pressure, touch **Ventilator Shutdown**. To exit without changing the unit of pressure, touch **Cancel**.

6.1.5 Enabling Software Options

Every software option has a unique enable code for each ventilator. A unique option code is required for each software option before it can be enabled.

NOTE

Do not install an option until you have verified that the ventilator serial number on the enclosure matches the serial number shown on the Ventilator Information screen (section 6.2.1). If a serial number must be reprogrammed, do so before enabling an option.

1. From the System Settings screen, touch Software Options.
2. Use the on-screen keypad on the Enable Software Options screen to enter the option code, then touch **Accept**.

Enable Software Options

Serial Number : 123456789

Software Options Installed
PPV, AVAPS, C-Flex, Ramp, Auto-Trak+, HFT, HFT-60

Please enter the option code:

0366746660

1 2 3
4 5 6
7 8 9
0 ← Back ✓ Accept

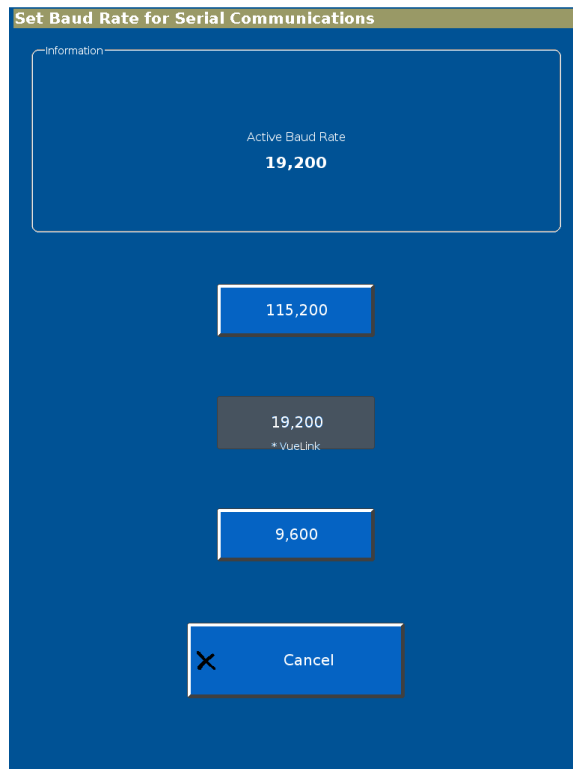
Back to System Settings

3. If the option code is invalid, the screen prompts you to reenter.
4. When the software option has been successfully enabled, the screen displays *Enabled:* followed by the option name.
5. Repeat as needed to enable additional options.
6. To exit the Enable Software Options screen at any time, touch **Back to System Settings**.

6.1.6 Baud Rate

Use the Set Baud Rate screen to change the ventilator Baud rate for serial communications during ventilation mode. Diagnostic mode always uses 19,200 Baud.

1. From the System Settings screen, touch **Baud Rate**.
2. Touch the button to select the Baud rate.



3. The screen then displays this message: *Baud rate is now set to:* followed by the selected Baud rate.

6.1.7 Alarm Volume Escalation

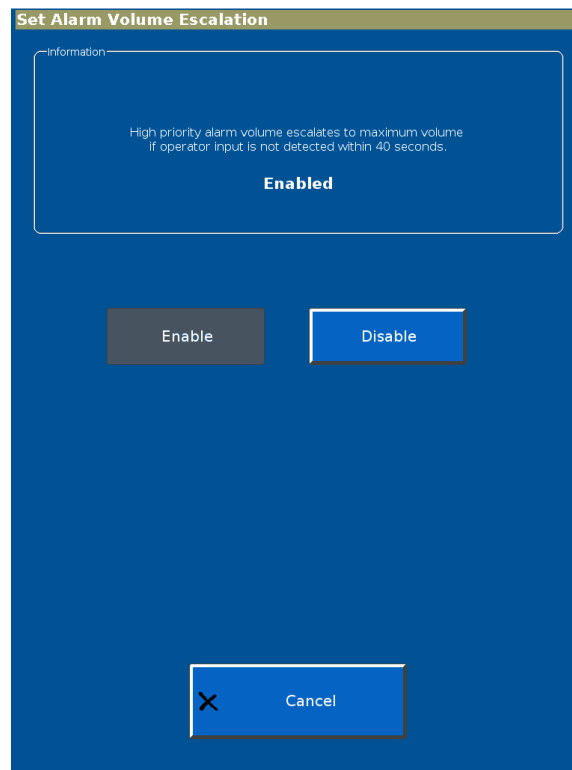
The Alarm Volume Escalation function escalates alarm volume to its maximum if an operator input is not detected within 40 seconds after a high priority alarm occurs. Alarm volume automatically returns to the user setting when the ventilator detects a touch on the touchscreen or a button press.

NOTE

The Alarm Escalation function is only available in software versions 2.30 or later.

Enable or disable the Alarm Volume Escalation function from Diagnostic mode:

1. From the System Settings screen, select **Alarm Volume Escalation**.
2. The current setting appears at the top of the screen.
3. Touch **Enable** or **Disable** to change the setting.



4. The new setting takes effect after turning the ventilator off and on again.

6.2 Service

The Service button provides access to these functions:

- Ventilator information
- Pneumatic controls
- Output controls
- Miscellaneous (significant event log, download mode, and touchscreen diagnostics, high pressure leak test, and system leak test).

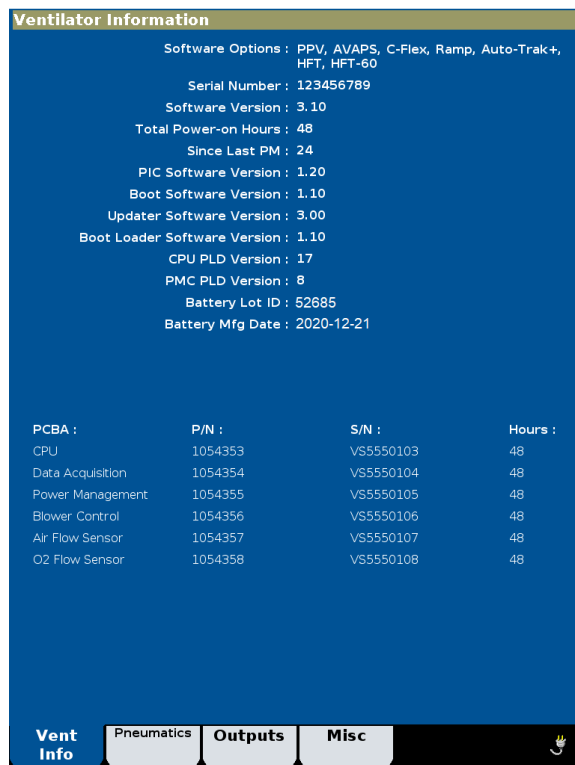
NOTE

Service button functions are intended for use by qualified service technicians.

6.2.1 Viewing Ventilator Information

Ventilator information is used for maintenance and troubleshooting.

1. From the Service screen, touch the **Vent Info** tab.
2. The Ventilator Information screen displays software options, serial numbers, software versions, power-on hours, hours since last PM, and information on the internal battery and PCBAs.



6.2.2 Pneumatic Controls

Use the Pneumatic Controls screen to adjust flows, pressures, O₂ concentrations, and the state of each solenoid.

1. From the Service screen, touch the **Pneumatics** tab.
2. The screen displays real-time pneumatic information and pneumatic controls.

Avg Air SLPM	0.0	Avg O2 SLPM	0.0	Avg Machine cmH2O	-0.46	Avg Proximal cmH2O	0.02
Barometric mmHg	751.7	O2 Inlet psi	0.00	Blower RPM	3000	Blower Amp	-7.50
Blower Volts	0.00	Blower Celsius	0.0	35V Supply Volts	0.00	24V Supply Volts	0.00
12V Supply Volts	0.00	5V Supply Volts	0.00	3.3V Supply Volts	0.00	1.8V Supply Volts	0.00
Battery Volts	0.00	Battery %	0	Battery Amp	-15.00	Battery Celsius	0.0
Backup Volts	0.00	Cooling Fan RPM	0	CPU Celsius	0.0	Motor Celsius	0.0
Data Celsius	0.0						

Real-time pneumatic information

Pneumatic Controls

Pressure
0
cmH2O

Flow
0
SLPM

O2
21
%

Solenoid 1
Purge Line
is connected to
None

Solenoid 2
Machine Pressure Sensor
is connected to
Machine Pressure Line

Solenoid 3
Solenoid 4 Active Port
is connected to
Machine Pressure Line

Solenoid 4
Prox Pressure Sensor
is connected to
Prox Pressure

Vent Info
Pneumatics
Outputs
Misc

Pneumatic control buttons

3. Table 6-1 summarizes the acceptable ranges for the pneumatic information that appears at the top of the screen.

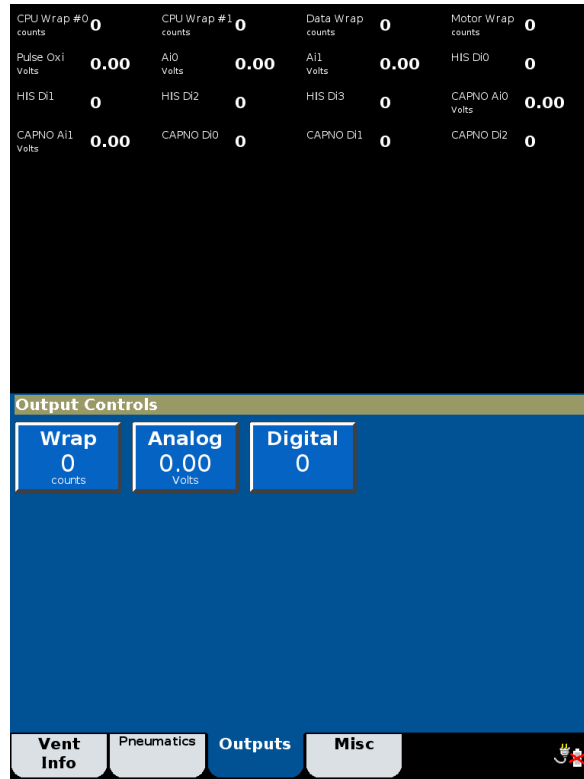
Table 6-1: Acceptable Ranges for Pneumatic Information

Parameter	Acceptable range	Parameter	Acceptable range
Acceptable temperature ranges			
Blower Celsius	≤ 95.0	Motor Celsius	≤ 60.0
Battery Celsius	≤ 100.0	Data Celsius	≤ 60.0
CPU Celsius	≤ 60.0		
Acceptable voltage ranges			
1.8V Supply Volts	1.73 to 1.88 V	24V Supply Volts	22.6 to 26.88 V
3.3V Supply Volts	3.04 to 3.52 V	35V Supply Volts	32.85 to 40.15 V
5V Supply Volts	4.50 to 5.60 V	Backup Volts	3.12 to 3.48 V
12V Supply Volts	11.50 to 13.00	Battery Volts	10.00 to 16.90 V (fully discharged to fully charged)
Acceptable Amp/RPM ranges			
Blower Amp	Varies. Occasional 1 A peak at VMOTOR ~ 14.3 V and 21,000 RPM and 0.5 A peak at VMOTOR ~ 7 V and 10,000 RPM		
Blower RPM	0 (blower not turning: 3000 RPM displayed) to ~ 22 V at ~ 31,000 RPM		
Battery Amp	+2.6 to 0.0 A (battery charging to charge complete); ~ 1.0 A at VBATT ~ 15 V without blower running		
Battery information			
Battery %	Indicates battery health		

6.2.3 Output Controls

Use the Output Controls screen to set and verify wrap outputs. (Analog and digital outputs are reserved for internal use only.)

1. From the Service screen, touch the **Outputs** tab.
2. The screen shows diagnostic information and output controls.



Results:

For any of the DAC Wrap signals, the ADC count out should be equal to the DAC count in ± 23 counts over the full range of 0 to 4050 counts. An out-of-specification result could be a fault in any one of the following:

- ADC chip internal fault
- DAC chip internal fault
- Addressing error of the ADC or DAC
- SPI interface failure (DAC only reads data from SPI bus, ADC reads and writes data)
- DAC Wrap feedback path shorted to adjacent signal or open

Note that a fault of Vref may not appear here, as the paired DAC and ADC chips use a common reference voltage. There is at least one other ADC input that is generated from a separate reference (that is, 3.3V supply) that would fail if Vref were off significantly.

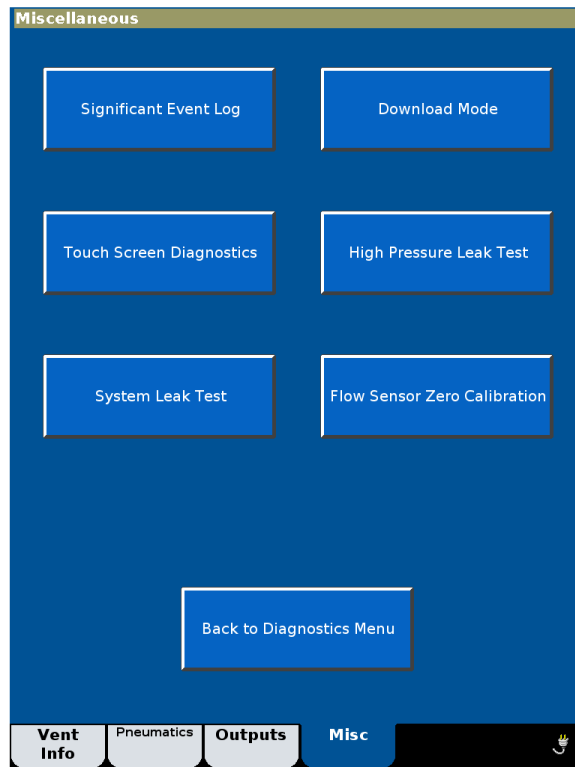
6.2.4 Miscellaneous

Use the Miscellaneous screen to access the significant event log, touchscreen diagnostics, download mode, high pressure leak test, system leak test, and flow sensor zero calibration.

NOTE

Flow sensor zero calibration is available on ventilators with software version 3.10 or later.

1. From the Service screen, touch the **Misc** tab.

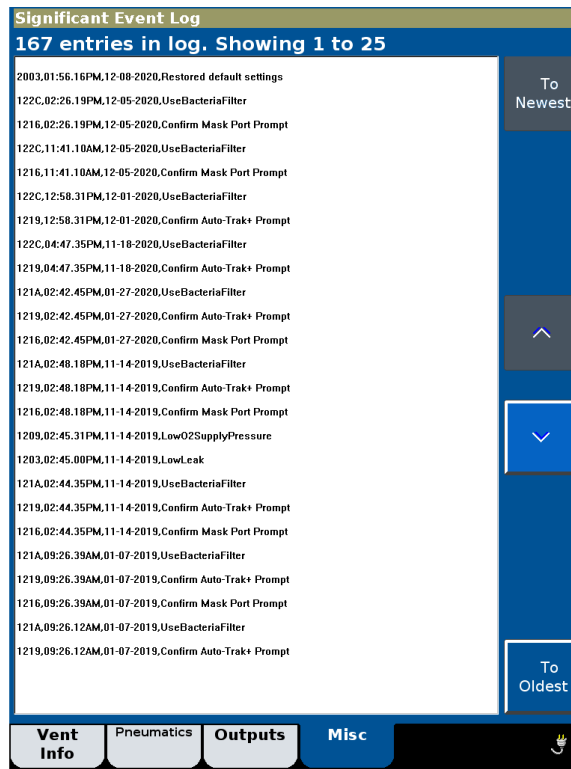


2. To exit the Miscellaneous screen at any time, touch **Back to Diagnostics Menu**.

6.2.4.1 Significant Event Log

Use the significant event log to view a log of setting changes, alarms, and diagnostic codes.

1. From the Miscellaneous screen, touch **Significant Event Log**.
2. Use the arrow buttons to page through the significant event log 25 entries at a time.



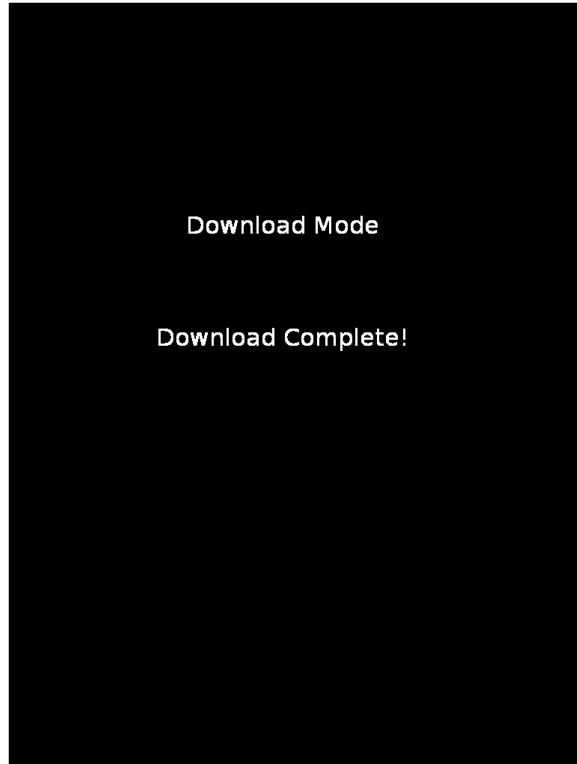
3. To display the beginning or end of the significant event log, select **To Newest** or **To Oldest**.

See section 7.2 for information on interpreting the significant event log and saving it to a computer.

6.2.4.2 Download Mode

Use the Download mode screen to load operational software onto the CPU PCBA.

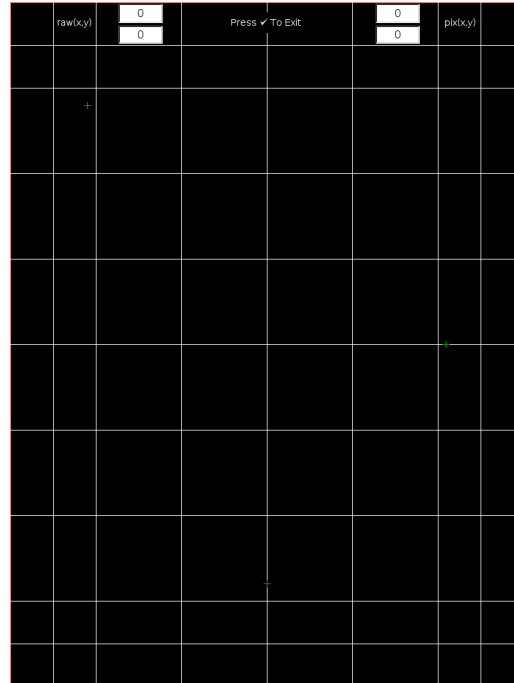
1. From the Miscellaneous screen, touch **Download Mode** to prepare the ventilator for a software download. See section 7.5 for more information on downloading software.
2. When the software download is complete, the download complete screen appears.



6.2.4.3 Touchscreen Diagnostics

Use the Touchscreen Diagnostics screen to verify touchscreen x and y coordinates.

1. From the Miscellaneous screen, touch **Touchscreen Diagnostics**.
2. At the touchscreen diagnostics screen, touch the screen in multiple places to verify correct touchscreen function.



- Press the Accept button to exit the Touchscreen Diagnostics screen and return to the Misc tab screen.
- The Touchscreen Diagnostics screen displays a grid with the following pixel line coordinates: 64, 128, 256, 384, 512, 640, 704, and 755 for the X direction and 64, 128, 256, 384, 512, 640, 768, 896, and 960 in the Y direction in the portrait oriented screen layout.
- The Touchscreen Diagnostics screen displays a cursor at the calibrated coordinate location where a user touch is detected. The calibrated coordinate location is the initial user touch location adjusted by calibration algorithm.
- The Touchscreen Diagnostics screen displays the ADC (raw) and the cursor (pixel) coordinate values of the location where a user touch is detected.

6.2.4.4 High Pressure Leak Test

Section 9.5.1 describes how to run the high pressure leak test as part of the performance verification.

6.2.4.5 System Leak Test

Section 9.5.2 describes how to run the system leak test as part of the performance verification.

6.2.4.6 Flow Sensor Zero Calibration

Section 9.9 describes how to run the flow sensor zero calibration as part of the performance verification.

6.3 Touchscreen Calibration

Use the **Touchscreen Calibration** button to calibrate the touchscreen x and y coordinates:

1. From the Diagnostics Menu, touch **Touchscreen Calibration**.

NOTE

*If the **Touchscreen Calibration** button does not respond, press the Accept button to begin.*

2. Follow the onscreen instructions to perform the calibration. Touch the middle of each target with a blunt, narrow object.

6.4 Diagnostic Codes, Alarms, and Troubleshooting

Table 6-2 lists possible ventilator diagnostic codes (generated by the ventilator when an event such as a setting change or fault condition is detected, or when an alarm indicates patient or ventilator conditions), and the recommended repair for each. Follow the repair procedures in order until the problem is resolved.

NOTE

See section 8 for information on removing and replacing ventilator components. See Chapter 9 for performance verification procedures.

Table 6-2: Diagnostic Codes and Troubleshooting

Diagnostic code	Description	Recommended repair
1000-10FF Vent Inop Diagnostic Codes High-priority error conditions that preclude continued safe operation of the ventilator. A Vent Inop alarm displays on the screen, turns on remote alarm interfaces, and disables O ₂ flow and blower operation. Immediately place the patient on another means of ventilatory support. CBIT = continuous built-in tests. POST = power on self test.		
1000 (CBIT)	3.3 V supply failed. Twenty consecutive measurements of the 3.30 V supply are greater than 3.52 V.	Replace the PM PCBA.
1001 (CBIT)	12 V supply failed. Twenty consecutive measurements of the 12.0 V supply on the DA PCBA are less than 10.5 V or greater than 13.0 V.	Replace the PM PCBA.
1002 (CBIT)	Blower temperature too high. Blower temperature is greater than or equal to 115° C for longer than 10 min.	1. Verify that the cooling fan is operational 2. Replace the blower. 3. Replace the MC PCBA.
1003 (CBIT)	Internal temperature high at CPU PCBA. The internal temperature measured on the CPU PCBA is greater than 70°C for longer than 5 seconds.	Replace the CPU PCBA.
1004 (CBIT)	Internal temperature high at DA PCBA. The internal temperature measured on the DA PCBA is greater than 70°C for longer than 5 seconds.	1. Verify that the cooling fan is operational. 2. Replace the DA PCBA.
1005 (CBIT)	Internal temperature high at MC PCBA. The internal temperature measured on the MC PCBA is greater than 70°C for longer than 5 seconds.	1. Verify that the cooling fan is operational. 2. Replace the MC PCBA.
1006 (CBIT)	DA PCBA ADC failed. DAC output is not equal to 150 counts for 6 consecutive measurements.	1. Replace the DA PCBA to MC PCBA cable. 2. Replace the DA PCBA.
1007 (POST) 1008 (CBIT)	Machine and proximal pressure sensors failed. Auto-zeroing of machine and proximal pressure transducers in POST failed.	1. Replace the DA PCBA to MC PCBA cable. 2. Replace the DA PCBA. 3. Replace the MC PCBA. 4. Replace the PM PCBA. 5. Replace the CPU PCBA.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
1009	Pressure regulation high. In ventilation modes, the measured proximal pressure is greater than 5 cmH₂O above the proximal pressure target for 5 seconds (± 1 second), or the measured machine pressure is greater than 5 cmH₂O above the machine pressure target for 5 seconds (± 1 second). The proximal pressure is 25 cmH₂O greater than the pressure limit listed below and greater than the HIP setting for 1 second: Pressure limit • CPAP mode: CPAP setting • S/T mode: IPAP setting • PCV mode: IPAP setting • AVAPS mode: IPAP Max Pressure setting • PPV mode: IPAP setting for machine-initiated breaths, PPV Max P for patient-initiated breath or The measured machine pressure is 25 cmH₂O greater than the pressure limit listed below + the estimated pressure drop due to the air flow through the patient circuit, and it is greater than HIP setting for 1 second: Pressure limit • CPAP mode: CPAP setting • S/T mode: IPAP setting • PCV mode: IPAP setting • AVAPS mode: IPAP Max Pressure setting • PPV mode: IPAP setting for machine-initiated breaths, PPV Max P for patient-initiated breath • HFT: 34 cmH₂O or The measured machine or proximal pressure is ≥ 64 cmH₂O for 1 second.	1. Verify the proximal and machine tubing connections. 2. Verify the pressures and flows. 3. Replace the DA PCBA. 4. Replace the MC PCBA.
100A (CBIT)	DA PCBA ADC reference failed. The ADC reading from the measured 3.3 V supply is less than 2413 – 290 counts or greater than 2869 + 165 counts for 6 consecutive samples, scheduled to be 10 ms apart.	1. Verify 3.3V in diagnostics. 2. Verify 2.5V ref on DA PCBA (see Figure 6-1). 3. Replace the DA PCBA to MC PCBA cable. 4. Replace the DA PCBA. 5. Replace the PM PCBA. 6. Replace the CPU
100B (POST)	Watchdog test failed. Watchdog timer was not strobed as expected with an 8-ms and a 12-ms window.	1. Replace the CPU PCBA. 2. Replace the MC PCBA. 3. Replace the flow sensor assembly.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
1100-11FF Check Vent Diagnostic Codes High-priority error conditions that require immediate attention. Ventilator continues to operate with limited performance. Do not use the ventilator until the problem is corrected. CBIT = continuous built-in tests. POST = power on self test.		
1100 (CBIT)	Program CRC test failed. The CRC of the ventilator program block in RAM is computed periodically and compared with stored CRC value to ensure that the program image is valid. When the CRC values do not match, the ventilator restarts.	1. Reinstall operational software. 2. Replace the CPU PCBA.
1101	Ventilator restarted due to anomalies detected during operation. This could include invalid or corrupted information, unanticipated situations, or object allocation errors. NOTE If diagnostic code 1101 occurs in conjunction with diagnostic code 3007 (software exception), no action is required.	1. Reinstall operational software. 2. Replace the CPU PCBA.
1102 (POST)	Primary alarm failed. When the Primary Audible Alarm Test fails for either speaker, alarms are annunciated using both the primary and backup audio devices.	1. Listen for audible sound from the speakers. 2. Verify that the speakers are connected. 3. Verify that the braided wires are not touching the speaker housing. 4. Verify that the resistance of each speaker is 6.8 to 9.2 Ω (Figure 6-2). 5. Replace speaker #1 (MC PCBA). 6. Replace speaker #2 (PM PCBA). 7. Replace the CPU PCBA.
1104 (POST)	Backup alarm failed. When the Backup Audible Alarm Test fails, alarms normally annunciated by the backup audio device use the primary speakers.	1. Replace the MC PCBA. 2. Replace the CPU PCBA. 3. Replace the PM PCBA.
1105 (POST)	Alarm LED failed. Either (1) the LED is on and the voltage signal from the power management controller is less than 1.0 V or greater than 2.5 V or (2) the LED is off and the voltage is greater than or equal to 0.5 V.	1. Disconnect all power (section 8.2). If this code does not recur when power is reconnected, no further action is required. 2. Replace the power switch overlay. 3. Replace the PM PCBA. 4. Replace the UI PCBA. 5. Replace the UI to PM PCBA cable.
1106 (POST)	Machine pressure sensor calibration data error. When the integrity of the calibration data cannot be verified for the machine pressure transducer, the proximal pressure sensor is used to measure machine pressure (solenoid 3 is de-energized; solenoid 4 is energized). Proximal pressure is not measured and pressure-related alarms are compromised.	Replace the DA PCBA.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
1107 (POST)	Proximal pressure sensor calibration data error. When the integrity of the calibration data cannot be verified for the proximal pressure transducer, the proximal pressure is not measured and pressure-related alarms are compromised.	Replace the DA PCBA.
1108 (POST) 1109 (CBIT)	Machine pressure sensor autozero failed. The proximal pressure sensor is used to measure machine pressure (solenoid 3 de-energized; solenoid 4 energized), the proximal pressure is not measured, and pressure-related alarms are compromised.	1. Verify pin alignment between solenoids and the DA PCBA. 2. Replace the machine auto-zero solenoid (SOL 2 and SOL 4). 3. Replace the DA PCBA.
110A (POST) 110B (CBIT)	Proximal pressure sensor autozero failed. The proximal pressure is not measured and pressure-related alarms are compromised.	1. Verify pin alignment between solenoids and the DA PCBA. 2. Replace the proximal auto-zero solenoid (SOL 3 and SOL 4). 3. Replace the DA PCBA.
110C (CBIT)	Machine pressure sensor range error. The proximal pressure sensor is used to measure machine pressure (solenoid 3 de-energized; solenoid 4 energized), proximal pressure is not measured, and pressure-related alarms are compromised.	1. Cycle the ventilator power to reset the proximal pressure sensor. 2. Replace the DA PCBA.
110D (CBIT)	Proximal pressure sensor range error. The proximal pressure is not measured and pressure-related alarms are compromised.	1. Cycle the ventilator power to reset proximal pressure sensor. 2. Replace the DA PCBA.
110E (POST)	Air flow sensor calibration data error. When the integrity of the calibration data cannot be verified for the air flow sensor, the ventilator continues to operate with air only. Flow-related patient data is disabled. In AVAPS mode, the default volume is used. Standby is disabled. Volume, leak, disconnect, and occlusion alarms are compromised.	1. Perform the flow sensor zero calibration. 2. Replace the flow sensor assembly. 3. Replace the DA PCBA.
110F (POST)	O ₂ flow sensor calibration data error. When the integrity of the O ₂ flow sensor calibration data cannot be verified, the ventilator continues to operate with air only.	1. Perform the flow sensor zero calibration. 2. Replace the flow sensor assembly. 3. Replace the DA PCBA.
1110 (POST)	O ₂ pressure sensor calibration data error. When the integrity of the O ₂ supply pressure transducer calibration data cannot be verified, the ventilator continues to operate with air only.	Replace the DA PCBA.
1111 (CBIT)	O ₂ device failed. The ventilator continues to deliver breaths targeting the 21% O ₂ concentration setting regardless of the user-set O ₂ setting.	1. Verify that the O ₂ source pressure is 40 to 87 psig. 2. Perform the high pressure leak test (section 9.5). 3. Verify O ₂ flows (section 9.12). 4. Inspect the O ₂ inlet filter for contamination or debris. 5. Replace the O ₂ valve. 6. Replace the DA PCBA.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
1112 (CBIT)	O ₂ pressure sensor range error. The ventilator continues to deliver breaths targeting the 21% O ₂ concentration setting regardless of the user-set O ₂ setting.	1. Verify correct O ₂ pressure sensor function. 2. Replace the DA PCBA.
1113 (POST)	Barometer calibration data error. When the integrity of the barometer calibration data cannot be verified, the ventilator uses the default barometric pressure of 686.0 mmHg (approximately 900 m/2953 ft above sea level).	Replace the DA PCBA.
1114	Barometer sensor range error. When a barometer range test fails 150 consecutive times, the ventilator uses the default barometric pressure of 686.0 mmHg (approximately 900 m/2953 ft above sea level).	1. Verify correct barometric pressure sensor function. 2. Replace the DA PCBA.
1115	Auxiliary alarm supply failed. Three consecutive measurements of the auxiliary alarm supply were less than 9.0 V or greater than 11.0 V.	1. Replace the MC PCBA. 2. Replace the PM PCBA. 3. Replace the power supply. 4. Replace the CPU PCBA.
1116	1.8 V supply failed. Twenty consecutive measurements of the 1.80 V supply were less than 1.73 V or greater than 1.88 V.	1. Replace the CPU PCBA. 2. Replace the DA PCBA.
1117	3.3 V supply failed. Twenty consecutive measurements of the 3.30 V supply were less than 3.04 V.	1. Replace the PM PCBA. 2. Replace the DA PCBA.
1118	5 V supply failed. Three consecutive measurements of the 5 V supply were less than 4.5 V or greater than 5.6 V.	Replace the PM PCBA.
1119	12 V supply failed. Twenty consecutive measurements of the 12.0 V supply measured at the DA PCBA were less than 11.5 V or greater than 13.0 V.	1. Replace the PM PCBA. 2. Replace the DA PCBA.
111A (POST)	24 V supply failed. AC power is connected to the ventilator and the 24 V supply measured on the PM PCBA were out of the range 22.6 to 26.88 V.	1. Verify the AC outlet for proper voltage. 2. Verify AC voltage before the power supply (section 6.6). If not present, replace the AC inlet. 3. Verify 24 V after the power supply. If not present, replace the power supply. 4. Replace the PM PCBA.
111B (POST)	35 V supply failed. Three consecutive measurements of the 35 V supply were less than 32.85 V or greater than 40.15 V two seconds after startup.	1. Replace the PM PCBA. 2. Replace the MC PCBA.
111C (CBIT)	DA PCBA ADC failed. Six consecutive measurements of the DAC output were greater than or less than 23 counts.	Replace the DA PCBA.
111D (CBIT)	MC PCBA ADC failed. Six consecutive measurements of the DAC output were greater than or less than 23 counts.	Replace the MC PCBA.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
111E (CBIT)	CPU PCBA ADC failed. Six consecutive measurements of the DAC output were outside the range of ± 23 counts of the DAC output used.	Replace the CPU PCBA.
111F (CBIT)	Internal temperature high at CPU PCBA. The internal temperature measured on the CPU PCBA was greater than 60°C for longer than 5 seconds.	Replace the CPU PCBA.
1120 (CBIT)	Internal temperature high at DA PCBA. The internal temperature measured on the DA PCBA was greater than 60°C for longer than 5 seconds.	1. Verify that the cooling fan is operational. 2. Replace the DA PCBA.
1121 (CBIT)	Internal temperature high at MC PCBA. The internal temperature measured on the MC PCBA was greater than 60°C for longer than 5 seconds.	1. Verify that the cooling fan is operational. 2. Replace the MC PCBA.
1122 (CBIT)	Blower temperature high. The blower temperature was greater than 95°C for longer than 60 seconds.	1. Verify that the air inlet filter is not dirty or blocked. 2. Verify that the cooling fan is operational. 3. Replace the blower. 4. Replace the MC PCBA.
1123 (CBIT)	Battery temperature high. The battery temperature was greater than 100°C.	1. Replace the internal battery. 2. Replace the PM PCBA.
1124 (CBIT)	Battery failed. When the PM PCBA detects a battery error, the ventilator continues to ventilate and the battery charger turns off.	1. Verify that the PM PCBA is equipped with PIC firmware version 1.30. 2. Replace the internal battery. 3. Replace the PM PCBA.
1125 (CBIT)	Cooling fan speed error. The cooling fan speed is less than 2000 RPM. Ventilator overheating possible.	1. Verify that the cooling fan RPM is 4000 ± 1000 RPM. 2. Replace the fan. 3. Replace the PM PCBA.
1126	Flash file system error. When the program block validity test fails, the ventilator enters the download mode.	1. Repeat the software download. 2. Replace the CPU PCBA.
1127	OVP circuit failed. The 12/3.3 V OVP circuit did not detect a 3.3 V over-voltage condition either (1) within 100 msec after the 3.3 V and/or the 12 V OVP test signal was enabled or (2) the 3.3 V and/or 12 V OVP test signal was enabled longer than 200 msec.	1. Replace the MC PCBA. 2. Replace the PM PCBA.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
1134	Blower stalled Software determined that the blower cannot produce sufficient pressure, or the Blower speed signal has failed.	1. Verify that the blower is connected to the MC PCBA. 2. Verify that the blower RPM monitor increases above 3000 RPM when the pressure controller is set to a value above 0 cmH₂O. 3. If blower RPM does not increase above 3000 RPM replace one of the following to re-establish the tachometer signal. 4. Replace blower. 5. Replace the MC PCBA. 6. Replace the CPU.
1200-120F Alarm Message Diagnostic Codes Alarm conditions that indicate a patient or ventilator condition that requires immediate attention.		
1200	Alarm message: <i>Patient Disconnect</i> Patient is no longer connected to the ventilator, either through circuit, mask, or ET tube; or the patient circuit is disconnected from the ventilator and the patient is no longer receiving ventilatory support. Ventilation continues.	1. Check patient. 2. Confirm that the ventilator and alarm settings are appropriate. 3. If the problem persists, provide alternative ventilation. Service the ventilator.
1201	Alarm message: <i>Patient Circuit Occluded</i> Patient circuit occluded.	1. Check patient. 2. Check patient circuit for bulk liquid, crimps, or blocked filter. 3. Confirm that the ventilator and alarm settings are appropriate. 4. If the problem persists, provide alternative ventilation. Service the ventilator.
1202	Alarm message: <i>Proximal Pressure Line Disconnect</i> Proximal pressure line is disconnected. Air flow to patient continues.	1. Check patient. 2. Reconnect the proximal pressure line. 3. Confirm that the ventilator and alarm settings are appropriate. 4. If the problem persists, provide alternative ventilation. Service the ventilator.
1203	Alarm message: <i>Low Leak-CO₂ Rebreathing Risk</i> Exhalation port may be occluded. Ventilation continues if possible.	1. Check patient, as possibility of CO₂ rebreathing could pose a potential problem. 2. Check the port for occlusions. 3. If the problem persists, provide alternative ventilation. Service the ventilator.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
1204	Alarm message: <i>Low Internal Battery</i> Battery can provide operating power for only an additional 15 minutes under nominal conditions. Autoresets when ventilator is connected to AC power.	1. Connect the ventilator to AC power. 2. If the problem persists, provide alternative ventilation. Service the ventilator.
1205	Alarm message: <i>Pressure Regulation High</i> Pressures exceed ventilator-defined thresholds. Ventilation continues. Autoresets when alarm condition removed. Transitions to the ventilator inoperative state if pressure continues to rise.	1. Check patient. 2. Confirm that the ventilator and alarm settings are appropriate. 3. If the problem persists, provide alternative ventilation. Service the ventilator.
1206	Alarm message: <i>High Inspiratory Pressure</i> Measured inspiratory pressure is greater than the HIP setting and the ventilator cycles into exhalation. Autoresets after a complete inspiration without the alarm condition.	1. Check patient. 2. Confirm that the ventilator and alarm settings are appropriate. 3. If the problem persists, provide alternative ventilation. Service the ventilator.
1207	Alarm message: <i>Low Inspiratory Pressure</i> Measured inspiratory pressure is less than the LIP setting.	1. Check patient. 2. Confirm that the ventilator and alarm settings are appropriate. 3. If the problem persists, provide alternative ventilation. Service the ventilator.
1208	Alarm message: <i>Oxygen Not Available</i> O ₂ supply pressure out of range, O ₂ device failed, air flow sensor and/or O ₂ flow sensor calibration failed, or O ₂ inlet pressure sensor calibration failed. The ventilator discontinues O ₂ support.	1. Check patient. 2. Check if the high/low O ₂ source is the problem and correct. 3. If the problem persists, provide alternative ventilation. Service the ventilator.
1209	Alarm message: <i>Low O₂ Supply Pressure</i> O ₂ supply pressure is less than 40 psig and delivered O ₂ is at least 5% lower than O ₂ setting. The ventilator continues to deliver as much O ₂ as possible, but ends O ₂ support when O ₂ inlet pressure drops to less than 18 psig. Autoresets when O ₂ supply pressure exceeds 23 psig.	1. Check patient. 2. Confirm that the ventilator and alarm settings are appropriate. 3. If the problem persists, provide alternative ventilation. Service the ventilator.
120A	Alarm message: <i>High O₂ Supply Pressure</i> O ₂ inlet pressure is greater than 92 psig, O ₂ enrichment ends. Autoresets when O ₂ supply pressure falls below 87 psig.	1. Check patient. If the O ₂ manifold is installed, disconnect O ₂ source from ventilator, then reconnect O ₂ source. 2. If the problem persists, provide alternative ventilation. Service the ventilator.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
120B	Alarm message: PPV Max V Estimated delivered patient tidal volume is greater than the PPV maximum volume alarm limit. Possible causes are excessive patient inspiratory effort; a significant change in the leak around the patient interface; or high PPV %, Max E, or Max R setting. Ventilator cycles to exhalation. Initially an information message. If condition persists for three consecutive PPV inspirations, this escalates to a high-priority alarm.	1. Check the patient. 2. Confirm ventilator and alarm settings are appropriate. 3. Check for circuit or mask leaks. 4. If problem persists, provide alternative ventilation. Service the ventilator.
120C	Alarm message: PPV Max P Computed target pressure is greater than the PPV maximum pressure alarm limit. Possible causes are excessive patient inspiratory effort; a significant change in the leak around the patient interface; or high PPV %, Max E, or Max R setting. Target pressure is limited. Initially an information message. If condition persists for three consecutive PPV inspirations, this escalates to a high-priority alarm.	1. Check the patient. 2. Confirm ventilator and alarm settings are appropriate. 3. Check for circuit or mask leaks. 4. If problem persists, provide alternative ventilation. Service the ventilator.
120D	Alarm message: <i>Low Rate</i> A low-priority alarm if the measured respiratory rate is less than the Lo Rate setting, escalating to a high-priority alarm in 60 sec. Begins as a high-priority alarm if: • The Lo Rate setting is ≤ 4 BPM and there are no breaths for $> 60/\text{Lo Rate}$ setting. • The Lo Rate setting is > 4 BPM and there are no breaths for > 15 sec.	1. Check patient. 2. Confirm that the ventilator and alarm settings are appropriate. 3. If the problem persists, provide alternative ventilation. Service the ventilator.
120E	Alarm message: <i>Low Minute Ventilation</i> Estimated minute ventilation is less than the Lo $\dot{V}_E$ setting. Escalates to a high-priority alarm if the alarm condition persists for more than 60 sec.	1. Check patient. 2. Confirm that the ventilator and alarm settings are appropriate. 3. If the problem persists, provide alternative ventilation. Service the ventilator.
120F	Alarm message: <i>Low Tidal Volume</i> Estimated tidal volume is less than the Lo V_T setting. Escalates to a high-priority alarm if the alarm condition persists for more than 60 sec.	1. Check patient. 2. Confirm that the ventilator and alarm settings are appropriate. 3. If the problem persists, provide alternative ventilation. Service the ventilator.
1210	Alarm message: <i>High Tidal Volume</i> Measured estimated tidal volume is greater than the Hi V_T setting. Escalates to a high-priority alarm if the alarm condition persists for more than 60 sec.	1. Check patient. 2. Confirm that the ventilator and alarm settings are appropriate. 3. If the problem persists, provide alternative ventilation. Service the ventilator.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
1211	Alarm message: <i>High Rate</i> Measured respiratory rate is greater than the Hi Rate setting. Escalates to a high-priority alarm if the alarm condition persists for more than 60 sec.	1. Check patient. 2. Confirm that the ventilator and alarm settings are appropriate. 3. If the problem persists, provide alternative ventilation. Service the ventilator.
1212	Alarm message: <i>Running on Internal Battery</i> System is powered by internal battery. Autoresets when ventilator is connected to AC power.	Connect ventilator to AC power.
1213	Alarm message: <i>Using Default Settings</i> Displayed after power on if setting values are corrupted or not set, or if default values were restored by the user.	1. Check patient. 2. Check and adjust settings as required.
1214	Alarm message: <i>AVAPS: Target Vt Not Achieved. Insufficient Max Pressure</i> AVAPS target pressure is greater than Max P setting. The ventilator limits applied pressure to Max P.	1. Check patient. 2. Confirm that pressure settings are compatible with target. 3. Evaluate pressure and volume settings.
1215	Alarm message: <i>AVAPS: Target Vt Exceeded. Min Pressure Too High</i> AVAPS target pressure is less than Min P setting. The ventilator limits applied pressure to Min P.	1. Check patient. 2. Confirm that pressure settings are compatible with target. 3. Evaluate pressure and volume settings.
1216	Alarm message: <i>Mask:x, Exh Port:y</i> <i>Use Menu to change</i> Displays when ventilator is turned on. Displays selected mask type and exhalation port.	1. Select mask and port from Menu tab. 2. Message is removed when user confirms selections, or after 5 minutes.
1218	Alarm message: <i>Power Has Been Restored</i> Power is restored following loss of power. The ventilator restarts and continues ventilation in the mode set before power was lost.	1. Check patient. 2. Confirm that the ventilator and alarm settings are appropriate.
1219	Alarm message: <i>Trigger:+x, E-Cycle:+x</i> Use Menu to change Displays when ventilator is turned on. Auto-Trak+ is active and using the displayed settings. This message is displayed for 5 minutes after start-up.	Confirm that Auto-Trak+ settings are appropriate.
122C	Alarm message: Bacteria filter must be installed onto gas outlet Displays when ventilator is turned on. An inspiratory bacteria filter must be installed on the patient gas outlet port.	1. Confirm that a bacteria filter is installed. 2. Install a bacteria filter if one is not present.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
122D	Alarm message: Cannot Reach Target Flow Indicates that machine pressure reached its maximum and could not achieve the target flow. The high flow nasal cannula size may be too small for the flow setting. This low-priority alarm occurs during high flow therapy (HFT). When there's a significant flow restriction for more than 10 seconds, a low-priority alarm occurs. After 10 seconds, the alarm escalates to a high-priority alarm.	1. Check the patient circuit for occlusions, kinks, blocked tubing, secretions, or condensation in the circuit. 2. Check the high flow therapy patient interface for blockage or displacement from the patient circuit. 3. Check that high flow patient interface size is appropriate for the flow setting. 4. Check that an occlusive interface is NOT in use (for example, a cannula seated within the nares, an NIV mask, or direct connection to an ETT/trach). 5. Check for patient movement, positioning, or coughing that may lead to increased resistance in the gas pathway.
122E	Alarm message: Patient Circuit Occluded Gas flow the patient is obstructed. Possible patient circuit occlusion. This high-priority alarm occurs during HFT. If the alarm does not autoreset despite troubleshooting and determining that there is no blockage, use the Alarm Reset button to reset the alarm and restore the set flow.	1. Check the patient circuit for occlusions, kinks, blocked tubing, secretions, or condensation in the circuit. 2. Check the high flow therapy patient interface for blockage or displacement from the patient circuit. 3. Check that high flow patient interface size is appropriate for the flow setting. 4. Check that an occlusive interface is NOT in use (for example, a cannula seated within the nares, an NIV mask, or direct connection to an ETT/trach). 5. Check for patient movement, positioning, or coughing that may lead to increased resistance in the gas pathway. 6. If the problem persists, provide alternative ventilation.
122F	Alarm message: Patient alarms are disabled during HFT Patient alarms are not available in HFT. Manually reset to confirm and clear the audible alarm.	Information only: no action required.
2000 - 200 Informational Diagnostic Codes (no user action required)		
2000	System startup (diagnostic).	Occurs when ventilator is powered on in diagnostic mode: no action required.
2001	System startup (ventilation).	Occurs when ventilator is powered on in normal ventilation: no action required.
2002	System shutdown.	Occurs when ventilator is powered off: no action required.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
2003	Restored default settings.	Occurs when default settings are restored: no action required.
3xxx	Miscellaneous events.	Information only: no action required.
5xxx: Miscellaneous Diagnostic Codes		
5000	Passed high pressure leak test.	No action required.
5001	Failed high pressure leak test. Leak detected.	1. Verify that O₂ source is adequate for this test. 2. Check for leaks at the O₂ fitting, O₂ filter element cap, O₂ solenoid valve, and O₂ pressure transducer. 3. Check that the O₂ solenoid valve is fully closed by verifying that there is zero flow across the O₂ flow sensor. If not, replace the O₂ solenoid valve. 4. Verify that the O₂ pressure transducer is reading correctly. If not, replace the DA PCBA.
5002	Failed high pressure leak test. Start pressure too low.	1. Verify that O₂ source is adequate for this test. 2. Check for leaks at the O₂ fitting, O₂ filter element cap, O₂ solenoid valve, and O₂ pressure transducer. 3. Check that the O₂ solenoid valve is fully closed by verifying that there is zero flow across the O₂ flow sensor. If not, replace the O₂ solenoid valve. 4. Verify that the O₂ pressure transducer is reading correctly. If not, replace the DA PCBA.
5003	Failed high pressure leak test. Start pressure too high.	1. Verify that O₂ source is adequate for this test. 2. Verify that the O₂ pressure transducer is reading correctly. If not, replace the DA PCBA.
5004	Failed high pressure leak test. Pressure rise detected.	1. Verify shut off valve is closed on the that O₂ source is adequate for this test. 2. Check for leaks at the O₂ fitting. 3. Check that the O₂ solenoid valve is fully closed by verifying that there is zero flow across the O₂ flow sensor. If not, replace the O₂ solenoid valve. 4. Verify that the O₂ pressure transducer is reading correctly. If not, replace the DA PCBA.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
5005	Passed system leak test.	No action required.
5006	Failed system leak test. Leak detected.	1. Verify that the leak test fitting gasket is present and undamaged. 2. Verify that the internal exhalation port, air inlet port, gas outlet port and proximal port are plugged properly. 3. Verify that the system leak test syringe tubing is properly clamped. 4. Check for disconnected or cut tubing from the GDS to the gas outlet port, and from the gas outlet port to the base assembly. 5. Check for misaligned or cut rubber boots from the GDS to the blower, and from the blower to the gas outlet port. 6. Check for leaks at the flow sensor assembly, solenoid valves, and pressure transducers. 7. Verify that the machine and proximal pressure transducers are reading correctly. If not, replace the DA PCBA.
5007	Failed system leak test. Start pressure too low.	1. Verify that the internal exhalation port, air inlet port, gas outlet port and proximal port are plugged properly. 2. Verify that the system leak test syringe tubing is properly clamped. 3. Check for disconnected or cut tubing from the GDS to the gas outlet port, and from the gas outlet port to the base assembly. 4. Check for misaligned or cut rubber boots from the GDS to the blower, and from the blower to the gas outlet port. 5. Check for leaks at the flow sensor assembly, solenoid valves, and pressure transducers. 6. Verify that the machine and proximal pressure transducers are reading correctly. If not, replace the DA PCBA.
5008	Failed system leak test. Start pressure too high.	1. Verify that the system leak test syringe tubing is properly clamped. 2. Verify that the machine and proximal pressure transducers are reading correctly. If not, replace the DA PCBA.

Table 6-2: Diagnostic Codes and Troubleshooting (Continued)

Diagnostic code	Description	Recommended repair
5009	Failed system leak test. Pressure rise detected.	1. Verify that the system leak test syringe tubing is properly clamped. 2. Verify that the machine and proximal pressure transducers are reading correctly. If not, replace the DA PCBA.
500A	Flow sensor zero calibration passed.	No action required.
500B	Flow sensor zero calibration failed. Gas outlet or internal leak orifice not blocked.	1. Verify that the gas outlet and internal leak orifice are fully blocked and repeat the calibration. 2. Perform a system leak test.
500C	Flow sensor zero calibration failed. Pressure not stabilized.	Allow the ventilator to run for 10 minutes in Diagnostic mode and repeat the calibration.
500D	Flow sensor zero calibration failed. Offset out of range.	Replace the flow sensor assembly and repeat the calibration.
5021 (POST)	Speaker test (PM PCBA & MC PCBA)	1. If FAIL is displayed, follow the recommended repair for diagnostic code 1102. 2. If PASS is displayed, no action required.

6.5 Symptom-Based Troubleshooting

Table 6-3 summarizes symptom-based troubleshooting for the ventilator. Follow the repair procedures in order until the problem is resolved.

Table 6-3: Symptom-Based Troubleshooting

Symptom	Recommended repair
Ventilation stops, but the ventilator has power. The ventilator may be in Standby or in the Vent Inoperative state. When the ventilator is in the Vent Inoperative state, continued safe ventilator operation may be in jeopardy. O ₂ flow and blower operation are disabled.	Check the patient. If the ventilator is in Standby, reconnect the patient and ventilation should resume. If the Alarm LED on the front panel is continuously lit, and/or the Vent Inoperative screen is displayed, provide alternative ventilation. Service the ventilator.
The touchscreen is unresponsive or does not respond properly. The ventilator continues to function at the selected settings. Patient settings and patient data continue to be visible and accurate, and alarms continue to be annunciated.	Check the patient. If the patient requires a setting change, provide alternative ventilation. Service the ventilator. NOTE <i>If you cannot shut off the ventilator when the touchscreen is unresponsive, press the On/Shutdown button, then the Accept button on the front bezel.</i>
The ventilator does not switch from battery to AC power.	Check the patient. Make sure that the ventilator is connected to AC power. (If the ventilator is connected to AC power and the ventilator is functioning properly, the On/Shutdown LED should be on.) If the problem persists, provide alternative ventilation. Service the ventilator.
The ventilator does not switch from AC power to battery. A backup alarm should annunciate.	Check the patient. If the problem persists, provide alternative ventilation. Service the ventilator.
The estimated exhaled tidal volume (V _T) reading is inaccurate.	Check the patient. Check for large leaks. Make sure that the ventilator and alarm settings are appropriate. Make sure an approved patient circuit is in use. Adjust the mask to ensure proper fit and adequate leak compensation. If the problem persists, provide alternative ventilation. Service the ventilator.

6.6 Miscellaneous Troubleshooting Tips

Table 6-4 summarizes troubleshooting tips for the ventilator. Follow the repair procedures in order until the problem is resolved.

NOTE

Before performing any troubleshooting, disconnect and reconnect all power (section 8.2).

Table 6-4: Miscellaneous Troubleshooting Tips

Symptom	Recommended repair
Cannot turn ventilator off because the LCD is blank or the touchscreen is unresponsive.	Press On/Shutdown and then release and press the Accept button.
Cooling fan does not operate when the ventilator is off and the internal battery is charging.	1. Replace fan. 2. Replace PM PCBA. 3. Replace power supply.
DAC ADC reference voltage failure.	Verify that the MC PCBA is fully seated onto the CPU PCBA.
Diagnostic code 100A (page 100)	Measure the 2.5V ref voltage ($2500 \text{ mV} \pm 4 \text{ mV}$) on the back side of the DA PCBA at the junction of R107 and C72 (Figure 6-1).
Diagnostic code 1102 (page 101)	Measure the resistance of the speaker (6.8 to 9.2Ω) at the housing and the terminal end (Figure 6-2).
<i>Low Leak-CO₂ Rebreathing Risk</i> alarm occurs during performance verification O ₂ accuracy test.	Verify the test setup and that the Whisper Swivel is correctly installed.
Numerous DRPTA codes with blank time and date: 00:00.00, 00-00-0000	Replace CPU

Table 6-4: Miscellaneous Troubleshooting Tips

Symptom	Recommended repair
Unexpected touchscreen response.	Calibrate the touchscreen (section 6.3).
Ventilator does not power on, amber LED flashes once every second.	Replace PM PCBA.
Ventilator operates on battery power but not on AC power.	1. Verify AC outlet for proper voltage. 2. Verify that power cord is functional. 3. Verify power supply (24V): a. With AC power disconnected, remove J1 from PM PCBA. b. Reconnect AC power. c. Verify that 24V is present between the orange and brown wires on the power supply harness connector. d. If 24V is present, replace the PM PCBA. e. If 24V is not present, go to next step. 6. Verify that AC power is present: a. Disconnect AC power. b. Remove EMI shroud. c. Reconnect AC power. d. Verify that AC voltage is present between the blue and brown wires coming from the AC inlet. e. If AC power is present, replace the power supply. f. If AC power is not present, replace the AC inlet.
Ventilator powers on by itself	1. Replace the UI PCBA. 2. Replace the power switch overlay. 3. Replace the PM PCBA.

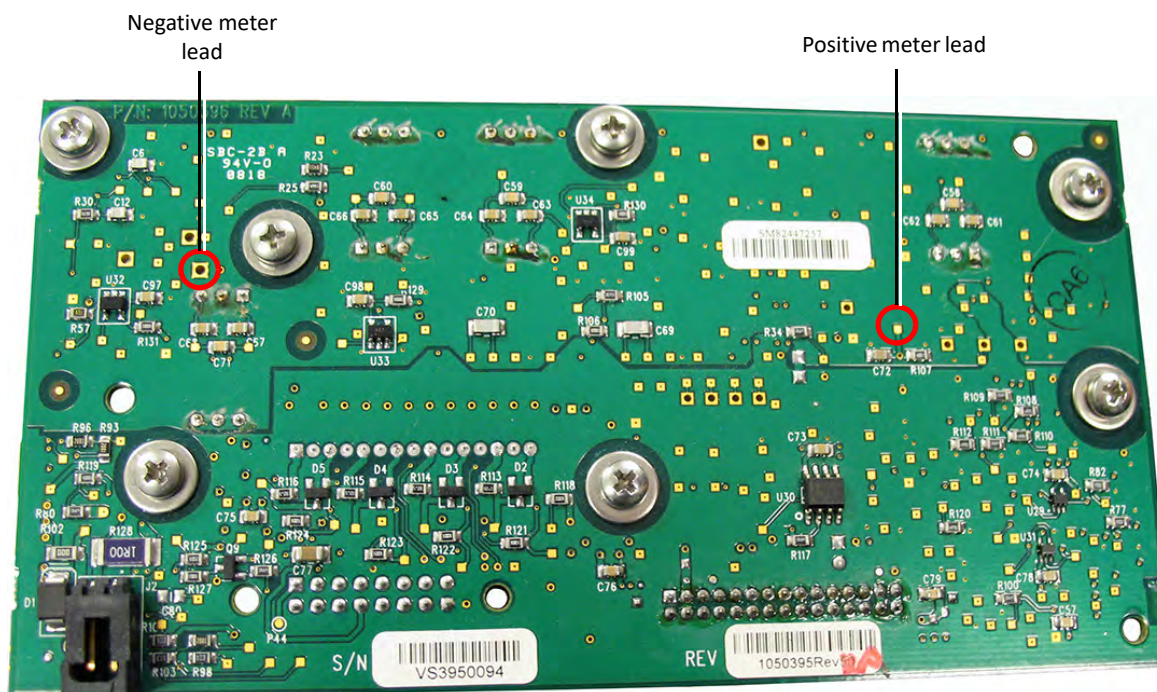
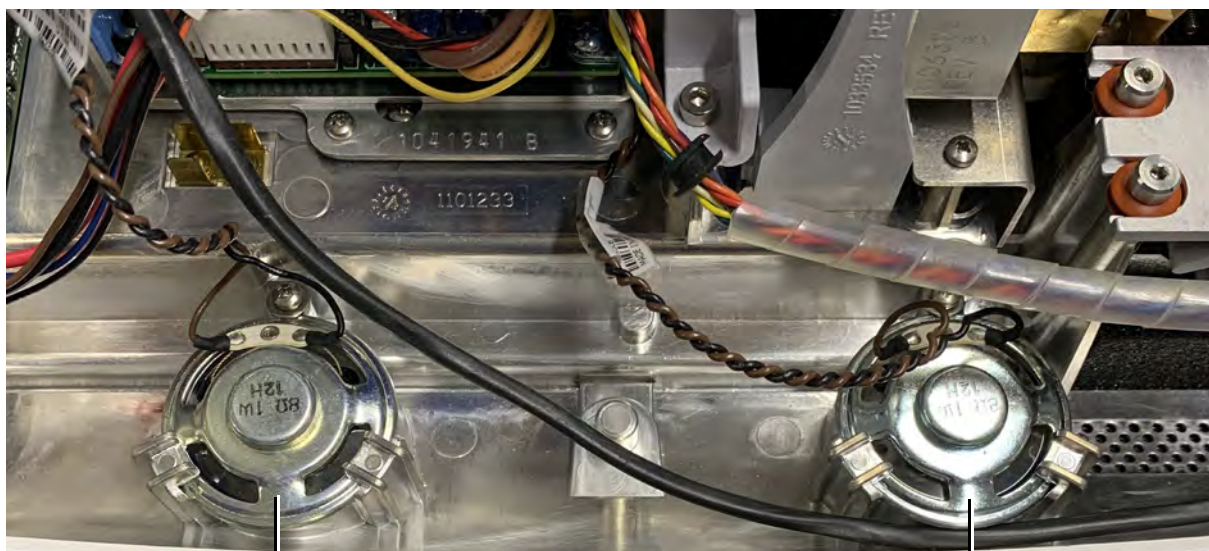
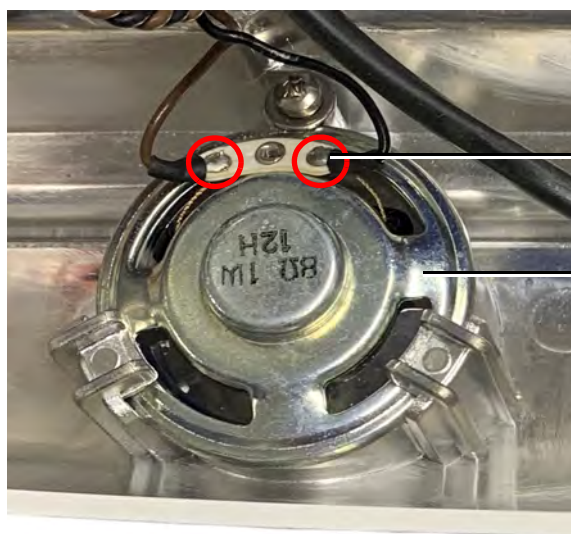


Figure 6-1: Voltage Measurement Contacts on the Data Acquisition (DA) PCBA



Primary speaker

Primary speaker



Speaker terminal

Speaker housing

Figure 6-2: Resistance Measurement Contacts on the Primary Speakers

6.7 Battery Troubleshooting Tips

In rare cases, the following battery issues may occur. Please follow the recommended actions in these situations:

Battery issue	Action to take
The battery is not fully charged	- Recharge the battery by connecting the ventilator to AC power for a minimum of 5 hours. Pressing the Help button shows the approximate time remaining until the battery is fully charged. - Replace the battery if it is not fully charged within 16 hours, or if the ventilator displays this alarm: Check Vent: Battery Failed.
The ventilator may display a high priority alarm: Check Vent: Battery Failed	- If AC power fails, and the backup battery is not functioning, an audible and visual alarm annunciates for at least two minutes. Immediately discontinue ventilator use and secure an alternative means of ventilation. - If this occurs while the ventilator is plugged into an AC power source, the ventilator continues to provide the prescribed therapy; however, the battery failure alarm cannot be cleared without power cycling the ventilator. Philips recommends switching the patient to an alternate form of ventilation and servicing the ventilator.
The battery may fail to charge if stored for an extended period of time without the ventilator plugged into AC power	- If the battery is older than five years from the date of manufacture identified on the battery label, replace the battery. - If the battery fails to charge within 16 hours, obtain a replacement battery. Install and fully charge the replacement battery, and then follow the internal battery test instructions (section 9.16).

If the backup battery fails, request a replacement battery from Philips. Do not dispose of the failed battery. In the USA only, Philips may also send a battery return kit that includes a prepaid postal label and return instructions (battery return kit order number 989805663471, part number 1146145).

7 Reports and Software Downloads

7.1	Setting Up the Service PC	120
7.2	Generating a Diagnostic Report (DRPTA)	128
7.3	Generating a Flow Sensor Zero Calibration Report (FSZR)	130
7.4	Clearing the Significant Event Log	131
7.5	Downloading Ventilator Software	132
7.5.1	Downloading Software from InCenter	132
7.5.2	Downloading Software to the Ventilator	137
7.6	Programming the Ventilator Serial Number and Power-On Hours	140
7.6.1	Programming the Ventilator Serial Number	140
7.6.2	Programming Ventilator Power-On Hours	141
7.7	Upgrading PM PCBA PMC (PIC) Firmware	141

This section describes how to set up and use a service PC to generate diagnostic reports, download software to the ventilator, or program the ventilator serial number.

7.1 Setting Up the Service PC

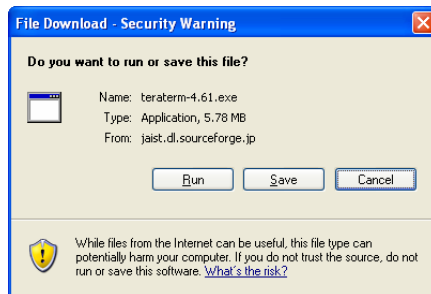
This section describes how to set up a service PC to communicate with the ventilator. Once communication is enabled, you can generate diagnostic reports, download software to the ventilator, or program the ventilator serial number.

Follow these steps to set up the Tera Terminal program, which enables the ventilator to communicate with a service PC.

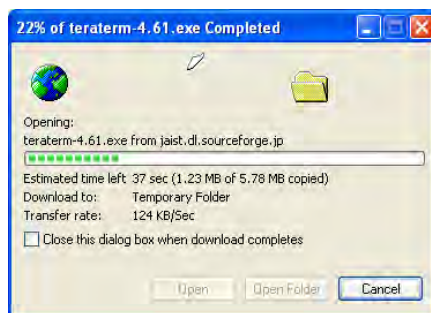
NOTE

Use Tera Term-4.79 only. Other versions will not work properly.

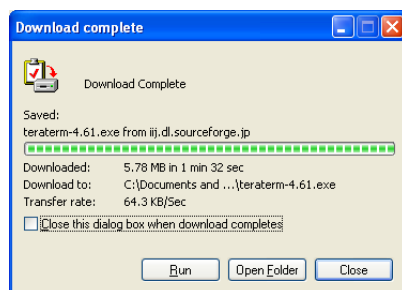
1. From your web browser go to: <http://tssh2.sourceforge.jp/>, then select the **download page** link.
2. Select **teraterm-4.79.exe**.
3. If the PC does not allow the download, follow the instructions for “click this link.”
4. Select **Run** on the **File Download** screen.



5. A progress screen is displayed during the file download.



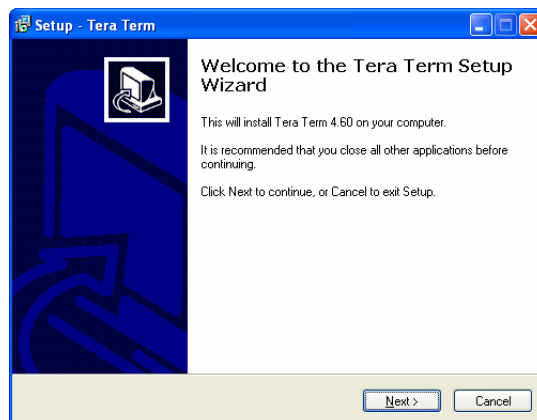
6. When the file download is complete, select **Run**.



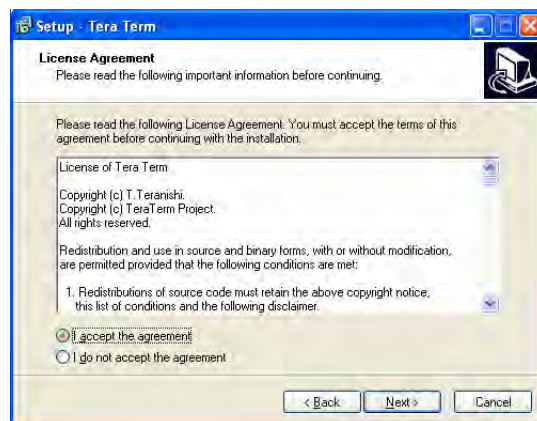
7. If the security warning screen appears, select **Run**.



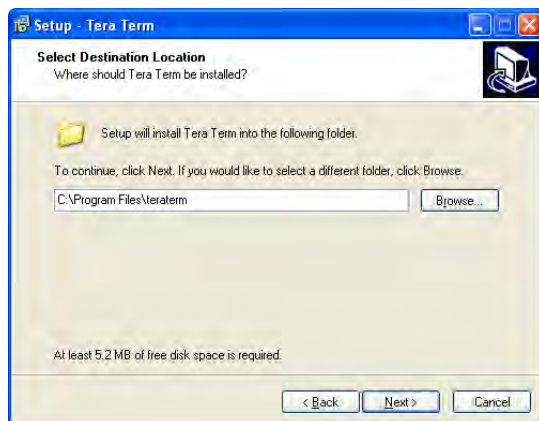
8. When the Tera Term setup screen appears, select **Next**.



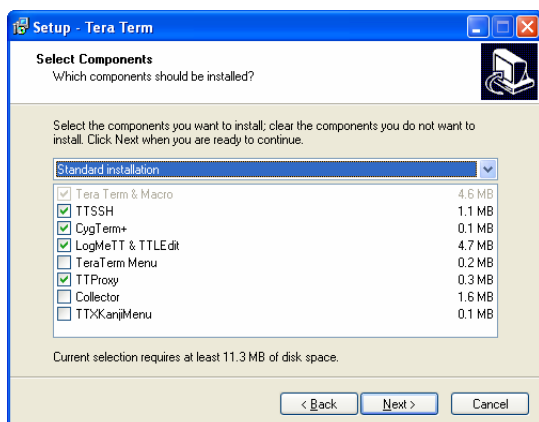
9. Select **I accept the agreement**, then select **Next**.



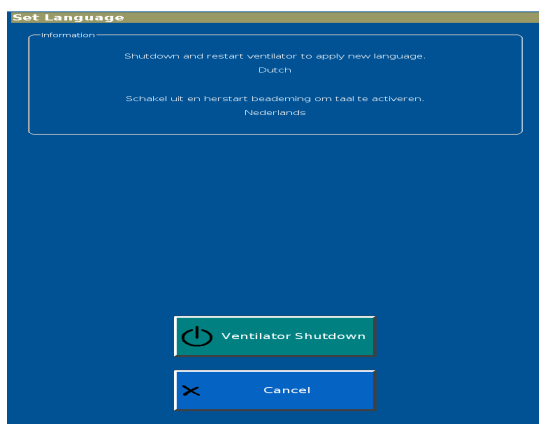
10. Select a destination, then select **Next**.



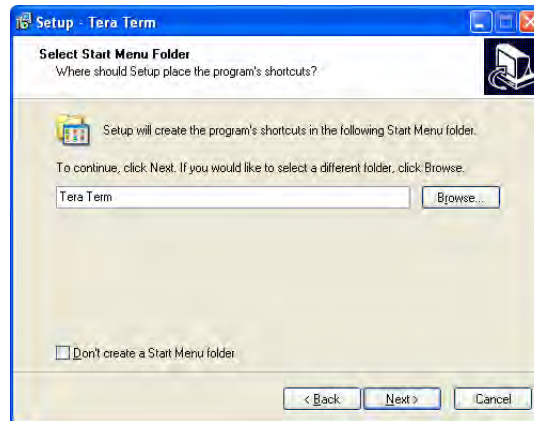
11. Select **Standard installation** on the Select Components screen, then select **Next**.



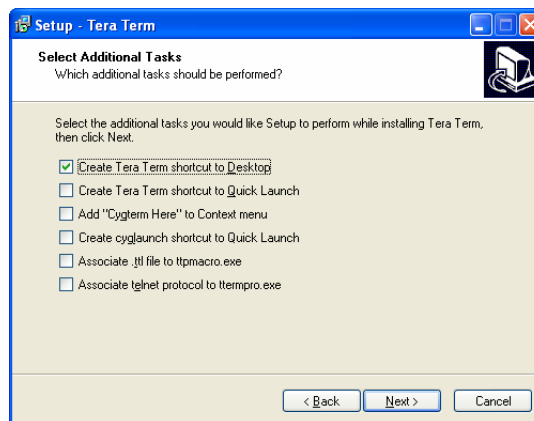
12. Select a language, then select **Next**.



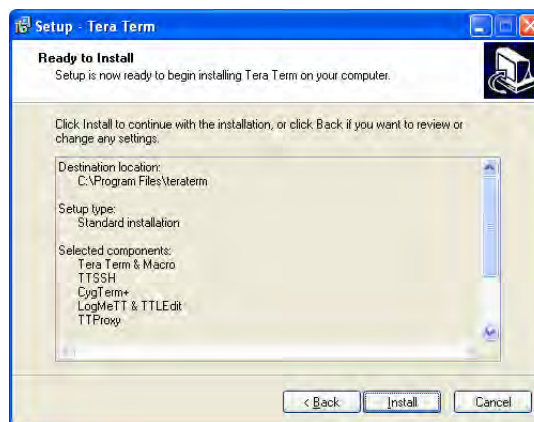
13. At the Select Start Menu screen, select **Next**.



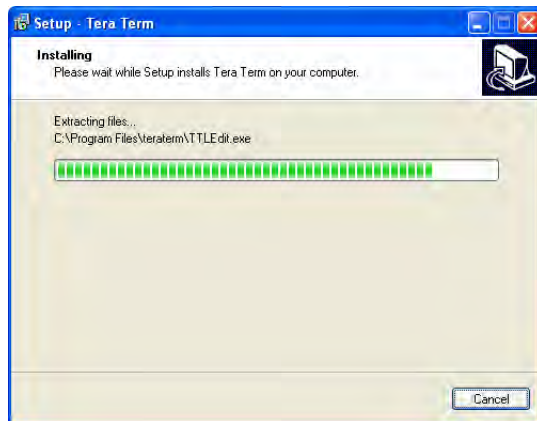
14. At the Select Additional Tasks screen select **Create Tera Term shortcut to Desktop**, then select **Next**.



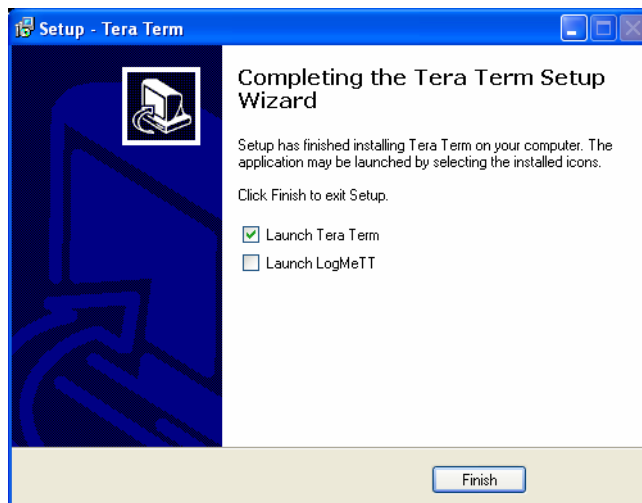
15. At the Ready to Install screen, select **Install**.



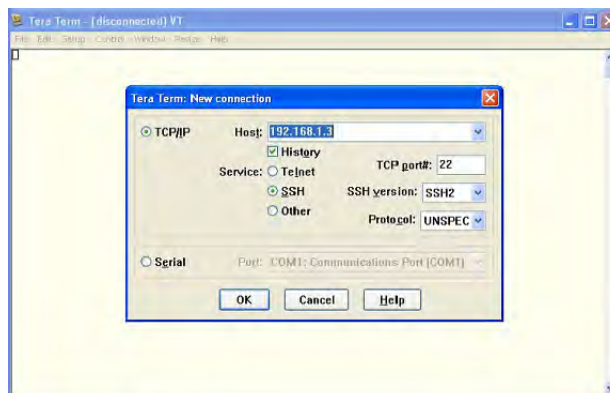
16. Tera Term begins installing on the PC.



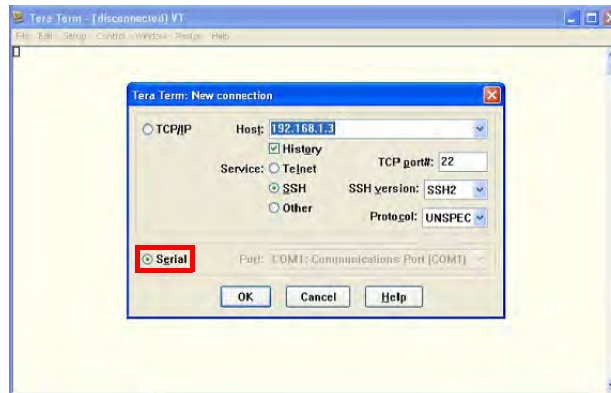
17. At the Completing the Tera Term Setup screen, select **Launch Tera Term**, then select **Finish**.



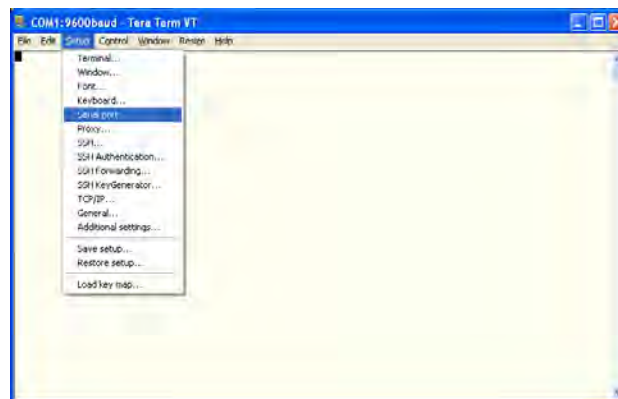
18. Once the Tera Term Setup is installed, the New Connection screen appears.



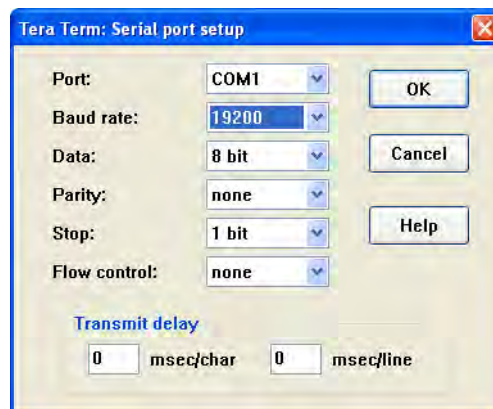
19. Select **Serial**, then **OK**.



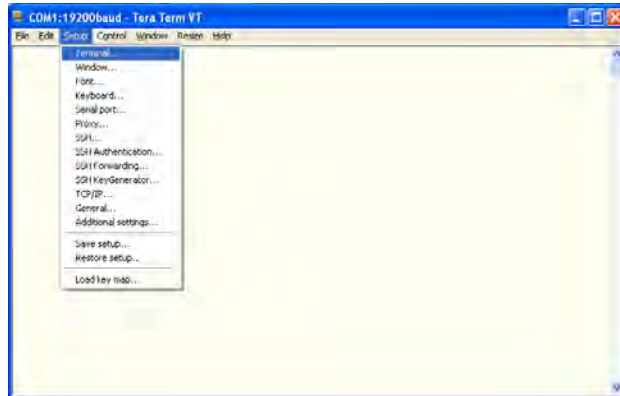
20. Select **Setup**, then **Serial port**.



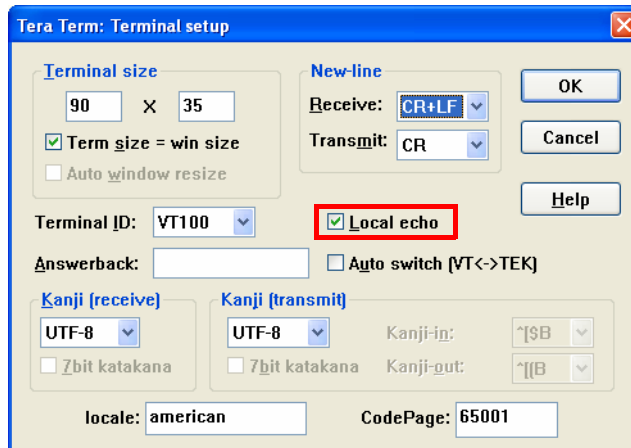
21. Select the following serial port properties, then **OK**.
Note: ensure that the *Port* selection matches the COM port in use.



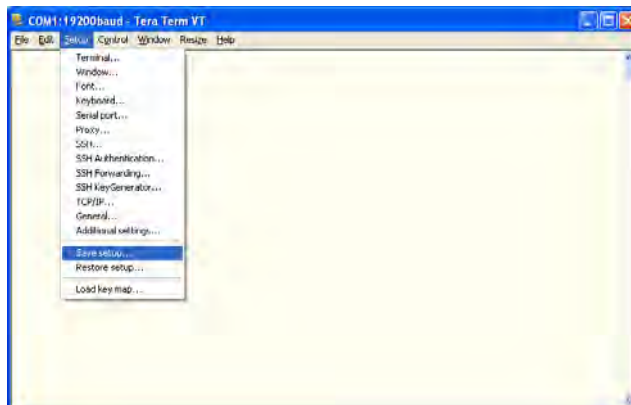
22. Select **Setup**, then **Terminal**.



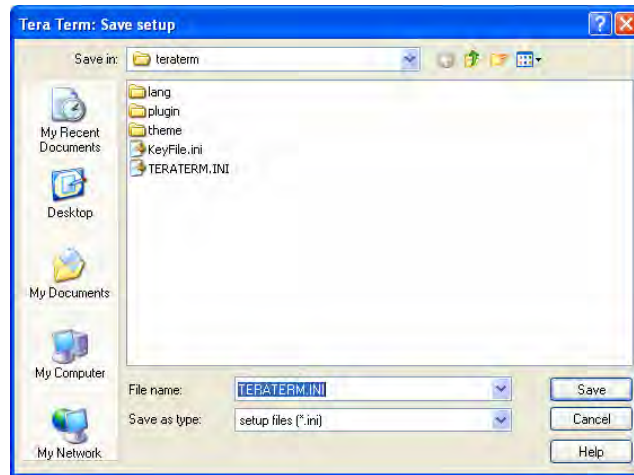
23. Select the following terminal properties, then **OK**.



24. Select **Setup**, then **Save setup**.



25. At the Save setup screen, select **Save**.



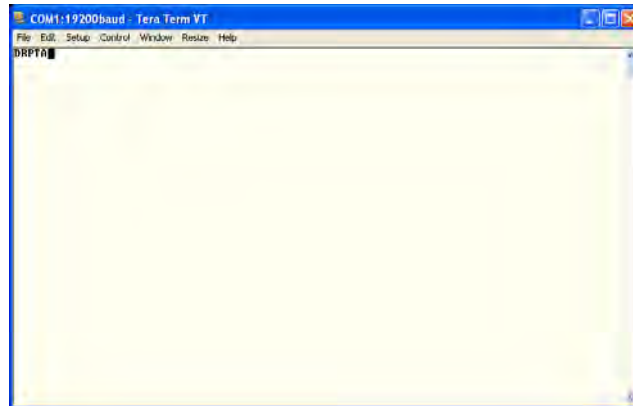
7.2 Generating a Diagnostic Report (DRPTA)

Use the DRPTA command to save ventilator diagnostic codes to a computer.

NOTE

Do not connect the null modem cable until instructed to do so. If the null modem cable is already connected when the ventilator powers on, the ventilator and PC cannot communicate. In such a case, disconnect the cable from the ventilator, switch off ventilator power, and remove all power sources (AC and battery) from the ventilator. Reconnect and switch on ventilator power, then reconnect the null modem cable to the ventilator.

1. Place the ventilator in Diagnostic mode.
2. Connect the 25-pin to 9-pin HIS/EMR null modem cable between the PC serial port and the ventilator.
3. Launch Tera Term to enable communication with the ventilator.
4. Type **DRPTA** (all caps) in the dialog box and press Enter.



- If the command is successful, a DRPTA appears.

```

COM1:19200baud - Tera Term VT
File Edit Setup Control Window Resize Help
DRPTA
?ERROR,06:15 , [^~^~^~]
DRPTA
DRPTA,06:15 ,2000,06:09.41AM,01-26-2009,System Startup (Diagnostic)
1213,06:09.41AM,01-26-2009,UsingDefaultSettings
2002,04:30.40PM,01-23-2009,System Shutdown
2000,04:09.23PM,01-23-2009,System Startup (Diagnostic)
1213,04:09.22PM,01-23-2009,UsingDefaultSettings
2002,04:09.16PM,01-23-2009,System Shutdown
2003,04:09.01PM,01-23-2009,Restored default settings
2000,12:52.19PM,01-23-2009,System Startup (Diagnostic)
2002,04:11.24PM,01-22-2009,System Shutdown
2000,02:24.40PM,01-22-2009,System Startup (Diagnostic)
2002,02:20.39PM,01-22-2009,System Shutdown
2000,08:24.12AM,01-22-2009,System Startup (Diagnostic)
2002,08:24.06AM,01-22-2009,System Shutdown
4034,08:17.04AM,01-22-2009,SettingPressureUnit 1, 0
2000,08:17.08AM,01-22-2009,System Startup (Diagnostic)
2002,08:17.43AM,01-22-2009,System Shutdown
4034,08:17.42AM,01-22-2009,SettingPressureUnit 0, 1
2000,08:02.21AM,01-22-2009,System Startup (Diagnostic)
2002,08:02.16AM,01-22-2009,System Shutdown
4025,08:00.32AM,01-22-2009,SettingLowRRLimit 10, 1
2001,08:00.17AM,01-22-2009,System Startup (Ventilation)
1217,08:00.17AM,01-22-2009,NotForPatientUse
1216,08:00.17AM,01-22-2009,Confirm Mask Port Prompt
1213,08:00.14AM,01-22-2009,UsingDefaultSettings
2002,08:00.10AM,01-22-2009,System Shutdown
2003,08:00.07AM,01-22-2009,Restored default settings
2000,07:59.41AM,01-22-2009,System Startup (Diagnostic)
2002,07:59.35AM,01-22-2009,System Shutdown
4001,07:59.30AM,01-22-2009,Mode S/T, CPAP
4002,07:59.30AM,01-22-2009,SettingPctO2 21
400E,07:59.30AM,01-22-2009,SettingCapCPAP 4
4025,07:58.56AM,01-22-2009,SettingLowRRLimit 10, 1
1200,07:58.44AM,01-22-2009,LowRate
2001,07:58.17AM,01-22-2009,System Startup (Ventilation)
1217,07:58.17AM,01-22-2009,NotForPatientUse
1216,07:58.17AM,01-22-2009,Confirm Mask Port Prompt
1213,07:58.14AM,01-22-2009,UsingDefaultSettings
2002,07:58.10AM,01-22-2009,System Shutdown
2000,00:03.13AM,03-01-2009,System Startup (Diagnostic)
1213,00:03.12AM,03-01-2009,UsingDefaultSettings
2002,00:03.07AM,03-01-2009,System Shutdown
2000,00:01.13AM,02-28-2009,System Startup (Diagnostic)
1213,00:01.12AM,02-28-2009,UsingDefaultSettings
2002,00:01.07AM,02-28-2009,System Shutdown
2000,07:37.18AM,01-22-2009,System Startup (Diagnostic)
1213,07:37.17AM,01-22-2009,UsingDefaultSettings
2002,07:37.08AM,01-22-2009,System Shutdown
4033,07:37.07AM,01-22-2009,SettingLanguage 2, 0
2000,07:36.39AM,01-22-2009,System Startup (Diagnostic)
1213,07:36.37AM,01-22-2009,UsingDefaultSettings
2002,07:36.32AM,01-22-2009,System Shutdown
4033,07:36.31AM,01-22-2009,SettingLanguage 0, 2
4033,07:30.31AM,01-22-2009,SettingLanguage 8, 0
4033,07:29.03AM,01-22-2009,SettingLanguage 0, 8
4033,07:27.04AM,01-22-2009,SettingLanguage 1, 0
4033,07:26.59AM,01-22-2009,SettingLanguage 0, 1
4033,07:26.36AM,01-22-2009,SettingLanguage 8, 0
4033,07:26.28AM,01-22-2009,SettingLanguage 0, 8
2000,06:32.25AM,01-22-2009,System Startup (Diagnostic)
1213,06:32.25AM,01-22-2009,UsingDefaultSettings
2002,02:58.57PM,01-21-2009,System Shutdown
2000,01:18.46PM,01-21-2009,System Startup (Diagnostic)
1213,01:18.46PM,01-21-2009,UsingDefaultSettings
2002,03:04.27PM,01-20-2009,System Shutdown
4033,02:34.32PM,01-20-2009,SettingLanguage 1, 0
4034,02:33.16PM,01-20-2009,SettingPressureUnit 1, 0

```

These example lines of a DRPTA report explain how to interpret DRPTA information.

2000,04:09.23PM,01-23-2009,System Startup (Diagnostic)

	Time of event	Date of event	Description
Diagnostic code			

4025,08:00.32AM,01-22-2009,SettingLowRRLimit 10, 1

	Time of event	Date of event	Description	
Diagnostic code				New setting
				Previous setting

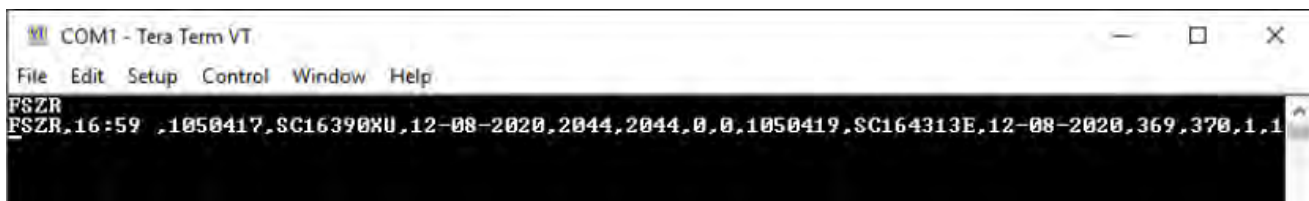
7.3 Generating a Flow Sensor Zero Calibration Report (FSZR)

The FSZR command saves the details of the air and O₂ flow sensor zero calibrations to a service PC.

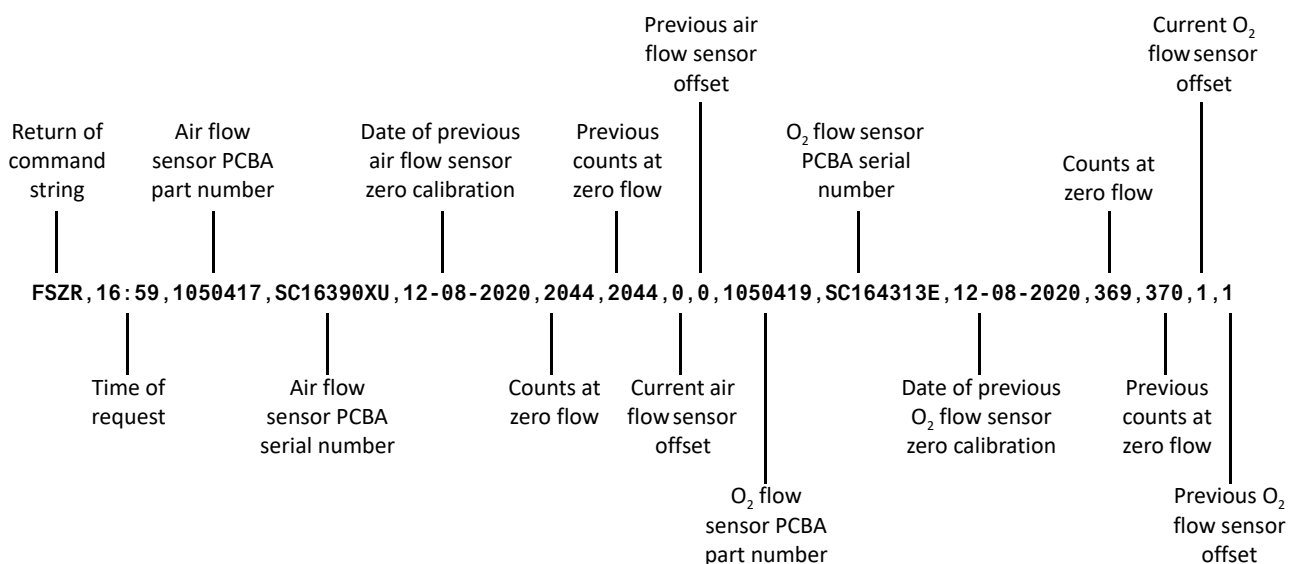
NOTE

Do not connect the null modem cable until instructed to do so. If the null modem cable is already connected when the ventilator powers on, the ventilator and PC cannot communicate. In such a case, disconnect the cable from the ventilator, switch off ventilator power, and remove all power sources (AC and battery) from the ventilator. Reconnect and switch on ventilator power, then reconnect the null modem to the ventilator.

1. Place the ventilator in Diagnostic mode.
2. Connect the 25-pin to 9-pin HIS/EMR null modem cable between the PC serial port and the ventilator.
3. Launch Tera Term to enable communication with the ventilator.
4. Type **FSZR** (all caps) in the dialog box and press Enter.
5. If the command is successful, the FSZR appears.



6. This example line of an FSZR report explains how to interpret FSZR information.



7.4 Clearing the Significant Event Log

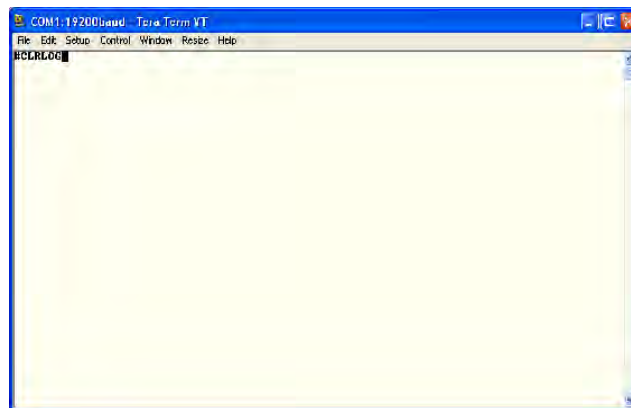
Use the #CLRLOG command to allow the PC to clear the significant event log.

CAUTION

Only qualified service technicians are to clear the significant event log.

NOTE

- *Clear the significant log only after using the DRPTA command to save the information to the PC using Tera Term.*
 - *Do not connect the null modem cable until instructed to do so. If the null modem cable is already connected when the ventilator powers on, the ventilator and PC will not communicate. In such a case, disconnect the cable from the ventilator, switch off ventilator power, and remove all power sources (AC and battery) from the ventilator. Reconnect and switch on ventilator power, then reconnect the null modem cable to the ventilator.*
1. Enter Diagnostic mode by pressing and holding the Accept button and turning on the ventilator by pressing the On/Shutdown button. Within 5 seconds, press the Accept button again to enter Diagnostic mode.
 2. Connect the 25-pin to 9-pin HIS/EMR null modem cable between the PC serial port and the ventilator.
 3. Launch Tera Term to enable communication with the ventilator.
 4. Type: **#CLRLOG** (all caps) in the dialog box, and press Enter to clear the diagnostic log.



5. When the diagnostic log has been successfully cleared, this message appears:
?CLRLOGOK
6. Clearing the diagnostic log is complete.

7.5 Downloading Ventilator Software

Download ventilator software from InCenter, or contact Philips to request a service representative installation on site (charges may apply).

Worldwide, visit Philips at www.healthcare.philips.com:

1. Select your location and language.
2. Select the **About** drop-down menu.
3. Select **Contact**. Call the Response Center nearest you or visit Philips' website.

7.5.1 Downloading Software from InCenter

If you do not have an InCenter account:

1. Send an email to PCCI_CS_OPS@philips.com that includes:
 - Subject line: ***Request for access to InCenter Service P&S and Software Downloads for Respiratory Care-Ventilators.***
 - Customer full name
Company/institution
Street address
City, state, postal/zip code
Country
 - Telephone number
 - Email address
 - V60/V60 Plus product serial number (to confirm that the request is from a valid customer).
2. The InCenter team processes your request and emails a temporary password to you within 72 hours.
3. Once you log into InCenter, you can create a new password.

If you already have an InCenter account, use this link:

Philips/InCenter2.0/login (or <https://philips.mizecx.com/login.html>).

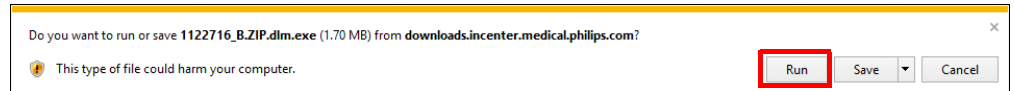
Once you are logged in:

1. Select **Service**.
2. Select **Software > Software Downloads > Respiratory Care-Ventilation**.
3. Select **V60**.
4. Select the appropriate **Software Version**.
5. Create a folder on the desktop named *V60 Operational Software*.

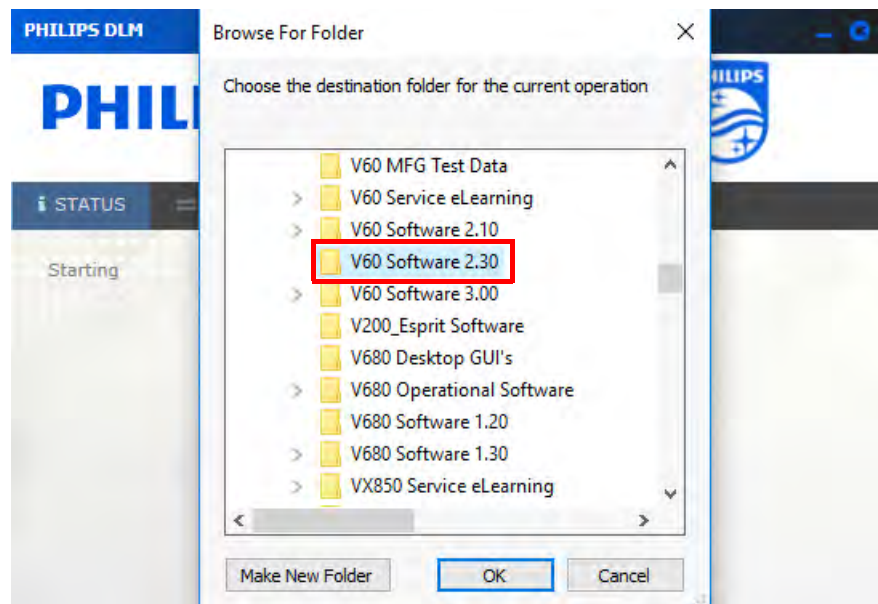
6. Select the **V60 Software** link.

Section	Size
V60 Software Version 2.30 (Approved for use in ALL REGIONS EXCEPT Korea, China)	1.50 MB

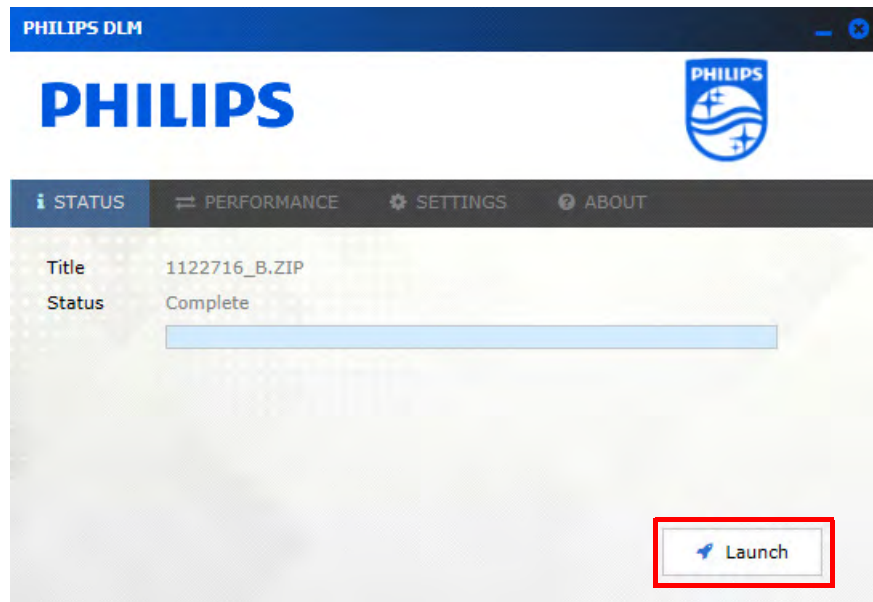
7. Select **Run** to allow the download to the service PC.



8. Select the *V60 Operational Software* folder and select **OK**.



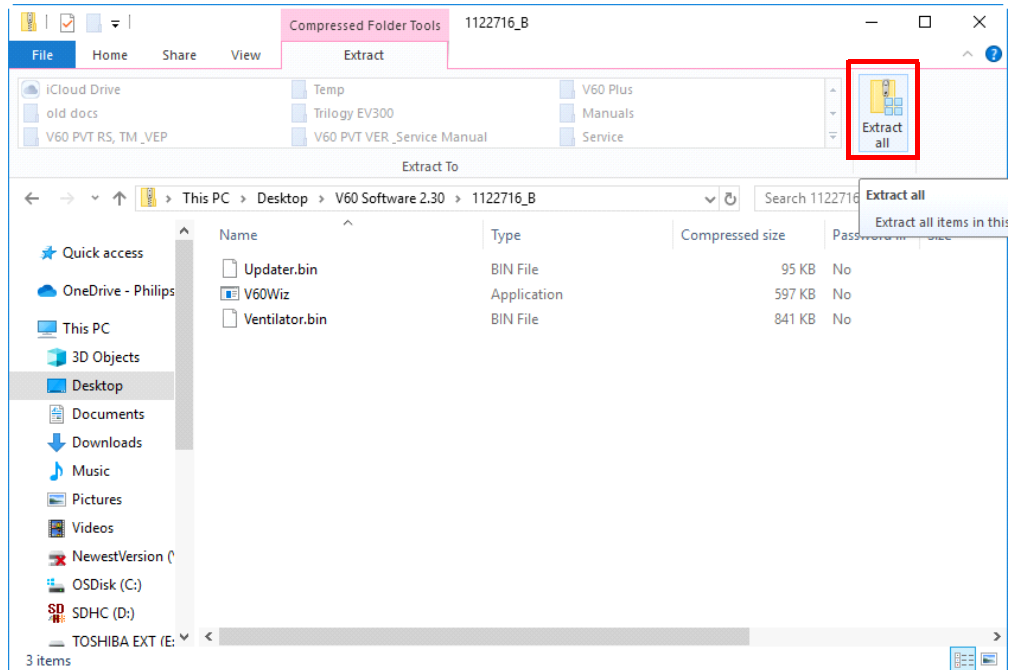
9. When the download is complete, select **Launch** to open.



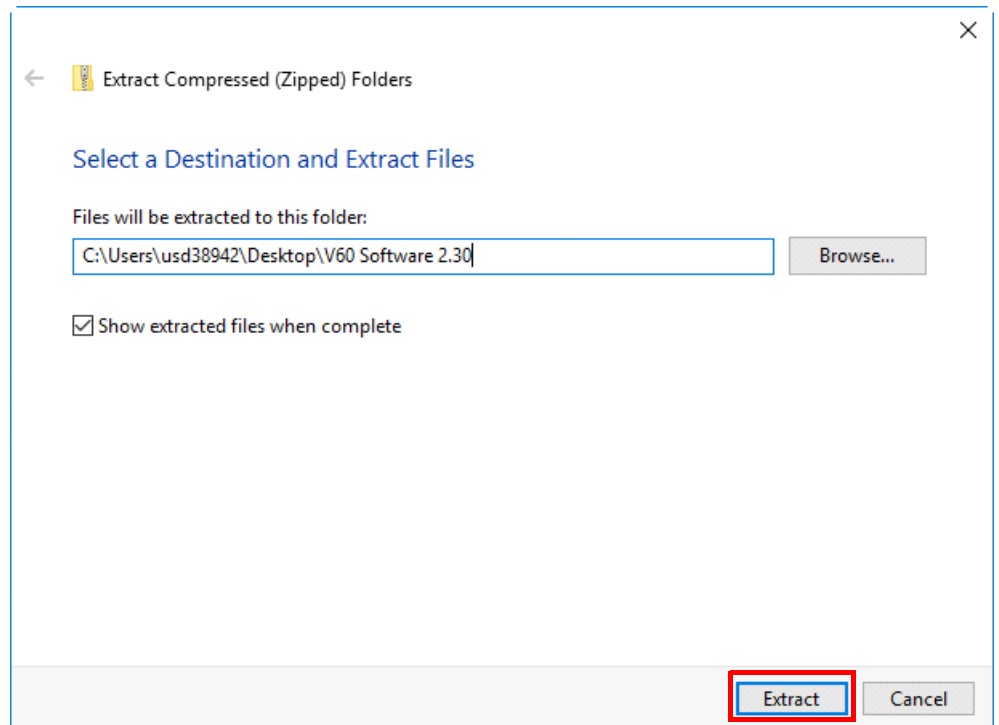
10. Double-click on the zip file to access the content.



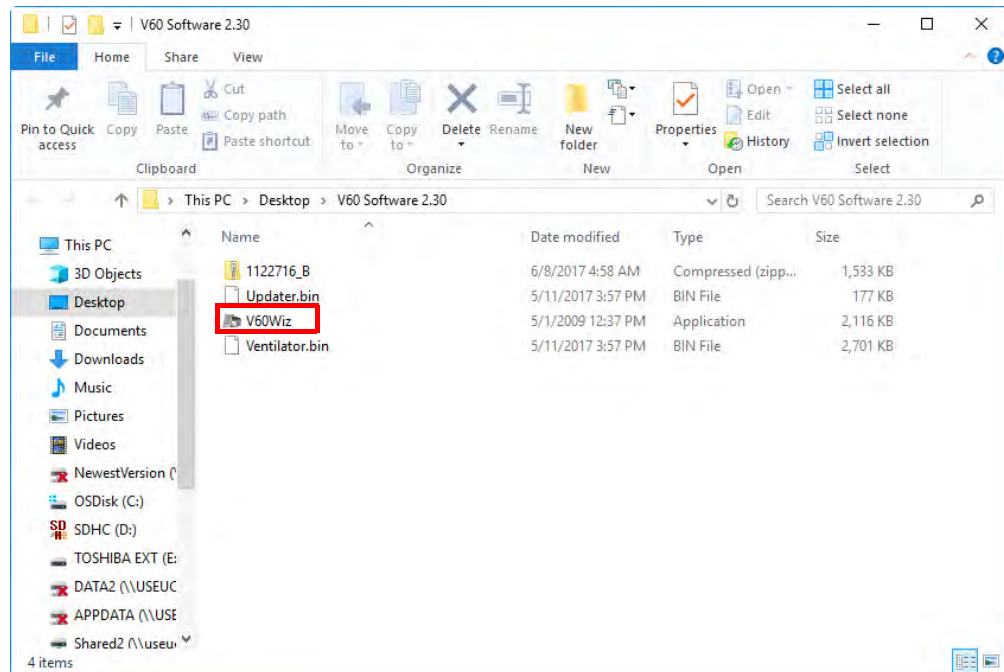
11. Select **Extract all**.



12. Navigate to the *V60 Operational Software* folder and select **Extract**.



13. The **V60** Download Wizard is now ready to launch.



7.5.2 Downloading Software to the Ventilator

NOTE

If a null modem cable other than the Philips HIS/EMR null modem cable is connected when the ventilator powers on, the ventilator and PC cannot communicate. In such a case, disconnect the cable from the ventilator, switch off ventilator power, and remove all power sources (AC and battery) from the ventilator. Reconnect and switch on ventilator power, then reconnect the null modem cable to the ventilator.

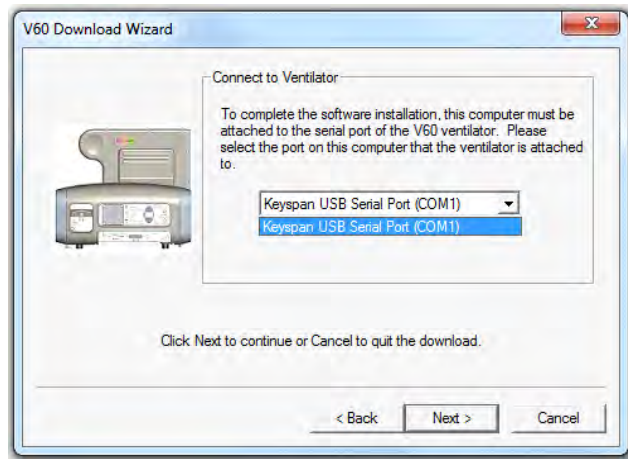
Required equipment (see section 1.2):

PC or laptop with Windows 7 or newer operating system, serial port, or USB port
Cable assembly, HIS/EMR null modem
Adapter, USB to serial (if needed)

1. Connect the 25-pin to 9-pin HIS/EMR null modem cable between the PC serial port and the ventilator.
2. If the ventilator is not already in Diagnostic mode, press and hold the Accept button and press the On/Shutdown button to turn on the ventilator. Within 5 seconds, release and press the Accept button again to enter Diagnostic mode.
3. Launch the V60 Download Wizard and place the ventilator in software download mode: select **Service**, **Misc**, then **Download** mode.
4. When the ventilator is in download mode, select **Next** to continue or **Cancel** to exit.



5. Select the serial port to which the ventilator is connected.



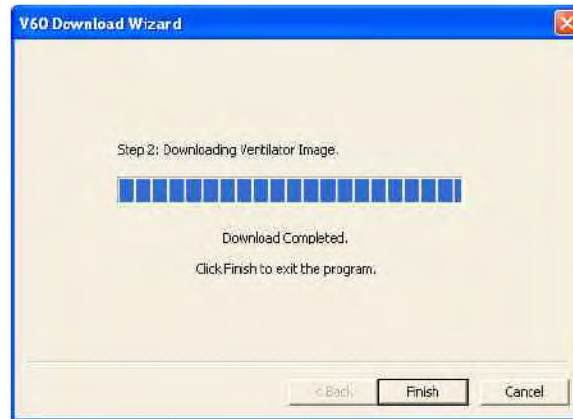
6. Select **Next** to start the download sequence or **Cancel** to exit.
7. The Updater Image download starts and shows a progress bar.



8. When the updater image download is complete the ventilator image download starts automatically.



9. When the download is complete, select **Finish**.



10. Turn the ventilator off by pressing and holding the On/Shutdown button on the user interface.
11. Enter Diagnostic mode by pressing and holding the Accept button and turning on the ventilator by pressing the On/Shutdown button on the user interface. Within 5 seconds, press the Accept button again to enter Diagnostic mode.
12. Touch **Service** and verify that the software version is correct.

Software download is complete.

NOTE

Refer to Table 9-2 for required performance verification testing to perform after a software upgrade.

7.6 Programming the Ventilator Serial Number and Power-On Hours

The ventilator serial number and power-on hours must be re-programmed to the CPU PCBA whenever you replace the CPU PCBA. Install ventilator software before programming the ventilator serial number or power-on hours.

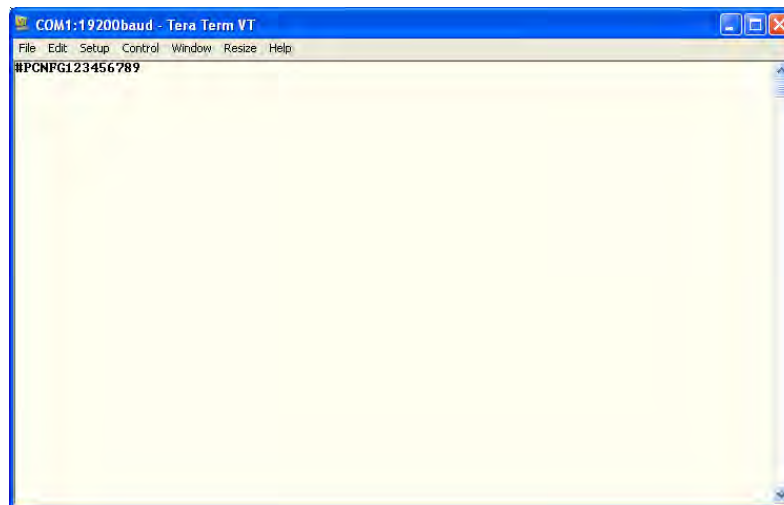
NOTE

Only qualified service technicians are to program the ventilator serial number and power-on hours.

7.6.1 Programming the Ventilator Serial Number

Follow these steps to re-program the ventilator serial number to a new CPU PCBA:

1. Enter Diagnostic mode by pressing and holding the Accept button and turning on the ventilator by pressing On/Shutdown. Within 5 seconds, press the Accept button again to enter Diagnostic mode.
2. Connect the 25-pin to 9-pin HIS/EMR null modem cable between the PC serial port and the ventilator.
3. Launch Tera Term to enable communication with the ventilator.
4. Type: **#PCNFGxxxxxxxx** (all caps) in the dialog box (xxxxxxxx is the ventilator serial number), and press Enter.



5. The ventilator stores the serial number and the dialog box displays this response:
?CFGOK
6. Touch **Misc** then **Vent Info**, and verify that the serial number displayed on the Vent Info screen matches the ventilator serial number.

Programming the serial number is complete.

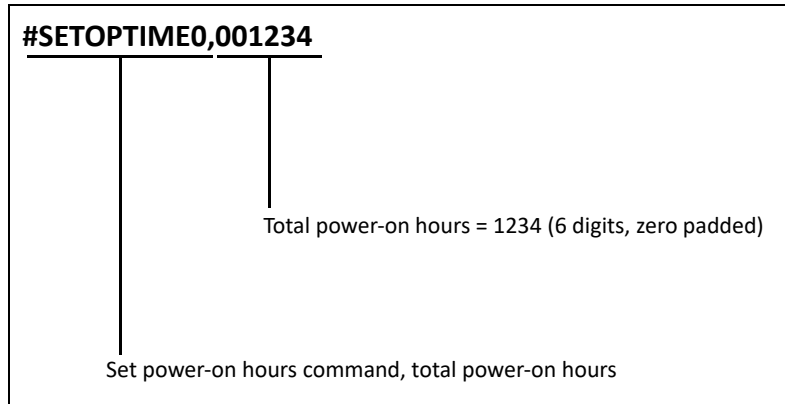
7.6.2 Programming Ventilator Power-On Hours

Follow these steps to re-program the ventilator power-on hours to a new CPU PCBA:

1. If the ventilator is not already in Diagnostic mode, press and hold the Accept button and press the On/Shutdown button to turn on the ventilator. Within 5 seconds, release and press the Accept button again to enter Diagnostic mode.
2. Connect the 25-pin to 9-pin HIS/EMR null modem cable between the PC serial port and the ventilator.
3. Launch Tera Term to enable communication with the ventilator.
4. Type: **#SETOPTIME** (all caps) with the additional information listed in the table below separated by a command, and then press **Enter**.

Field	Description
Operating time ID	0 = Total power-on hours 1 = CPU PCBA 2 = PM PCBA 3 = MC PCBA 4 = DA PCBA 5 = O ₂ flow sensor PCBA 6 = Air flow sensor PCBA
Hours	Must be 6 digits, zero padded (for example: 001234), up to a maximum of 596523.

5. For example, this command sets the total power-on hours to 1234 hours:
#SETOPTIME0,001234.



6. Programming the power-on hours is complete.

7.7 Upgrading PM PCBA PMC (PIC) Firmware

Go to InCenter [Philips/InCenter2.0/login](https://philips.incenter2.0/login) (or <https://philips.mizecx.com/login.html>) for PIC firmware upgrade instructions.

8 Removal and Installation

8.1	Repacking and Shipping	145
8.2	Disconnecting All Power	146
8.3	Air Inlet Filter	147
8.4	Internal Battery	148
8.5	Top Cover	150
8.6	AC Inlet	151
8.7	Fan	152
8.8	O ₂ Inlet Fitting	153
8.9	DA PCBA to MC PCBA Cable	154
8.10	MC PCBA Retention Bracket	155
8.11	Motor Controller (MC) PCBA	156
8.12	Separating the UI from the Base	158
8.13	Front Panel	159
8.14	Gas Outlet Port	160
8.15	UI Retainer	160
8.16	Proximal Pressure Port	161
8.17	Alarm Speakers	162
8.18	Power Management (PM) PCBA	163
8.19	Power Supply	165
8.19.1	1st Generation Power Supply and Shroud	166
8.19.2	2nd Generation Power Supply and Shroud	167
8.20	CPU PCBA	169
8.21	Real-Time Clock Battery	170
8.22	Left Side Wall	171
8.23	Gas Delivery Subsystem (GDS)	172
8.24	Right Side Wall	174
8.25	O ₂ Inlet Filter	175
8.26	Data Acquisition (DA) PCBA	176
8.27	O ₂ Solenoid Valve	178
8.28	Air and O ₂ Flow Sensor Assembly	179
8.29	Solenoid Valves	181
8.30	Blower	182
8.31	Opening the User Interface (UI)/Rear Bezel	183
8.32	Power Switch Overlay	184
8.33	Switch PCBA	185
8.34	Front Bezel, Touchscreen	186
8.35	LCD	188
8.35.1	Original (HYDIS) LCD	188
8.35.2	2nd-Generation (NEC) LCD	190
8.36	User Interface (UI) PCBA	192
8.36.1	Original UI PCBA	192
8.36.2	2nd-Generation UI PCBA	193
8.37	Backlight Inverter PCBA	194

8.38	LCD Tray	194
8.39	Bottom Feet	195
8.39.1	Removing Bottom Feet Configured for the Universal Stand	195
8.39.2	Converting Ventilator Feet (Universal Stand to V60/V60 Plus Stand)	196
8.40	Labels	197
8.41	Component Replacement Data Form	202

This section describes how to remove and install the replaceable ventilator components. Document all findings and repairs on the Component Replacement Data Form (section 8.41).

WARNING

To avoid personal injury, disconnect all power from the ventilator before servicing or cleaning.

CAUTION

- Component removal and installation is to be performed only by a qualified service technician.
 - To avoid equipment damage due to static electricity, perform all repairs in an anti-static, electrostatic discharge (ESD) protected environment.
 - Replacing the CPU PCBA deletes the serial number, significant event log entries, and ventilator preferences. Review the significant event log before removing the CPU PCBA.
-

8.1 Repacking and Shipping

CAUTION

To prevent possible damage to the ventilator, always ship it with the original packing material. If the original material is not available, contact Philips to order replacements.

NOTE

Transport of lithium ion batteries is strictly controlled by international regulations and laws. Do not ship the battery either in the ventilator or separately.

Remove the battery from the ventilator before shipping the ventilator. Ship the ventilator in appropriate packaging.

If necessary, Philips will send you a battery return kit (order number 989805663471, part number 1146145) that contains a prepaid postal label and instructions for returning the battery for failure analysis if it has failed within 5 years of its manufacture date.

8.2 Disconnecting All Power

Follow these steps to disconnect AC and battery power.

1. Shut down and then unplug the ventilator.
2. Remove the left-side (battery compartment) cover.
3. Disconnect the internal battery from the power harness connector.



8.3 Air Inlet Filter

Follow these steps to remove the air inlet filter. Reverse to install.

1. Turn the unit off and disconnect the power cord from the outlet.
2. Twist the locking pin 1/4 turn with a slotted screwdriver or by hand, and pull down on locking pin to remove right side panel (locking pin is captive).
3. Remove the air inlet filter.



8.4 Internal Battery

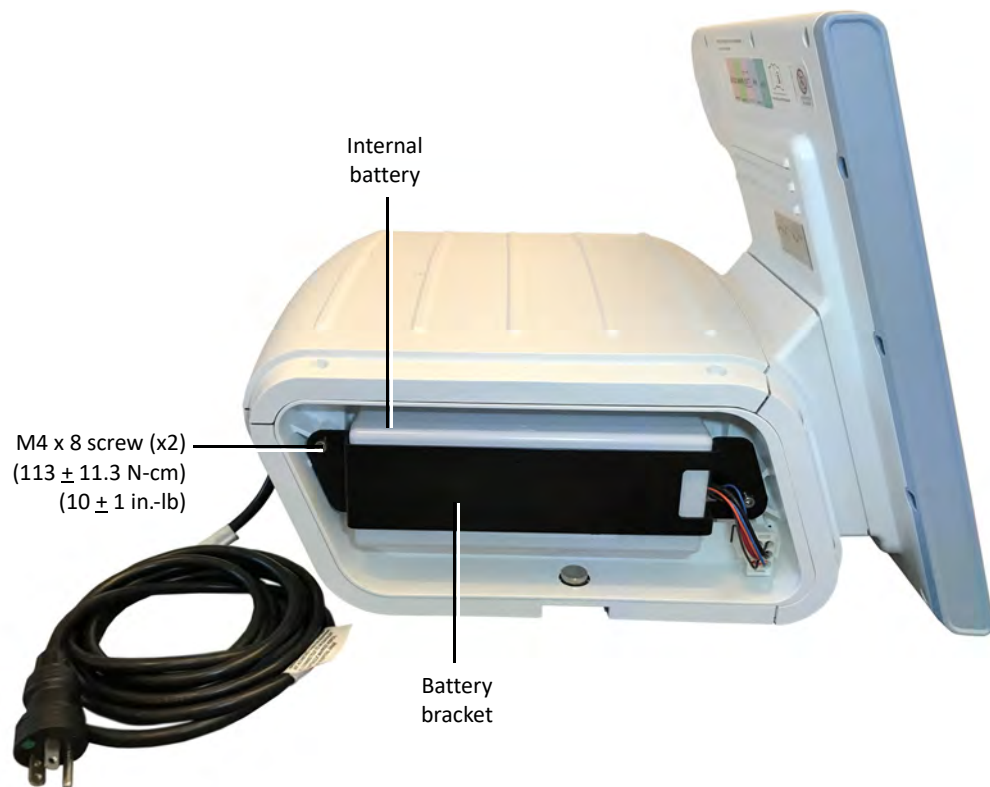
Follow these steps to remove and install the internal battery.

WARNING

- Do not attempt to connect or disconnect the battery while the battery is in use.
- Replace the battery only with another battery specified by the manufacturer. Use the battery with the V60/V60 Plus ventilator only.

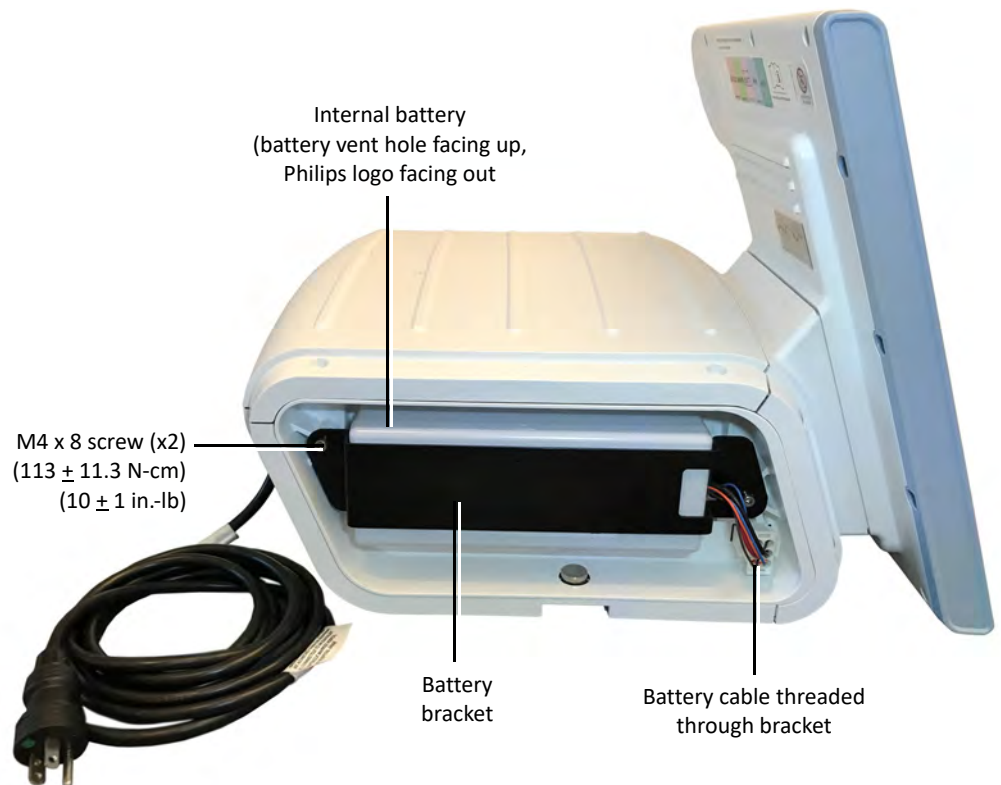
To remove the battery:

1. Turn the unit off and disconnect the power cord from the outlet.
2. Remove the side panel by turning the captive Phillips head fastener a 1/4 turn and releasing.
3. Disconnect the internal battery from the power harness connector.
4. Using a 3-mm hex wrench, remove the battery bracket by removing the screws. This permits removal of the battery from the battery compartment.



To install the battery:

1. Hold the battery so that the vent hole faces up and the Philips logo faces out. Thread the battery cable through the battery bracket. Position and place the battery inside the battery compartment. Pinch the end of the battery connector and plug it into the power harness connector until it locks into place.
2. Reinstall the battery bracket by replacing the screws (use a 3-mm hex wrench).



3. Reinstall the side panel and secure the fastener with a 1/4 turn clockwise.
4. Make sure that the battery is properly installed by plugging the ventilator into an AC power receptacle and verifying that the yellow Battery (charged) LED on the front panel flashes. The flashing LED indicates the battery is charging.

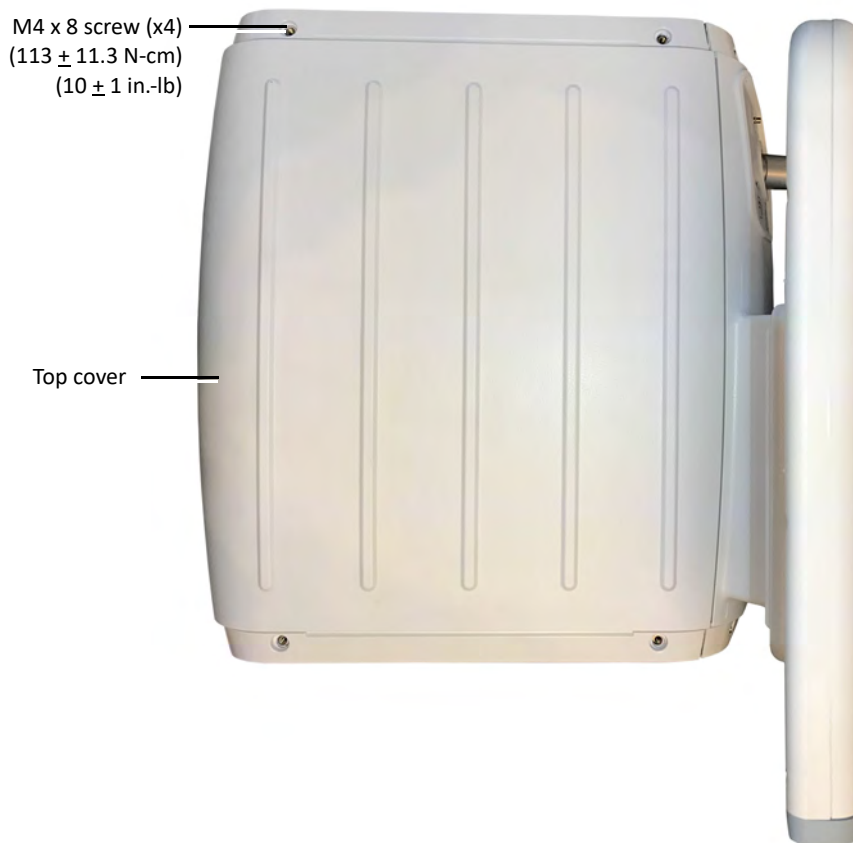
After installing a new battery:

- Charge the battery for at least 5 hours before being placing it into service.
- Dispose of the old battery according to your institution's protocol. Follow all local, state, and federal regulations with respect to environmental protection.

8.5 Top Cover

Follow these steps to remove the top cover. Reverse to install.

1. Disconnect all power (section 8.2).
2. Turn and pull down on the locking pin to remove right side panel (locking pin is captive).
3. Remove the screws that attach the top cover, then remove the top cover.

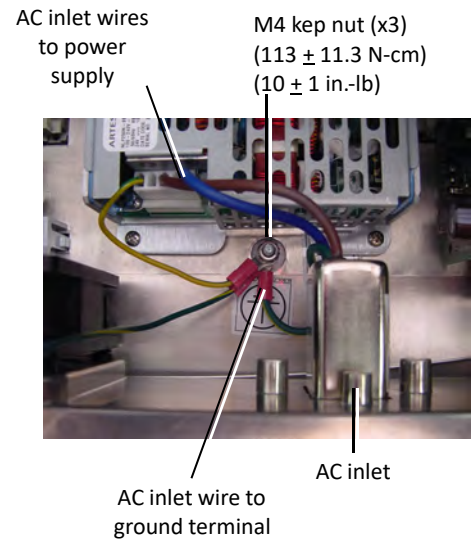
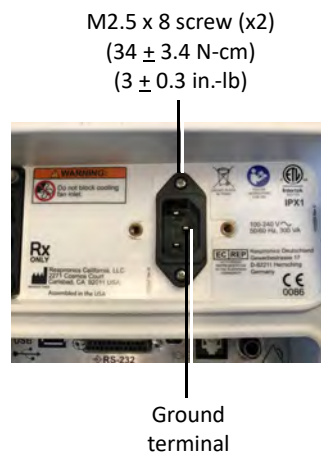
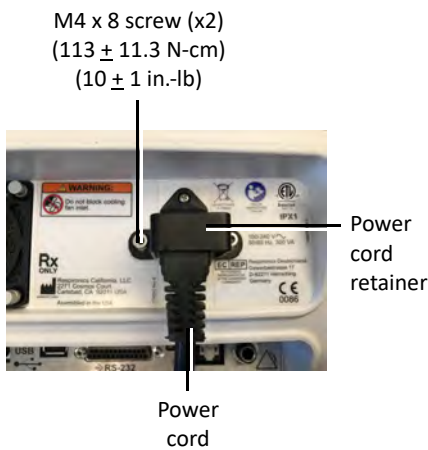


8.6 AC Inlet

Follow these steps to remove the AC inlet. Reverse to install.

1. Remove the top cover (section 8.5).
2. Remove the EMI shroud from the power supply (section 8.19).
3. Remove the screws that attach the power cord retainer, then remove the retainer and power cord.
4. Remove the screws that attach the AC inlet to the back panel.
5. Disconnect AC inlet cables from the power supply and ground terminal.
6. Feed the cable through back panel cutout, and pull the AC inlet from the back panel.
7. Install ground wires and nuts in this order to ensure proper grounding:
 - a. Kep nut
 - b. AC inlet wire
 - c. Kep nut
 - d. Power supply connector wire
 - e. GDS ground wire
 - f. Kep nut

When reinstalling, orient the AC inlet with ground terminal as shown.



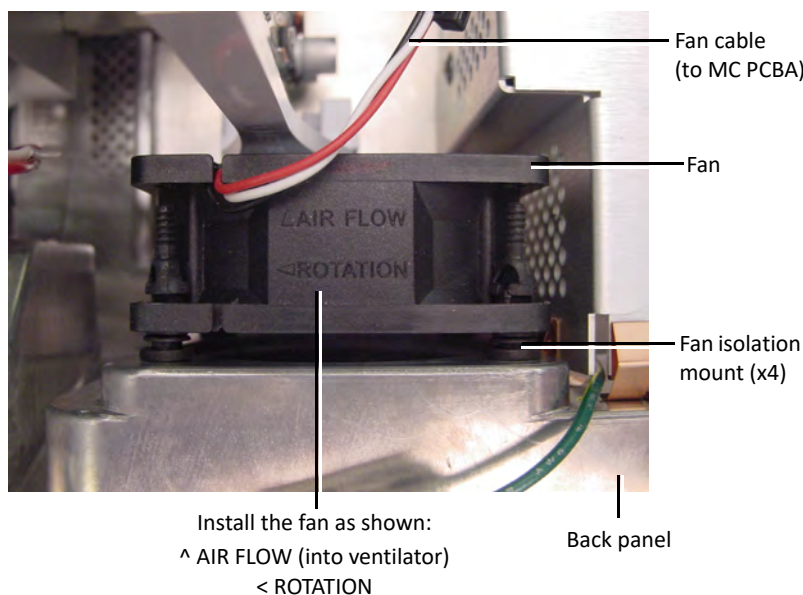
8.7 Fan

Follow these steps to remove the fan. Reverse to install. See section 5 (Maintenance) for fan filter replacement intervals.

1. Remove the top cover (section 8.5).
2. Remove the fan mount push pins that attach the fan to the back panel (pliers may be required).
3. Disconnect the fan cable from the motor controller (MC) PCBA.
4. Remove the fan from inside the back panel.
5. Remove the fan filter assembly (fan filter and housing) from outside the back panel.

NOTE

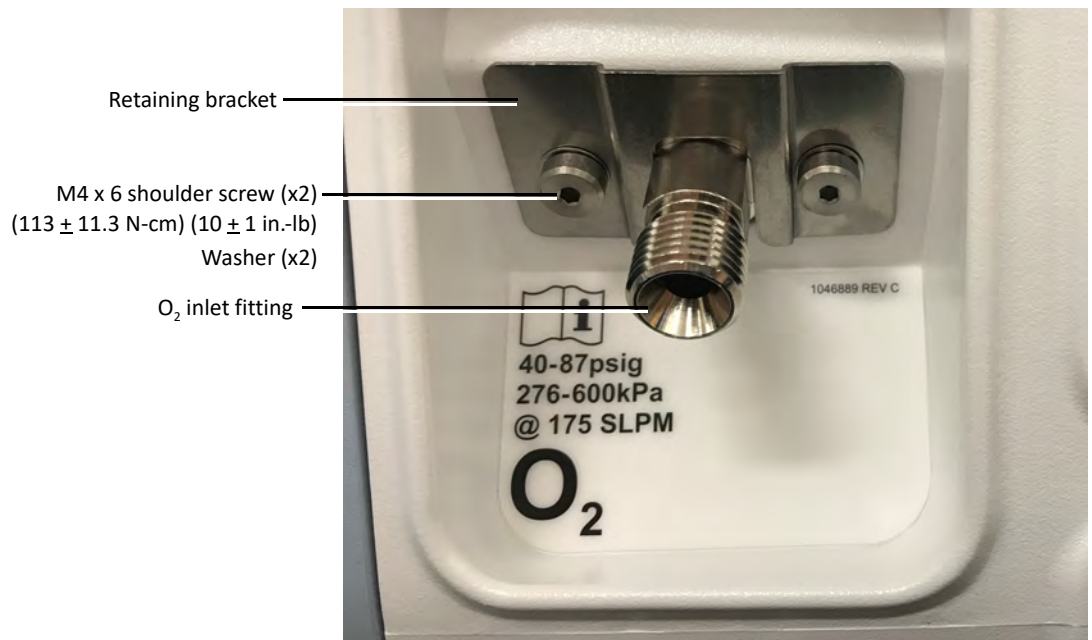
When installing, orient the fan as shown (cable at the top inside of the fan). Orient the fan filter and housing as shown.



8.8 O₂ Inlet Fitting

Follow these steps to remove the O₂ inlet fitting. Reverse to install.

1. Disconnect all power (section 8.2).
2. Loosen the screws that attach the retaining bracket to the GDS, then remove the bracket.
3. Pull to remove the O₂ inlet fitting. When installing the O₂ inlet fitting, align its flat sides so that it fits through the retaining bracket.



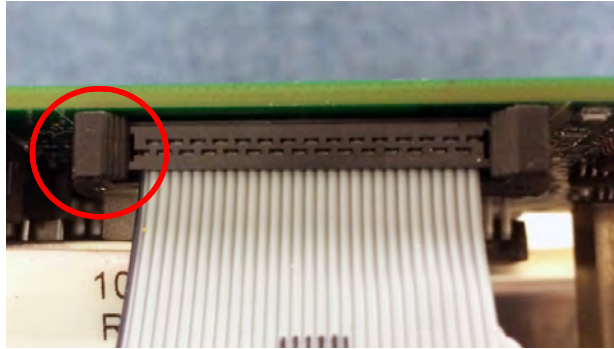
NOTE

Slight flexing of the retaining bracket may be visible. The retaining bracket is designed to flex slightly to ensure that it can be positioned securely.

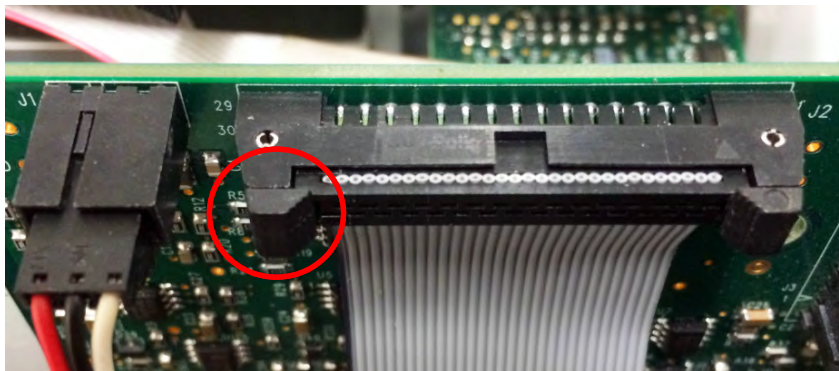
8.9 DA PCBA to MC PCBA Cable

Follow these steps to remove the DA PCBA to MC PCBA cable. Reverse to install.

1. Remove the top cover (section 8.5).
2. Release the J3 locking tabs on the DA PCBA.



3. Release the J2 locking tabs on the MC PCBA.



4. Remove the DA PCBA to MC PCBA cable from the ventilator.

CAUTION

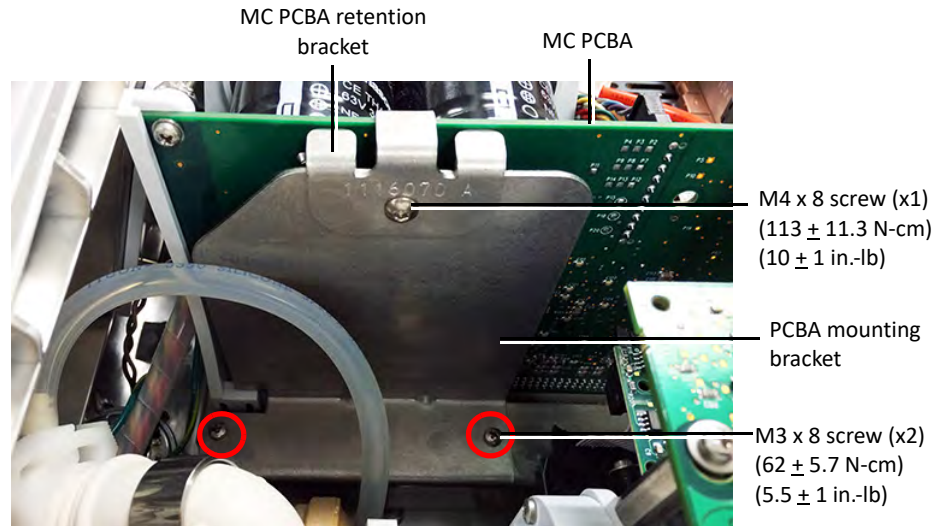
When reinstalling, verify correct cable installation.



8.10 MC PCBA Retention Bracket

Follow these steps to remove the MC PCBA retention bracket. Reverse to install.

1. Remove the top cover (section 8.5).
2. Remove the screw that attaches the MC PCBA retention bracket.

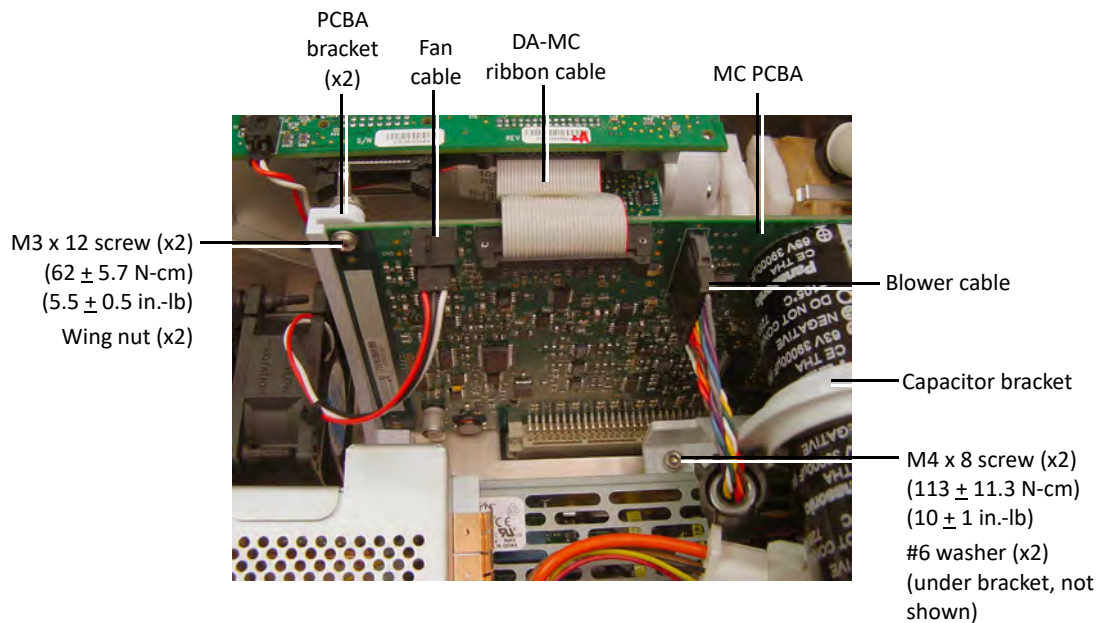


3. Remove the MC PCBA retention bracket.
4. Remove the screws that attach the PCBA mounting bracket to the base assembly.
5. Remove the PCBA mounting bracket.

8.11 Motor Controller (MC) PCBA

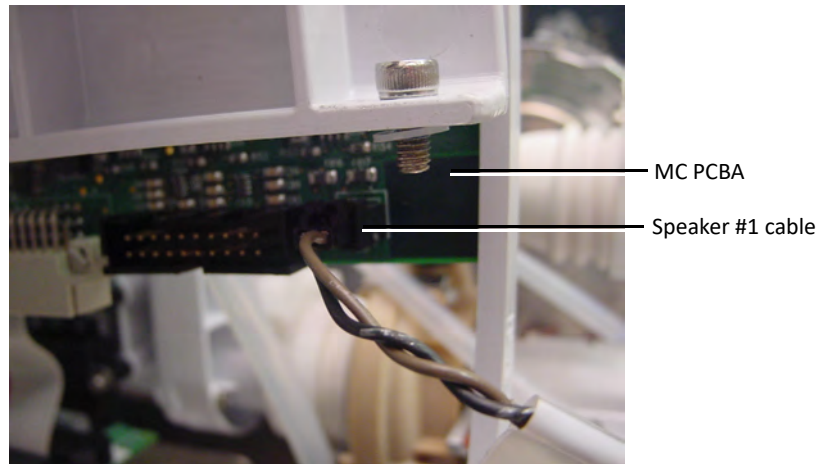
Follow these steps to remove the MC PCBA. Reverse to install.

1. Remove the top cover (section 8.5).
2. If installed, remove the MC PCBA retention bracket (section 8.10).
3. Remove the screws and wing nuts that attach the MC PCBA to the PCBA brackets.



4. Loosen the captive screws that attach the capacitor bracket to the base.
5. Disconnect cables:
 - Blower cable
 - Fan cable
 - DA-MC ribbon cable

6. Gently pull the MC PCBA up from its connection on the CPU PCBA, then disconnect the speaker #1 cable.



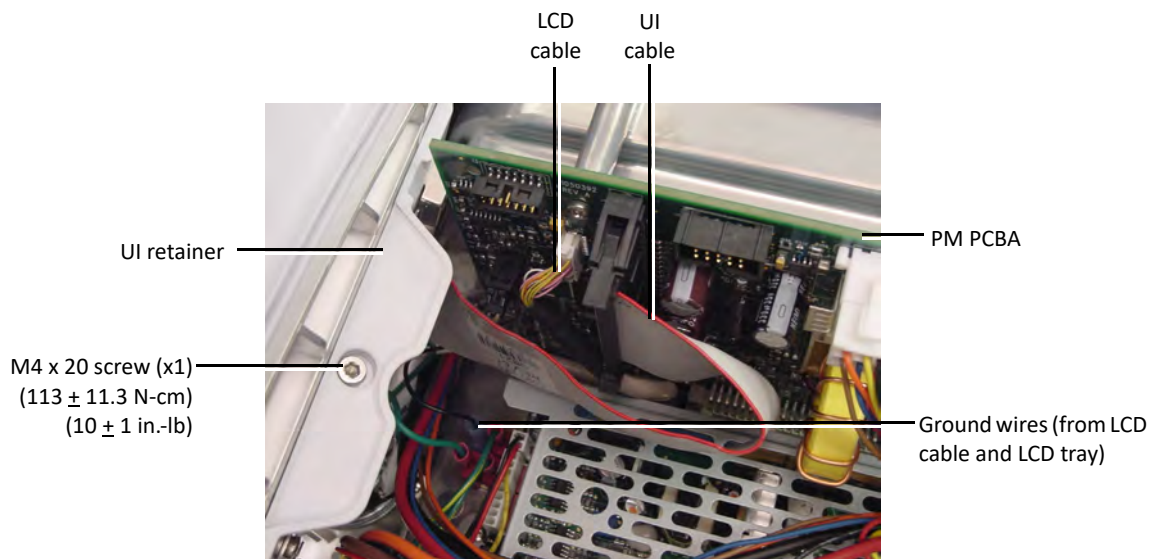
NOTE

To avoid bending connector pins, reinstall the MC PCBA, and then the PCBA brackets. Verify that the MC PCBA does not protrude above the brackets.

8.12 Separating the UI from the Base

Follow these steps to separate the UI from the base. Reverse to install.

1. Remove the top cover (section 8.5).
2. Remove the MC PCBA (section 8.11).
3. Disconnect cables:
 - LCD cable from PM PCBA.
 - LCD cable ground wires from the ground terminal.
 - LCD tray ground wires from the ground terminal.
 - UI cable (ribbon cable) from the PM PCBA.
4. Loosen the captive screw that attaches the UI retainer to the UI.
5. Slide the retainer up, then remove the UI from the base.



NOTE

- When connecting the LCD cable to the PM PCBA, ensure that the connector tab faces the front panel.
- After installing a new UI assembly, perform the touchscreen calibration (section 6.3).

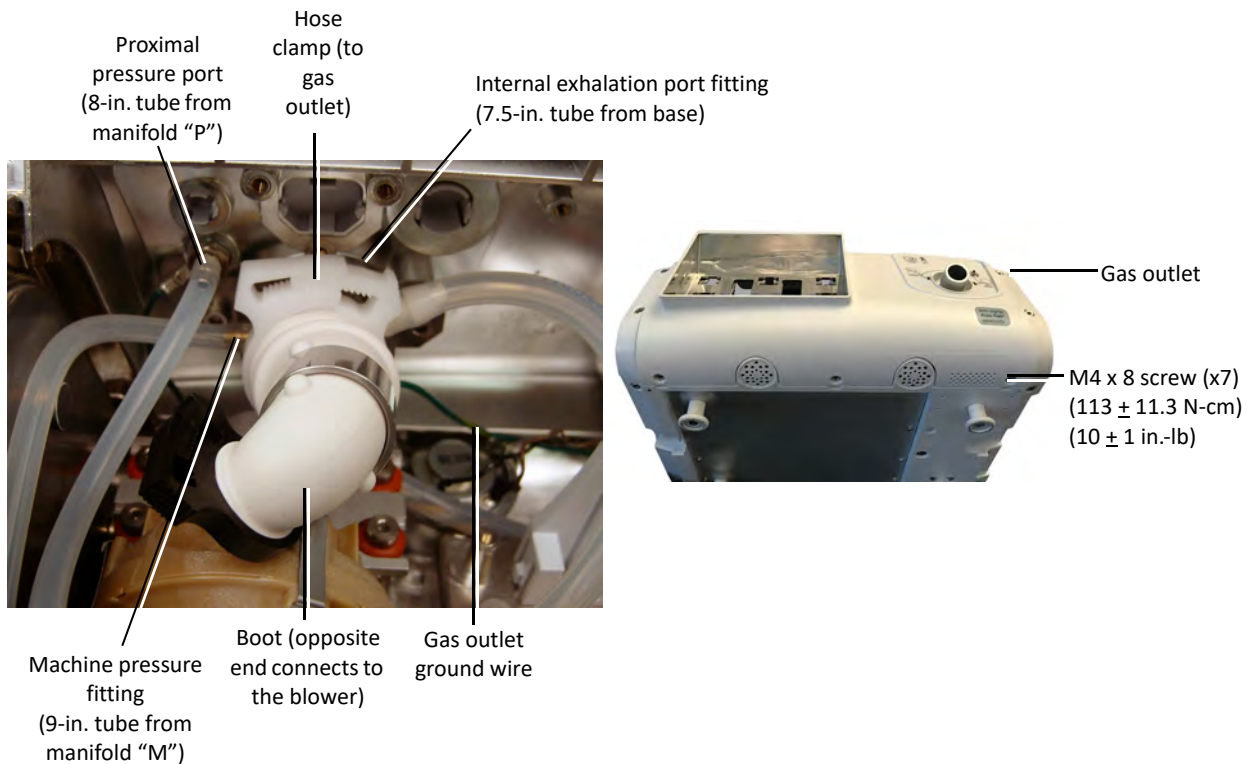
8.13 Front Panel

Follow these steps to remove the front panel. Reverse to install.

1. Separate the UI from the base (section 8.12).
2. Remove the hose clamp and boot that attach the blower to the gas outlet.
3. Remove the tubing from the barbed fittings inside the front panel.
4. Disconnect the gas outlet and proximal port ground wires from the base.
5. Remove the screws that attach the front panel to the base and side walls.

When reinstalling tubing, ensure that:

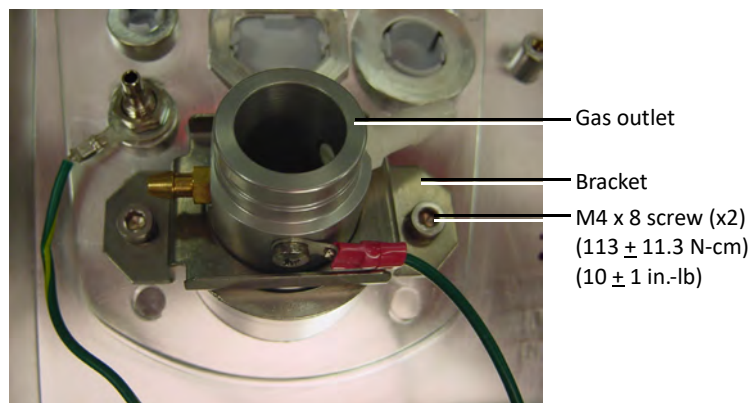
- Longer (9-in.) tube is connected between manifold barb “M” (machine) to barbed gas outlet fitting.
- Shorter (8-in.) tube is connected between manifold barb “P” (proximal) and barbed proximal pressure port.



8.14 Gas Outlet Port

Follow these steps to remove the gas outlet port. Reverse to install.

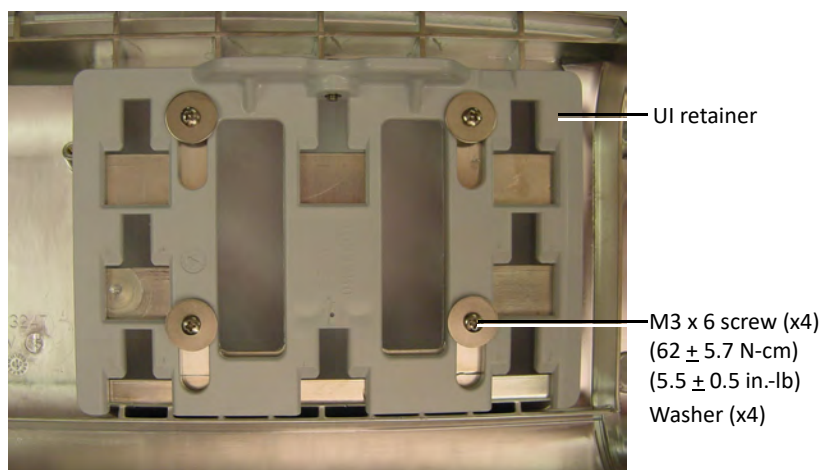
1. Remove the front panel (section 8.13).
2. Remove the screws that attach the gas outlet bracket to the inside of the front panel.



8.15 UI Retainer

Follow these steps to remove the UI retainer. Reverse to install.

1. Remove the front panel (section 8.13).
2. Remove the screws and washers that attach the UI retainer to the inside of the front panel.

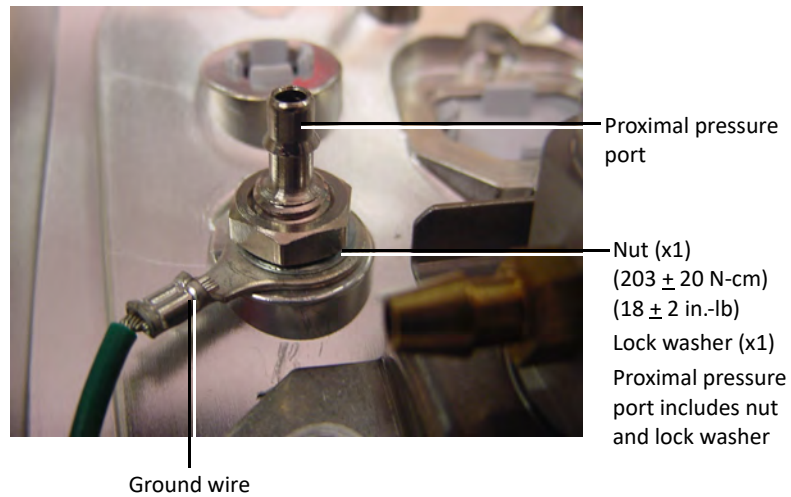


8.16 Proximal Pressure Port

Follow these steps to remove the proximal pressure port. Reverse to install.

1. Remove the front panel (section 8.13).
2. Remove the nut and lock washer that attach the proximal pressure port to the inside of the front panel. The proximal pressure port includes the nut and lock washer.)

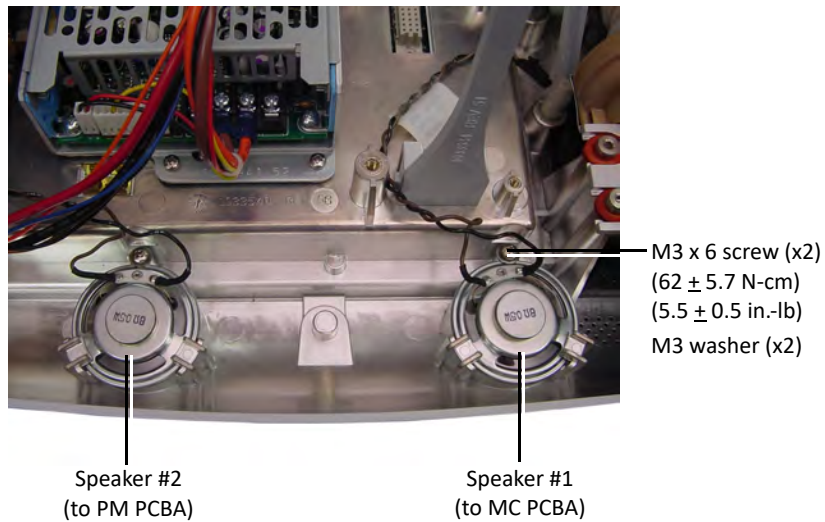
When reinstalling the proximal pressure port, install the ground wire first, then the lock washer and nut.



8.17 Alarm Speakers

Follow these steps to remove the alarm speakers. Reverse to install.

1. Remove the front panel (section 8.13).
2. Disconnect speaker #2 from the power management (PM) PCBA. (Speaker #1 is disconnected when the MC PCBA is disconnected.)
3. Remove the screw and washer that attaches each speaker to the base.



8.18 Power Management (PM) PCBA

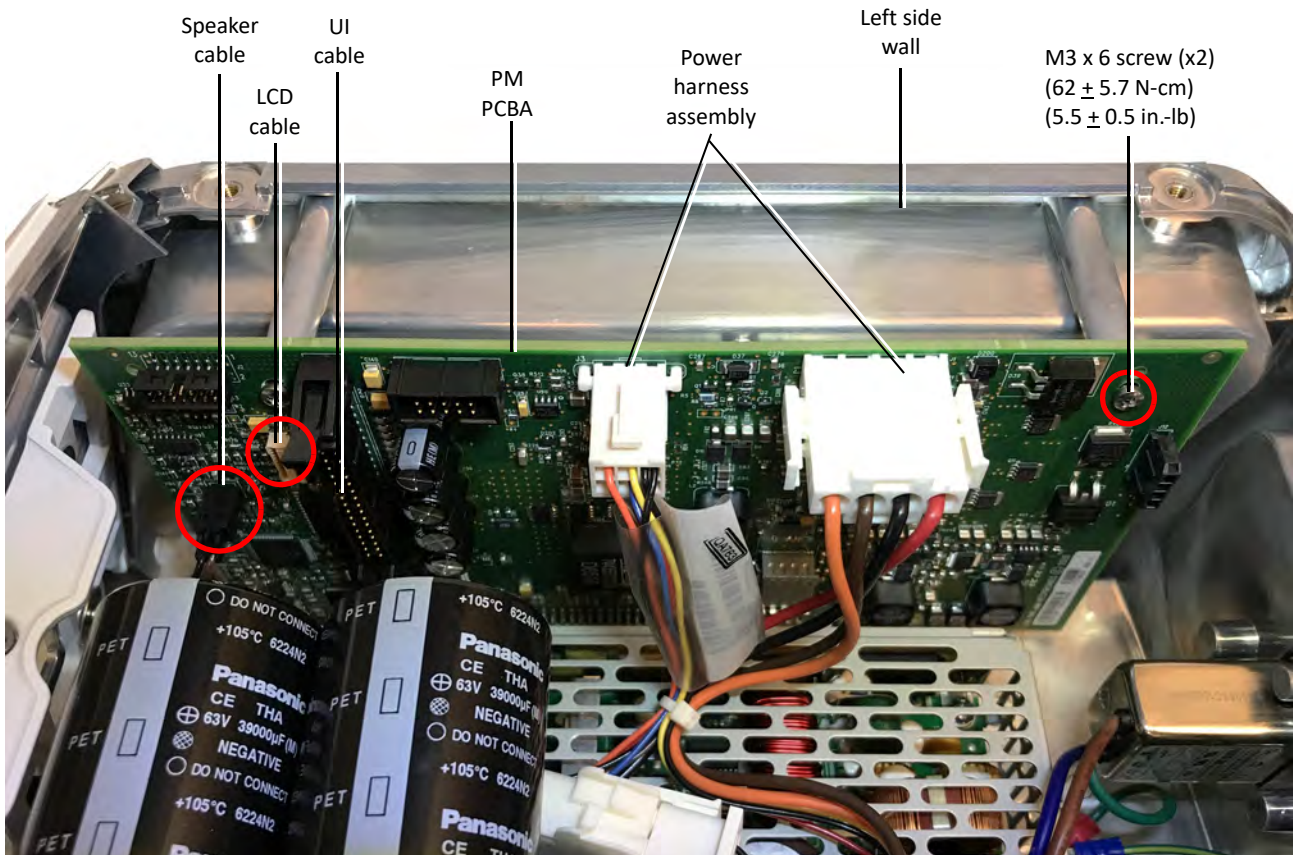
Follow these steps to remove the PM PCBA. Reverse to install.

1. Remove the top cover (section 8.5).
2. Disconnect cables:
 - Speaker #2 cable
 - Power harness assembly
 - UI cable
 - LCD cable

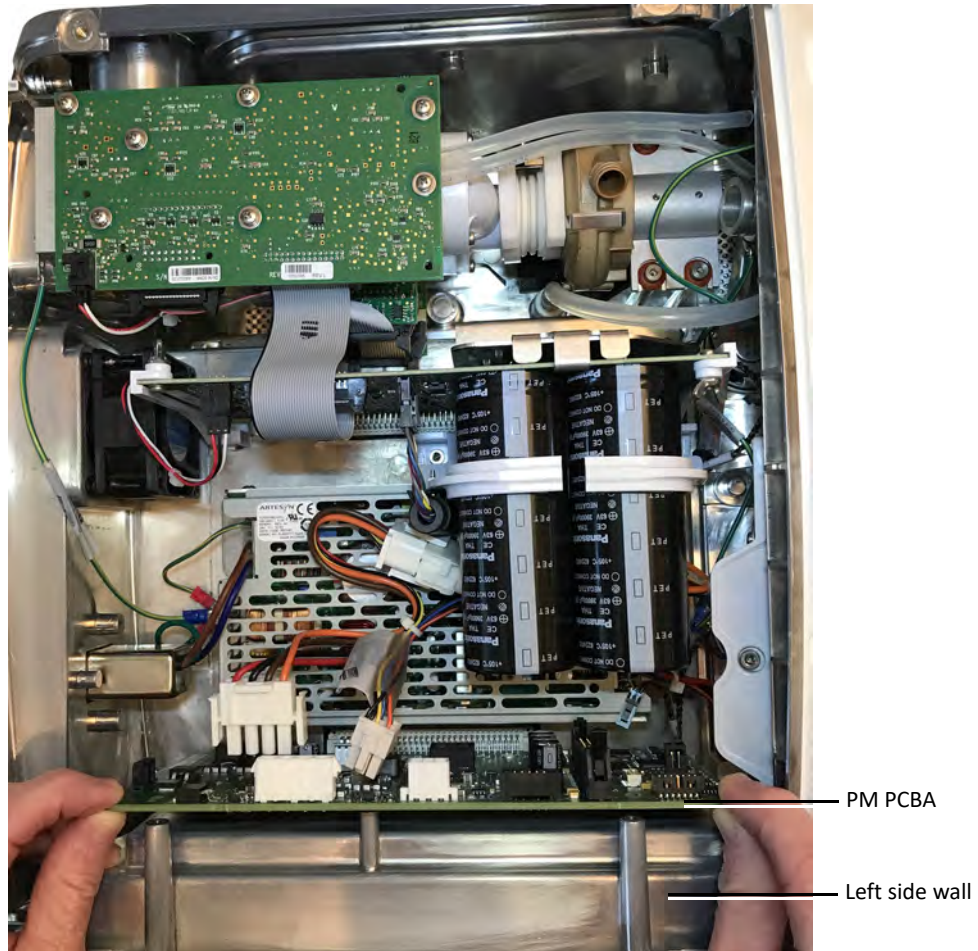
CAUTION

To avoid damaging components on the back side of the PM PCBA, hold the PM PCBA away from the left side wall standoffs when removing.

3. Remove the screws that attach the PM PCBA to the left side wall.



4. Slightly push the PM PCBA away from the left side wall while gently pulling up one side of the PM PCBA and removing it from its connection on the CPU PCBA.



8.19 Power Supply

There are two version of power supplies and shrouds:

- The 1st generation (original, manufactured by Artesyn) power supply that has been obsoleted by the manufacturer. Philips will continue to provide the original power supply while supplies last.
- The 2nd generation power supply (manufactured by Megmeet). The 2nd generation power supply is backward-compatible with ventilators built with the original power supply. The 2nd generation power supply is designed for use with ventilators equipped with coated rear bezels. The 2nd generation power supply must be installed with its own EMI shroud and EMI gasket installed in the base assembly.

8.19.1 1st Generation Power Supply and Shroud

Follow these steps to remove the 1st generation power supply. Reverse to install.

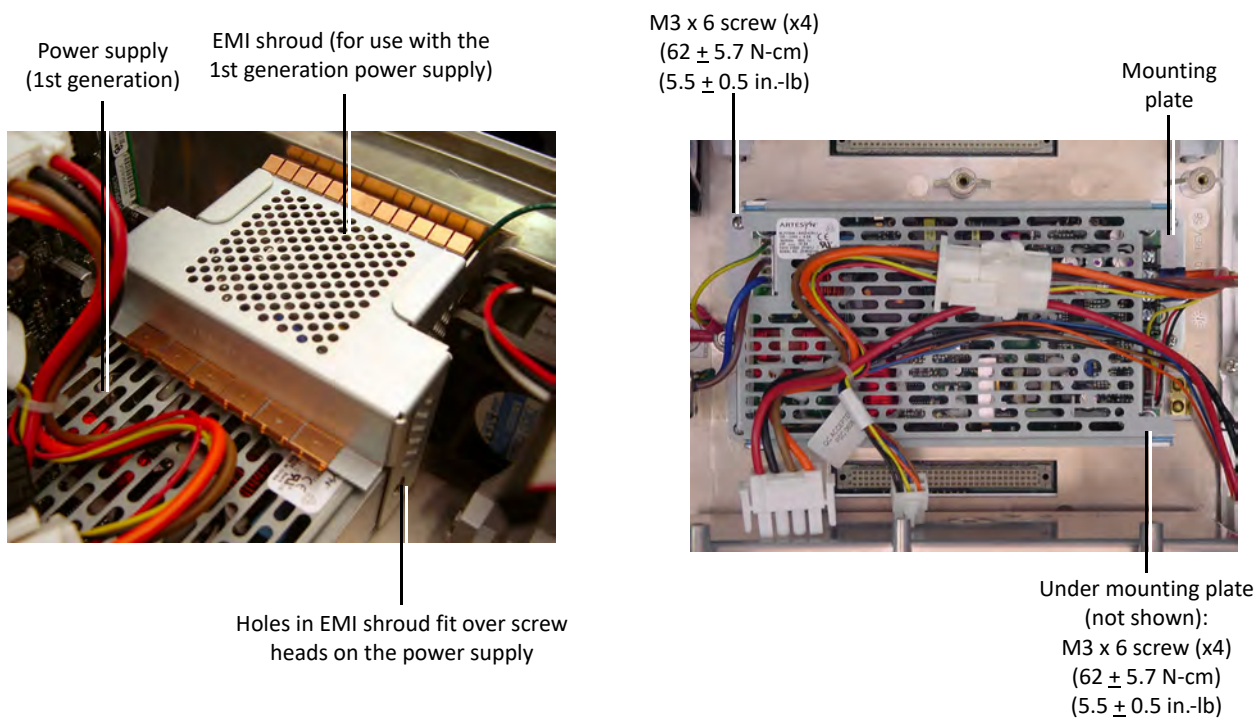
NOTE

Do not remove any connections from the power supply terminal strip.

1. Remove MC PCBA (section 8.11) and PM PCBA (section 8.18).
2. Remove EMI shroud from power supply by slightly lifting the shroud away from the power supply with a small screwdriver.
3. Remove the screws that attach the mounting plate to the base. (The power supply includes the attached mounting plate.)
4. Disconnect AC inlet cable and power harness.

NOTE

Squeeze the EMI shroud before reinstalling to ensure that it fits snugly over the power supply.



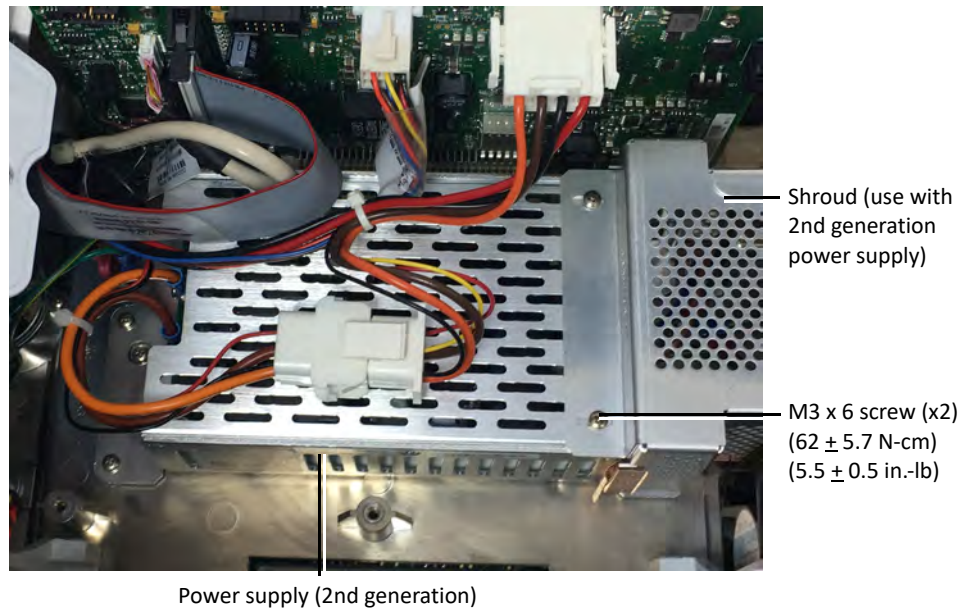
8.19.2 2nd Generation Power Supply and Shroud

Follow these steps to remove the 2nd generation power supply. Reverse to install.

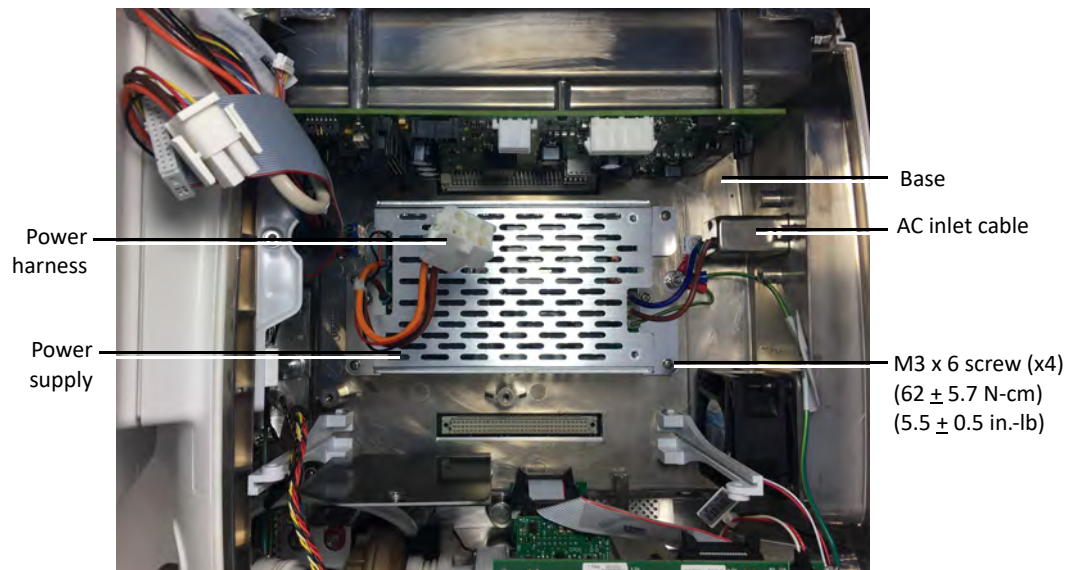
NOTE

- Do not remove any connections from the power supply terminal strip.
- The 2nd generation power supply must be installed with its own EMI shroud and EMI gasket installed at the back of the base.
- Install the 2nd generation power supply in a ventilator equipped with a coated rear bezel.

1. Remove MC PCBA (section 8.11) and PM PCBA (section 8.18).
2. Remove EMI shroud from power supply by removing the screws that secure the shroud to the power supply.



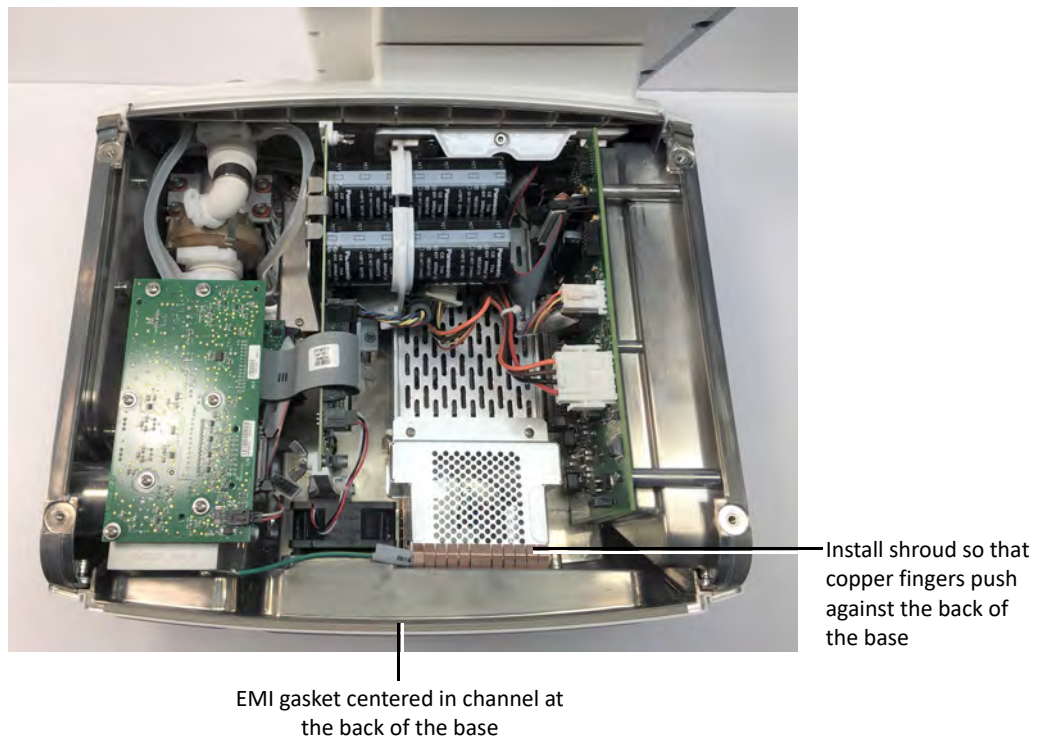
3. Remove the screws that attach the power supply to the base.



4. Disconnect the AC inlet cable and power harness.

NOTE

- Install the 2nd generation shroud so that its copper fingers push against the back of the base.
- Ensure that the EMI gasket is centered in the channel at the back of the base.



8.20 CPU PCBA

Follow these steps to remove the CPU PCBA. Reverse to install.

NOTE

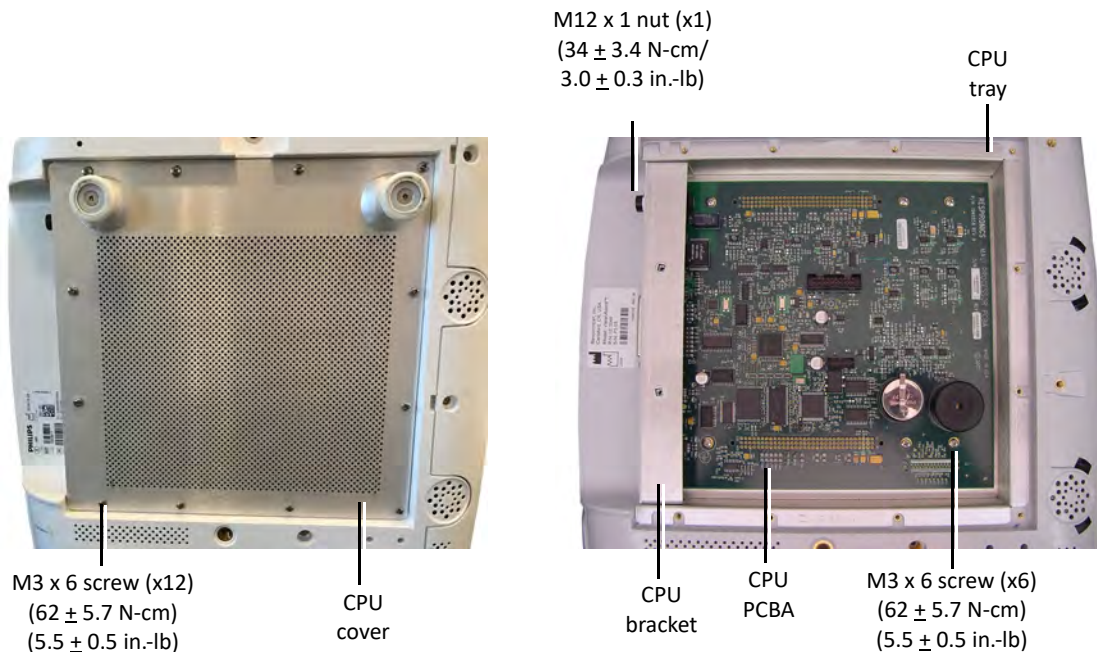
Replacing the CPU PCBA deletes the serial number, installed options, significant event log entries, and ventilator preferences. Review the significant event log before removing the CPU PCBA. To reinstall options on a newly-installed CPU PCBA, contact Philips technical support:

- *USA and Canada: 1-800-722-9377.*
- *International: www.healthcare.philips.com (select your location for contact information).*

1. Remove MC PCBA (section 8.11) and PM PCBA (section 8.18).
2. Remove the screws that attach the CPU cover to the underside of the base.
3. Remove the screws that attach the CPU PCBA to the CPU tray.
4. Remove the nut that attaches the CPU bracket to the CPU PCBA.

NOTE

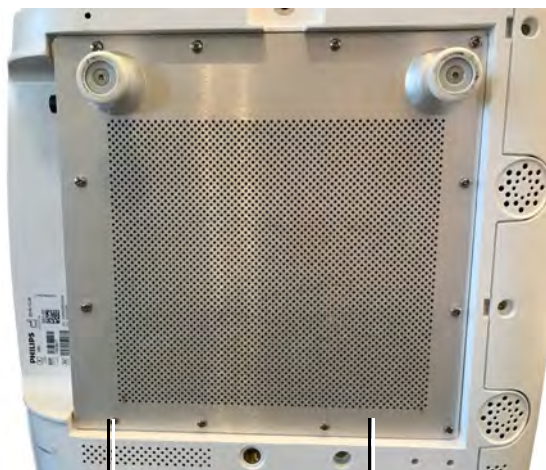
After installing a new CPU PCBA, reprogram the ventilator serial number and power-on hours (section 7.6).



8.21 Real-Time Clock Battery

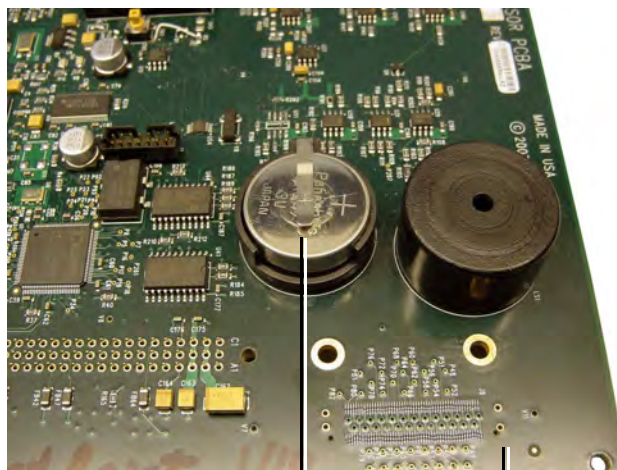
Follow these steps to remove the real-time clock battery. Reverse to install.

1. Disconnect all power (section 8.2).
2. Remove the screws that attach the CPU cover to the underside of the base.
3. Remove the real-time clock battery from the CPU PCBA.
4. When installing the real-time clock battery, ensure that the positive (+) side of the battery faces up.



M3 x 6 screw (x12)
(62 ± 5.7 N-cm)
(5.5 ± 0.5 in.-lb)

CPU cover



Real-time clock battery
(positive side facing up)

CPU
PCBA

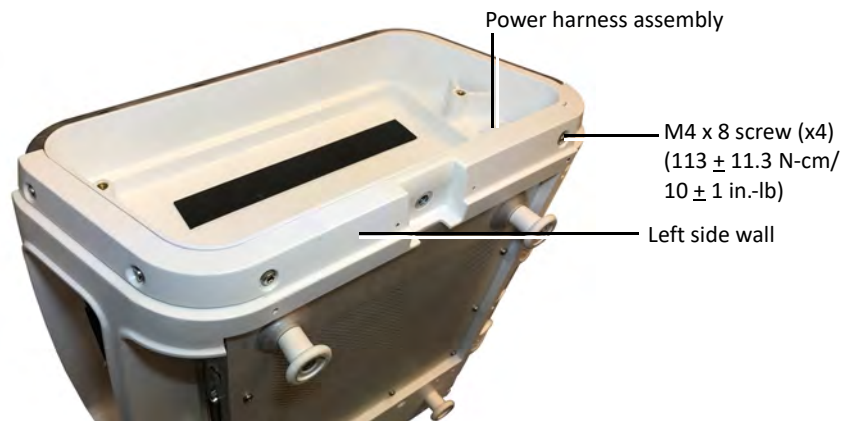
8.22 Left Side Wall

Follow these steps to remove the left side wall. Reverse to install.

1. Remove the front panel (section 8.13).
2. Remove the internal battery (section 8.4).
3. Remove the PM PCBA (section 8.18).
4. Detach the power harness assembly connector from the left side wall.
5. Remove the screws that attach the left side wall to the base.

NOTE

At reinstallation, install the power harness connector with its red wires toward the top of the side wall.



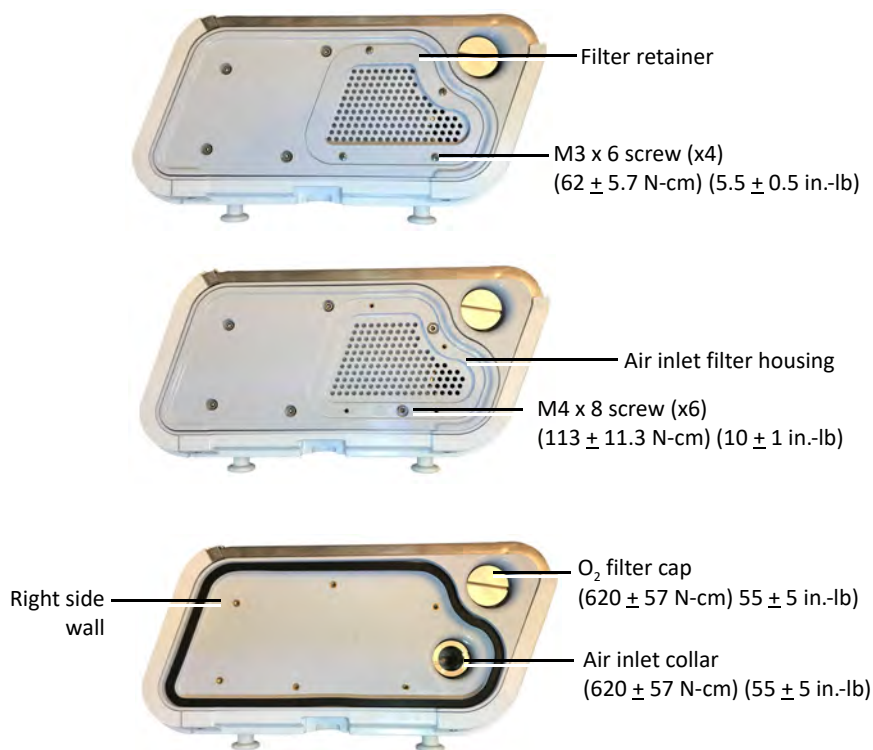
8.23 Gas Delivery Subsystem (GDS)

Follow these steps to remove the GDS. Reverse to install.

NOTE

The O₂ filter cap and air inlet collar attach the GDS to the ventilator. When they are removed, the GDS is not attached to the ventilator.

1. Remove the top cover (section 8.5).
2. Remove the O₂ inlet fitting (section 8.8).
3. Remove the screws that attach the filter retainer, then remove the filter retainer and air inlet filter.



4. Remove the screws that attach the air inlet filter housing, then remove the housing.
5. Remove the tubing from the barbed fittings inside the front panel.
6. Loosen the hose clamp that attaches the boot to the manifold cap.

NOTE

When reinstalling, verify that the boot is attached to the blower before reinstalling the GDS.

7. Remove the screw that attaches the ground cable to the manifold.

8. Remove the O₂ filter cap and air inlet collar from the right side wall.

NOTE

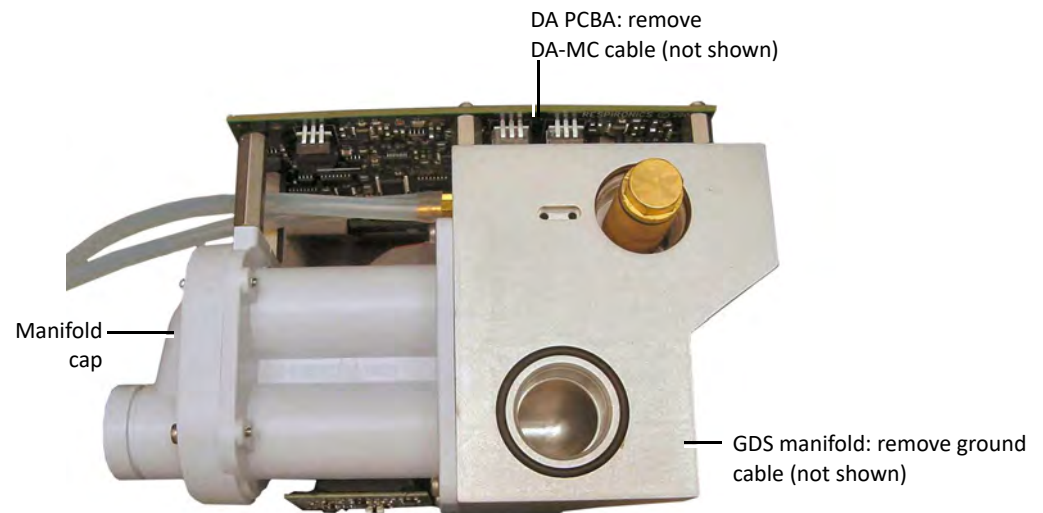
When reinstalling, apply a thin coat of Krytox to the inlet collar flange on the side wall. Tighten the air inlet collar first, and then the O₂ filter cap.

9. Disconnect the DA-MC cable from the DA PCBA.
10. Remove the GDS from the base.

NOTE

When reinstalling, connect the tubing so that:

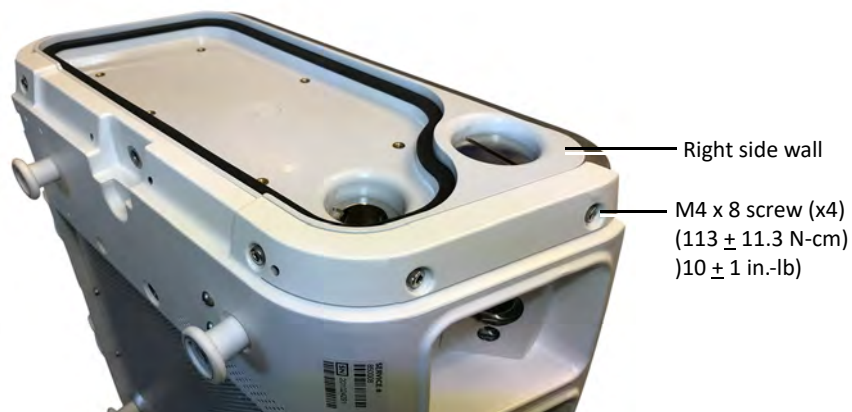
- *The longer (9-in.) tube connects between manifold "M" (machine) barb and barbed gas outlet fitting.*
- *The shorter (8-in.) tube connects between manifold "P" (proximal) barb and barbed proximal pressure port.*



8.24 Right Side Wall

Follow these steps to remove the right side wall. Reverse to install.

1. Remove the front panel (section 8.13).
2. Remove the GDS (section 8.23).
3. Remove screws that attach the right side wall to the base.



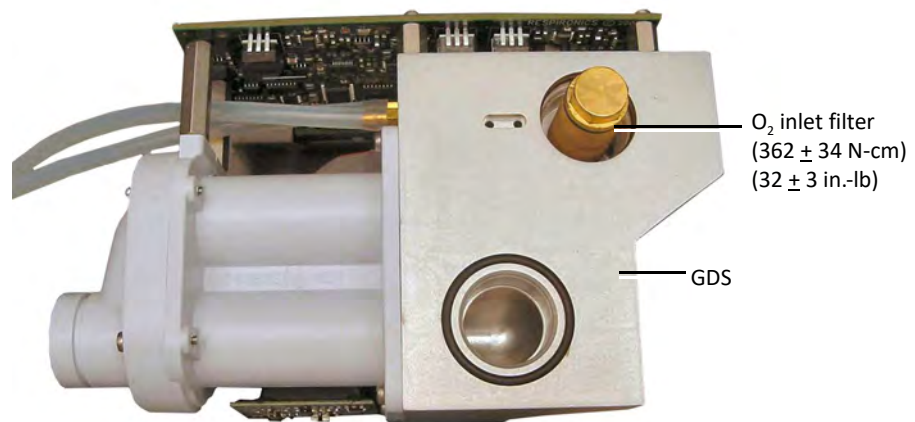
8.25 O₂ Inlet Filter

Follow these steps to remove the O₂ inlet filter. Reverse to install.

NOTE

When installing the O₂ inlet filter, ensure that the smaller end of the filter is opposite the threads in the GDS.

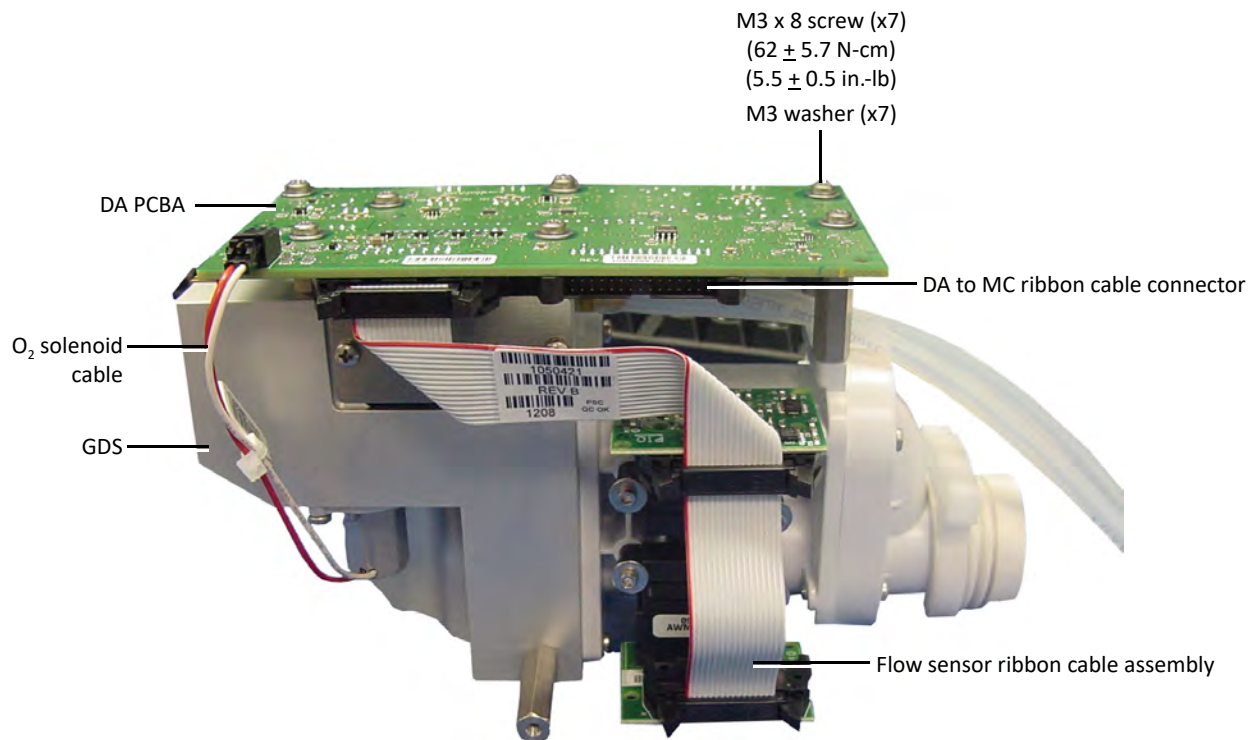
1. Remove the GDS (section 8.23).
2. Use a wrench to loosen the O₂ inlet filter and remove it from the GDS.



8.26 Data Acquisition (DA) PCBA

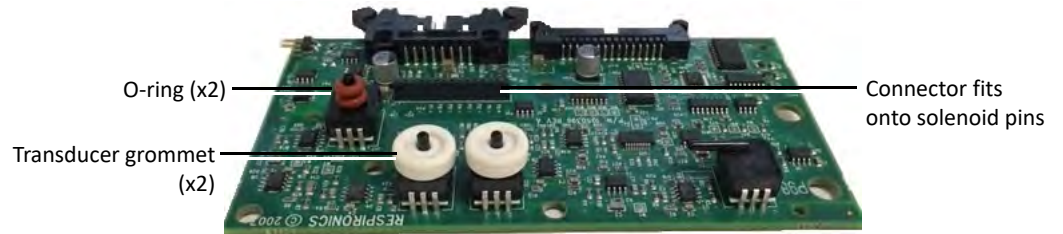
Follow these steps to remove the DA PCBA. Reverse to install.

1. Remove the GDS (section 8.23).
2. Disconnect these cables from the DA PCBA:
 - O₂ solenoid cable
 - Flow sensor ribbon cable assembly
3. Remove the screws and washers that attach the DA PCBA to the manifold.
4. Remove the DA PCBA.

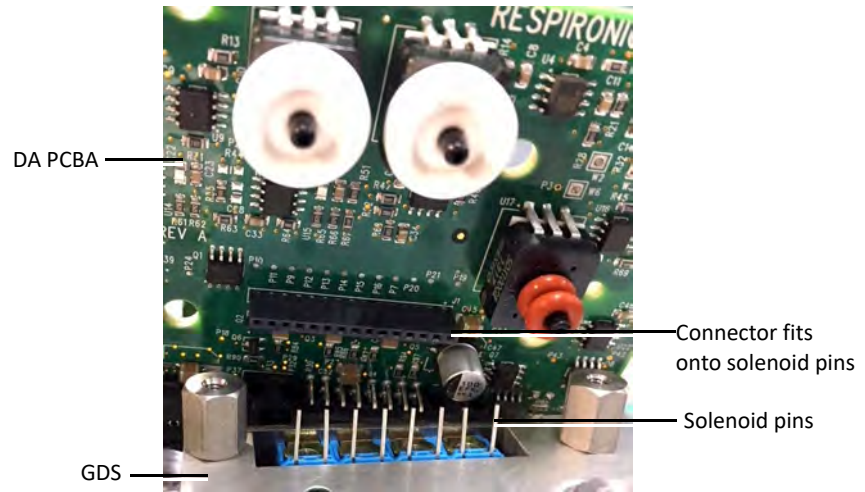


When installing the DA PCBA:

- Ensure that the transducer grommets and o-rings are installed as shown.



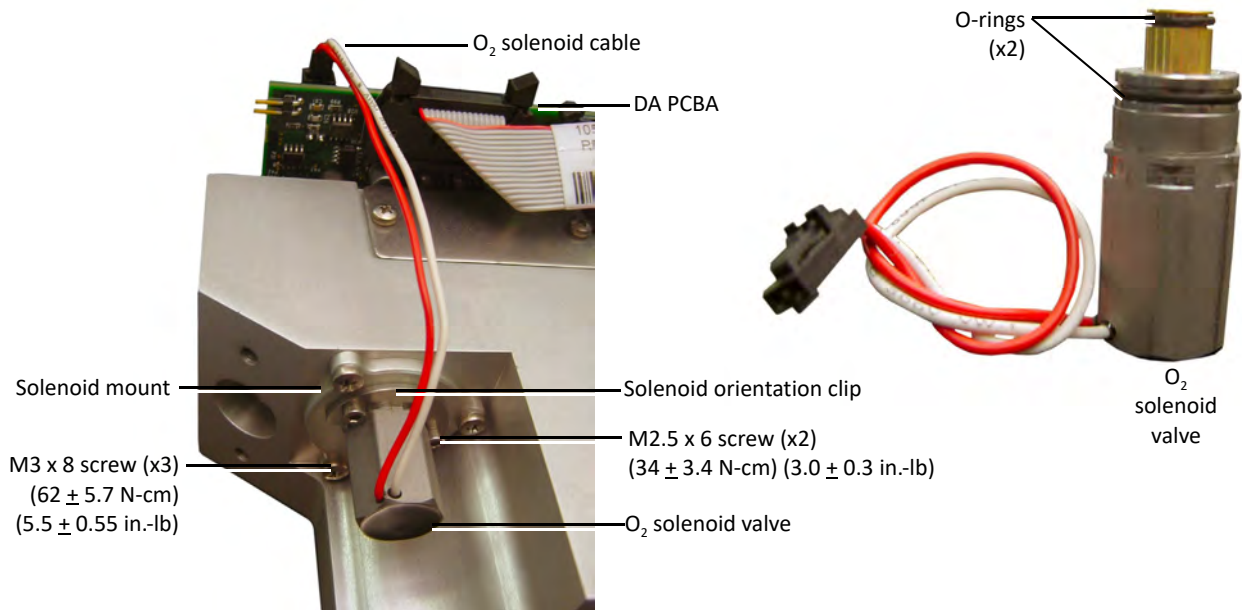
- Carefully install the DA PCBA onto the solenoid pins without flexing the PCBA or bending the pins.



8.27 O₂ Solenoid Valve

Follow these steps to remove the O₂ solenoid valve. Reverse to install.

1. Remove the GDS (section 8.23).
2. Disconnect the O₂ solenoid cable from the DA PCBA.
3. Remove the screws that attach the solenoid orientation clip to the solenoid mount.



When installing the O₂ solenoid, apply a thin coat of Krytox on the o-rings.



Correct: o-ring lightly lubricated

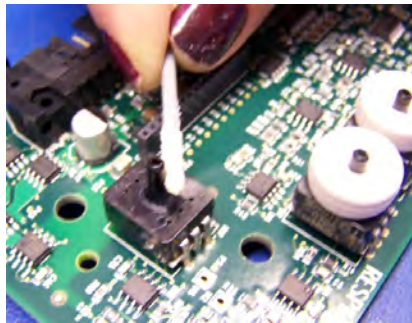


Incorrect: too much lubricant on the o-ring

8.28 Air and O₂ Flow Sensor Assembly

Follow these steps to remove the air and O₂ flow sensor assembly. Reverse to install.

1. Remove the GDS (section 8.23).
2. Remove the DA PCBA from the GDS (section 8.26).
3. Remove the O₂ solenoid valve from the GDS (section 8.27).
4. Apply a thin coat of Krytox to both o-rings on the O₂ solenoid valve.
5. Reinstall the O₂ solenoid valve to the replacement air and O₂ flow sensor assembly (section 8.27).
6. Remove and discard the o-rings and grommets from the DA PCBA or GDS.
7. Apply a thin coat of Krytox to the stem of the sensor on the DA PCBA.



Correct: sensor stem lightly lubricated

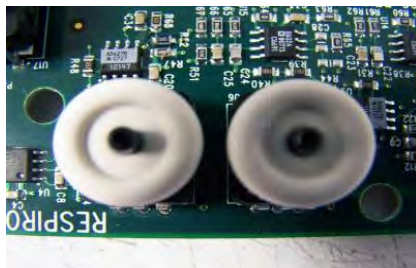


Incorrect: too much lubricant on the sensor stem

8. Install new o-rings on the DA PCBA and apply a thin coat of Krytox to both o-rings.



9. Install new grommets on the DA PCBA.



Correct: grommets correctly installed



Incorrect: grommets upside down

10. Reinstall the DA PCBA (section 8.26).
11. Reinstall the GDS (section 8.23).

8.29 Solenoid Valves

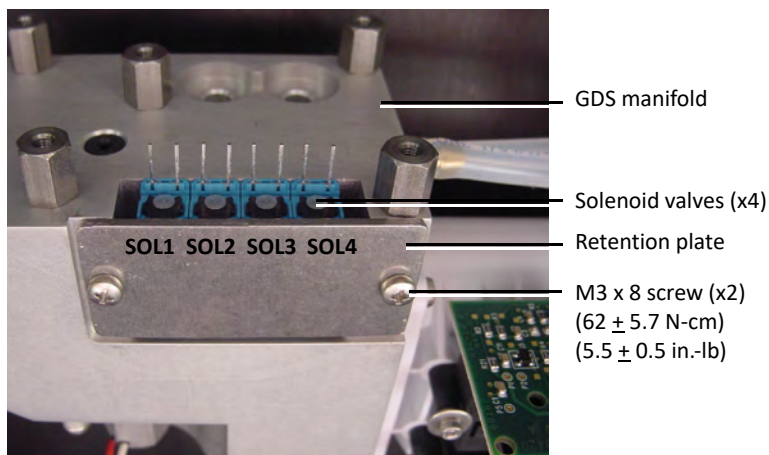
Follow these steps to remove the solenoid valves. Reverse to install.

1. Remove the DA PCBA (section 8.26).
2. Remove the screws that attach the retention plate to the manifold.
3. When replacing the solenoid valves, ensure that the solenoid valve seals are properly installed to the manifold.

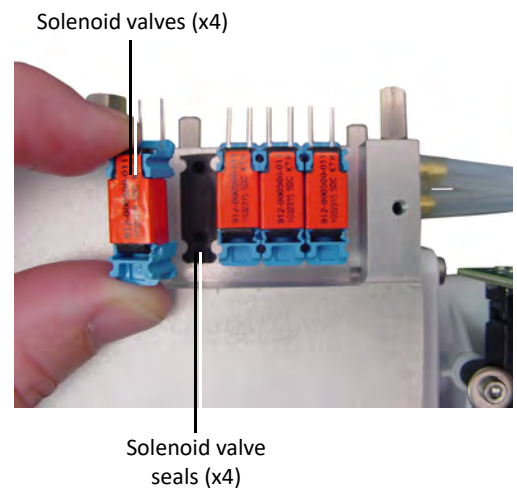
NOTE

When installing a new solenoid valve:

- *Do not bend solenoid pins.*
- *Install a new solenoid valve seal.*



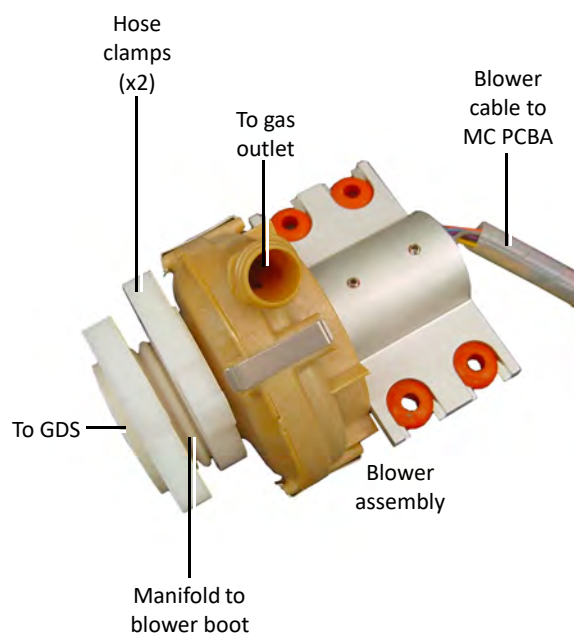
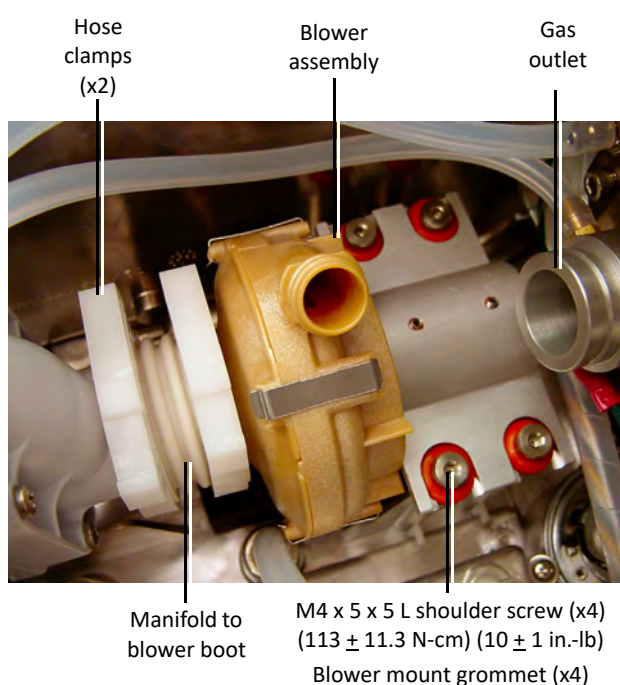
SOL1 Purge solenoid
SOL2 Machine pressure solenoid
SOL3 Proximal pressure solenoid
SOL4 Crossover solenoid



8.30 Blower

Follow these steps to remove the blower. Reverse to install.

1. Remove the top cover (section 8.5).
2. Disconnect the blower cable from the MC PCBA.
3. Remove the boot and hose clamps that attach the blower to the gas outlet.
4. Remove the shoulder screws that attach the blower to the base.
5. Loosen the clamps on the boot that attaches the blower to the GDS, then remove the blower, boot, and clamps.



NOTE

When installing the blower:

- *Install new motor mount grommets when installing a new blower.*
- *Ensure that the boot is fully and clamped to the blower before installing the blower.*

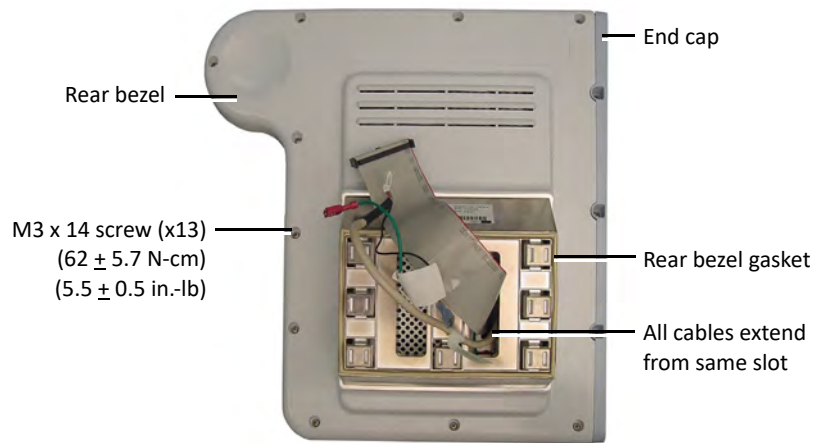
8.31 Opening the User Interface (UI)/Rear Bezel

Follow these steps to open the UI and remove the rear bezel. Reverse to install.

CAUTION

Replace EMI-coated bezels with EMI-coated bezels only.

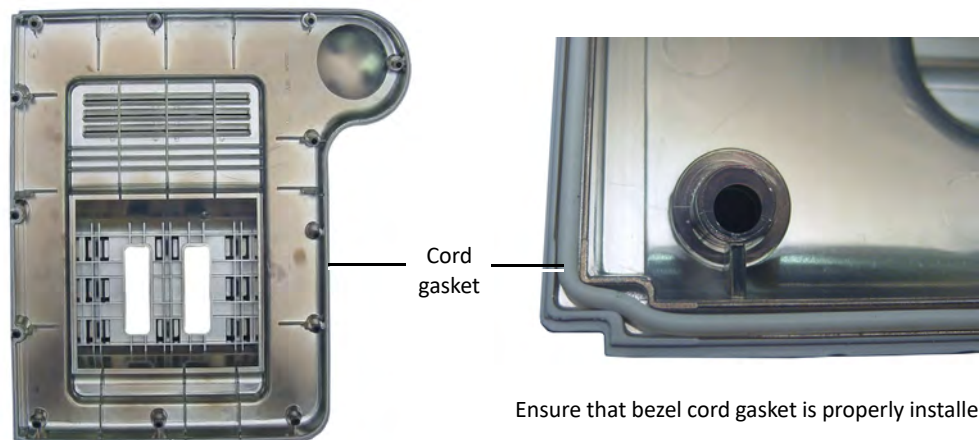
1. Separate the UI from the base (section 8.12).
2. Remove the screws from the end cap and remove the end cap.



3. Remove the screws from the rear bezel.
4. Separate the front and rear bezels.

When reinstalling the rear bezel:

- Verify that all cables extend through the same slot.
- Ensure that the gasket is properly installed around the inside of the bezel.



8.32 Power Switch Overlay

Follow these steps to remove the power switch overlay. Reverse to install.

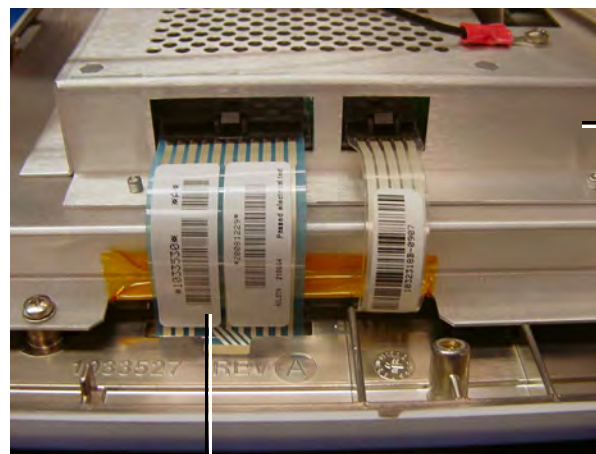
1. Open the UI (section 8.31).
2. From inside the front bezel, disconnect the power switch overlay cable from the UI PCBA.
3. Carefully peel the power switch overlay from the front bezel.
4. Once the power switch overlay is removed, use isopropyl alcohol to remove any remaining adhesive. Ensure that the bezel surface is clean and dry.

CAUTION

- Do not flex the overlay.
 - When installing a new power switch overlay, peel the backing from the overlay, feed the cable through the bezel cutout, align the overlay to the front bezel, and press to adhere.
-



Power switch overlay
position on front bezel

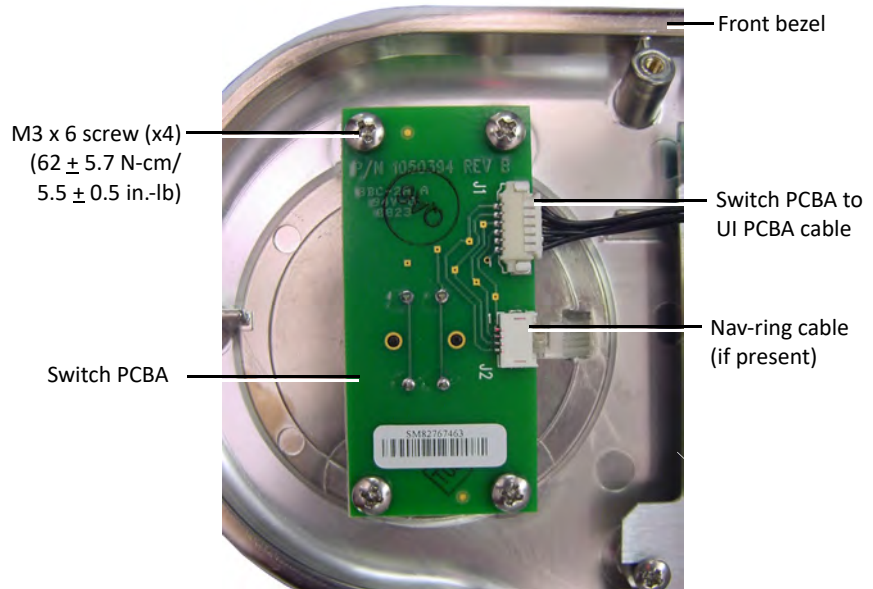


Power switch
overlay cable

8.33 Switch PCBA

Follow these steps to remove the switch PCBA. Reverse to install.

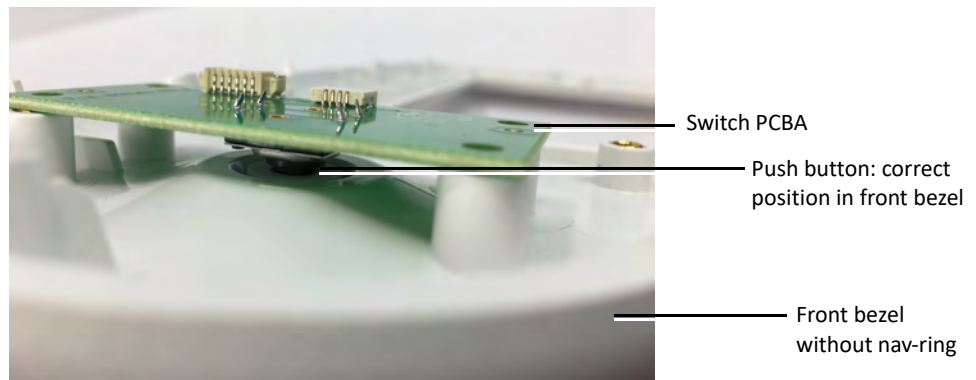
1. Open the UI (section 8.31).
2. Remove the screws that attach the switch PCBA to the inside the front bezel.
3. Disconnect the nav-ring cable (if present) and UI PCBA cable from the switch PCBA.



NOTE

During installation, verify that:

- *The nav-ring cable (if present) is fully seated into its connector on the switch PCBA.*
- *For the front bezel without nav-ring, the push button on the switch PCBA is positioned in the front bezel as shown.*



8.34 Front Bezel, Touchscreen

Follow these steps to remove the front bezel and touchscreen. Reverse to install.

CAUTION

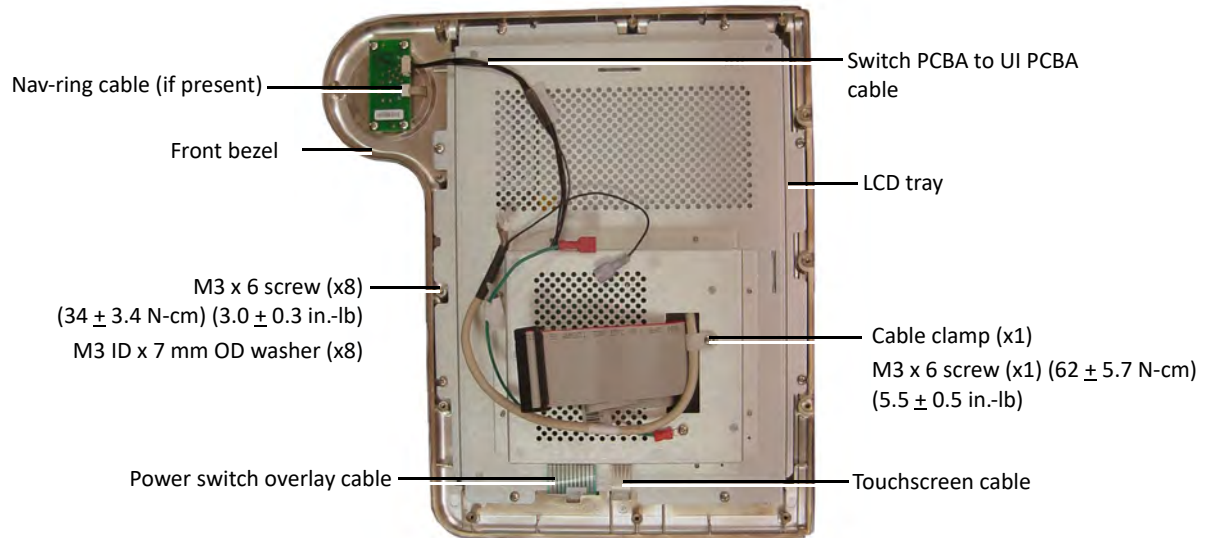
- Replace EMI-coated bezels with EMI-coated bezels only.
 - When installing a new touchscreen, remove the protective film and avoid touching the screen surface.
 - To replace the nav-ring assembly, replace the front bezel. The nav-ring assembly (if present) is not separately replaceable.
 - After installing a new UI assembly, perform the touchscreen calibration (section 6.3).
-

NOTE

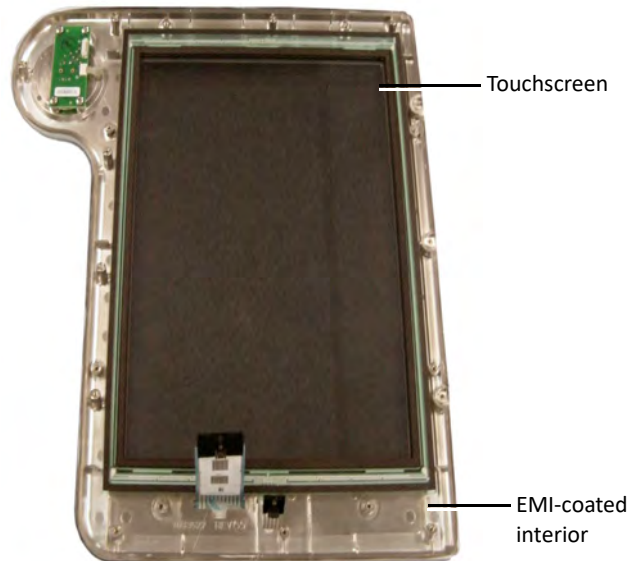
The most recent front bezel no longer includes a nav-ring.

1. Open the UI (section 8.31).
2. Disconnect these cables from the UI PCBA:
 - Switch PCBA cable
 - Nav-ring cable (if present)
 - Power switch overlay cable
 - Touchscreen cable
3. Remove the switch PCBA.
4. Remove the screw that attaches the cable clamp to the LCD tray.

5. Remove the screws and washers that attach the LCD tray to the front bezel, then remove the LCD tray.



6. Remove the touchscreen from the front bezel.



8.35 LCD

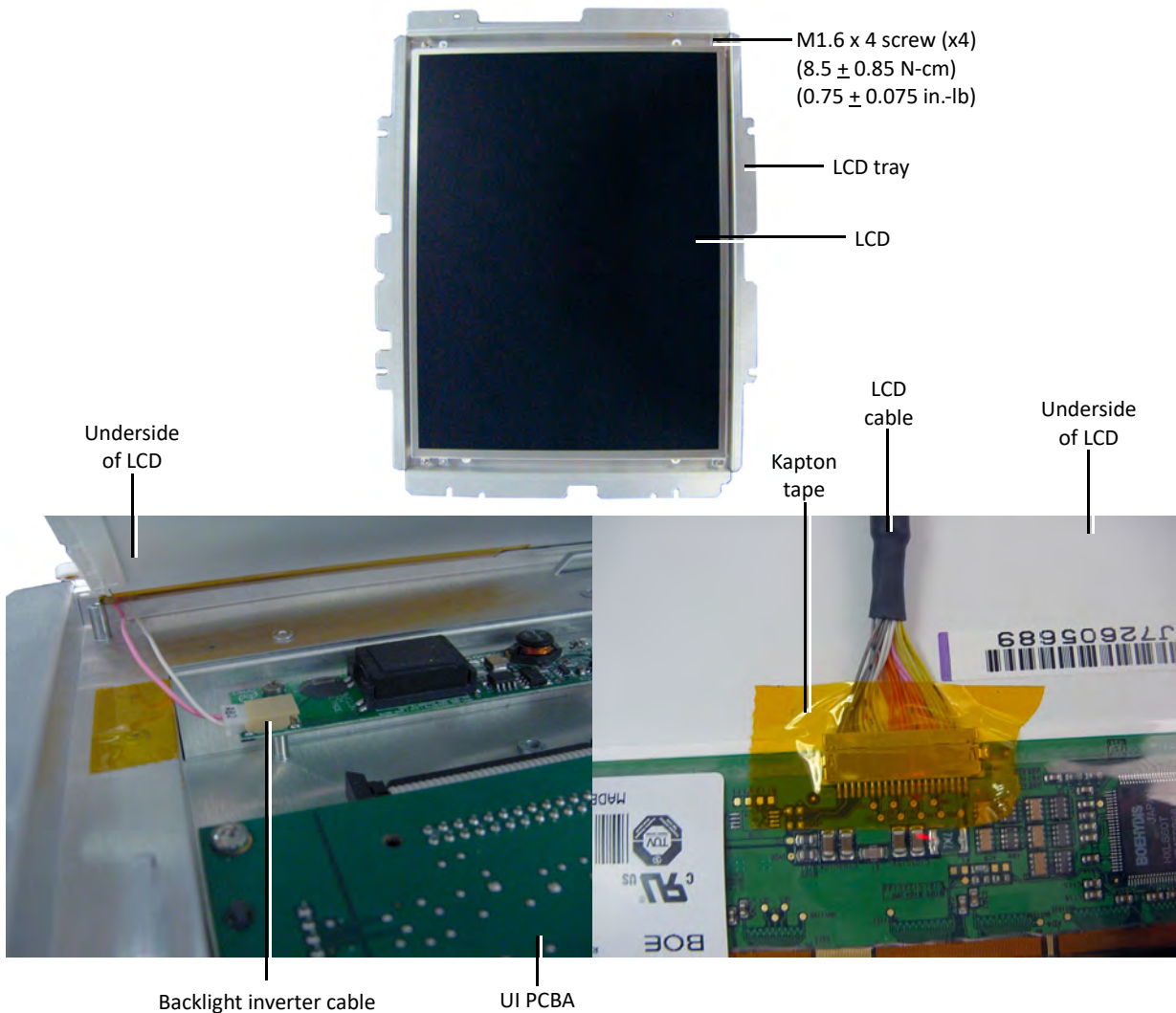
There are two versions of LCDs:

- The original LCD that has been obsoleted by the manufacturer (HYDIS). Philips will continue to provide the HYDIS LCD while supplies last.
- The 2nd-generation LCD (manufactured by NEC). The 2nd-generation LCD is *not* backward-compatible with ventilators built with the original LCD. Installing the 2nd-generation LCD requires several hardware changes and a software upgrade.

Ventilators with serial numbers 100069779 and later and 201005565 and later are equipped with the 2nd-generation (NEC) LCD and associated parts.

8.35.1 Original (HYDIS) LCD

Follow these steps to remove the HYDIS LCD. Reverse to install.



1. Open and separate the UI bezel (section 8.31).
2. Remove the front bezel (section 8.34).
3. Remove the screws that attach the LCD to the LCD tray.
4. With the LCD face up, carefully lift the LCD slightly to disconnect the backlight inverter and LCD cable.
5. Remove the LCD.

NOTE

- *When installing a new LCD, remove the protective film before reinstalling the LCD tray to the front bezel, and avoid touching the screen surface.*
- *When installing the LCD cable to the LCD, use a new piece of Kapton tape.*

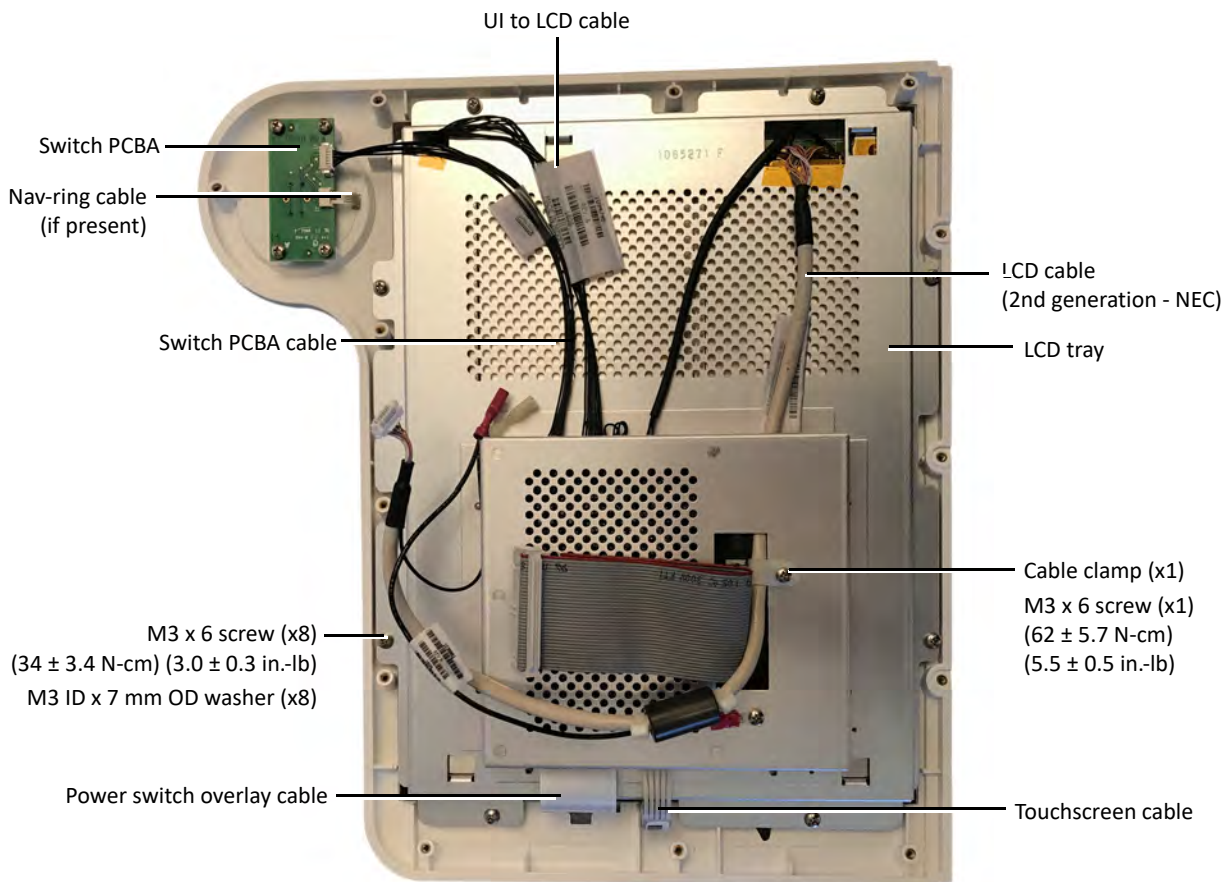
8.35.2 2nd-Generation (NEC) LCD

Follow these steps to remove the NEC LCD. Reverse to install.

NOTE

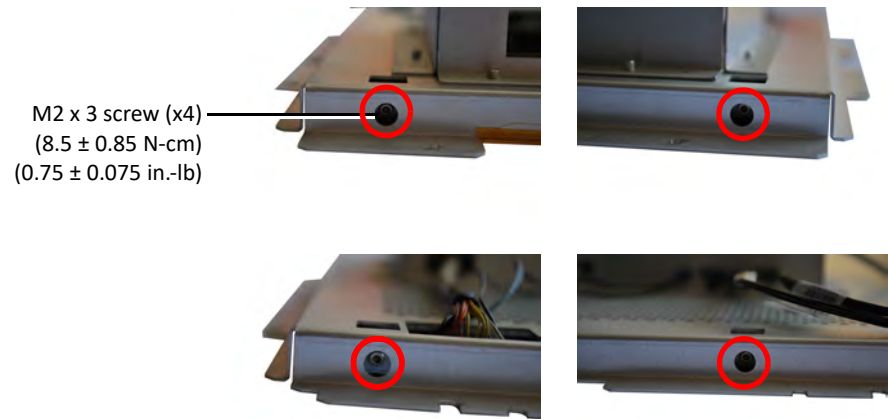
When installing a new LCD, remove the protective film before reinstalling the LCD tray to the front bezel and avoid touching the screen surface.

1. Open the UI (section 8.36).
2. Disconnect the following cables:
 - Switch PCBA cable
 - UI to LCD cable
 - LCD cable
 - Power switch overlay cable
 - Touchscreen cable



3. Remove the screw that attaches the cable clamp to the LCD tray.
4. Remove the screws and washers that attach the LCD tray to the front bezel, then remove the LCD tray from front bezel.

5. Remove the screws that attach the LCD to the LCD tray.



6. With the LCD face up, carefully lift the LCD slightly to disconnect the LCD cable and UI PCBA to LCD cable.
7. Remove the LCD from the LCD tray.

8.36 User Interface (UI) PCBA

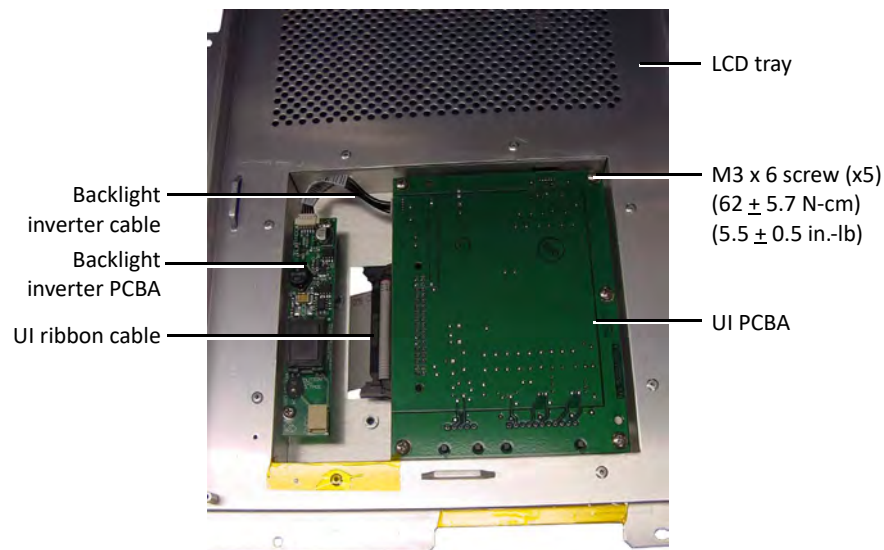
There are two versions of UI PCBAs:

- The original UI PCBA, which is compatible with the original (HYDIS) LCD and backlight inverter PCBA. Philips will continue to provide the original UI PCBA while supplies last.
- The 2nd-generation UI PCBA, which is compatible with the 2nd-generation (NEC) LCD and incorporates backlight inverter circuitry into the UI PCBA. The 2nd-generation UI PCBA requires software version 2.10 or later.

8.36.1 Original UI PCBA

Follow these steps to remove the UI PCBA. Reverse to install.

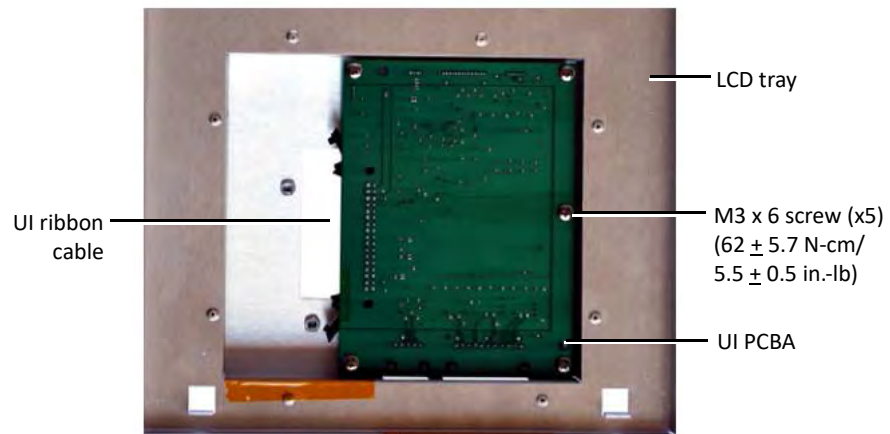
1. Remove the LCD (section 8.35)
2. Remove the screws that attach the UI PCBA to the LCD tray.
3. Disconnect these cables from the UI PCBA:
 - Backlight inverter cable
 - UI ribbon cable



8.36.2 2nd-Generation UI PCBA

Follow these steps to remove the UI PCBA. Reverse to install.

1. Remove the LCD (section 8.35)
2. Remove the screws that attach the UI PCBA to the LCD tray.
3. Disconnect the UI ribbon cable from the UI PCBA.



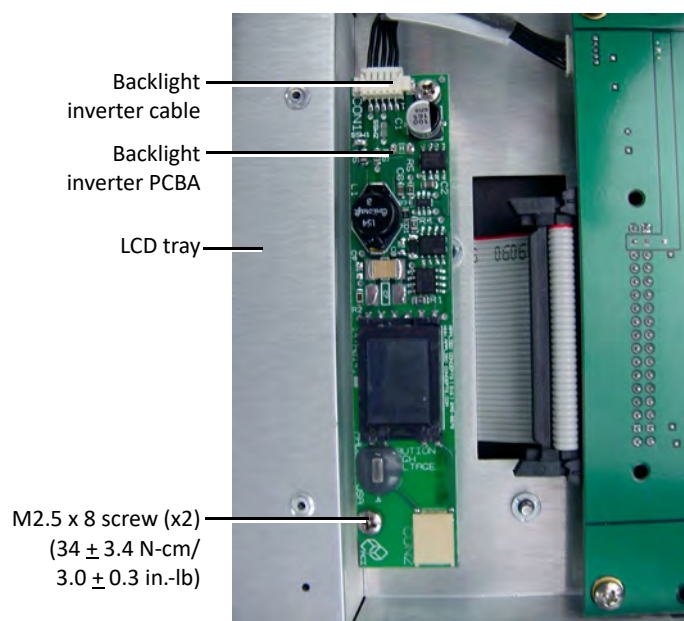
8.37 Backlight Inverter PCBA

NOTE

These instructions apply to the original (HYDIS) LCD only.

Follow these steps to remove the backlight inverter PCBA. Reverse to install.

1. Remove the LCD (section 8.35).
2. Remove the screws that attach the backlight inverter PCBA to the LCD tray.
3. Disconnect the backlight inverter cable from the backlight inverter PCBA.



8.38 LCD Tray

Follow these steps to remove the LCD tray. Reverse to install.

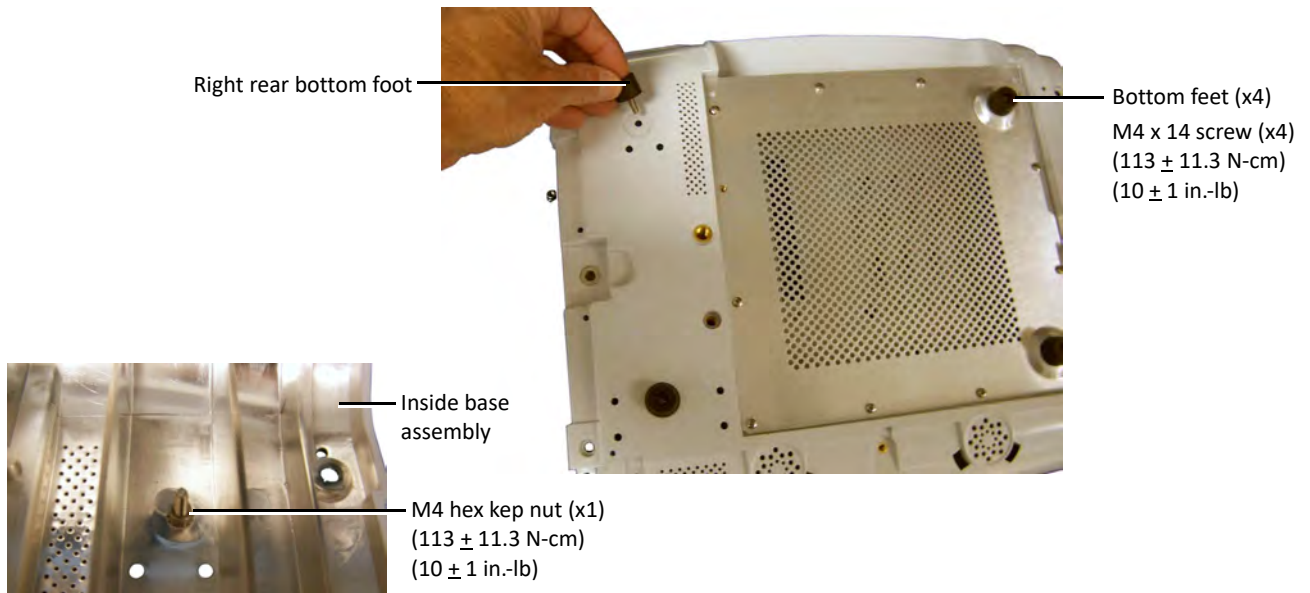
1. Remove the UI PCBA (section 8.36).
2. Remove the backlight inverter PCBA (section 8.37).

8.39 Bottom Feet

The ventilator may be equipped to fit either the universal stand or the V60/V60 Plus stand. Follow the applicable instructions below to remove the bottom feet as needed. Reverse these steps to install.

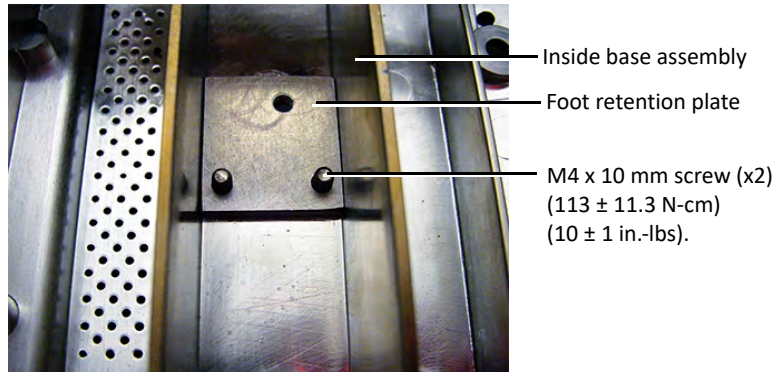
8.39.1 Removing Bottom Feet Configured for the Universal Stand

1. Remove the screws that attach the front and left rear bottom feet to the base assembly.
2. Disconnect all power (section 8.2).
3. Remove the GDS (section 8.23).
4. From inside the base assembly, remove the hex nut that attaches the screw and right rear bottom foot.

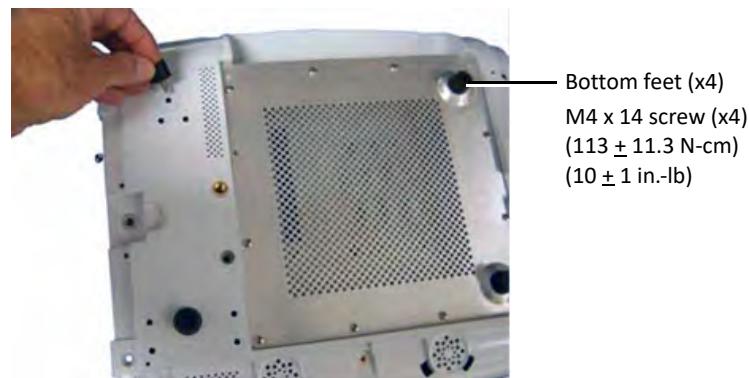


8.39.2 Converting Ventilator Feet (Universal Stand to V60/V60 Plus Stand)

1. Remove the bottom feet (section 8.39.1).
2. From inside the base assembly, align the three holes of the foot retention plate and then secure to the base assembly.



3. From outside the base assembly, reinstall the bottom feet.



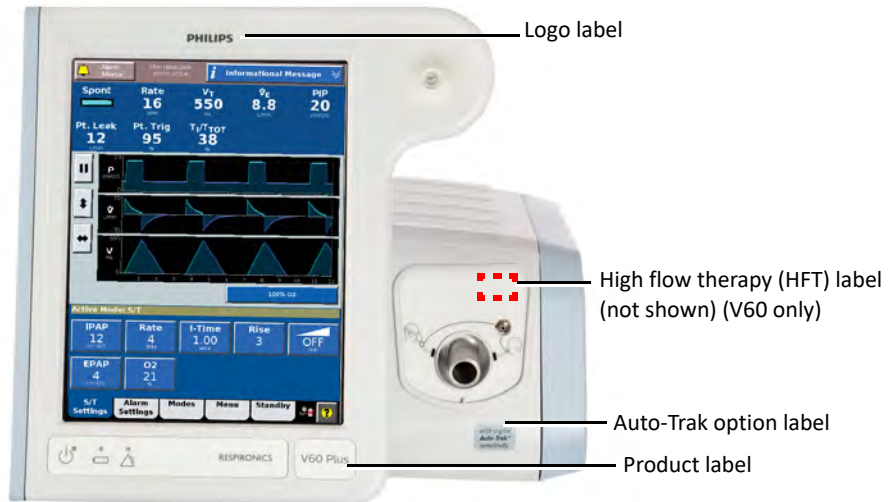
To remove the bottom feet, remove the screws that attach the bottom feet to the base assembly.

8.40 Labels

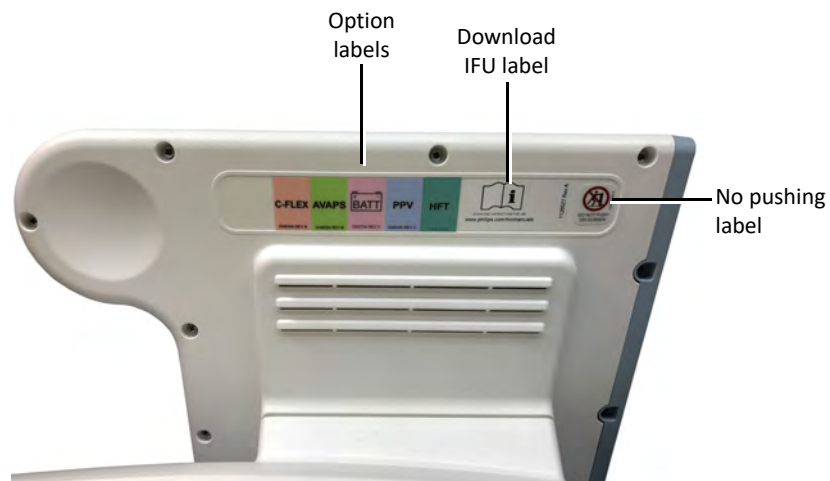
Follow these steps to remove and replace labels.

1. Use isopropyl alcohol to remove any remaining adhesive from the original part. Ensure that surface is clean and dry.
2. Peel backing from new part and press to adhere.

Front of the UI and front panel:

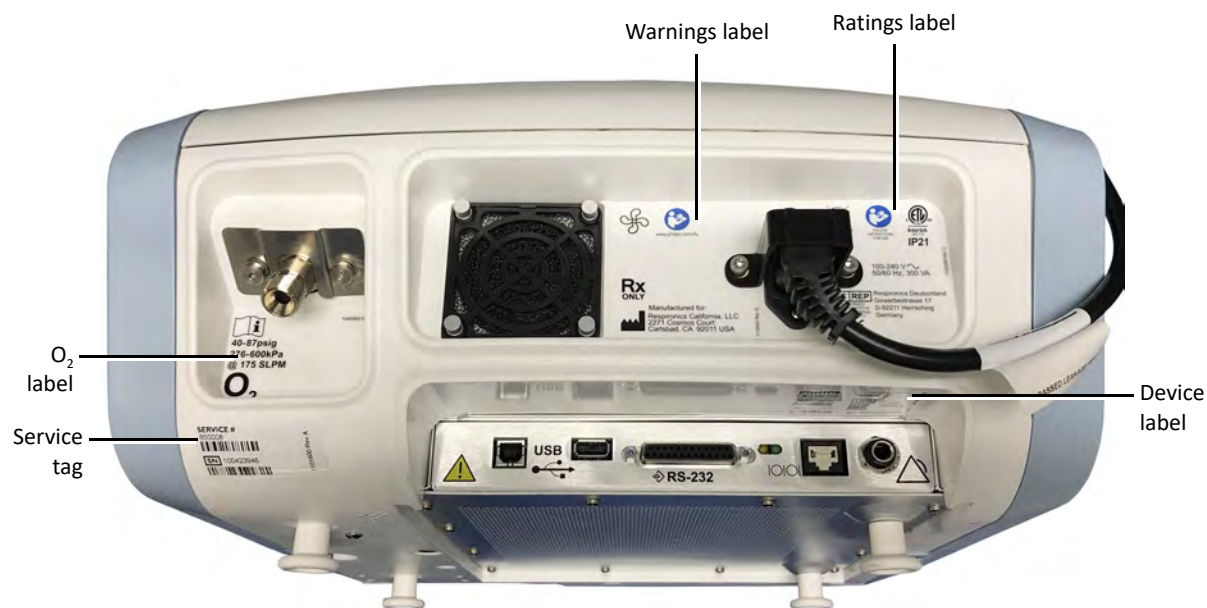


Back of the UI:

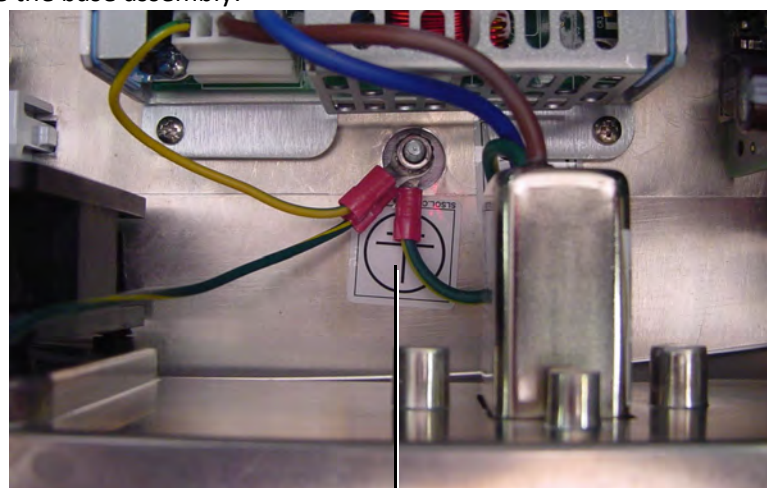


Back of the base assembly:

NOTE: When replacing the base assembly, carefully remove the device label and service tag, and reapply to the new base assembly.



Inside the base assembly:



Protective earth
ground label

Country-specific labels:

Argentina:



Argentina device label

Device label

Australia:



Australia device label

Device label

Brazil:

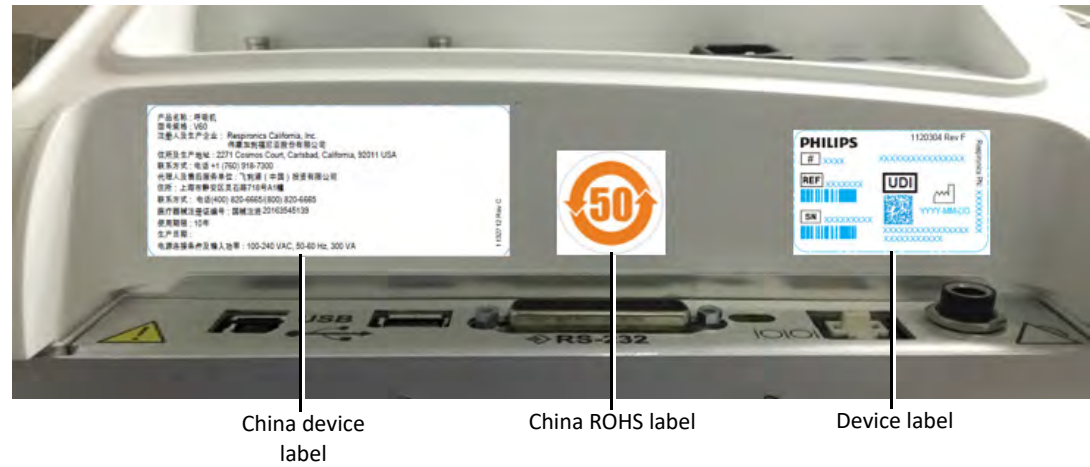


Argentina device label

Brazil Inmetro label

Device label

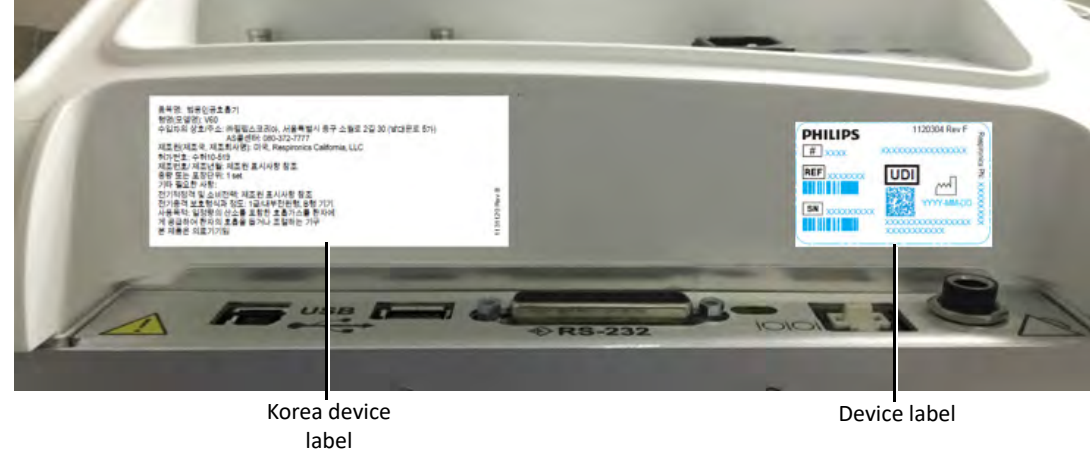
China:



Indonesia:



Korea:



Venezuela:



Venezuela device label

Device label

Vietnam:



Vietnam device label

Device label

8.41 Component Replacement Data Form

Complete this form when replacing ventilator components.

Customer information			
Facility name:			
Contact name:			
Address:			
City/State/Zip			
Phone:			
Email:			
Ventilator information			
Serial number:		Service number:	
Reason for component replacement			
Component information			
Removed components		Installed components	
Part number	Lot/serial number (if applicable)	Part number	Lot/serial number (if applicable)
Technician name (print):			Date
Technician signature:			

9 Performance Verification

9.1	Performance Verification Tests	204
9.2	Pneumatic Calibration Analyzer Setup	209
9.2.1	Measurement Selection Screen	209
9.2.2	Averaging Setup Menu	211
9.2.3	Trigger Options	212
9.2.4	Configurations	213
9.3	Preliminary Procedures	216
9.3.1	Cleaning and Inspection	216
9.3.2	Touchscreen Calibration	216
9.3.3	Record Ventilator Information	217
9.4	Test 1: Electrical Safety	219
9.5	Test 2: Leak Tests	221
9.5.1	High Pressure Leak Test	221
9.5.2	System Leak Test	223
9.6	Test 3: Controls	225
9.7	Test 4: Pressure Accuracy	227
9.7.1	Pressure Accuracy Test Example	230
9.8	Test 5: Air Delivery	232
9.9	Test 6: Flow Sensor Zero Calibration	236
9.10	Test 7: Air Flow Accuracy	238
9.11	Test 8: O₂ Flow Accuracy	241
9.12	Test 9: O₂ Mix Accuracy	244
9.13	Test 10: S/T Performance	248
9.14	Test 11: Alarms	250
9.15	Test 12: Power Fail	252
9.15.1	Power Fail Test - Internal Battery Installed	252
9.15.2	Power Fail Test - Internal Battery Not Installed	254
9.16	Test 13: Internal Battery	255
9.17	Preparing the Ventilator for Use	257
9.18	Performance Verification Troubleshooting/Repair	259
9.18.1	Test 1: Electrical Safety	259
9.18.2	Test 2: Leak Tests	260
9.18.3	Test 3: Controls	260
9.18.4	Test 4: Pressure Accuracy	261
9.18.5	Test 5: Air Delivery	261
9.18.6	Test 6: Flow Sensor Zero Calibration	261
9.18.7	Test 7: Air Flow Accuracy	261
9.18.8	Test 8: O ₂ Flow Accuracy	262
9.18.9	Test 9: O ₂ Mix Accuracy	262
9.18.10	Test 10: S/T Performance	262
9.18.11	Test 11: Alarms	263
9.18.12	Test 12: Power Fail	263
9.18.13	Test 13: Internal Battery	263
9.19	Electrical Safety Data Form	265
9.20	Performance Verification Data Form	267

9.1 Performance Verification Tests

Performance verification verifies the integrity of the sensors and other critical components in the ventilator using external measurement devices.

Table 9-1 summarizes performance verification steps. Table 9-2 summarizes which performance verification tests are required based on the type of service performed.

Run all tests in order and document on the Electrical Safety data Form (section 9.8) or Performance Verification Data Form (section 9.9).

See section 1.2 for a list of the recommended tools, test equipment, and materials required to service and maintain the ventilator.

CAUTION

Performance verification is to be performed only by a qualified service technician.

NOTE

An O₂ source capable of delivering 140 LPM (40-87 PSI) is required for O₂ system tests.

Table 9-1: Performance Verification Steps

Step	Description
1	All service events: clean and inspect the ventilator (section 9.3.1)
2	All service events: record ventilator information (section 9.3.3)
3	Testing (required tests determined by the service performed):
	• Test 1 - Electrical safety (section 9.4)
	• Test 2 - Leak tests (section 9.5)
	• Test 3 - Controls (section 9.6)
	• Test 4 - Pressure accuracy (section 9.7)
	• Test 5 - Air delivery (section 9.8)
	• Test 6 - Flow sensor zero calibration (section 9.9)
	• Test 7- Air flow accuracy* (section 9.10)
	• Test 8 - O ₂ flow accuracy* (section 9.11)
	• Test 9 - O ₂ mix accuracy (section 9.12)
	• Test 10 - S/T performance (section 9.13)
	• Test 11 - Alarms (section 9.14)
	• Test 12 - Power fail (section 9.15)
	• Test 13 - Internal battery (section 9.16)
4	All service events: prepare the ventilator for use (section 9.17)
* Flow testing at altitudes above 1951 m (6400 ft.) cannot attain 130 SLPM.	

Table 9-2: Performance Verification Test Requirements

Service performed	Required tests
Annual preventive maintenance (PM)	All
AC inlet: removal/replacement	Electrical safety (section 9.4)
Air & O ₂ flow sensor assembly: removal/replacement	- Electrical safety (section 9.4) - Leak tests (section 9.5) - Pressure accuracy (section 9.7) - Air delivery (section 9.8) - Flow sensor zero calibration (section 9.9) - Air flow accuracy (section 9.10) - O₂ flow accuracy (section 9.11) - O₂ mix accuracy (section 9.12)
Backlight inverter cable: removal/replacement	- Electrical safety (section 9.4) - Ventilator controls (section 9.6)
Backlight inverter PCBA: removal/replacement	- Electrical safety (section 9.4) - Touchscreen calibration (section 6.3) - Ventilator controls (section 9.6)
Base assembly	All
Bezel, front	- Electrical safety (section 9.4) - Ventilator controls (section 9.6)
Bezel, rear	- Electrical safety (section 9.4) - Ventilator controls (section 9.6)
Blower: removal/replacement	- Electrical safety (section 9.4) - Leak test (system) (section 9.5) - Pressure accuracy (section 9.7) - Air delivery (section 9.8) - Flow sensor zero calibration (section 9.9) - Air flow accuracy (section 9.10)
CPU PCBA: removal/replacement	- Electrical safety (section 9.4) - Alarms (section 9.14)
Data acquisition (DA) PCBA: removal/replacement	- Electrical safety (section 9.4) - Leak tests (section 9.5) - Pressure accuracy (section 9.7) - Air delivery (section 9.8) - Flow sensor zero calibration (section 9.9) - Air flow accuracy (section 9.10) - O₂ flow accuracy (section 9.11) - O₂ mix accuracy (section 9.12)
DA PCBA to flow sensors cable: removal/replacement	Electrical safety (section 9.4)
DA PCBA to motor controller (MC) PCBA cable: removal/replacement	Electrical safety (section 9.4)
Fan: removal/replacement	Electrical safety (section 9.4)

Service performed	Required tests
Gas delivery subsystem (GDS): removal/replacement	- Electrical safety (section 9.4) - High pressure leak test (section 9.5) - System leak test (section 9.5) - Pressure accuracy (section 9.7) - Air delivery (section 9.8) - Flow sensor zero calibration (section 9.9) - Air flow accuracy (section 9.10) - O₂ flow accuracy (section 9.11) - O₂ mix accuracy (section 9.12)
Gas outlet port: removal/replacement	- Electrical safety (section 9.4) - System leak test (section 9.5) - Pressure accuracy (section 9.7)
Internal battery: removal/replacement	- Electrical safety (section 9.4) - Internal battery (section 9.16)
LCD: removal/replacement	- Electrical safety (section 9.4) - Ventilator controls (section 9.6)
LCD cable: removal/replacement	- Electrical safety (section 9.4) - Ventilator controls (section 9.6)
MC PCBA: removal/replacement	- Electrical safety (section 9.4) - Air delivery (section 9.8) - Flow sensor zero calibration (section 9.9) - Air flow accuracy (section 9.10) - Internal battery (section 9.16)
O ₂ inlet filter: removal/replacement	- Electrical safety (section 9.4) - High pressure leak test (section 9.5) - System leak test (section 9.5) - Pressure accuracy (section 9.7) - Flow sensor zero calibration (section 9.9) - O₂ flow accuracy (section 9.11) - O₂ mix accuracy (section 9.12)
O ₂ inlet fitting: removal/replacement	- Electrical safety (section 9.4) - High pressure leak test (section 9.5)
O ₂ valve: removal/replacement	- Electrical safety (section 9.4) - High pressure leak test (section 9.5) - System leak test (section 9.5) - Pressure accuracy (section 9.7) - Flow sensor zero calibration (section 9.9) - O₂ flow accuracy (section 9.11) - O₂ mix accuracy (section 9.12)
Panel, front: removal/replacement	- Electrical safety (section 9.4) - System leak test (section 9.5) - Pressure accuracy (section 9.7)
Power harness cable: removal/replacement	- Electrical safety (section 9.4) - Internal battery (section 9.16)

Service performed	Required tests
Power management (PM) PCBA: removal/replacement	- Electrical safety (section 9.4) - Internal battery (section 9.16)
Power supply: removal/replacement	Electrical safety (section 9.4)
Power switch overlay: removal/replacement	- Electrical safety (section 9.4) - Ventilator controls (section 9.6)
Rubber boots: removal/replacement/adjustment	- Electrical safety (section 9.4) - System leak test (section 9.5) - Pressure accuracy (section 9.7)
Software option Auto-Trak+ enabled	- Electrical safety (section 9.4) - Flow sensor zero calibration (section 9.9) - Air flow accuracy (section 9.10) - O₂ flow accuracy (section 9.11) - O₂ mix accuracy (section 9.12)
Software option AVAPS enabled	- Electrical safety (section 9.4) - Flow sensor zero calibration (section 9.9) - Air flow accuracy (section 9.10) - O₂ flow accuracy (section 9.11) - O₂ mix accuracy (section 9.12)
Software option C-Flex enabled	- Electrical safety (section 9.4) - Flow sensor zero calibration (section 9.9) - Air flow accuracy (section 9.10) - O₂ flow accuracy (section 9.11) - O₂ mix accuracy (section 9.12)
Software option HFT enabled	- Electrical safety (section 9.4) - Flow sensor zero calibration (section 9.9) - Air flow accuracy (section 9.10) - O₂ flow accuracy (section 9.11) - O₂ mix accuracy (section 9.12)
Software option PPV enabled	- Electrical safety (section 9.4) - Pressure accuracy (section 9.7) - Flow sensor zero calibration (section 9.9) - Air flow accuracy (section 9.10) - O₂ flow accuracy (section 9.11) - O₂ mix accuracy (section 9.12)
Software upgrade only	- Electrical safety (section 9.4) - Preoperational check (section 4.4)

Service performed	Required tests
Solenoid valve (SOL 1-4): removal/replacement	• Electrical safety (section 9.4) • High pressure leak test (section 9.5) • System leak test (section 9.5) • Pressure accuracy (section 9.7) • Air delivery (section 9.8) • Flow sensor zero calibration (section 9.9) • Air flow accuracy (section 9.10) • O₂ flow accuracy (section 9.11) • O₂ mix accuracy (section 9.12)
Speaker: removal/replacement	• Electrical safety (section 9.4) • Alarms (section 9.14)
Switch PCBA: removal/replacement	• Electrical safety (section 9.4) • Ventilator controls (section 9.6)
Top cover: removal/replacement	• Electrical safety (section 9.4)
Touchscreen: removal/replacement	• Electrical safety (section 9.4) • Ventilator controls (section 9.6)
UI PCBA to PM PCBA Cable: removal/replacement	• Electrical safety (section 9.4) • Ventilator controls (section 9.6)
User Interface (UI) PCBA: removal/replacement	• Electrical safety (section 9.4) • Ventilator controls (section 9.6)
User Interface: removal/replacement	• Electrical safety (section 9.4) • Ventilator controls (section 9.6)

9.2 Pneumatic Calibration Analyzer Setup

Set up the Certifier FA Plus pneumatic calibration analyzer using these screens:

- Measurement Selection Screen (section 9.2.1)
- Averaging Setup Menu (section 9.2.2)
- Trigger Options menu (section 9.2.3)
- Configurations menu (section 9.2.4)

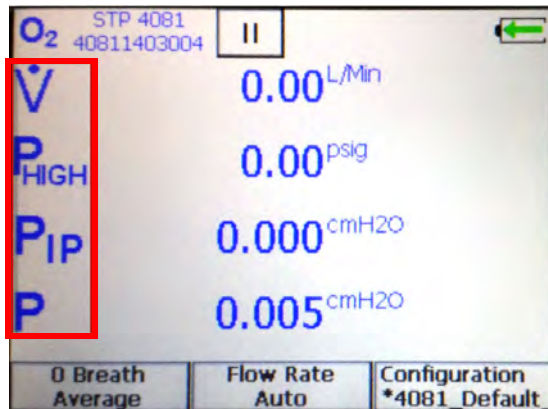
NOTE

When measuring flow, use the pneumatic calibration analyzer in standard temperature and pressure (STP).

9.2.1 Measurement Selection Screen

Use the Measurement Selection Screen to add or remove parameters from the Certifier FA Plus screen.

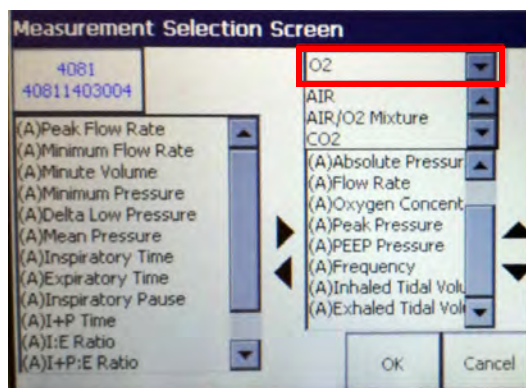
1. Touch any parameter on the analyzer touch screen to display the **Measurement Selection Screen**.



2. At the **Measurement Selection Screen**, use the arrows to add and remove parameters for display on the main screen:
 - To add a parameter, select it in the left column and touch the right arrow.
 - To remove a parameter, select it in the right column and touch the left arrow.
 - To change the order of parameters, select a parameter in the right column and touch the up or down arrow to adjust the order as needed.
 - Select these analyzer parameters for use with the ventilator performance verification:

Analyzer parameter	Unit
High Pressure	psig
Low Pressure	cmH ₂ O
Absolute Pressure	mmHg
Temperature	°C
Flow Rate	SLPM
Oxygen Concentration	%
Peak Pressure	cmH ₂ O
PEEP Pressure	cmH ₂ O

3. To select or change the measured gas, select the gas from the list.

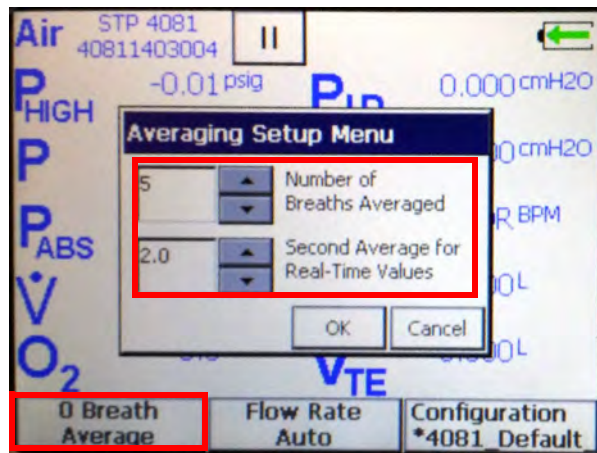


4. Touch **OK** when parameters selection and order is complete.

9.2.2 Averaging Setup Menu

Use the Averaging Setup Menu to select averages for breath parameters (how many breaths are averaged) and real-time transducer values (the time interval used for averaging).

1. Touch the **Breath Average** button to display the **Averaging Setup Menu**.
2. Use the up and down arrows to set these values:
 - **Number of Breaths Averaged** = 5
 - **Second Average for Real-Time Values** = 2.0

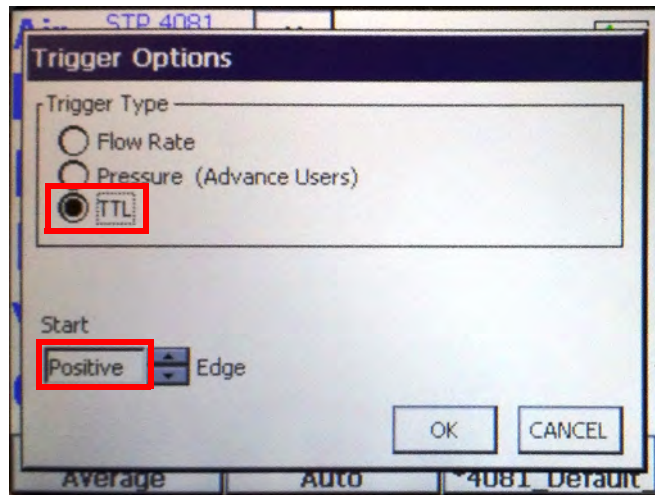


3. Touch **OK** when complete.

9.2.3 Trigger Options

Use Trigger Options to define how the analyzer detects the start of the inspiratory and expiratory breath cycles.

1. Touch the **Trigger** options button to display the **Trigger Options** menu.

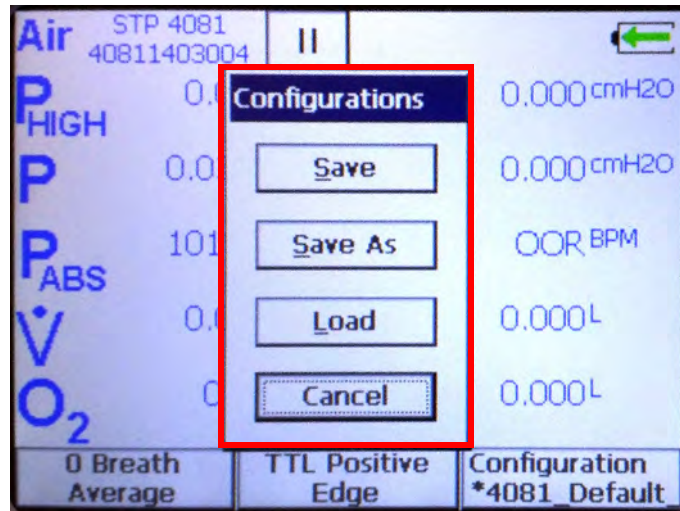


2. Select **TTL**.
3. Use the arrow buttons to select **Positive** for start trigger.
4. Touch **OK** when complete.

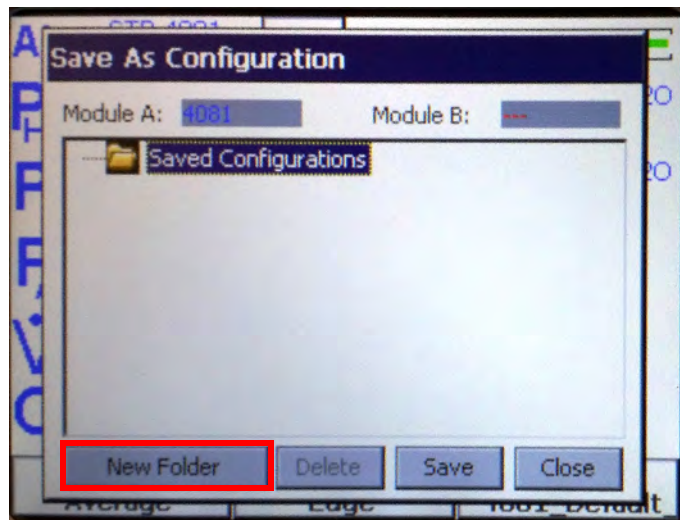
9.2.4 Configurations

Use the Configurations menu to save test configurations and switch between saved configurations.

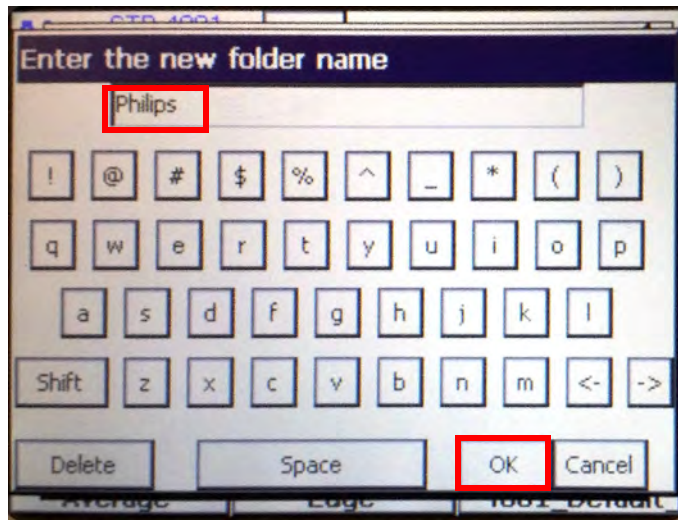
1. Touch the **Configuration** button to display the **Configurations** menu.



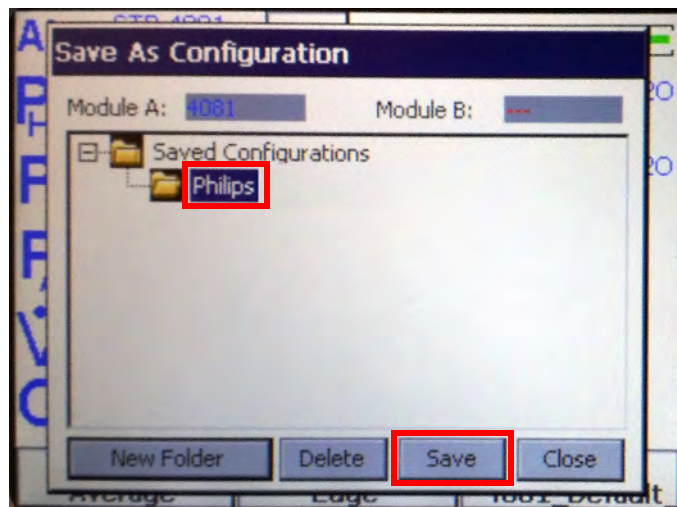
2. To create a Philips folder, touch **Save As**, then touch **New Folder**. If a Philips folder already exists go to step 4.



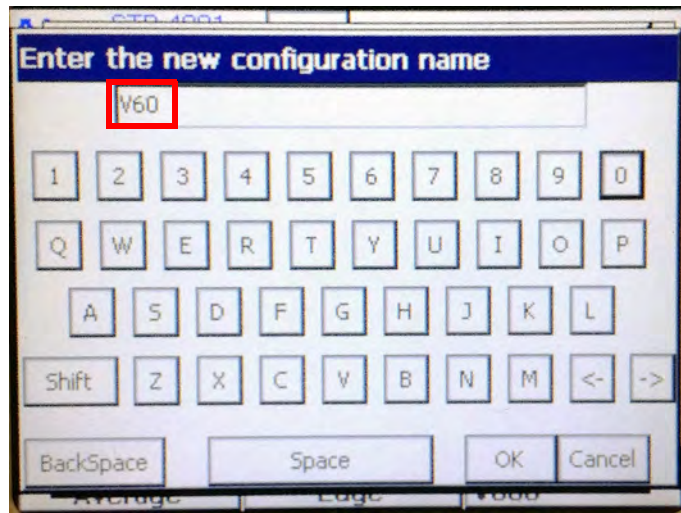
3. Use the touchscreen keyboard to enter **Philips**, then touch **OK**.



4. Highlight **Philips** and touch **Save**.



5. Use the touchscreen keyboard to enter the new configuration name (V60), then touch **OK**.



9.3 Preliminary Procedures

This section describes how to:

- Clean and inspect the ventilator (Section 9.3.1)
- Calibrate the touchscreen (Section 9.3.2)
- View and record ventilator information (Section 9.3.3)

9.3.1 Cleaning and Inspection

WARNING

To prevent disease transmission, use protective equipment when handling contaminated bacteria filters or other patient accessories.

Before servicing the ventilator, clean and inspect as follows:

- Remove the humidifier from the ventilator, if applicable.
- Remove the accessories from the ventilator, if applicable.
- Inspect the ventilator exterior, including the nav-ring (if present), and note any damage.
- Clean the ventilator exterior (Section 5.1).
- Remove and inspect the cooling fan filter and air inlet filter. Clean or replace filters as needed.

9.3.2 Touchscreen Calibration

1. If the ventilator is not already in Diagnostic mode, press and hold the Accept button, and press the On/Shutdown button on the user interface. Within 5 seconds of power up, release and press the Accept button again to enter the Diagnostics menu.
2. Perform touchscreen calibration (Section 6.3).

9.3.3 Record Ventilator Information

1. Touch **Service** to display the Ventilator Information screen, and record the following information on the Electrical Safety Data Form (section 9.19) or Performance Verification Data Form (section 9.20):
 - Software options (installed)
 - Ventilator serial number
 - Software version
 - Total power-on hours
 - Hours since last PM
 - PIC software version
 - CPU PLD version
 - PMC PLD version
 - Battery lot ID
 - Battery mfg date

Ventilator Information

Software Options : PPV, AVAPS, C-Flex, Ramp, Auto-Trak+,
HFT, HFT-60
Serial Number : 123456789
Software Version : 3.10
Total Power-on Hours : 48
Since Last PM : 24
PIC Software Version : 1.20
Boot Software Version : 1.10
Updater Software Version : 3.00
Boot Loader Software Version : 1.10
CPU PLD Version : 17
PMC PLD Version : 8
Battery Lot ID : 52685
Battery Mfg Date : 2020-12-21

PCBA :	P/N :	S/N :	Hours :
CPU	1054353	VS5550103	48
Data Acquisition	1054354	VS5550104	48
Power Management	1054355	VS5550105	48
Blower Control	1054356	VS5550106	48
Air Flow Sensor	1054357	VS5550107	48
O2 Flow Sensor	1054358	VS5550108	48

Vent Info Pneumatics **Outputs** Misc

- Record the PCBA information on the Electrical Safety Data Form (section 9.19) or Performance Verification Data Form (section 9.20).

Ventilator Information

Software Options : AVAPS, C-Flex, Ramp
 Serial Number : 123456789
 Software Version : P1.00.062
 Total Power-on Hours : 48
 Since Last PM : 24
 PIC Software Version : P1.00.062
 Boot Software Version : P1.00.062
 Updater Software Version : P1.00.062
 Boot Loader Software Version : P1.00.062
 CPU PLD Version : 15
 PMC PLD Version : 14
 Battery Lot ID : 52685
 Battery Mfg Date : 1976-07-20

PCBA :	P/N :	S/N :	Hours :
CPU	1054355	123456789	48
Data Acquisition	1054356	123456789	48
Power Management	1054358	123456789	48
Blower Control	1054357	123456789	48
Air Flow Sensor	1058898	123456789	48
O2 Flow Sensor	1058898	123456789	48

Vent Info Pneumatics **Outputs** Misc

- Capture and save a copy of the significant event log (DRPTA) (Section 7.2).
- Adjust the time and date as needed (Section 6.1.2).
- Turn the ventilator off.

9.4 Test 1: Electrical Safety

The electrical safety test verifies that the ground resistance and forward and reverse leakage current are within specified limits (Figure 9-1).

WARNING

To avoid a shock hazard, do not touch the ventilator under test with anything other than the electrical safety analyzer test probe.

NOTE

- *The gas outlet port is made of anodized aluminum. Score the upper inside surface to achieve a good ground resistance reading.*
- *The O₂ fitting is not grounded.*

Required equipment (section 1.2):

0.25-in. test adapter
Electrical safety analyzer

1. Inspect the AC power cord and replace if damage is evident.
2. With the electrical safety analyzer off, connect the ventilator AC power cord to the analyzer.
3. Set the electrical safety analyzer output current source to 25 A.
4. Verify that ground resistance is ≤ 200 milliohms ($m\Omega$) at these test points (Figure 9-1):
 - Proximal pressure port
 - Gas outlet port (inside of port must be scored to achieve a reading)
 - O₂ inlet fitting retention plate screws
5. Attach the 0.25-in. test adapter to the gas outlet port.
6. Turn the ventilator on and verify that the cooling fan is operating.
7. Verify that the forward and reverse leakage current is: ≤ 280 microamperes (μA).
8. Turn the ventilator off and remove the 0.25-in. adapter.
9. Disconnect the ventilator AC power cord from the electrical safety analyzer.

The electrical safety test is complete.



Electrical safety analyzer set to measure ground resistance

Proximal pressure port



Electrical safety analyzer set to measure ground resistance

Gas outlet port



Electrical safety analyzer set to measure ground resistance

O₂ inlet fitting retention plate screw

Figure 9-1:Electrical Safety Test Points

9.5 Test 2: Leak Tests

Leak tests include the high pressure leak test and the system leak test.

9.5.1 High Pressure Leak Test

The high pressure leak test verifies that there are no leaks on the high-pressure (O₂) side of the GDS.

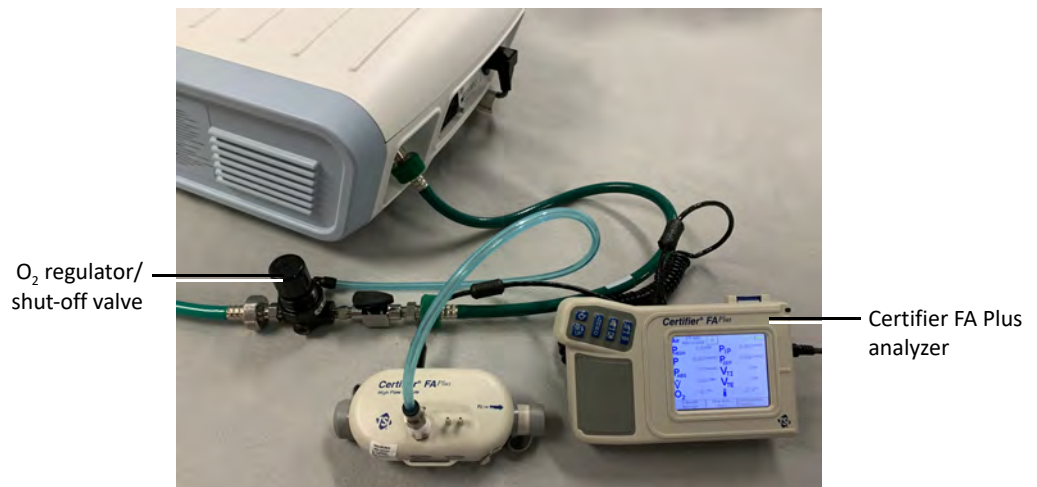
NOTE

The O₂ pressure source connected to the inlet side of the test regulator must be capable of supplying at least 50 psig to conduct this test.

Required equipment (section 1.2):

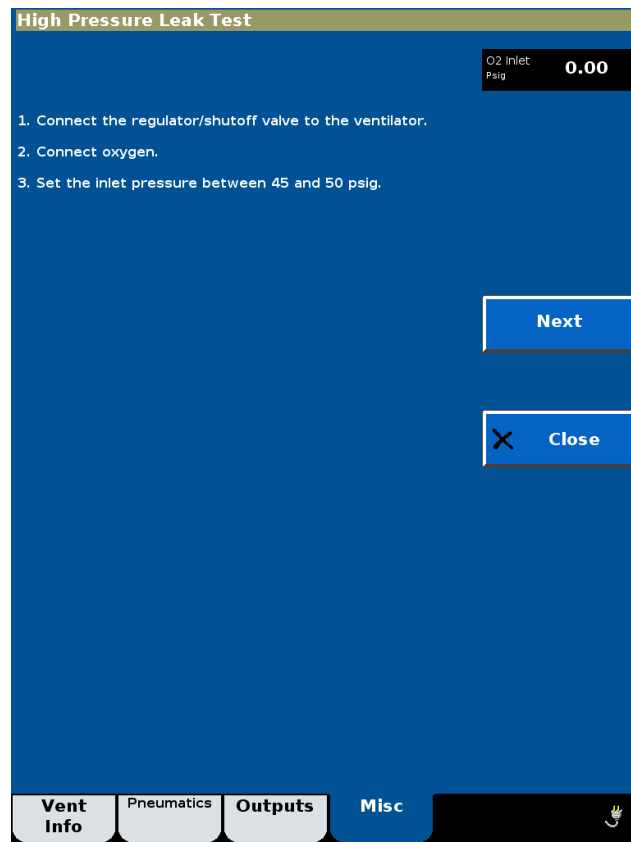
Pneumatic calibration analyzer
O ₂ regulator/shut-off valve

1. Verify that the ventilator is connected to an AC mains outlet.
2. Set up the ventilator for the high pressure leak test as shown.



3. If the ventilator is not already in Diagnostic mode, press and hold the Accept button and turn the ventilator on by pressing the On/Shutdown button. Within 5 seconds, release and press the Accept button again to enter the Diagnostics menu.
4. Touch **Service**, then **Pneumatics**, and verify that the O₂ inlet display and the analyzer display read 45 to 50 psig. If needed, adjust the test regulator to achieve an O₂ inlet pressure of 45 to 50 psig.

5. Touch **Misc**, then touch **High Pressure Leak Test**, and follow the onscreen prompts.



6. When pressure is within the 45 to 50-psig range to start the test, recheck the O₂ inlet pressure displayed on the ventilator and analyzer displays, and record the values.
7. Upon successful completion of the test, record the **Threshold** and **Pressure Drop** test results as displayed by the ventilator.
8. Touch **Close** and then remove the O₂ regulator/shut-off valve and hose from the ventilator.
9. If no further testing is required, turn the ventilator off.

The high pressure leak test is complete.

9.5.2 System Leak Test

The System leak test verifies that there are no leaks on the low pressure side of the GDS, or connections between the rubber boots, blower patient outlet, and internal tubing.

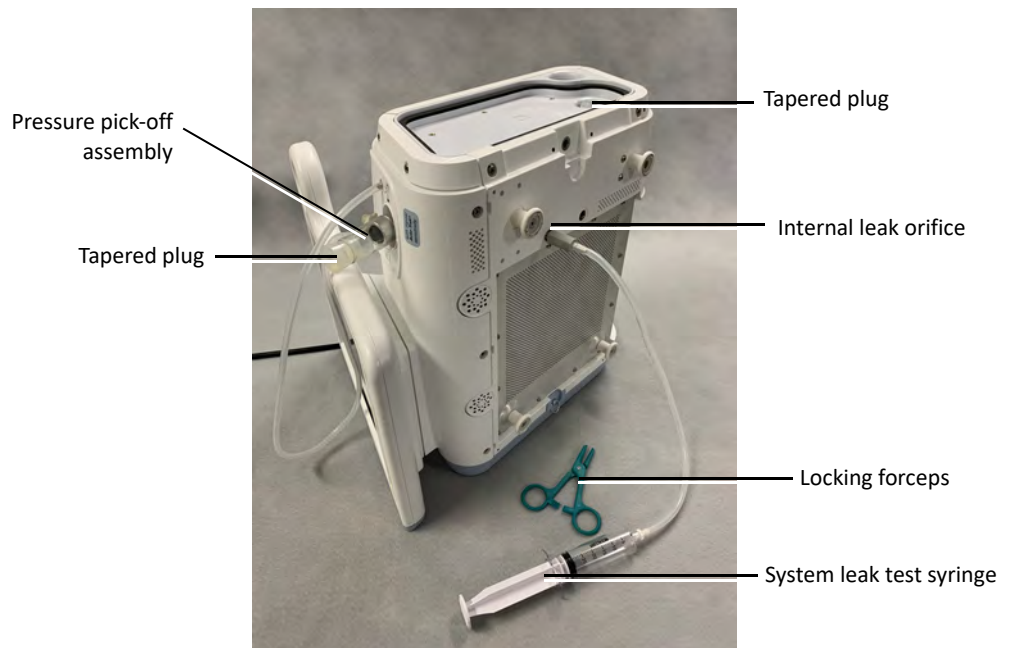
Required equipment (section 1.2):

23/32 - 61/64-in. tapered plug (x2)
Locking forceps
Pressure pick-off assembly
System leak test syringe

1. Verify that the ventilator is connected to an AC mains outlet.
2. Remove the right side cover, air inlet filter retainer, and air inlet housing.
3. Set up the ventilator for the system leak test as shown.

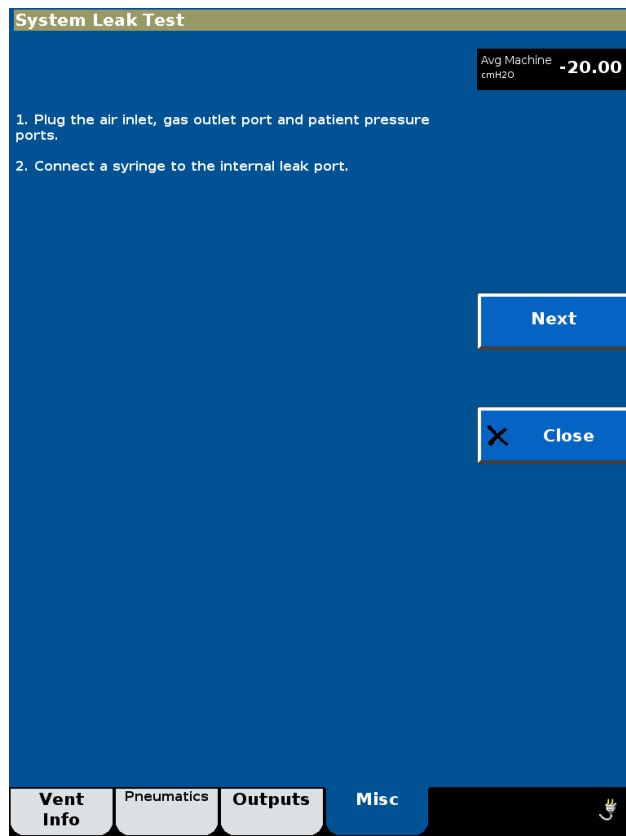
NOTE

Verify that the leak test syringe plunger is pulled back before connecting it to the internal leak orifice.



4. If the ventilator is not already in Diagnostic mode, press and hold the Accept button and turn the ventilator on by pressing the On/Shutdown button on the UI. Within 5 seconds, release and press the Accept button again to enter the Diagnostics menu.

5. Touch **Service**, **Misc**, and **System Leak Test**, then follow the onscreen prompts.



6. Upon successful completion of the test, record the **Threshold** and **Pressure Drop** test results as displayed by the ventilator.
 7. Touch **Close**, then remove the plugs and system leak test syringe.
 8. Turn the ventilator off.
- The system leak test is complete.

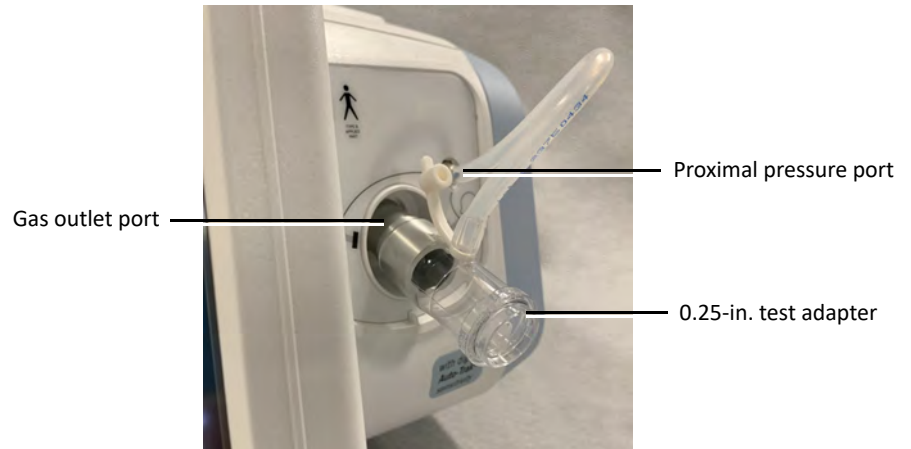
9.6 Test 3: Controls

The controls test verifies that the touchscreen, nav-ring (if present), and Accept button work correctly.

Required equipment (section 1.2):

0.25-in. test adapter

1. Verify that the ventilator is connected to an AC mains outlet.
2. Connect the 0.25-in. test adapter to the ventilator gas outlet port.



3. Turn on the ventilator by pressing the On/Shutdown button.
4. Select these ventilator settings and alarm limits:

Ventilator settings		Alarm limits	
Mode:	S/T	High Rate:	30 BPM
IPAP:	20 cmH ₂ O	Low Rate:	4 BPM
EPAP:	4 cmH ₂ O	Hi Vt:	2500 mL
Rate:	12 BPM	Lo Vt:	Off mL
I-Time:	1.00 secs	HIP:	50 cmH ₂ O
Rise:	1	LIP:	Off cmH ₂ O
Ramp:	Off	Low VE:	Off L/min
O ₂ :	21%	LIP T:	20 secs

5. Verify that the AC power icon is displayed on the ventilator GUI.
6. Verify that the On/Shutdown LED is green.
7. Touch **IPAP** to display the IPAP adjustment screen, then use the nav-ring to change the value to 40 cmH₂O. If the nav-ring is not present, use the touchscreen arrows to change the value.
8. Press the Accept button to accept the new setting.

9. Touch **IPAP** to display the IPAP adjustment screen, then use the touchscreen arrows and **Accept** button to return the IPAP setting to 20 cmH₂O.
10. Touch **Menu**, then **Brightness** and verify that the display information is visible when brightness is set to its minimum value.
11. Adjust brightness to 5, then touch **Close**.
12. Touch **Screen Lock**, then attempt to change a setting. Verify that the *Screen locked* message appears at the top of the screen.
13. Press the Accept button to unlock the screen.
14. Press the On/Shutdown button, then touch **Ventilator Shutdown**.
15. Verify that the On/Shutdown LED is amber.
16. Turn the ventilator off.
17. Remove the 0.25-in. test adapter from the ventilator.

The controls test is complete.

9.7 Test 4: Pressure Accuracy

The pressure accuracy test verifies the accuracy of the machine and proximal pressure transducers.

Required equipment (section 1.2):

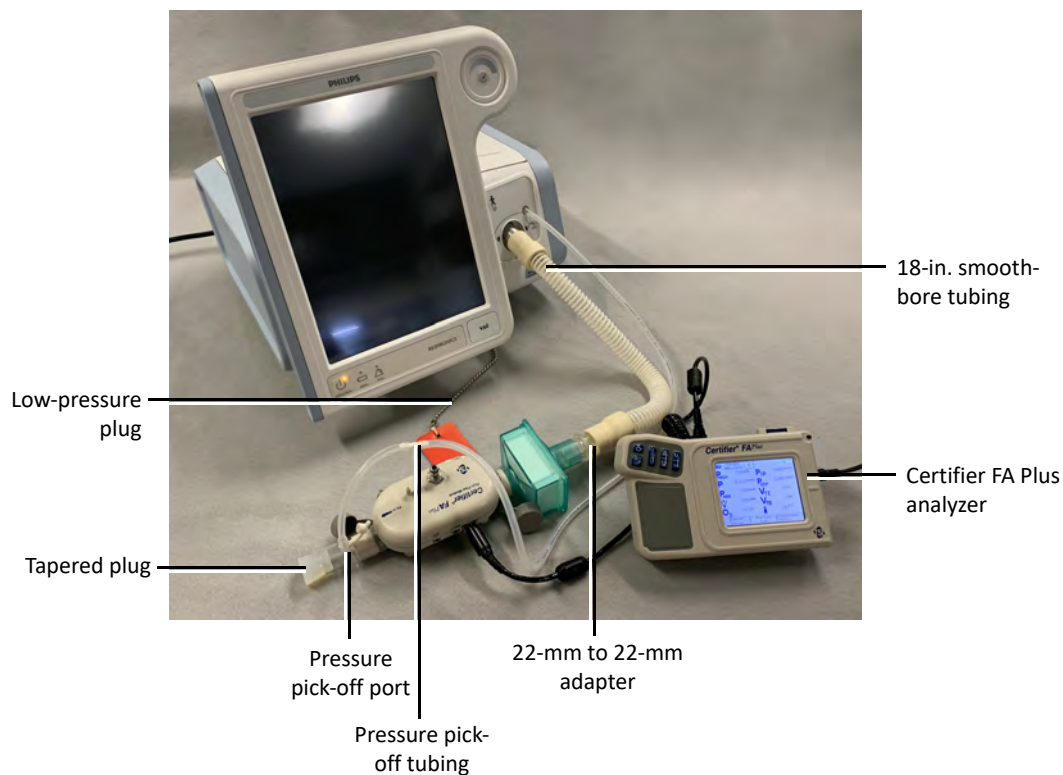
18-in. smooth-bore tubing
22-mm to 22-mm adapter
23/32 - 61/64-in. tapered plug
Pneumatic calibration analyzer
Low-pressure plug
Pressure pick-off port
Pressure pick-off tubing

1. Verify that the ventilator is connected to an AC mains outlet.
2. If the ventilator is not already in Diagnostic mode, press and hold the Accept button and turn the ventilator on by pressing the On/Shutdown button on the user interface. Within 5 seconds release and press the Accept button again to enter the Diagnostics Menu.
3. If the ventilator has not been powered on for at least 10 minutes, wait 10 minutes and then proceed.
4. Touch **Service**, then **Pneumatics**.
5. Verify that the barometric pressure reading displayed on the ventilator is within $\pm 3.5\%$ of the analyzer reading.
6. Zero the analyzer's pressure transducers.
7. Record the ventilator software version on the Performance Verification Data Form.
8. Plug the internal leak orifice with the low-pressure plug.



Use the low-pressure plug to plug the internal leak orifice (underside of the ventilator)

9. Connect the pneumatic calibration analyzer to the ventilator as shown.



10. Using the Pneumatic Controls, select:

Pressure:	0 cmH ₂ O
Flow:	0 SLPM
O ₂ :	21%
Solenoid 1:	None
Solenoid 2:	Machine Pressure Line
Solenoid 3:	Machine Pressure Line
Solenoid 4:	Prox Pressure

11. Set ventilator pressure values and verify that they correspond to pressure measurements:

NOTE: If the pressure accuracy test fails at 0 cmH₂O, restart the ventilator in ventilation mode. Once the ventilator passes POST, repeat the pressure accuracy test.

Set Pressure to:	Verify that the <i>Avg Machine</i> and <i>Avg Proximal</i> displays read:
0 cmH ₂ O	-1.00 to 1.00 cmH ₂ O (software version 3.00 and earlier) -3.5 to 5.5 cmH ₂ O (software version 3.10 and later)
Set Pressure to:	Verify that the analyzer, <i>Avg Machine</i> , and <i>Avg Proximal</i> displays read (see section 9.7.1 for example test calculations):
10 cmH ₂ O	Analyzer and <i>Avg Machine</i> : 7.6 to 12.4 cmH ₂ O (analyzer reading + <i>Avg Machine</i> zero offset)
	<i>Avg Proximal</i> : Lower limit = (analyzer reading x 0.96) - 2 Upper limit = (analyzer reading x 1.04) + 2 (<i>Avg Proximal</i> reading - <i>Avg Proximal</i> zero offset)
35 cmH ₂ O	Analyzer and <i>Avg Machine</i> : 31.6 to 38.4 cmH ₂ O (analyzer reading + <i>Avg Machine</i> zero offset)
	<i>Avg Proximal</i> : Lower limit = (analyzer reading x 0.96) - 2 Upper limit = (analyzer reading x 1.04) + 2 (<i>Avg Proximal</i> reading - <i>Avg Proximal</i> zero offset)
60 cmH ₂ O	Analyzer and <i>Avg Machine</i> : 55.6 to 64.4 cmH ₂ O (analyzer reading + <i>Avg Machine</i> zero offset)
	<i>Avg Proximal</i> : Lower limit = (analyzer reading x 0.96) - 2 Upper limit = (analyzer reading x 1.04) + 2 (<i>Avg Proximal</i> reading - <i>Avg Proximal</i> zero offset)

12. To reset the pressure setting to 0, touch **Flow**, then **Accept**.
13. Remove all test equipment from the ventilator.
14. If no further testing is required, turn the ventilator off.

The pressure accuracy test is complete.

9.7.1 Pressure Accuracy Test Example

Zero offset readings:

- *Avg Machine* reading at 0 cmH₂O = (-0.24)
- *Avg Proximal* reading at 0 cmH₂O = (-0.21)

Analyzer and *Avg Machine* tolerances and calculations:

At 10 cmH₂O (7.6 to 12.4 cmH₂O):

- Analyzer reading at 10 cmH₂O = 10.23
- *Avg Machine* reading at 0 cmH₂O = (-0.24)
- Calculation (analyzer reading plus *Avg Machine* zero offset):
 $10.23 + (-0.24) = 9.99 \text{ cmH}_2\text{O}$

At 35 cmH₂O (31.6 to 38.4 cmH₂O):

- Analyzer reading at 35 cmH₂O = 35.23
- *Avg Machine* reading at 0 cmH₂O = (-0.24)
- Calculation (analyzer reading plus *Avg Machine* zero offset):
 $35.23 + (-0.24) = 34.99 \text{ cmH}_2\text{O}$

At 60 cmH₂O (55.6 to 64.4 cmH₂O):

- Analyzer reading at 60 cmH₂O = 60.26
- *Avg Machine* reading at 0 cmH₂O = (-0.24)
- Calculation (analyzer reading plus *Avg Machine* zero offset):
 $60.26 + (-0.24) = 60.02 \text{ cmH}_2\text{O}$

Avg Proximal tolerances and calculations:

At 10 cmH₂O (see lower and upper limits):

- Analyzer reading at 10 cmH₂O = 10.23
- *Avg Proximal* reading at 10 cmH₂O = 10.04
- *Avg Proximal* reading at 0 cmH₂O = (-0.21)
- Tolerances:
 - Lower limit = (analyzer reading x 0.96) – 2 = (10.23 x 0.96) – 2 = 7.82
 - Upper limit = (analyzer reading x 1.04) + 2 = (10.23 x 1.04) + 2 = 12.64
- Calculation (*Avg Proximal* reading – *Avg Proximal* zero offset): $10.04 - (-0.21) = 10.25$

At 35 cmH₂O (see lower and upper limits):

- Analyzer reading at 35 cmH₂O = 35.23
- *Avg Proximal* reading at 35 cmH₂O = 35.05
- *Avg Proximal* reading at 0 cmH₂O = (-0.21)
- Tolerances:
 - Lower limit = (analyzer reading x 0.96 – 2) = (35.23 x 0.96) – 2 = 31.82
 - Upper limit = (analyzer reading x 1.04 + 2) = (35.23 x 1.04) + 2 = 38.64
- Calculation (*Avg Proximal* reading – *Avg Proximal* zero offset): $35.05 - (-0.21) = 35.26$

At 60 cmH₂O (see lower and upper limits)

- Analyzer reading at 60 cmH₂O = 60.26
- *Avg Proximal* reading at 60 cmH₂O = 60.06
- *Avg Proximal* reading at 0 cmH₂O = (-0.21)
- Tolerances:
 - Lower limit = (analyzer reading x 0.96) – 2 = (60.26 x 0.96) – 2 = 55.85
 - Upper limit = (analyzer reading x 1.04) + 2 = (60.26 x 1.04) + 2 = 64.67
- Calculation (*Avg Proximal* reading – *Avg Proximal* zero offset): $60.06 - (-0.21) = 60.27$

Test 4: Pressure accuracy	Pass value	Fail value
Barometric pressure		
Analyzer barometric pressure display	mmHg	
Ventilator barometric pressure display = $\pm 3.5\%$ of the analyzer reading	mmHg	mmHg
Pressure at 0 cmH₂O		
Ventilator software version		
Avg Machine display = -1.00 to 1.00 cmH₂O (software version 3.00 and earlier) -3.5 to 5.5 cmH₂O (software version 3.10 and later)	-0.24 cmH ₂ O	cmH ₂ O
Avg Proximal display = -1.00 to 1.00 cmH₂O (software 3.00 and earlier) -3.5 to 5.5 cmH₂O (software 3.10 and later)	-0.21 cmH ₂ O	cmH ₂ O
Pressure at 10 cmH₂O		
Analyzer display	10.23 cmH ₂ O	
Avg Machine display	10.00 cmH ₂ O	
(Analyzer display + Avg Machine zero offset) = 7.6 to 12.4 cmH ₂ O	9.99 cmH ₂ O	cmH ₂ O
Avg Proximal display	10.04 cmH ₂ O	
Lower limit (Avg Proximal display) = (analyzer reading x 0.96) -2	7.82 cmH ₂ O	
Upper limit (Avg Proximal display) = (analyzer reading x 1.04) +2	12.64 cmH ₂ O	
Avg Proximal value = (Avg Proximal - Avg Proximal zero offset)	10.25 cmH ₂ O	cmH ₂ O
Pressure at 35 cmH₂O		
Analyzer display	35.23 cmH ₂ O	
Avg Machine display	35.00 cmH ₂ O	
(Analyzer display + Avg Machine zero offset) = 31.6 to 38.4 cmH ₂ O	34.99 cmH ₂ O	cmH ₂ O
Avg Proximal display	35.05 cmH ₂ O	
Lower limit (Avg Proximal display) = (analyzer reading x 0.96) -2	31.82 cmH ₂ O	
Upper limit (Avg Proximal display) = (analyzer reading x 1.04) +2	38.64 cmH ₂ O	
Avg Proximal value = (Avg Proximal - Avg Proximal zero offset)	35.26 cmH ₂ O	cmH ₂ O
Pressure at 60 cmH₂O		
Analyzer display	60.26 cmH ₂ O	
Avg Machine display	60.00 cmH ₂ O	
(Analyzer display + Avg Machine zero offset) = 55.6 to 64.4 cmH ₂ O	60.02 cmH ₂ O	cmH ₂ O
Avg Proximal display	60.06 cmH ₂ O	
Lower limit (Avg Proximal display) = (analyzer reading x 0.96) -2	55.85 cmH ₂ O	
Upper limit (Avg Proximal display) = (analyzer reading x 1.04) +2	64.67 cmH ₂ O	
Avg Proximal value = (Avg Proximal - Avg Proximal zero offset)	60.27 cmH ₂ O	cmH ₂ O

9.8 Test 5: Air Delivery

The air delivery test verifies the accuracy and function of the blower.

NOTE

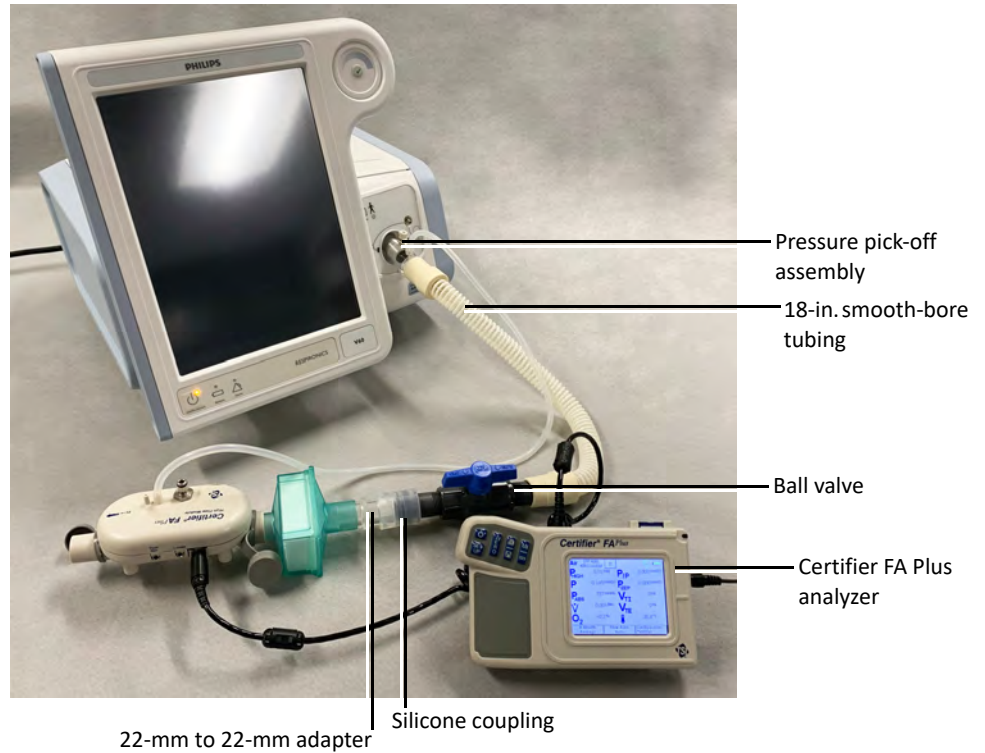
Do not perform the air delivery test if the barometric pressure is below 600.1 mmHg or above 781.2 mmHg. Record the displayed barometric pressure from the Pneumatics screen and record "N/A" in the air delivery section of the Performance Verification Data Form.

Required equipment (section 1.2):

18-in. smooth-bore tubing
22-mm to 22-mm adapter
Ball valve
Pneumatic calibration analyzer
Coupling, straight silicone
Pressure pick-off assembly

1. Verify that the ventilator is connected to an AC mains outlet.
2. If the ventilator is not already in Diagnostic mode, press and hold the Accept button and turn the ventilator on by pressing the On/Shutdown button on the user interface. Within 5 seconds release and press the Accept button again to enter the **Diagnostics** menu.
3. Touch **Service**, then **Pneumatics**.
4. Disconnect the O₂ source from the ventilator.

5. Set up the ventilator for the air delivery test as shown.



6. Confirm that the analyzer is set to:

- Gas source: **Air**
- Gas condition: **STP**

7. Using the Pneumatic Controls, select:

Pressure:	0 cmH ₂ O
Flow:	0 SLPM
O ₂ :	21%
Solenoid 1:	None
Solenoid 2:	Machine Pressure Line
Solenoid 3:	Machine Pressure Line
Solenoid 4:	Prox Pressure

8. Verify that the barometric pressure displayed on the Pneumatic Controls screen is within $\pm 3.5\%$ of the analyzer reading.
9. Using the recorded barometric pressure, identify and record the appropriate cmH₂O and SLPM parameters (Table 9-3), rounding down the barometric pressure if needed.
10. Ensure that the ball valve is fully open, then touch **Flow** and set to 200 SLPM.

11. Begin closing the ball valve until the low pressure display on the analyzer is greater than the cmH₂O test parameter (Table 9-3).
 12. Verify that the flow displayed on the analyzer is greater than the SLPM test parameter (Table 9-3).
 13. Touch **Pressure**, then **Accept** to return the flow setting to zero.
 14. Turn the ventilator off.
 15. If no further testing is required, remove the test equipment from the ventilator.
- The air delivery test is complete.

Table 9-3: Air Delivery Barometric Pressure Compensation

mmHg	cmH ₂ O	SLPM	mmHg	cmH ₂ O	SLPM	mmHg	cmH ₂ O	SLPM
781.2	65.27	141.84	715.1	62.25	128.92	654.3	59.51	117.15
778.5	65.16	141.32	712.5	62.12	128.42	651.8	59.40	116.69
775.9	65.04	140.81	709.8	62.00	127.93	649.4	59.29	116.23
773.2	64.92	140.29	707.2	61.88	127.44	646.9	59.19	115.78
770.6	64.80	139.78	704.6	61.76	126.95	644.4	59.08	115.33
767.9	64.68	139.26	701.9	61.63	126.47	641.9	58.98	114.88
765.3	64.67	139.17	699.3	61.51	125.99	639.4	58.87	114.44
762.6	64.54	138.59	696.6	61.39	125.52	637.0	58.77	114.00
760.0	64.41	138.02	694.0	61.27	125.04	634.5	58.67	113.56
757.4	64.28	137.45	691.5	61.16	124.52	632.0	58.56	113.13
754.7	64.15	136.88	689.0	61.04	124.00	629.7	58.47	112.65
752.1	64.02	136.32	686.6	60.93	123.48	627.4	58.38	112.17
749.4	63.89	135.76	684.1	60.82	122.97	625.2	58.28	111.70
746.8	63.76	135.21	681.6	60.71	122.46	622.9	58.19	111.23
744.2	63.63	134.67	679.1	60.60	121.96	620.6	58.10	110.77
741.5	63.51	134.12	676.6	60.48	121.46	618.3	58.01	110.31
738.9	63.38	133.58	674.2	60.37	120.97	616.0	57.91	109.86
736.2	63.25	133.05	671.7	60.26	120.48	613.8	57.82	109.41
733.6	63.12	132.52	669.2	60.15	119.99	611.5	57.73	108.96
731.0	63.00	131.99	666.7	60.05	119.51	609.2	57.64	108.51
728.3	62.87	131.47	664.2	59.94	119.03	606.9	57.55	108.07
725.7	62.75	130.95	661.8	59.83	118.55	604.6	57.46	107.63
723.0	62.62	130.44	659.3	59.72	118.08	602.4	57.38	107.20
720.4	62.50	129.93	656.8	59.61	117.61	600.1	57.29	106.77
717.8	62.37	129.42						

9.9 Test 6: Flow Sensor Zero Calibration

The flow sensor zero calibration calculates flow sensor offsets and compensates for drift in the air and O₂ flow sensors.

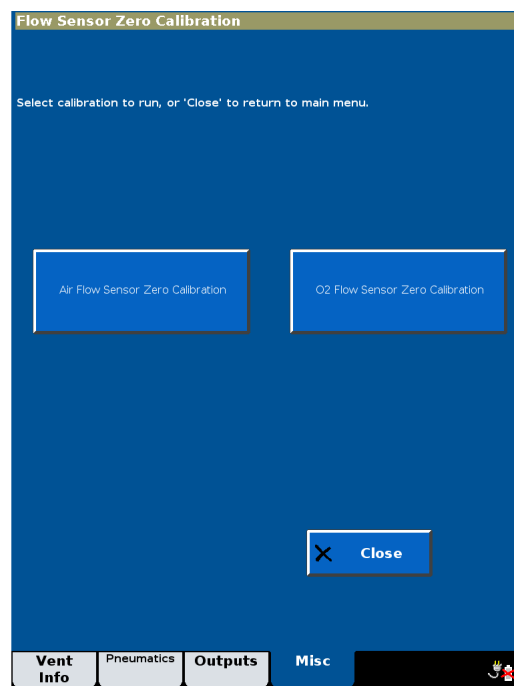
NOTE

- *Flow sensor zero calibration is available on ventilators with software version 3.10 or later.*
- *Avoid gas flow from any source when performing the flow sensor zero calibration.*

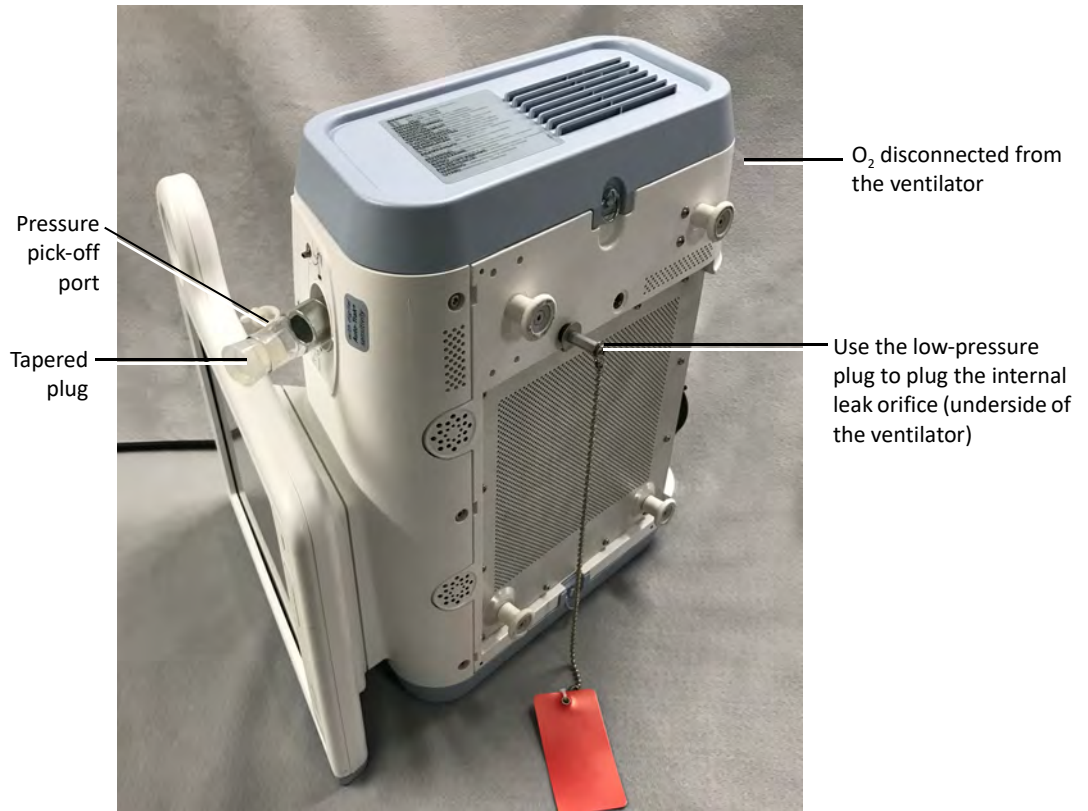
Required equipment (section 1.2):

23/32 - 61/64-in. tapered plug
Low-pressure plug
Pressure pick-off port

1. Verify that the ventilator is connected to an AC mains outlet.
2. If the ventilator is not already in Diagnostic mode, press and hold the Accept button and turn the ventilator on by pressing the On/Shutdown button on the user interface. Within 5 seconds, press the Accept button again to enter the Diagnostics Menu.
3. If the ventilator has not been powered on for at least 10 minutes, wait 10 minutes and then proceed.
4. Touch **Service**, **Miscellaneous**, and then **Flow Sensor Zero Calibration**.
5. Touch **Air Flow Sensor Zero Calibration**.



6. Follow the onscreen instructions:
 - Disconnect O₂ from the ventilator
 - Block the gas outlet port
 - Block the internal leak orifice



7. Touch **Start Test** and follow the onscreen instructions.
 8. After the air flow sensor zero calibration is complete, touch **Close**.
 9. Touch **O₂ Flow Sensor Zero Calibration**.
 10. Follow the onscreen instructions:
 - Disconnect O₂ from the ventilator
 - Block the gas outlet port
 - Block the internal leak orifice
 11. After the O₂ flow sensor zero calibration is complete, touch **Close**.
 12. Remove all test equipment from the ventilator.
 13. If no further testing is required, turn the ventilator off.
- The flow sensor zero calibration is complete.

9.10 Test 7: Air Flow Accuracy

The air flow accuracy test verifies the accuracy of the air flow sensor and function of the blower.

NOTE

- *When using the Certifier FA Plus, the flow accuracy test requires that the temperatures of the delivered gas and ambient air must be within 10°C of each other, and that the relative humidity of the gas must be less than 30% at 21.1 °C.*
- *Most flow analyzer flow sensors are sensitive to relative humidity and typically indicate higher-than-actual flow readings when the relative humidity is above 10%. Consult the manufacturer's instructions for correcting any flow inaccuracies due to high relative humidity.*

Required equipment (section 1.2):

18-in. smooth-bore tubing
22-mm to 22-mm adapter
Pneumatic calibration analyzer
Low-pressure plug
Pressure pick-off port
Pressure pick-off tubing

1. Verify that the ventilator is connected to an AC mains outlet.
2. If the ventilator is not already in Diagnostic mode, press and hold the Accept button and turn the ventilator on by pressing the On/Shutdown button on the user interface. Within 5 seconds release and press the Accept button again to enter the Diagnostics menu.
3. Touch **Service**, then **Pneumatics**.

4. Plug the internal leak orifice with the low-pressure plug.



Use the low-pressure plug to plug the internal leak orifice (underside of the ventilator)

5. Set up the ventilator for the air flow accuracy test as shown.



Pressure pick-off tubing

18-in. smooth-bore tubing

Low-pressure plug

Certifier FA Plus analyzer

Pressure pick-off port

6. Confirm that the analyzer is set to:
- Gas source: **Air**
 - Gas condition: **STP**

7. Using the Pneumatic Controls, select:

Pressure:	0 cmH ₂ O
Flow:	0 SLPM
O ₂ :	21%
Solenoid 1:	None
Solenoid 2:	Machine Pressure Line
Solenoid 3:	Machine Pressure Line
Solenoid 4:	Prox Pressure

8. Record on the Performance Verification Data Form:

- Relative humidity (%)
- Temperature (°C)

9. Verify that the set air flow values correspond to these flow measurements:

Set Flow to:	Verify that analyzer and Avg Air flow displays read:
0 SLPM	-1.0 to 1.0 SLPM
10 SLPM	8.6 to 11.4 SLPM
35 SLPM	33.2 to 36.8 SLPM
60 SLPM	56.2 to 63.8 SLPM
140 SLPM	129.8 to 150.2 SLPM

10. Set the air flow to 120 SLPM, then remove the low-pressure plug and verify that the flow reading on the analyzer drops by approximately 8 SLPM, but not more than 30 SLPM.
11. Touch **Pressure**, then **Accept** to zero the flow setting.
12. Turn the ventilator off.
13. If no further testing is required, remove the test equipment from the ventilator.

The air flow accuracy test is complete.

9.11 Test 8: O₂ Flow Accuracy

The O₂ flow accuracy test verifies the accuracy of the O₂ flow sensor and function of the O₂ valve.

NOTE

- *When using the Certifier FA Plus, the flow accuracy test requires that the temperatures of the delivered gas and ambient air must be within 10°C of each other, and that the relative humidity of the gas must be less than 30% at 21.1 °C.*
- *Most flow analyzer flow sensors are sensitive to relative humidity and typically indicate higher-than-actual flow readings when the relative humidity is above 10%. Consult the manufacturer's instructions for correcting any flow inaccuracies due to high relative humidity.*

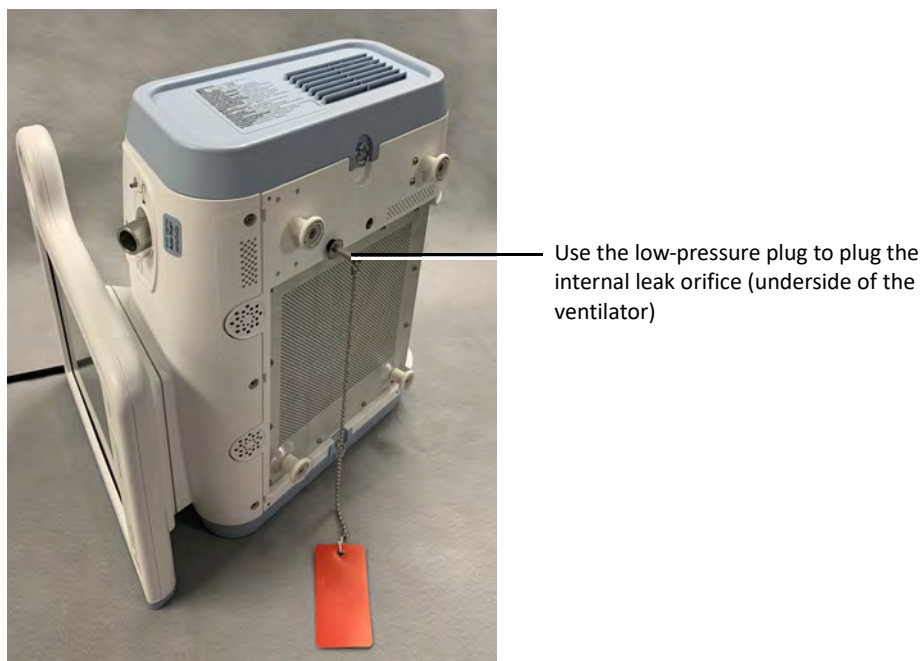
Required equipment (section 1.2):

18-in. smooth-bore tubing
22-mm to 22-mm adapter
Pneumatic calibration analyzer
Low-pressure plug
Pressure pick-off port
Pressure pick-off tubing

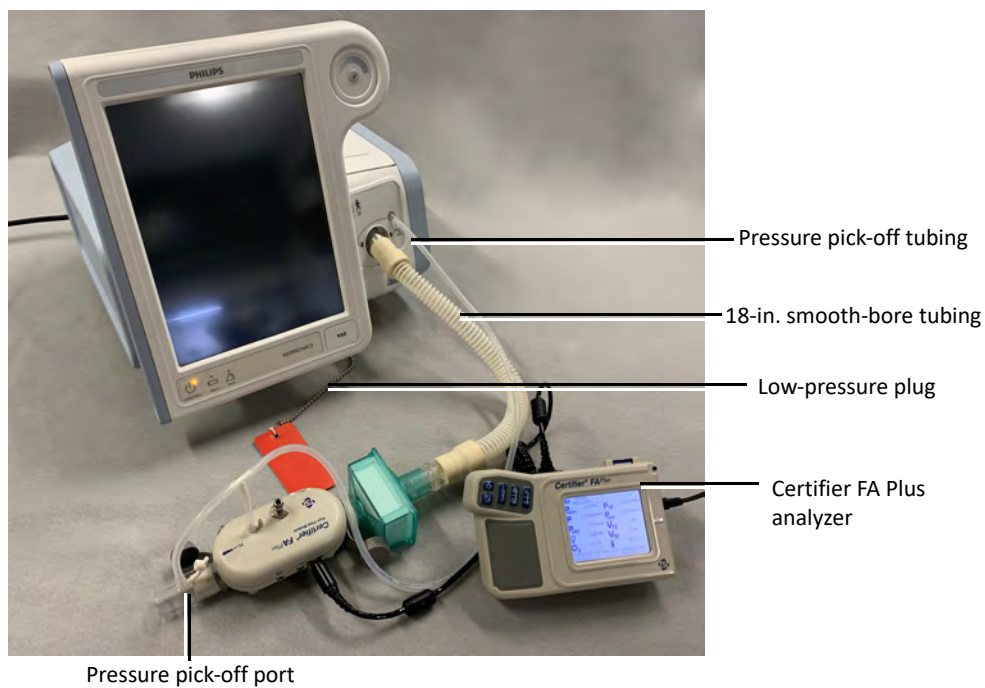
Required equipment:

1. Verify that the ventilator is connected to an AC mains outlet.
2. If the ventilator is not already in Diagnostic mode, press and hold the Accept button and turn the ventilator on by pressing the On/Shutdown button on the user interface. Within 5 seconds release and press the Accept button again to enter the Diagnostics menu.
3. Touch **Service**, then **Pneumatics**.
4. Connect the O₂ source to the ventilator.

5. Plug the internal leak orifice with the low-pressure plug.



6. Set up the ventilator for the O₂ flow accuracy test as shown.



7. Confirm that the analyzer is set to:
- Gas source: **O₂**
 - Gas condition: **STP**

8. Using the Pneumatic Controls, select:

Pressure:	0 cmH ₂ O
Flow:	0 SLPM
O ₂ :	100%
Solenoid 1:	None
Solenoid 2:	Machine Pressure Line
Solenoid 3:	Machine Pressure Line
Solenoid 4:	Prox Pressure

9. Record on the Performance Verification Data Form:

- Relative humidity (%)
- Temperature (°C)

10. Verify that the set O₂ flow values correspond to these flow measurements:

Set Flow to:	Verify that analyzer and Avg O₂ flow displays read:
0 SLPM	-1.0 to 1.0 SLPM
10 SLPM	8.6 to 11.4 SLPM
35 SLPM	33.2 to 36.8 SLPM
60 SLPM	56.2 to 63.8 SLPM
140 SLPM	129.8 to 150.2 SLPM

11. Touch **Pressure**, then **Accept** to zero the flow setting.
12. Touch **O₂** and set to 21%.
13. Turn the ventilator off.
14. Remove the test equipment from the ventilator.

The O₂ flow accuracy test is complete.

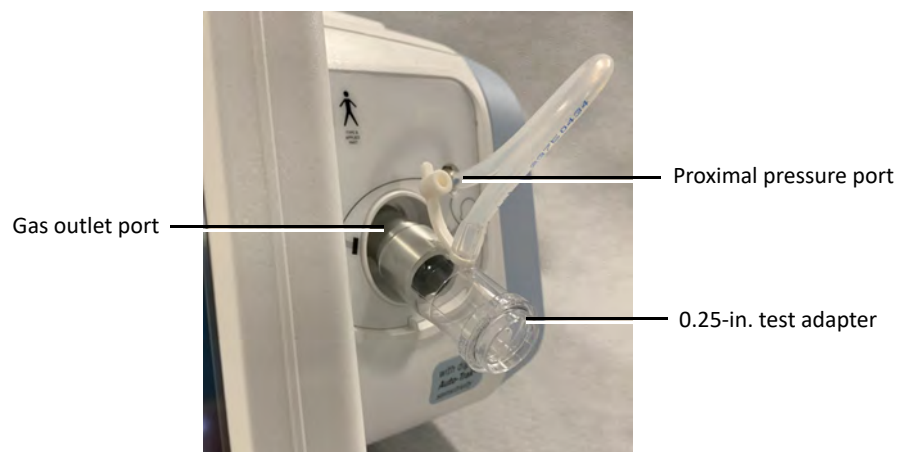
9.12 Test 9: O₂ Mix Accuracy

The O₂ mix accuracy test verifies the accuracy of the O₂ percentage delivered to the patient.

Required equipment (section 1.2):

0.25-in. test adapter
18-in. smooth-bore tubing
22-mm to 22-mm adapter
Pneumatic calibration analyzer with O ₂ sensor
Low-pressure plug
Pressure pick-off port
Pressure pick-off tubing

1. Verify that the ventilator is connected to an AC main outlet.
2. Connect the 0.25-in. test adapter to the ventilator gas outlet port.



3. If the ventilator is not already in normal ventilation mode, cycle power to the ventilator to enter normal ventilation mode.
4. Select these ventilator settings and alarm limits:

Ventilator settings		Alarm limits	
Mode:	S/T	High Rate:	30 BPM
IPAP:	15 cmH ₂ O	Low Rate:	4 BPM
EPAP:	4 cmH ₂ O	Hi Vt:	2500 mL
Rate:	12 BPM	Lo Vt:	Off mL
I-Time:	1.00 secs	HIP:	50 cmH ₂ O
Rise:	2	LIP:	Off cmH ₂ O
Ramp:	Off	Low VE:	Off L/min
O ₂ :	21%	LIP T:	20 secs

5. Reset any alarms if necessary.

6. With the O₂ source disconnected, touch **O2** and set to 22%.
7. Verify that the ventilator alarms and displays *Oxygen Not Available*.
8. Touch **O2** and set to 21%.
9. Verify that the *Oxygen Not Available* alarm is crossed out, then reset the alarm.
10. Turn the ventilator off and remove the 0.25-in. test adapter.
11. Connect the O₂ source to the ventilator.
12. Enter Diagnostic mode: press and hold the Accept button and turn the ventilator on by pressing the On/Shutdown button on the user interface. Within 5 seconds release and press the Accept button again to enter the Diagnostics menu.
13. Touch **Service**, then **Pneumatics**.
14. Plug the internal leak orifice with the low-pressure plug.

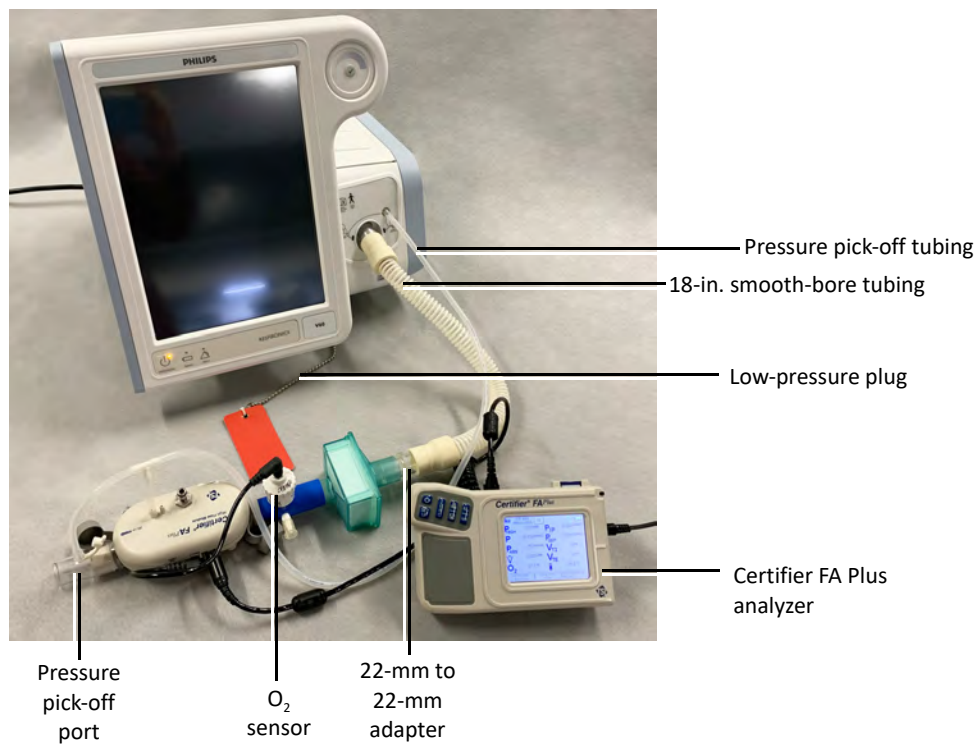


Use the low-pressure plug to plug the internal leak orifice (underside of the ventilator)

NOTE

Calibrate the O₂ analyzer sensor prior to proceeding.

15. Set up the ventilator for the O₂ mix accuracy test as shown.



16. Confirm that the analyzer is set to:

- Gas source: **Air/O₂**
- Gas condition: **STP**

17. Using the Pneumatic Controls, select:

Pressure:	0 cmH ₂ O
Flow:	10 SLPM
O ₂ :	21%
Solenoid 1:	None
Solenoid 2:	Machine Pressure Line
Solenoid 3:	Machine Pressure Line
Solenoid 4:	Prox Pressure

18. Verify that the set O₂% values correspond to the measured values:

O ₂ setting (after approximately 1 min)	Verify measurements (after approximately 1 min)
21%	Analyzer = 16% to 26%
30%	Analyzer = 25.6% to 34.4%
60%	Analyzer = 56.2% to 63.8%
100%	Analyzer = 97% to 103%

19. Touch **O₂** and set to 21%.
20. Touch **Pressure** then **Accept** to zero the flow setting.
21. Turn the ventilator off.
22. If no further testing is required, remove the test equipment from the ventilator.
- The O₂ mix accuracy test is complete.

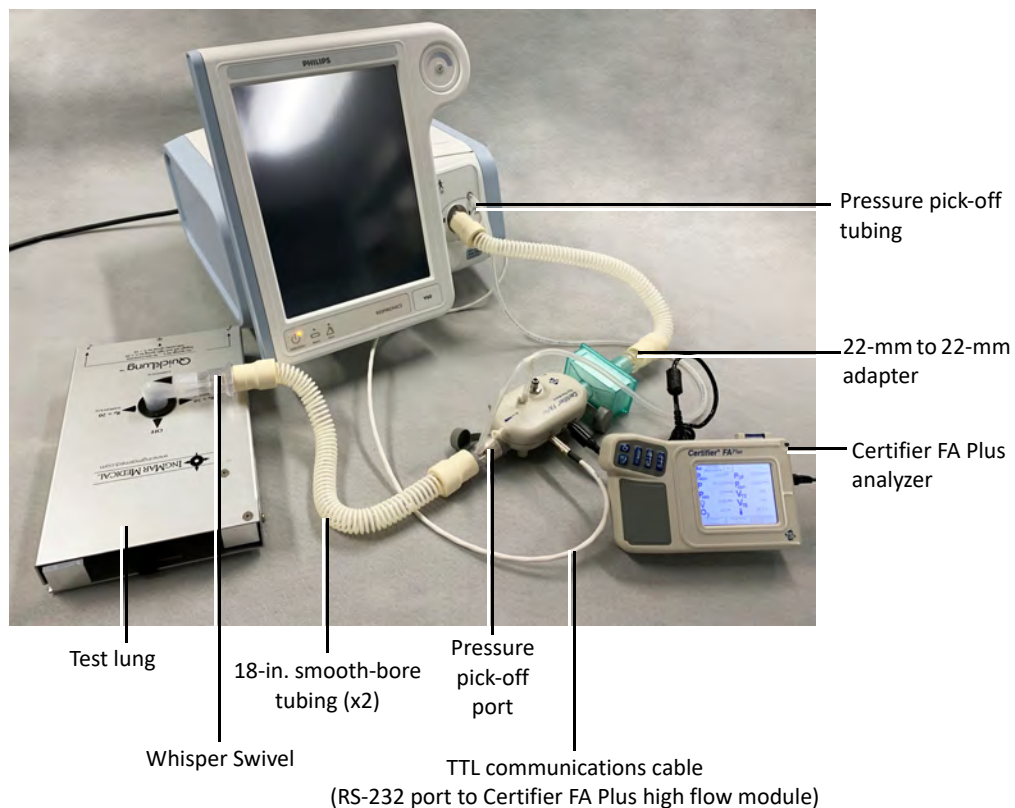
9.13 Test 10: S/T Performance

The S/T performance test verifies the accuracy of the IPAP and EPAP settings.

Required equipment (section 1.2):

18-in. smooth-bore tubing (x2)
22-mm to 22-mm adapter
Pneumatic calibration analyzer with O ₂ sensor
Pressure pick-off port
Pressure pick-off tubing
Test lung
TTL communications cable
Whisper Swivel

1. Verify that the ventilator is connected to an AC mains outlet.
2. Set up the ventilator for the S/T performance test as shown.



3. Set up the test lung with a resistance of **Rp20** and a compliance of **20**.
4. If the ventilator is not already in normal ventilation mode, cycle power to the ventilator to enter normal ventilation mode.

5. Select these ventilator settings and alarm limits:

Ventilator settings		Alarm limits	
Mode:	S/T	High Rate:	30 BPM
IPAP:	15 cmH ₂ O	Low Rate:	4 BPM
EPAP:	4 cmH ₂ O	Hi Vt:	2500 mL
Rate:	12 BPM	Lo Vt:	Off mL
I-Time:	1.00 secs	HIP:	50 cmH ₂ O
Rise:	2	LIP:	Off cmH ₂ O
Ramp:	Off	Low VE:	Off L/min
O ₂ :	21%	LIP T:	20 secs

6. Reset any alarms if necessary.
7. Let the ventilator operate for at least one minute.
8. Watch the waveforms on the ventilator display to verify that the unit cycles between IPAP and EPAP.
9. Verify that the set IPAP and EPAP values correspond to the measured values:

Ventilator setting:	Verify analyzer measurements:
IPAP = 40 cmH ₂ O	36.4 to 43.6 cmH ₂ O (PIP)
EPAP = 25 cmH ₂ O	22 to 28 cmH ₂ O (PEEP)

10. Turn ventilator off.
 11. If no further testing is required, remove the test equipment from the ventilator.
- The S/T performance test is complete.

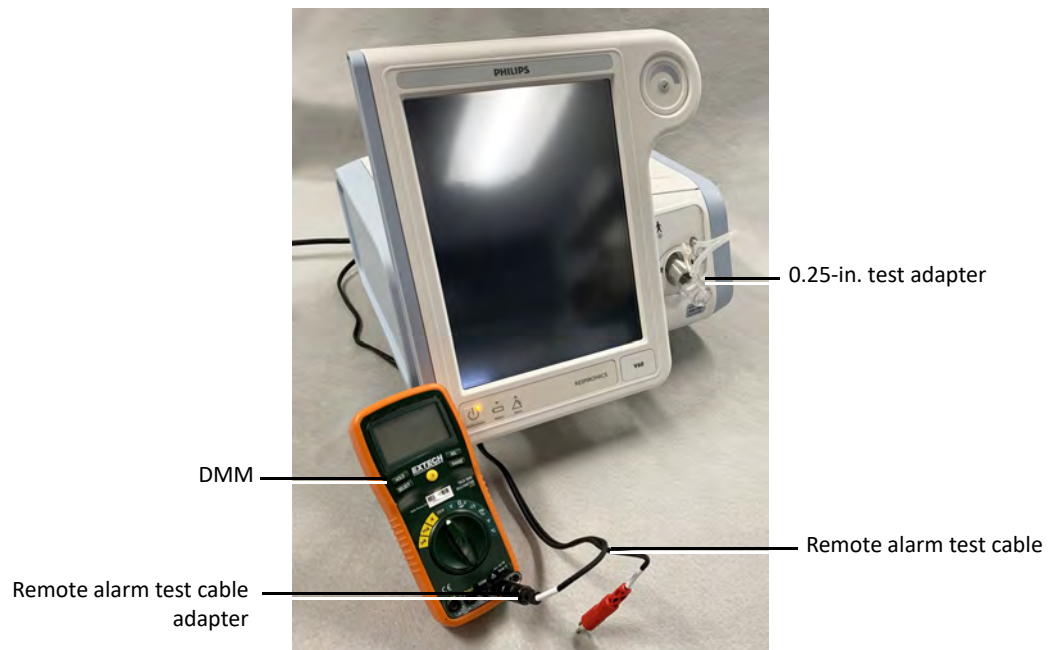
9.14 Test 11: Alarms

This test verifies the performance of the remote alarm connector output and alarm volume adjustment control.

Required equipment (section 1.2):

0.25-in. test adapter
DMM
Remote alarm test cable
Remote alarm test cable adapter

1. Verify that the ventilator is connected to an AC mains outlet.
2. Set up the ventilator for the alarms test as shown.



3. If the ventilator is not already in normal ventilation mode, cycle power to the ventilator to enter normal ventilation mode.

4. Select these ventilator settings and alarm limits:

Ventilator settings		Alarm limits	
Mode:	S/T	High Rate:	30 BPM
IPAP:	15 cmH ₂ O	Low Rate:	4 BPM
EPAP:	4 cmH ₂ O	Hi Vt:	2500 mL
Rate:	12 BPM	Lo Vt:	Off mL
I-Time:	1.00 secs	HIP:	50 cmH ₂ O
Rise:	2	LIP:	Off cmH ₂ O
Ramp:	Off	Low VE:	Off L/min
O ₂ :	21%	LIP T:	20 secs

5. Connect the adapter's double banana plugs to the DMM with the GND tab to the common jack and set the DMM to measure resistance.
6. Connect the RCA plug (labeled *TIP*) of the remote alarm test cable to the adapter.
7. Plug the ¼-in. phono connector into the remote alarm phono jack at the back of the ventilator.
8. Reset any alarms if necessary and verify that the DMM reads infinite resistance (open circuit).
9. Remove the RCA plug (labeled *TIP*) from the adapter and connect the RCA plug (labeled *RING*) in its place.
10. Reset any alarms if necessary, and verify that the DMM reads 0.0 to 3 ohms.
11. Disconnect the proximal line from the ventilator to create a *Proximal Pressure Line Disconnect* alarm.
12. Touch **Menu**, then **Loudness**, and verify that the audible alarm is still audible when set to 1 and steadily becomes louder as the value increases to 10.
13. Verify that the DMM reads infinite resistance (open circuit).
14. Remove the RCA plug (labeled *RING*) from the adapter and connect the RCA plug (labeled *TIP*) in its place.
15. Verify that the DMM reads 0.0 to 3 ohms.
16. Reconnect the proximal line to the ventilator and verify that the audible alarm is automatically silenced.
17. Remove the remote alarm test cable from the ventilator remote alarm phono jack.
18. Turn the ventilator off.
19. If no further testing is required, remove the test adapter from the ventilator.

The alarms test is complete.

9.15 Test 12: Power Fail

This test verifies the integrity of the power fail alarm.

- Section 9.15.1 describes how to perform the test if an internal battery *is* installed in the ventilator.
- Section 9.15.2 describes how to perform the test if an internal battery is *not* installed in the ventilator.

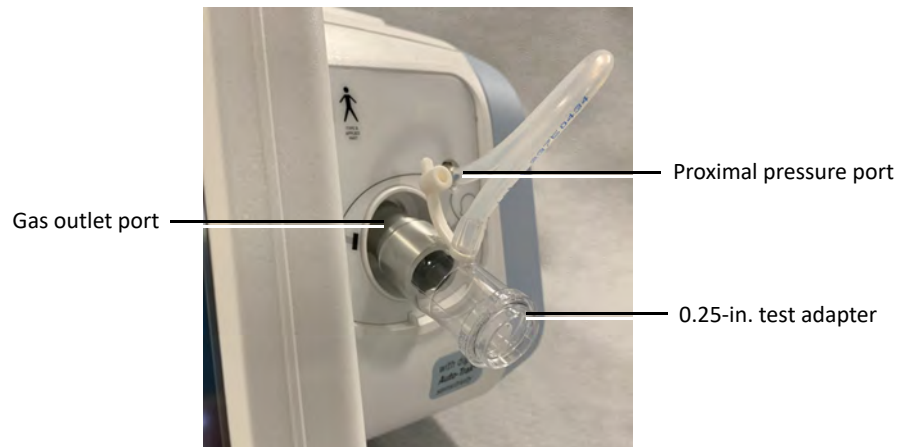
Required equipment (section 1.2):

0.25-in. test adapter

9.15.1 Power Fail Test - Internal Battery Installed

If the internal battery *is* installed:

1. Verify that the ventilator is off.
2. Disconnect the AC power cord from the AC mains outlet.
3. Disconnect the internal battery from the ventilator.
4. Reconnect the power cord to the AC mains outlet.
5. Connect the 0.25-in. test adapter to the ventilator gas outlet port.



6. Turn the ventilator on by pressing the On/Shutdown button.

7. Select these ventilator settings and alarm limits:

Ventilator settings		Alarm limits	
Mode:	S/T	High Rate:	30 BPM
IPAP:	15 cmH ₂ O	Low Rate:	4 BPM
EPAP:	4 cmH ₂ O	Hi Vt:	2500 mL
Rate:	12 BPM	Lo Vt:	Off mL
I-Time:	1.00 secs	HIP:	50 cmH ₂ O
Rise:	1	LIP:	Off cmH ₂ O
Ramp:	Off	Low VE:	Off L/min
O ₂ :	21%	LIP T:	20 secs

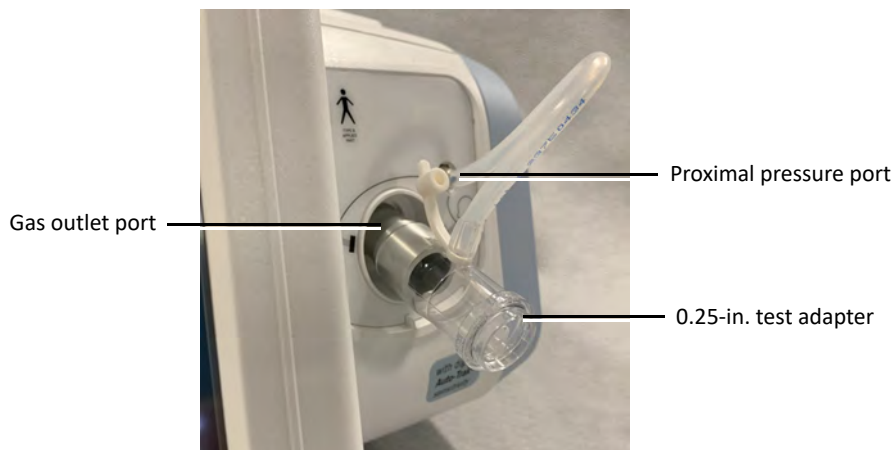
8. With the ventilator operating on AC power, disconnect the power cord from the AC mains outlet.
9. Verify that the audible alarm sounds and start a timer. After 2 minutes, verify that the audible alarm is still sounding.
10. Press and hold the On/Shutdown button for about 5 seconds to turn ventilator power off, then verify that the audible alarm is silenced.
11. Reconnect the internal battery to the ventilator.
12. Reconnect the ventilator into an AC mains outlet and verify that the AC indicator is on.
13. Turn the ventilator off and remove the 0.25-in. test adapter.

The power fail alarm test is complete.

9.15.2 Power Fail Test - Internal Battery Not Installed

If the internal battery *is not* installed:

1. Verify that the ventilator is connected to an AC mains outlet.
2. Connect the 0.25-in. test adapter to the ventilator gas outlet port.



3. Turn the ventilator on by pressing the On/Shutdown button.
4. Select these ventilator settings and alarm limits:

Ventilator settings		Alarm limits	
Mode:	S/T	High Rate:	30 BPM
IPAP:	15 cmH ₂ O	Low Rate:	4 BPM
EPAP:	4 cmH ₂ O	Hi Vt:	2500 mL
Rate:	12 BPM	Lo Vt:	Off mL
I-Time:	1.00 secs	HIP:	50 cmH ₂ O
Rise:	1	LIP:	Off cmH ₂ O
Ramp:	Off	Low VE:	Off L/min
O ₂ :	21%	LIP T:	20 secs

5. With the ventilator operating on AC power, disconnect the power cord from the AC mains outlet.
6. Verify that the audible alarm sounds and start a timer. After 2 minutes, verify that the audible alarm is still sounding.
7. Press and hold the On/Shutdown button for about 5 seconds to turn ventilator power off, then verify that the audible alarm is silenced.
8. Reconnect the ventilator to an AC mains outlet and verify that the AC indicator is on.
9. Turn the ventilator off and remove the 0.25-in. test adapter.

The power fail alarm test is complete.

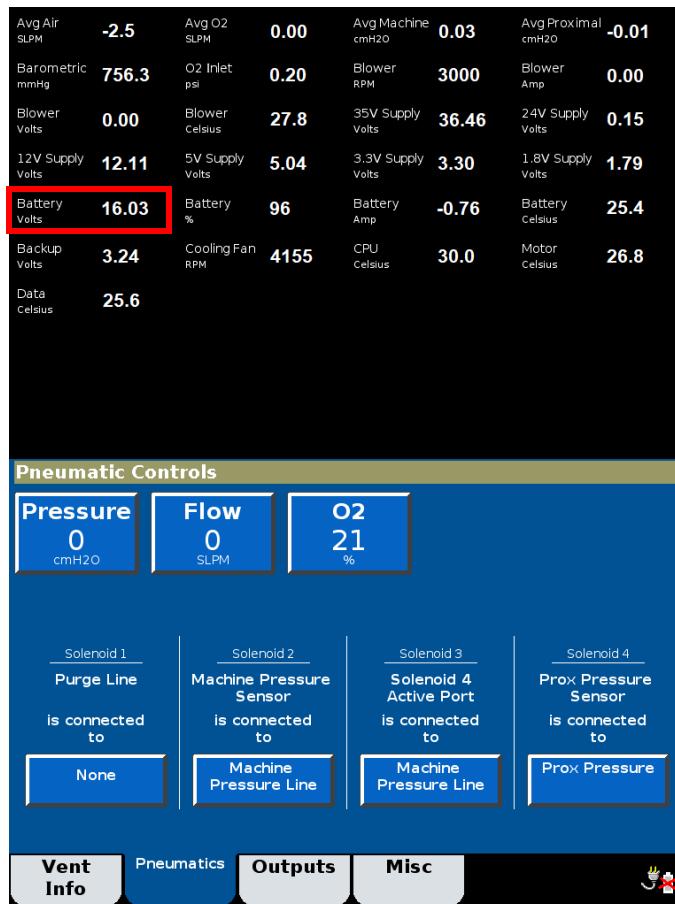
9.16 Test 13: Internal Battery

This test verifies that the ventilator can transition to and from battery power.

Required equipment (section 1.2):

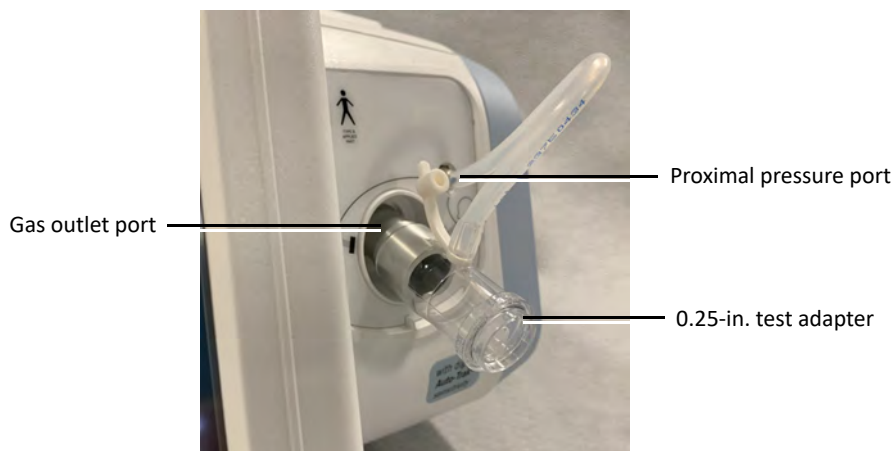
0.25-in. test adapter

1. Verify that the ventilator is connected to an AC mains outlet.
2. If the ventilator is not already in Diagnostic mode, press and hold the Accept button and turn on the ventilator by pressing the On/Shutdown button on the user interface. Within 5 seconds, release and press the Accept button again to enter the Diagnostic menu.
3. Disconnect the AC power cord from the AC mains outlet.
4. Verify that ventilator operation continues uninterrupted.
5. Touch **Service** and **Pneumatics**, wait at least 3 minutes, then verify that the **Battery Volts** on the Pneumatics screen is > 15.0 VDC.



6. Verify that nothing is attached to the gas outlet port.
7. Touch **Pressure** and set the pressure to 10 cmH₂O.

8. Let the ventilator run for at least 20 minutes on battery power, then verify that the *Battery Volts* on the Pneumatics screen is > 14.0 VDC.
9. Turn the ventilator power off.
10. With AC still disconnected, connect a 0.25-in. test adapter to the gas outlet port.



11. Turn on the ventilator by pressing the On/Shutdown button.
12. Select these ventilator settings and alarm limits:

Ventilator settings		Alarm limits	
Mode:	S/T	High Rate:	30 BPM
IPAP:	15 cmH ₂ O	Low Rate:	4 BPM
EPAP:	4 cmH ₂ O	Hi Vt:	2500 mL
Rate:	12 BPM	Lo Vt:	Off mL
I-Time:	1.00 secs	HIP:	50 cmH ₂ O
Rise:	1	LIP:	Off cmH ₂ O
Ramp:	Off	Low VE:	Off L/min
O ₂ :	21%	LIP T:	20 secs

13. Verify that the ventilator operates in normal ventilation, the message *Running on Internal Battery* is displayed in the Alert window, the *Battery In Use* icon is displayed, and the *Battery Low* alarm is off.
14. Reconnect the AC power cord.
15. Verify that ventilator operation is uninterrupted, the AC icon is displayed, and the *Battery* icon turns off.
16. Verify that the *Battery Charging* LED begins flashing within 30 seconds.
17. Turn the ventilator off.

The internal battery test is complete.

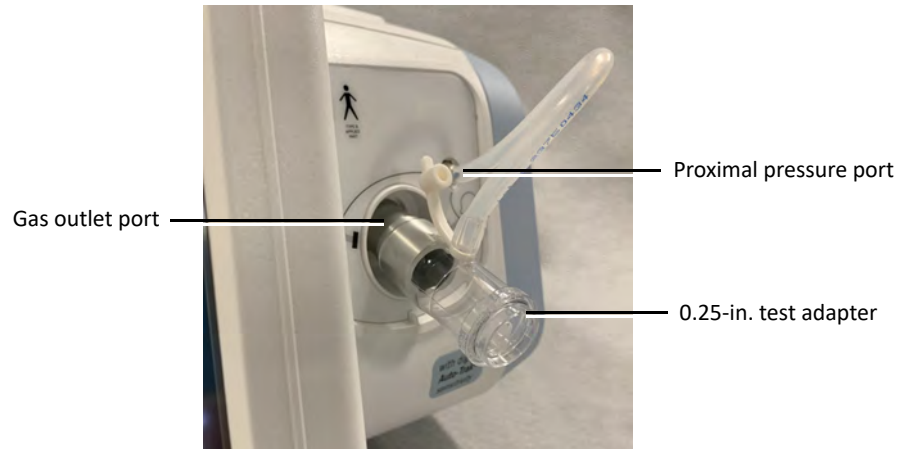
9.17 Preparing the Ventilator for Use

Follow these steps to prepare the ventilator for use operation after service and successful performance verification.

Required equipment (section 1.2):

0.25-in. test adapter

1. Verify that the ventilator is connected to an AC mains outlet.
2. Connect the 0.25-in. test adapter to the ventilator gas outlet port.



3. If the ventilator is not already in normal ventilation mode, cycle power to the ventilator to enter normal ventilation mode.
4. Select these ventilator settings and alarm limits:

Ventilator settings		Alarm limits	
Mode:	S/T	High Rate:	30 BPM
IPAP:	15 cmH ₂ O	Low Rate:	4 BPM
EPAP:	4 cmH ₂ O	Hi Vt:	2500 mL
Rate:	12 BPM	Lo Vt:	Off mL
I-Time:	1.00 secs	HIP:	50 cmH ₂ O
Rise:	2	LIP:	Off cmH ₂ O
Ramp:	Off	Low VE:	Off L/min
O ₂ :	21%	LIP T:	20 secs

5. Disconnect the tubing from the proximal pressure port and verify that the ventilator alarms and displays the high-priority alarm message *Proximal Pressure Line Disconnected or Occluded*.
6. Reconnecting the tubing and verify that the alarm autoresets and the audible alarm turns off.
7. Turn the ventilator off.
8. Remove all test equipment from the ventilator.

9. Enter Diagnostic mode: press and hold the Accept button and turn on the ventilator by pressing the On/Shutdown button on the user interface. Within 5 seconds, release and press the Accept button again to enter the Diagnostic menu.
10. Touch **System Settings**, then **Date/Time**, and verify that the date and time are correct.
11. Clear the significant event log.
12. Touch **System Settings**, then **Restore Default Settings**.
13. Touch **Date/Time** and verify that the date and time are correct.
14. Turn the ventilator off.
15. Enter the required information on the electrical safety and PM labels.
16. Affix the labels to the ventilator, and apply a chemical-resistant label over the electrical safety and PM labels.

The performance verification is complete.

9.18 Performance Verification Troubleshooting/Repair

Use the following troubleshooting procedures if the ventilator fails a performance verification test. Make sure that the external measurement devices such as the pneumatic calibration analyzer are calibrated and functioning properly.

Perform the repair procedures in the order listed until the problem is resolved. (See section 6 for Diagnostic mode procedures, and section 8 for component replacement procedures.)

NOTE

Before performing any troubleshooting, disconnect and reconnect all power (section 8.2).

CAUTION

Troubleshooting and repair should be performed only by a qualified service technician.

9.18.1 Test 1: Electrical Safety

Symptom	Recommended repair
Ground resistance out of range	1. Verify that the AC outlet is properly grounded. Try another AC outlet. 2. Verify that the AC power cord is completely inserted into the AC inlet. 3. Verify that ground wires are undamaged and properly secured to the AC inlet/power supply, gas outlet, proximal pressure port, and GDS (O₂ inlet fitting retainer screw). a. Replace AC inlet. b. Verify that excess Loctite is removed from the O₂ inlet fitting bracket retaining screws. c. Replace O₂ inlet fitting retainer bracket. 4. Check for visible damage to the power cord. 5. Replace the power cord.
Cooling fan not operating	1. Verify that the fan wires are properly seated in the connector on the MC PCBA. 2. Slave in a replacement fan and replace if it is operational. 3. Replace the MC PCBA.
Forward/reverse leakage current out of range	1. Verify secure connections of ground wires from the AC inlet, power supply, and GDS to the internal ground lug. 2. Replace the power cord and rerun the test. 3. Check for pinched cables and harnesses or damaged wire insulation throughout the ventilator. 4. Replace the power supply and rerun test.

9.18.2 Test 2: Leak Tests

Symptom	Recommended repair
O ₂ inlet reading out of range (45-50 psig)	1. Verify that the O₂ source is adequate for this test. 2. Check for leaks at the O₂ inlet fitting. 3. Verify that the O₂ solenoid valve is fully closed (there is zero flow across the O₂ flow sensor). If not, replace the O₂ solenoid valve. 4. Verify that the O₂ pressure transducer is reading correctly. If not, replace the DA PCBA.
High pressure leak test fails	1. Verify that the O₂ source is adequate for this test. 2. Check for leaks at the O₂ inlet fitting, O₂ filter element cap, O₂ solenoid valve, and O₂ pressure transducer. 3. Verify that the O₂ solenoid valve is fully closed by (there is zero flow across the O₂ flow sensor). If not, replace the O₂ solenoid valve. 4. Verify that the O₂ pressure transducer is reading correctly. If not, replace the DA PCBA.
System pressure leak test fails	1. Verify that the internal exhalation port, air inlet port, gas outlet port, and proximal port are plugged properly. 2. Verify that the system leak test syringe tubing is properly clamped. 3. Check for disconnected or cut tubing from the GDS to the gas outlet port, and from the gas outlet port to the base. 4. Check for misaligned or cut rubber boots from the GDS to the blower, and from the blower to the gas outlet port. 5. Check for leaks at the flow sensor assembly, solenoid valves, and pressure transducers. 6. Verify that the machine and proximal pressure transducers are reading correctly. If not, replace the DA PCBA.

9.18.3 Test 3: Controls

Symptom	Recommended repair
Touchscreen not responding properly	1. Calibrate the touchscreen. Replace the touchscreen if calibration is not possible. 2. Slave in a different user interface-to-PM PCBA cable, and replace original cable if the problem is resolved. 3. Replace the PM PCBA. 4. Replace the CPU PCBA.
Nav-ring not responding properly	1. Verify the connections between the nav-ring and the switch PCBA. 2. Slave in a different switch PCBA cable, and replace the original cable if the problem is resolved. 3. Replace the front bezel.
On/Shutdown switch not responding properly	1. Verify the connections between power switch overlay and UI PCBA. 2. Slave in a different power switch overlay and replace original overlay if this resolves the problem.

9.18.4 Test 4: Pressure Accuracy

Symptom	Recommended repair
Average machine or proximal pressure readings out of range	1. Verify that the internal leak orifice is plugged. 2. Check for leaks at circuit connections, calibration analyzer, filters, etc. 3. Check for kinked or cut tubing from GDS to gas outlet port, and from the gas outlet port to the base. 4. Check for kinked or cut rubber boots from the GDS to the blower, and from the blower to the gas outlet port. 5. Check for leaks at the solenoid valves and pressure transducers. 6. Replace the DA PCBA.

9.18.5 Test 5: Air Delivery

Symptom	Recommended repair
Measured air flow values out of range	1. Verify that the calibration analyzer is set to measure air in STP mode. 2. If the air flow sensor reading is not within limits as compared to the calibration analyzer, replace the flow sensor assembly. 3. Slave in a different air flow sensor to data acquisition cable. 4. Replace the DA PCBA.

9.18.6 Test 6: Flow Sensor Zero Calibration

Symptom	Recommended repair
Flow sensor zero calibration failed	1. Verify that the gas outlet and internal leak orifice are fully blocked. 2. Allow the ventilator to run for 10 minutes in Diagnostic mode and repeat the calibration. 3. Perform a system leak test. 4. Replace the flow sensor assembly. 5. Replace the DA PCBA.

9.18.7 Test 7: Air Flow Accuracy

Symptom	Recommended repair
Measured air flow values out of range	1. Verify that the low-pressure plug is installed into the internal leak orifice. 2. Verify that the calibration analyzer is set to measure air in STP mode. 3. Verify that the ventilator gas outlet port is unobstructed. 4. Perform the air flow sensor zero calibration (software version 3.10 or later). 5. If the air flow sensor reading is not within limits as compared to the calibration analyzer, replace the flow sensor assembly. 6. Slave in a different air flow sensor to data acquisition cable. 7. Replace the DA PCBA.

9.18.8 Test 8: O₂ Flow Accuracy

Symptom	Recommended repair
Measured O ₂ flow values out of range	1. Verify that the O₂ supply pressure remains within 40 to 87 psig throughout the test. 2. Verify that the internal leak orifice is plugged. 3. Verify that the calibration analyzer is set to measure O₂ in STP mode. 4. Verify that the ventilator gas outlet port is unobstructed. 5. Perform the O₂ flow sensor zero calibration (software version 3.10 or later). 6. Slave in a different flow sensor to DA PCBA cable. 7. Verify that the displayed air flow is not supplementing the O₂ flow. If so: a. Verify the O₂ supply. b. Replace the O₂ solenoid valve. 8. If O₂ flow sensor reading is not within limits as compared to the calibration analyzer, replace the flow sensor assembly. 9. Replace the DA PCBA.

9.18.9 Test 9: O₂ Mix Accuracy

Symptom	Recommended repair
The measured O ₂ percentage is out of range	1. Verify that the O₂ supply pressure remains within 40 to 87 psig throughout the test. 2. Verify that the test O₂ monitor is calibrated. 3. Verify that the external O₂ sensor is oriented with cable connector on top. 4. Replace the external O₂ sensor and retest. 5. Perform the O₂ flow sensor zero calibration (software version 3.10 or later). 6. Replace the flow sensor assembly. 7. Replace the O₂ solenoid valve.

9.18.10 Test 10: S/T Performance

Symptom	Recommended repair
IPAP and EPAP outside acceptable value	1. Verify correct test setup. 2. Check for leaks at circuit connections, test lung, analyzer, etc. 3. Replace the DA PCBA. 4. Replace the MC PCBA. 5. Replace the CPU PCBA.

9.18.11 Test 11: Alarms

Symptom	Recommended repair
Normally open or normally closed relay test failure (continuity check)	1. Verify continuity of the remote alarm test cable. 2. Replace the CPU PCBA.
Primary alarm volume not adjustable	Slave in PCBAs in this order until the problem is resolved: MC PCBA, PM PCBA, CPU PCBA.

9.18.12 Test 12: Power Fail

Symptom	Recommended repair
Backup audible alarm fails to sound	1. Replace the MC PCBA. 2. Replace the CPU PCBA.
Backup audible alarm fails to sound for at least two minutes	1. Replace the MC PCBA. 2. Replace the CPU PCBA.
Power switch turned off but backup alarm remains on	1. Replace the power switch overlay. 2. Replace the PM PCBA.

9.18.13 Test 13: Internal Battery

Symptom	Recommended repair
Ventilator cannot transition from AC to battery power	1. Verify the battery harness connections. 2. Verify that <i>Battery</i> is > 12 VDC. 3. Recharge the internal battery. 4. Replace the internal battery. 5. Replace the PM PCBA.
Internal battery becomes depleted prematurely	1. Verify that the internal battery is fully charged before test. 2. Replace the internal battery. 3. Replace the PM PCBA. 4. Replace the power supply.
Reconnecting AC power resets ventilator	1. Verify AC voltage before the power supply (section 6.6). If not present, replace the AC inlet. 2. Verify 24 V after the power supply. If not present, replace the power supply. 3. Replace the PM PCBA.

Symptom	Recommended repair
When AC power is connected after 10 minutes of battery operation, <i>Battery Charging</i> indicator does not light	Replace the PM PCBA.
Following ventilator power cycle, diagnostic code or continuous backup alarm condition occurs	1. Verify that the internal battery is fully charged before test (recharge for up to 8 to 12 hours if fully depleted). 2. Replace the internal battery. 3. Replace the PM PCBA. 4. Replace the CPU PCBA.

9.19 Electrical Safety Data Form

Complete this form for any service procedure that requires only the electrical safety test.
Retain this form for your service records.

Customer information			
Facility name:			
Contact name:			
Address:			
City/State/Zip			
Phone:			
Email:			
Preliminary ventilator cleaning and inspection			Circle one
Cleaned ventilator exterior?	YES	NO	
Inspected cooling fan filter?	YES	NO	
Inspected air intake filter?	YES	NO	
Touchscreen calibration			Circle one
Touchscreen calibration	PASS	FAIL	
Ventilator information			
Installed options (circle all that apply):	PPV	AVAPS	C-Flex
	RAMP	Auto-Trak+	HFT
	Other: _____		
Serial number:		CPU PLD version:	
Software version:		PMC PLD version:	
Total power-on hours:		Battery lot ID:	
Hours since last PM:		Battery mfg date:	
PIC software version:			
PCBA information			
PCBA	P/N	S/N	Hours
CPU			
Data acquisition			
Power management			
Blower control			
Air flow sensor			
O ₂ flow sensor			

Test 1: Electrical safety		Circle one	
Verify cooling fan operation?		PASS	FAIL
Resistance and leakage current	Pass value	Fail value	
Proximal pressure port GND resistance $\leq 200\text{ m}\Omega$	m Ω	m Ω	
Gas outlet port GND resistance $\leq 200\text{ m}\Omega$	m Ω	m Ω	
O ₂ fitting retainer screw GND resistance $\leq 200\text{ m}\Omega$	m Ω	m Ω	
Forward leakage current $\leq 280\text{ }\mu\text{A}$	μA	μA	
Reverse leakage current $\leq 280\text{ }\mu\text{A}$	μA	μA	

Preparing the ventilator for use	Circle one	
Disconnect proximal pressure tubing, ventilator alarms: <i>Proximal Pressure Line Disconnected or Occluded</i>	PASS	FAIL
Reconnect proximal pressure tubing: the alarm resets and the alarm message is struck-out	PASS	FAIL
Significant event log cleared	PASS	FAIL
Correct date/time	PASS	FAIL
Default settings restored	PASS	FAIL

Technician name (print):		Date:
Technician signature:		

9.20 Performance Verification Data Form

Complete this form for any service procedure that requires testing in addition to the electrical safety test. Retain this form for your service records.

Customer information			
Facility name:			
Contact name:			
Address:			
City/State/Zip			
Phone:			
Email:			
Preliminary ventilator cleaning and inspection			Circle one
Cleaned ventilator exterior?	YES	NO	
Inspected cooling fan filter?	YES	NO	
Inspected air intake filter?	YES	NO	
Touchscreen calibration			Circle one
Touchscreen calibration	PASS	FAIL	
Ventilator information			
Installed options (circle all that apply):	PPV	AVAPS	C-Flex
	RAMP	Auto-Trak+	HFT
	Other: _____		
Serial number:		CPU PLD version:	
Software version:		PMC PLD version:	
Total power-on hours:		Battery lot ID:	
Hours since last PM:		Battery mfg date:	
PIC software version:			
PCBA information			
PCBA	P/N	S/N	Hours
CPU			
Data acquisition			
Power management			
Blower control			
Air flow sensor			
O ₂ flow sensor			

Test 1: Electrical safety		Circle one	
Verify cooling fan operation?		PASS	FAIL
Resistance and leakage current	Pass value	Fail value	
Proximal pressure port GND resistance $\leq 200 \text{ m}\Omega$	$\text{m}\Omega$	$\text{m}\Omega$	
Gas outlet port GND resistance $\leq 200 \text{ m}\Omega$	$\text{m}\Omega$	$\text{m}\Omega$	
O ₂ fitting retainer screw GND resistance $\leq 200 \text{ m}\Omega$	$\text{m}\Omega$	$\text{m}\Omega$	
Forward leakage current $\leq 280 \text{ }\mu\text{A}$	μA	μA	
Reverse leakage current $\leq 280 \text{ }\mu\text{A}$	μA	μA	

Test 2: Leak tests	Pass value	Fail value
High-pressure leak test, O₂ inlet pressure at 45-50 psig		
Analyzer pressure display (45-50 psig)	psig	psig
O ₂ inlet pressure display (45-50 psig)	psig	psig
Threshold	psig	
Pressure drop	psig	
High-pressure leak test	PASS	FAIL
System leak test, machine pressure at 55-60 cmH₂O		
Threshold	cmH ₂ O	
Pressure drop	cmH ₂ O	
System leak test	PASS	FAIL

Test 4: Controls	Circle one				Circle one	
AC power indicator	PASS	FAIL		Touchscreen	PASS	FAIL
On/Shutdown LED green	PASS	FAIL		Brightness control	PASS	FAIL
Nav-ring (if present)	PASS	FAIL	N/A	Screen lock	PASS	FAIL
Accept button	PASS	FAIL		On/Shutdown LED amber	PASS	FAIL

Test 4: Pressure accuracy	Pass value	Fail value
<i>Ventilator must be powered on for at least 10 minutes.</i>		
Barometric pressure		
Analyzer barometric pressure display	mmHg	
Ventilator barometric pressure display = $\pm 3.5\%$ of the analyzer reading	mmHg	mmHg
Pressure at 0 cmH₂O		
Ventilator software version		
<i>Avg Machine</i> display = -1.00 to 1.00 cmH₂O (software version 3.00 and earlier) -3.5 to 5.5 cmH₂O (software version 3.10 and later)	cmH ₂ O	cmH ₂ O
<i>Avg Proximal</i> display = -1.00 to 1.00 cmH₂O (software 3.00 and earlier) -3.5 to 5.5 cmH₂O (software 3.10 and later)	cmH ₂ O	cmH ₂ O
Pressure at 10 cmH₂O		
Analyzer display	cmH ₂ O	
<i>Avg Machine</i> display	cmH ₂ O	
(Analyzer display + <i>Avg Machine</i> zero offset) = 7.6 to 12.4 cmH ₂ O	cmH ₂ O	cmH ₂ O
<i>Avg Proximal</i> display	cmH ₂ O	
Lower limit (<i>Avg Proximal</i> display) = (analyzer reading x 0.96) -2	cmH ₂ O	
Upper limit (<i>Avg Proximal</i> display) = (analyzer reading x 1.04) +2	cmH ₂ O	
<i>Avg Proximal</i> value = (<i>Avg Proximal</i> - <i>Avg Proximal</i> zero offset)	cmH ₂ O	cmH ₂ O
Pressure at 35 cmH₂O		
Analyzer display	cmH ₂ O	
<i>Avg Machine</i> display	cmH ₂ O	
(Analyzer display + <i>Avg Machine</i> zero offset) = 31.6 to 38.4 cmH ₂ O	cmH ₂ O	cmH ₂ O
<i>Avg Proximal</i> display	cmH ₂ O	
Lower limit (<i>Avg Proximal</i> display) = (analyzer reading x 0.96) -2	cmH ₂ O	
Upper limit (<i>Avg Proximal</i> display) = (analyzer reading x 1.04) +2	cmH ₂ O	
<i>Avg Proximal</i> value = (<i>Avg Proximal</i> - <i>Avg Proximal</i> zero offset)	cmH ₂ O	cmH ₂ O
Pressure at 60 cmH₂O		
Analyzer display	cmH ₂ O	
<i>Avg Machine</i> display	cmH ₂ O	
(Analyzer display + <i>Avg Machine</i> zero offset) = 55.6 to 64.4 cmH ₂ O	cmH ₂ O	cmH ₂ O
<i>Avg Proximal</i> display	cmH ₂ O	
Lower limit (<i>Avg Proximal</i> display) = (analyzer reading x 0.96) -2	cmH ₂ O	
Upper limit (<i>Avg Proximal</i> display) = (analyzer reading x 1.04) +2	cmH ₂ O	
<i>Avg Proximal</i> value = (<i>Avg Proximal</i> - <i>Avg Proximal</i> zero offset)	cmH ₂ O	cmH ₂ O

Test 5: Air delivery	Pass value	Fail value
Analyzer barometric pressure display	mmHg	
Ventilator barometric pressure display = $\pm 3.5\%$ of the analyzer reading	mmHg	mmHg
Analyzer pressure display (Table 9-3) > _____ cmH ₂ O (N/A if barometric pressure is < 600.1 mmHg or > 781.2 mmHg)	cmH ₂ O	cmH ₂ O
Analyzer flow display (Table 9-3) > _____ SLPM (N/A if barometric pressure is < 600.1 mmHg or > 781.2 mmHg)	SLPM	SLPM

Test 6: Flow sensor zero calibration	< Version 3.10 software	Pass value	Fail value
Ventilator must be powered on for at least 10 minutes			
Air flow sensor zero calibration	N/A	PASS	FAIL
O ₂ flow sensor zero calibration	N/A	PASS	FAIL

Test 7: Air flow accuracy		
Environmental conditions		
Measurements:	Relative humidity: %	Temperature °C
	Pass value	Fail value
Air flow test at 0 SLPM		
Analyzer flow display = -1.0 to 1.0 SLPM	SLPM	SLPM
Avg Air display = -1.0 to 1.0 SLPM	SLPM	SLPM
Air flow test at 10 SLPM		
Analyzer flow display = 8.6 to 11.4 SLPM	SLPM	SLPM
Avg Air display = 8.6 to 11.4 SLPM	SLPM	SLPM
Air flow test at 35 SLPM		
Analyzer flow display = 33.2 to 36.8 SLPM	SLPM	SLPM
Avg Air display = 33.2 to 36.8 SLPM	SLPM	SLPM
Air flow test at 60 SLPM		
Analyzer flow display = 56.2 to 63.8 SLPM	SLPM	SLPM
Avg Air display = 56.2 to 63.8 SLPM	SLPM	SLPM
Air flow test at 140 SLPM		
Analyzer flow display = 129.8 to 150.2 SLPM	SLPM	SLPM
Avg Air display = 129.8 to 150.2 SLPM	SLPM	SLPM
Remove low-pressure plug		
Analyzer flow display drops at approximately 8 SLPM, but not more than 30 SLPM	PASS	FAIL

Test 8: O ₂ flow accuracy		
Environmental conditions		
Measurements:	Relative humidity: %	Temperature °C
	Pass value	Fail value
O₂ flow test at 0 SLPM		
Analyzer flow display = -1.0 to 1.0 SLPM	SLPM	SLPM
Avg O ₂ display = -1.0 to 1.0 SLPM	SLPM	SLPM
O₂ flow test at 10 SLPM		
Analyzer flow display = 8.6 to 11.4 SLPM	SLPM	SLPM
Avg O ₂ display = 8.6 to 11.4 SLPM	SLPM	SLPM
O₂ flow test at 35 SLPM		
Analyzer flow display = 33.2 to 36.8 SLPM	SLPM	SLPM
Avg O ₂ display = 33.2 to 36.8 SLPM	SLPM	SLPM
O₂ flow test at 60 SLPM		
Analyzer flow display = 56.2 to 63.8 SLPM	SLPM	SLPM
Avg O ₂ display = 56.2 to 63.8 SLPM	SLPM	SLPM
O₂ flow test at 140 SLPM		
Analyzer flow display = 129.8 to 150.2 SLPM	SLPM	SLPM
Avg O ₂ display = 129.8 to 150.2 SLPM	SLPM	SLPM

Test 9: O ₂ mix accuracy	Pass value	Fail value
O ₂ setting 22% , O ₂ source disconnected: <i>Oxygen Not Available</i> alarm occurs? (circle one)	PASS	FAIL
O₂ setting 21% (after approx. 1 min.) Analyzer O ₂ display (16% to 26%)	%	%
O₂ setting 30% (after approx. 1 min.) Analyzer O ₂ display (25.6% to 34.4%)	%	%
O₂ setting 60% (after approx. 1 min.) Analyzer O ₂ display (56.2% to 63.8%)	%	%
O₂ setting 100% (after approx. 1 min.) Analyzer O ₂ display (97% to 103%)	%	%

Test 10: S/T performance	Pass value	Fail value
Waveform		
Pressure cycles between IPAP and EPAP pressures	PASS	FAIL
IPAP at 40 cmH₂O		
Analyzer pressure display = 36.4 to 43.6 cmH ₂ O	cmH ₂ O	cmH ₂ O
EPAP at 25 cmH₂O		
Analyzer pressure display = 22 to 28 cmH ₂ O	cmH ₂ O	cmH ₂ O

Test 11: Alarms	Circle one	
DMM to remote alarm test cable reads infinite resistance with no alarm	PASS	FAIL
DMM reads 0.0 to 3 Ω with no alarm	PASS	FAIL
Alarm volume steadily increases	PASS	FAIL
DMM reads infinite resistance with alarm	PASS	FAIL
DMM reads 0.0 to 3 Ω with alarm	PASS	FAIL
Audio alarm is automatically silenced	PASS	FAIL

Test 12: Power fail	Circle one	
Audible alarm sounds	PASS	FAIL
Audible alarm continues to sound after 2 minutes	PASS	FAIL
Audible alarm silenced	PASS	FAIL
AC indicator on	PASS	FAIL

Test 13: Internal battery	Pass value	Fail value
Transition from AC to battery operation does not interrupt ventilator operation and indicators operate correctly	PASS	FAIL
Wait at least 3 minutes and verify		
Battery volts ≥ 15.0 V	V	V
Wait at least 20 minutes and verify		
Battery volts ≥ 14.0 V	V	V
With AC still disconnected, ventilator powers up correctly in normal ventilation and indicators operate correctly	PASS	FAIL
Transition from battery to AC operation does not interrupt ventilator operation and indicators operate correctly.	PASS	FAIL
Battery charge indicator is flashing	PASS	FAIL

Preparing the ventilator for use	Circle one	
Disconnect proximal pressure tubing, ventilator alarms: <i>Proximal Pressure Line Disconnected or Occluded</i>	PASS	FAIL
Reconnect proximal pressure tubing: the alarm resets and the alarm message is struck-out	PASS	FAIL
Significant event log cleared	YES	NO
Correct date/time	YES	NO
Default settings restored	YES	NO

Performance verification		
Did the performance verification pass? (circle one)	YES	NO

Technician name (print):		Date:
Technician signature:		

A Replacement Parts

A.1	Complete Parts List	279
A.2	Recommended Inventory Parts List	287
A.3	Accessory Part Numbers	299
A.4	O ₂ Manifolds and Hoses	300
A.5	Universal Stand	301
A.6	V60 Stand	304

This section lists and illustrates components of the V60/V60 Plus ventilator.

CAUTION

Use only V60/V60 Plus ventilator repair parts. Only Philips parts are designed for use in the ventilator. Using non-Philips parts can alter ventilator reliability or result in damage, and affects the product warranty.

NOTE

All repair kits include necessary hardware.

For the most current list of approved accessories plus comprehensive ordering information for compatible parts available from Philips, contact your Philips representative or refer to the V60/V60 Plus accessories guide (part number 1152957MC), downloadable from philips.com/IFU.

To order parts, call the Response Center nearest you or visit Philips' website:

- In the United States, call 1-800-722-9377 and select option 4, 3.
- For other telephone numbers worldwide, go to www.healthcare.philips.com:
 1. Select your location and language.
 2. Select the **About** menu.
 3. Select **Contact**.

A.1 Complete Parts List

Table A-1 lists V60/V60 Plus ventilator replacement parts.

Table A-1: V60/V60 Plus Ventilator Replacement Parts

Description	Part number	Order number
Base assembly, China, V60 (gray)	1082329	989805632671
Base assembly, China, V60 (white)	1115091	453561533451
Base assembly, V60 (gray)	1053892	453561511351
Base assembly, V60/V60 Plus (white)	1115093	453561533471
Battery, internal	1076374	989805626941
Bezel, front, with nav-ring, V60 (gray)	1104191	453561530651
Bezel, front, with nav-ring, V60 (coated/white)	1115095	453561533491
Bezel, front, with nav-ring, V60 (non-coated/white)	1126910	453561536471
Bezel, front, with nav-ring, V60 Plus	1140747	453561537951
Bezel, front, without nav-ring, V60 (gray)	1149244	453561540911
Bezel, front, without nav-ring, V60 (coated/white)	1149240	453561540871
Bezel, front, without nav-ring, V60 (non-coated/white)	1149206	453561540831
Bezel, front, without nav-ring, V60 Plus	1149204	453561540811
Bezel, rear, V60 (gray)	1149523	453561540991
Bezel, rear, V60/V60 Plus (white)	1149425	453561540961
Blower assembly	1055434	453561512761
Boot kit, rubber (GDS-blower and blower-output ports)	1054197	453561511421
Box, shipping, V60/V60 Plus ventilator	1056561	453561512881
Bracket kit, PCBA (MC PCBA)	1054198	453561511431
Bracket kit, retention, MC PCBA	1117473	453561533891
Bracket, battery (left side wall)	1054199	453561508541
Bracket, capacitor (MC PCBA)	1054200	453561511441
Bracket, CPU	1111225	453561531761
Bracket, gas outlet	1054202	453561511461
Bracket, retaining, MC PCBA	1117474	453561533901
Button, Accept/Enter, package of 5 (front bezel)	1054204	453561511471

Table A-1: V60/V60 Plus Ventilator Replacement Parts (Continued)

Description	Part number	Order number
Cable, backlight inverter PCBA	1054206	453561511481
Cable, DA PCBA to flow sensors	1054218	453561511591
Cable, DA PCBA to MC PCBA (2nd generation)	1124812	453561536131
Cable, gas outlet port to ground	1054219	453561511601
Cable, GDS to ground	1054220	453561511611
Cable, LCD (1st generation/HYDIS)	1054222	453561511631
Cable, LCD (2nd generation/NEC)	1126886	453561536431
Cable, power harness	1054221	453561511621
Cable, proximal port to ground	1054106	453561511411
Cable, switch PCBA	1054223	453561511641
Cable, UI PCBA to LCD	1100820	453561528911
Cable, UI to ground	1054224	453561511651
Cable, UI to PM PCBA	1054225	453561511661
Cap, O ₂ filter element (GDS)	1054226	453561511671
Clamp kit, hose (GDS, blower, and outlet port)	1054239	453561511761
Clamp, cable, 3/16-in. dia. (LCD tray)	1054238	453561511751
Clip, capacitor bracket, ferrite	1054240	453561511771
Collar, air inlet (GDS/right side wall)	1054242	453561511791
Cover, CPU tray	1111269	453561531961
Cover, top (gray)	1054244	453561511811
Cover, top (white)	1111270	453561531971
End cap, bezel (UI)	1054245	453561511821
Fan guard, filter, and retainer	1054246	453561511831
Fan, cooling	1054277	453561512041
Filter, air inlet, package of 5	1054279	453561505991
Filter, cooling fan, package of 5	1054280	453561507301
Filter, O ₂ inlet (GDS)	1054278	453561512051
Fitting kit, O ₂ , Can/CSA, Canada (includes bracket)	1054284	453561512081

Table A-1: V60/V60 Plus Ventilator Replacement Parts (Continued)

Description	Part number	Order number
Fitting kit, O ₂ , DISS-CGA, USA (includes bracket)	1054286	453561512091
Fitting kit, O ₂ , NIST A-8, EU and Hong Kong (includes bracket)	1054297	453561512151
Fitting kit, O ₂ , SIS-AS2896, Australia (includes bracket)	1054298	453561512161
Fitting, barbed, 10-32 to 1/8-in., brass, package of 3 (GDS, gas outlet port)	1054283	453561512071
Fitting, barbed, white nylon, package of 2 (gas outlet port, base)	1054282	453561512061
Flow sensor assembly, air and O ₂	1058898	989805617141
Foam kit, sound insulation (top cover, base)	1054305	453561512171
Foot kit, bottom, package of 4 (gray)	1054302	453561508131
Foot kit, bottom, package of 4 (white)	1111277	453561532041
Front panel assembly, V60 (gray)	1054306	453561512181
Front panel assembly, English, V60/V60 Plus (white)	1140748	453561537961
Front panel assembly, non-English, V60/V60 Plus (white)	1115096	453561533501
Gas delivery subsystem (GDS)	1054307	453561512191
Gasket kit, capacitor bracket	1054309	453561512211
Gasket, air inlet collar, package of 5	1054308	453561512201
Gasket, cord, bezel (UI, rear bezel)	1054310	453561512221
Gasket, EMI (use with 2nd generation power supply) (base)	1149327	453561540971
Gasket, ESD shielding, 25-pin RS-232 (CPU PCBA)	1118481	453561533971
Gasket, housing, filter inlet (right side wall)	1054311	453561512231
Gasket, left side panel, package of 4	1054313	453561512251
Gasket, rear bezel (UI)	1054312	453561512241
Gasket, right side panel, package of 4	1054314	453561512261
Grommet, blower mount, package of 4	1054315	453561512271
Grommet, transducer, package of 2 (DA PCBA-GDS)	1054316	453561512281
Housing, air inlet filter (right side wall)	1054317	453561512291
Inlet, AC	1054318	453561512301
Isolator, PCBA mounting bracket	1117475	453561533911

Table A-1: V60/V60 Plus Ventilator Replacement Parts (Continued)

Description	Part number	Order number
Label kit, logo/product (gray) (UI)	1054321	453561512331
Label kit, logo/product (white) (UI)	1115097	453561533511
Label kit, logo/product, V60 Plus (white) (UI)	1140863	453561537971
Label kit, O ₂ /class/rating (base assembly)	1054323	453561512351
Label, Auto-Trak (front panel)	1054320	453561512321
Label, Auto-Trak+ option (UI)	1076718	453561516771
Label, AVAPS option (UI)	1054324	453561512361
Label, battery (UI)	1054325	453561512371
Label, C-Flex option (UI)	1054326	453561512381
Label, HFT, V60 (front panel) (outside the USA)	1140743	453561537911
Label, HFT-60 option (front panel) (USA)	1154168	453561544481
Label, HFT option (UI) (outside the USA)	1137294	453561537651
Label, HFT-60 option (UI) (USA)	1154107	453561544471
Label, patient interface, V60 (front panel/gray)	1054352	453561512521
Label, patient interface, English, V60/V60 Plus (front panel/white)	1150225	453561542831
Label, patient interface, non-English, V60/V60 Plus (front panel/white)	1115351	453561533821
Label, PPV option (UI)	1054328	453561512391
Label, protective earth ground (base)	1054337	453561512401
Label, warning, air inlet (right side panel)	1113477	453561532831
LCD assembly (2nd generation/NEC)	1100818	453561528891
LCD upgrade kit, HYDIS to NEC, V60 (UI)	1128427	453561536641
Mount, isolation, fan, package of 4	1055324	453561512751
Mount, O ₂ solenoid valve (GDS)	1054339	453561512421
Nut, hex, kep, M4, package of 10 (base grounding lug)	1054341	453561512441
Nut, hex, M12 x 1, stainless steel, package of 10 (remote alarm jack)	1055321	453561512721
Nut, wing, M3, package of 10 (MC PCBA to PCBA bracket)	1056418	453561512871
O-ring kit, O ₂ solenoid valve (GDS)	1126574	453561536351
O-ring, 2-023, Viton, 70 Du, package of 5 (O ₂ solenoid valve mount)	1054347	453561512481

Table A-1: V60/V60 Plus Ventilator Replacement Parts (Continued)

Description	Part number	Order number
O-ring, 2-103, Viton, 70 Du, package of 5 (DA PCBA-manifold)	1054348	453561512491
O-ring, 2-121, Viton 70 DU, package of 5 (GDS, O ₂ filter cap)	1054342	453561512451
O-ring, 2-123, Viton, 70 Du, package of 5 (GDS,air inlet collar)	1054343	453561512461
Overlay, power switch, V60 (UI/gray)	1149165	453561540721
Overlay, power switch, V60/V60 Plus (UI/white)	1149167	453561540741
Padding, left side wall, package of 2 (battery bracket)	1054353	453561512531
PCBA, backlight inverter	1054354	453561512541
PCBA, CPU (software 2.10)	1123932	453561535741
PCBA, CPU (software 2.30)	1134187	453561537241
PCBA, CPU (software 3.00)	1137293	453561537661
PCBA, CPU (software 3.10)	1141260	453561537991
PCBA, CPU (software 3.20)	1152616	453561544511
PCBA, data acquisition (DA)	1054356	453561512561
PCBA, motor controller (MC)	1134422	453561537531
PCBA, power management (PM) (PIC firmware 1.20)	1119527	453561534061
PCBA, power management (PM) (PIC firmware 1.30)	1149231	453561540781
PCBA, power management (PM) (PIC firmware 1.30, 4th generation)	1154028	453561544451
PCBA, switch (UI)	1054360	453561512601
PCBA, user interface (UI) (2nd generation)	1100786	453561528871
Pin, locking, side panel	1054363	453561512631
Pin, push, fan mount, package of 4	1054235	453561511731
Plate, foot retention	1111318	453561532301
Plate, O ₂ fitting retention	1123879	453561535731
Plate, power supply mounting (for use with 1st generation power supply)	1054364	453561512641
Plug kit, front panel (gray)	1054377	453561512671
Plug kit, front panel (white)	1111319	453561532311
Plug, blackout, RJ45, package of 5	1116110	453561533861

Table A-1: V60/V60 Plus Ventilator Replacement Parts (Continued)

Description	Part number	Order number
PM kit, annual	1054378	453561512681
Port, gas outlet (front panel)	1054104	453561511391
Port, proximal, 1/8-in. (front panel)	1054275	453561512021
Power cord, right-angle, Argentina, 10 A	1049627	989805615811
Power cord, right-angle, Australia, 10 A	1049653	989805614601
Power cord, right-angle, Brazil, 10 A	1075407	989805627161
Power cord, right-angle, China, 10 A	1049628	989805615821
Power cord, right-angle, Continental Europe, 10 A	1043253	989805612211
Power cord, right-angle, Denmark, 10 A	1049018	989805615801
Power cord, right-angle, Israel, 10 A	1050940	989805615851
Power cord, right-angle, Italy, 10 A	1049017	989805613481
Power cord, right-angle, Korea, 10 A	1109331	989805647101
Power cord, right-angle, North America, 10 A	1043249	989805613471
Power cord, right-angle, South Africa, 10 A	1043289	989805614591
Power cord, right-angle, Swiss,	1049016	989805615791
Power cord, right-angle, UK, 10 A	1043287	989805612601
Power supply (1st generation)	1054359	453561512591
Power supply (2nd generation)	1149230	453561540771
Retainer clip, O ₂ solenoid valve (GDS)	1054241	453561511781
Retainer, air inlet filter (air inlet housing)	1054105	453561511401
Retainer, power cord (base)	1054294	453561512141
Retainer, UI (front panel)	1054208	453561511491
Ring, vibration dampening (blower to outlet port boot)	1056191	453561512821
Screw, 2-32 x 3/8 in. L, self-tap, package of 10 (ferrite clip, capacitor bracket)	1054209	453561511501
Screw, 6-32 x 1/4 in. L, pan head, package of 10 (power supply/EMI shroud)	1054210	453561511511
Screw, M1.6 x 4, pan head, package of 10 (LCD to LCD tray)	1054212	453561511531
Screw, M2 x 3 socket head, package of 10 (NEC LCD to LCD tray)	1100819	453561528901

Table A-1: V60/V60 Plus Ventilator Replacement Parts (Continued)

Description	Part number	Order number
Screw, M2.5 x 6, socket head, package of 10 (O ₂ solenoid valve clip)	1054214	453561511551
Screw, M2.5 x 8, pan head, package of 10 (backlight inverter PCBA, AC inlet)	1054215	453561511561
Screw, M3 x 12, pan head, package of 10 (MC PCBA)	1054229	453561511701
Screw, M3 x 14, pan head, package of 10 (rear to front bezel, bezel end cap, flow sensor assembly)	1054230	453561511711
Screw, M3 x 4, pan head, package of 10 (gas outlet port ground wire)	1054216	453561511571
Screw, M3 x 6, pan head, package of 10 (CPU, CPU cover, speakers, base-CPU tray, power supply to mounting plate and base, PM PCBA, GDS ground wire, UI cable clamp, LCD tray ground wire, LCD-front bezel, switch PCBA, UI PCBA, UI ground wire, air inlet filter retainer)	1054227	453561511681
Screw, M4 x 8, button head, nylon patch, package of 10 (MC PCBA retention bracket)	1117512	453561533921
Screw, M3 x 8, pan head, package of 10 (solenoid valve retention plate, O ₂ solenoid valve mount, DA PCBA)	1054228	453561511691
Screw, M4 x 14, socket head, package of 10 (bottom feet)	1054234	453561511721
Screw, M4 x 5 dia. x 5 L, shoulder, package of 10 (blower mount)	1054211	453561511521
Screw, M4 x 8, socket head, package of 10 (power cord retainer, capacitor bracket, battery bracket, top cover to base, base to front panel, base to side walls, air inlet filter housing, gas outlet bracket, UI retainer)	1054233	453561509081
Screw, M4, captive, socket head, package of 10 (O ₂ fitting retention plate)	1054232	453561509651
Seal, solenoid valve, package of 4 (manifold)	1054236	453561511741
Shielding clips, EMI shroud	1054247	453561511841
Shroud, EMI (power supply) (for use with 1st generation power supply)	1054248	453561511851
Shroud, EMI (power supply) (for use with 2nd generation power supply)	1149229	453561540761
Side panel, left	1054249	453561511861
Side panel, right	1113508	453561532841
Side wall, left (interior wall) (gray)	1054251	453561511881
Side wall, left (interior wall) (white)	1111330	453561532421
Side wall, right (interior wall) (gray)	1054252	453561511891
Solenoid valve (purge, autozero, crossover) (GDS)	1054254	453561511911

Table A-1: V60/V60 Plus Ventilator Replacement Parts (Continued)

Description	Part number	Order number
Solenoid valve, O ₂ (GDS)	1054253	453561511901
Speaker assembly (base assembly)	1054255	453561511921
Standoffs, M3 x 10 M-F, package of 5 (GDS manifold)	1054256	453561511931
Standoffs, M3 x 30 M-F, package of 3 (flow sensor assembly, manifold)	1054267	453561511941
Tape, Kapton, 3/4-in. wide (LCD cable, LCD tray)	1061127	453561513131
Touchscreen (front bezel)	1142908	453561539061
Tray, CPU	1054269	453561511961
Tray, LCD (1st generation - HYDIS)	1054270	453561511971
Tray, LCD (2nd generation NEC)	1109872	453561531651
Tubing kit	1054271	453561511981
UI assembly, with nav-ring, V60 (gray)	1100823	453561528941
UI assembly, with nav-ring, V60 (white)	1126908	453561536451
UI assembly, with nav-ring, V60 Plus	1140745	453561537931
UI assembly, without nav-ring, V60 (gray)	1149242	453561540891
UI assembly, without nav-ring, V60 (white)	1149238	453561540851
UI assembly, without nav-ring, V60 Plus	1149202	453561540791
Washer, 9/64 in.ID x 5/8 in. OD, package of 10 (UI retainer)	1054289	453561512111
Washer, lock, internal tooth, 1/2-in., package of 10 (remote alarm connector, CPU bracket)	1054319	453561512311
Washer, M3 ID x 7 mm OD, package of 10 (LCD tray)	1054274	453561512011
Washer, M3 ID x 9 mm OD, package of 10 (DA PCBA, speakers)	1054276	453561512031
Washer, retainer, #6, plastic, package of 10 (capacitor bracket, original O ₂ fitting retainer, UI retainer)	1054288	453561512101

A.2 Recommended Inventory Parts List

Table A-2 lists the recommended replacement parts inventory for authorized V60/V60 Plus ventilator dealers and distributors.

Table A-2: V60/V60 Plus Ventilator Recommended Inventory Parts

Description	Part number	Order number
Battery, internal	1076374	989805626941
Blower assembly	1055434	453561512761
Boot kit, rubber (GDS-blower and blower-output ports)	1054197	453561511421
Cable, backlight inverter PCBA	1054206	453561511481
Cable, DA PCBA to flow sensors	1054218	453561511591
Cable, DA PCBA to MC PCBA (2nd generation)	1124812	453561536131
Cable, gas outlet port to ground	1054219	453561511601
Cable, GDS to ground	1054220	453561511611
Cable, LCD (1st generation/HYDIS)	1054222	453561511631
Cable, LCD (2nd generation/NEC)	1126886	453561536431
Cable, power harness	1054221	453561511621
Cable, proximal port to ground	1054106	453561511411
Cable, switch PCBA	1054223	453561511641
Cable, UI ground	1054224	453561511651
Cable, UI PCBA to LCD	1100820	453561528911
Cable, UI PCBA to PM PCBA	1054225	453561511661
Clamp kit, hose (secures boots between GDS, blower, and outlet port)	1054239	453561511761
Fan guard, filter, and retainer	1054246	453561511831
Fan, cooling	1054277	453561512041
Foot kit, bottom, package of 4 (gray)	1054302	453561508131
Foot kit, bottom, package of 4 (white)	1111277	453561532041
Filter, air inlet, package of 5	1054279	453561505991
Filter, cooling fan, package of 5	1054280	453561507301
Filter, O ₂ inlet (GDS)	1054278	453561512051
Flow sensor assembly, air and O ₂	1058898	989805617141

Table A-2: V60/V60 Plus Ventilator Recommended Inventory Parts (Continued)

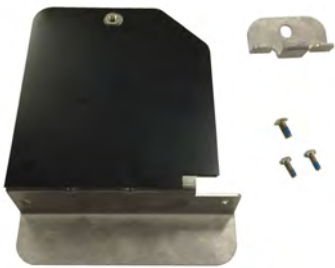
Description	Part number	Order number
Gasket, air inlet collar, package of 5	1054308	453561512201
Inlet, AC	1054318	453561512301
Mount, isolation, fan, package of 4	1055324	453561512751
Nut, hex, kep, M4 package of 10 (base grounding lug)	1054341	453561512441
Nut, hex, M12 x 1, stainless steel, package of 10 (remote alarm jack)	1055321	453561512721
Nut, wing, M3, package of 10 (MC PCBA to PCBA bracket)	1056418	453561512871
O-ring, 2-023, Viton, 70 Du, package of 5 (O ₂ solenoid valve mount)	1054347	453561512481
O-ring, 2-103, Viton 70 DU, package of 5 (DA PCBA-Manifold)	1054348	453561512491
O-ring, 2-121, Viton 70 DU, package of 5 (flow sensor assembly, O ₂ filter)	1054342	453561512451
O-ring, 2-123, Viton, 70 Du, package of 5 (air inlet)	1054343	453561512461
Overlay, power switch, V60 (UI/gray)	1149165	453561540721
Overlay, power switch, V60/V60 Plus (UI/white)	1149167	453561540741
PCBA, backlight inverter	1054354	453561512541
PCBA, CPU (Software 2.10)	1123932	453561535741
PCBA, CPU (Software 2.30)	1134187	453561537241
PCBA, CPU (software 3.00)	1137293	453561537661
PCBA, CPU (software 3.10)	1141260	453561537991
PCBA, CPU (software 3.20)	1152616	453561544511
PCBA, data acquisition (DA)	1054356	453561512561
PCBA, motor controller (MC)	1134422	453561537531
PCBA, power management (PM) (PIC firmware 1.20)	1119527	453561534061
PCBA, power management (PM) (PIC firmware 1.30)	1149231	453561540781
PCBA, power management (PM) (PIC firmware 1.30, 4th generation)	1154028	453561544451
PCBA, switch (UI)	1054360	453561512601
PCBA, user interface (UI) (2nd generation)	1100786	453561528871
Pin, locking, side panel	1054363	453561512631
Pin, push, fan mount, package of 4	1054235	453561511731

Table A-2: V60/V60 Plus Ventilator Recommended Inventory Parts (Continued)

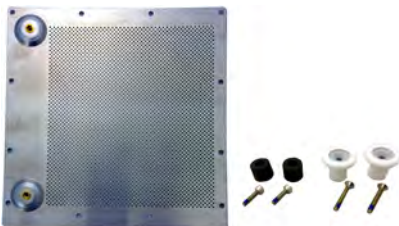
Description	Part number	Order number
Power cord, right-angle, Argentina, 10 A	1049627	989805615811
Power cord, right-angle, Australia, 10 A	1049653	989805614601
Power cord, right-angle, Brazil, 10 A	1075407	989805627161
Power cord, right-angle, China, 10 A	1049628	989805615821
Power cord, right-angle, Continental Europe, 10 A	1043253	989805612211
Power cord, right-angle, Denmark, 10 A	1049018	989805615801
Power cord, right-angle, Israel, 10 A	1050940	989805615851
Power cord, right-angle, Italy, 10 A	1049017	989805613481
Power cord, right-angle, Korea, 10 A	1109331	989805647101
Power cord, right-angle, North America, 10 A	1043249	989805613471
Power cord, right-angle, South Africa, 10 A	1043289	989805614591
Power cord, right-angle, Swiss, 10 A	1049016	989805615791
Power cord, right-angle, UK, 10 A	1043287	989805612601
Power supply (1st generation)	1054359	453561512591
Power supply (2nd generation)	1149230	453561540771
Screw, 2-32 x 3/8 in. L, self-tap, package of 10 (ferrite clip, capacitor bracket)	1054209	453561511501
Screw, 6-32 x 1/4 in. L, pan head, package of 10 (power supply/EMI shroud)	1054210	453561511511
Screw, M1.6 x 4, pan head, package of 10 (LCD to LCD tray)	1054212	453561511531
Screw, M2 x 3 socket head, package of 10 (NEC LCD to LCD tray)	1100819	453561528901
Screw, M2.5 x 6, socket head, package of 10 (O ₂ solenoid valve clip)	1054214	453561511551
Screw, M2.5 x 8, pan head, package of 10 (backlight inverter PCBA, AC inlet)	1054215	453561511561
Screw, M3 x 12, pan head, package of 10 (MC PCBA)	1054229	453561511701
Screw, M3 x 14, pan head, package of 10 (rear to front bezel, bezel end cap, flow sensor assembly)	1054230	453561511711
Screw, M3 x 4, pan head, package of 10 (gas outlet port ground wire)	1054216	453561511571

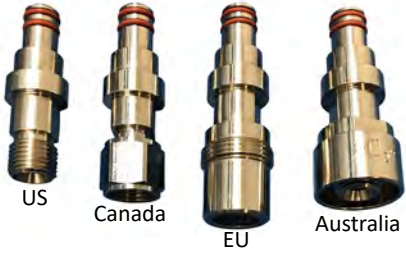
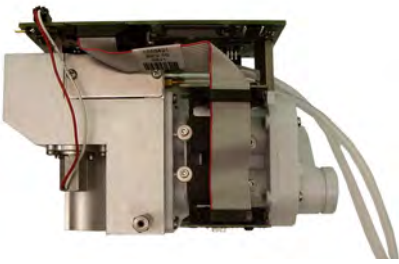
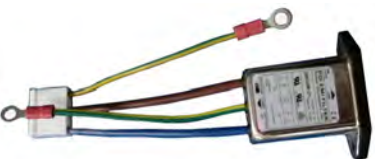
Table A-2: V60/V60 Plus Ventilator Recommended Inventory Parts (Continued)

Description	Part number	Order number
Screw, M3 x 6, pan head, package of 10 (CPU, CPU cover, speakers, base-CPU tray, power supply to mounting plate and base, PM PCBA, GDS ground wire, UI cable clamp, LCD tray ground wire, LCD-front bezel, switch PCBA, UI PCBA, UI ground wire, air inlet filter retainer)	1054227	453561511681
Screw, M3 x 8, pan head, package of 10 (solenoid valve retention plate, O ₂ solenoid valve mount, DA PCBA)	1054228	453561511691
Screw, M4 x 14, socket head, package of 10 (bottom feet)	1054234	453561511721
Screw, M4 x 5 dia. x 5 L, shoulder, package of 10 (blower mount)	1054211	453561511521
Screw, M4 x 8, socket head, package of 10 (power cord retainer, capacitor bracket, battery bracket, top cover to base, base to front panel, base to side walls, air inlet filter housing, gas outlet bracket, UI retainer)	1054233	453561509081
Solenoid valve (purge, autozero, crossover) (GDS)	1054254	453561511911
Solenoid valve, O ₂ (GDS)	1054253	453561511901
Speaker assembly (base assembly)	1054255	453561511921
Touchscreen (front bezel)	1142908	453561539061
Tubing kit	1054271	453561511981
Washer, 9/64 ID x 5/8 OD, package of 10 (UI retainer)	1054289	453561512111
Washer, lock, internal tooth, 1/2-in., package of 10 (remote alarm jack)	1054319	453561512311
Washer, M3 ID x 7 mm OD, package of 10 (LCD tray)	1054274	453561512011
Washer, M3 ID x 9 mm OD, package of 10 (DA PCBA, speakers)	1054276	453561512031
Washer, retainer, #6, plastic, package of 10 (capacitor bracket, original O ₂ fitting retainer, UI retainer)	1054288	453561512101

 Base assembly	 Battery, internal	 Bezel, front Shown: with nav-ring, V60 (white)
 Bezel, front Shown: without nav-ring, V60 Plus (white)	 Bezel, rear Shown: white	 Blower assembly
 Boot kit, rubber	 Bracket kit, PCBA (MC PCBA)	 Bracket kit, retention, MC PCBA
 Bracket, battery	 Bracket, capacitor (MC PCBA)	 Bracket, CPU

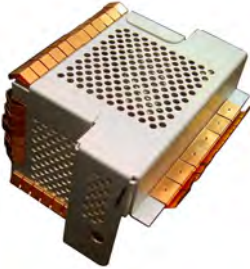
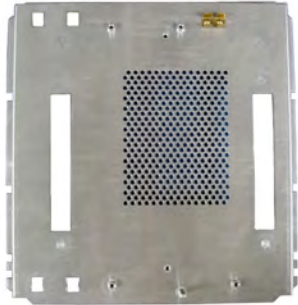
 Bracket, retaining, MC PCBA	 Button, Accept	 Cable, DA PCBA to flow sensors
 Cable, DA to MC PCBA (2nd generation)	 Cable, gas outlet port to ground	 Cable, GDS to ground
 Cable, LCD (1st generation/HYDIS)	 Cable, LCD (2nd generation)	 Cable, power harness
 Cable, proximal port to ground	 Cable, switch PCBA	 Cable, UI PCBA to LCD

 Cable, UI to ground	 Cable, UI to PM PCBA	 Cap, O₂ filter element
 Collar, air inlet	 Cover, CPU tray	 Cover, top
 End cap, bezel	 Fan guard, filter, and retainer	 Fan, cooling
 Filter, air inlet	 Filter, cooling fan	 Filter, O₂ inlet

 Fitting, barbed, 10-32 x 1/8-in., brass	 Fitting, barbed, nylon	 US Canada EU Australia Fitting, O₂ inlet
 Flow sensor assembly, air and O₂	 Foot kit, bottom, package of 4 (gray)	 Foot kit, bottom, package of 4 (white)
 Front panel assembly (white shown)	 Gas delivery subsystem (GDS)	 Housing, air inlet filter
 Inlet, AC	 Isolator, PCBA mounting bracket	 LCD assembly (2nd generation)

 Mount, isolation, fan	 Overlay, power switch	 PCBA, backlight inverter
 PCBA, CPU	 PCBA, DA	 PCBA, MC
 PCBA, PM	 PCBA, switch (UI)	 PCBA, UI
 Pin, locking, side panel	 Pin, push, fan mount	 Plate, foot retention

 Plate, O₂ fitting retention	 Port, gas outlet	 Port, proximal pressure
 Power supply (1st generation)	 Power supply (2nd generation)	 Retainer clip, O₂ solenoid valve
 Retainer, air inlet filter	 Retainer, power cord	 Retainer, UI
 Ring, vibration dampening	 Seal, solenoid valve	 Shielding clips, EMI shroud

 Shroud, EMI (1st generation power supply)	 Shroud, EMI (2nd generation power supply)	 Side panel, left
 Side panel, right	 Side wall, left (white)	 Side wall, right (white)
 Solenoid valve (purge, autozero, crossover)	 Solenoid valve, O₂	 Speaker assembly
 Touchscreen	 Tray, CPU	 Tray, LCD (1st generation/HYDIS)



Tray, LCD (2nd generation/NEC)



Tubing kit



**UI assembly, V60
(with nav-ring)**



**UI assembly, V60 Plus
(without nav-ring)**

A.3 Accessory Part Numbers

Table A-3 lists ventilator accessory part numbers.

Table A-3: Accessory Part Numbers

Description	Part number	Order number
O ₂ hoses		
Hose, O ₂ , DISS female x DISS female, green, (2.5 m) (8.2 ft)	1001664	989805616881
Hose, O ₂ , DISS female x DISS female, white, (2.5 m) (8.2 ft)	1002556	989805612421
Hose, O ₂ , DISS female x DISS male, white, (2.5 m) (8.2 ft)	1062978	989805616201
Hose, O ₂ , NIST x AFNOR, white, (2.5 m) (8.2 ft)	1054835	989805612701
Hose, O ₂ , NIST x AGA, white, (2.5 m) (8.2 ft)	1054832	989805615961
Hose, O ₂ , NIST x BS, white, (2.5 m) (8.2 ft)	1001663	989805612691
Hose, O ₂ , NIST x DIN, white, (2.5 m) (8.2 ft)	1054833	989805612551
Hose, O ₂ , NIST x NIST, white, (2.5 m) (8.2 ft)	1054836	989805613851
Hose, O ₂ , NIST x UNIFOR, white, (2.5 m) (8.2 ft)	1054834	989805615971
Hose, O ₂ , SIS, white, (2.5 m) (8.2 ft)	1001659	989805616871
Cables		
Cable, remote alarm, normally closed (alarm state = open), (15.24 m) (50 ft)	1003741	989805612391
Cable, remote alarm, normally open (alarm state = closed), (15.24 m) (50 ft)	1003742	989805611881
Cable, VueLink * Contact your Philips patient monitoring representative to order	Model M1032A Option A02*	
VueLink module * Contact your Philips patient monitoring representative to order	Model M1032A Option K6B*	
Patient circuits, filters, and brackets		
Bracket, support arm, rail-mount	1002497	989805611511
Filter, inspiratory/expiratory, single-use	1014047	989805618161
Knob, CleanClip mask storage bracket	1076197	989805629911
Patient circuit, single-limb, with proximal pressure line, single-use, 22-mm ID, package of 10	582073	989805609611
Support arm, three-section	332497	989805617961

A.4 O₂ Manifolds and Hoses

Table A-4 lists replacement parts for O₂ manifolds and hoses.

Table A-4: Replacement Bracket, hoses, and O₂ Manifold/Transport Kits

Description	Part number	Order number
Bracket, O ₂ manifold, V60/V680 (not shown)	1109667	453561531591
Hose, O ₂ manifold, DISS-F, green, (0.6 m) (2 ft), package of 2 (US)	1109894	989805648751
Hose, O ₂ manifold, DISS-F/M, white, (0.6 m) (2 ft), package of 2 (Canada)	1113511	453561532851
Hose, O ₂ manifold, NIST, white, (0.6 m) (2 ft), package of 2 (EMEA)	1109898	989805648761
Hose, O ₂ manifold, SIS, white, (0.6 m) (2 ft), package of 2 (Australia)	1113512	453561532861
O ₂ manifold/transport kit, DISS-M, includes hoses and bracket (US)	1109602	989805648241
O ₂ manifold/transport kit, DISS-F, includes hoses and bracket (Canada)	1113392	989805650191
O ₂ manifold/transport kit, NIST, includes hoses and bracket (EMEA)	1109881	989805648741
O ₂ manifold/transport kit, SIS, includes hoses and bracket (Australia)	1113371	989805650181

A.5 Universal Stand

Table A-5 lists replacement parts for the universal stand.

Table A-5: Universal Stand Replacement Parts

Description	Part number	Order number
Adapter plate, V60/V60 Plus (not shown)	1048873	989805611651
Base assembly	1048900	453561509641
Basket	1005839	453561508281
Bracket, E-cylinder	1005186	453561510291
Cord wrap	1049636	453561511321
Hardware kit (not shown)	1048896	453561506971
Rail, side	1049678	453561511331
Strap, E-cylinder, package of 2	1113129	989805650021
Thumbwheels, adapter plate, V60/V60 Plus, package of 2 (not shown)	1067580	989805630261





A.6 V60 Stand

Table A-6 lists replacement parts for the V60 stand.

Ventilator mounted on stand, PN 1109865 / 989805648681 (assembled) or 1109866 / 989805648691 (unassembled), shown with optional O₂ tank holder.

Table A-6: V60 Replacement Stand Parts

Description	Part number	Order number
Base assembly, V60 stand	1104444	453561530851
Base, tank holder, V60 stand	1104326	453561530921
Basket, V60 stand	1104445	453561530861
Caster, locking, V60 stand	1109413	453561531481
Column assembly, V60 stand	1104439	453561530811
Cord wrap, V60 stand	1104441	453561530831
Hardware kit, tank holder, V60 stand (not shown)	1104468	453561530941
Hardware kit, V60 stand (not shown)	1104458	453561530891
Bracket, humidifier, V60 stand	1104440	453561530821
Latch, quick release, V60 stand (not shown)	1104416	453561530781
Packaging, disassembled (not shown)	1109868	989805648711
Pad, left, tank holder base, V60 stand	1109412	453561531471
Pad, right, tank holder base, V60 stand	1104327	453561530931
Rail, side, V60 stand, package of 1	1104438	453561530801
Retainer, foot, V60 stand, package of 3 (not shown)	1104417	453561530791
Strap, tank bracket, V60 stand, package of 2	1104461	453561530911
Top platform assembly, V60 stand	1114908	453561533431
Upper bracket, tank holder, V60 stand	1104460	453561530901



V60 stand

B Specifications

B.1	Control Settings	308
B.2	Controls Active in V60/V60 Plus Ventilation Modes	309
B.3	Patient Data	310
B.4	Alarms	311
B.5	Alarm-Related Specifications	312
B.6	Menu Window Settings	313
B.7	Operator-Accessible Diagnostic Mode Functions	314
B.8	Physical Characteristics	315
B.9	Environmental Specifications	316
B.10	Pneumatic Specifications	317
B.11	Accessory Requirements	318
B.12	Electrical Specifications	319
B.13	Other Specifications	320

B.1 Control Settings

Parameter	Range	Resolution	Accuracy	Factory default
Mode settings				
Modes	CPAP, S/T, PCV, AVAPS (optional), PPV (optional)	N/A	N/A	S/T
Control settings				
C-Flex	OFF, 1 to 3	1	N/A	2
CPAP	4 to 25 cmH ₂ O	1 cmH ₂ O	± (2 cmH ₂ O + 4% of target)	4 cmH ₂ O
EPAP	4 to 25 cmH ₂ O	1 cmH ₂ O	± (2 cmH ₂ O + 4% of target)	4 cmH ₂ O
Flow (High flow therapy, HFT)	10 to 80 L/min or USA: 10 to 60 L/min	5 L/min	± (2 sL/min + 15% of target flow setting in sL/min)	10 L/min
IPAP <i>NOTE: Negative (subatmospheric) pressure settings are not available.</i>	4 to 40 cmH ₂ O	1 cmH ₂ O	± (2 cmH ₂ O + 4% of target)	12 cmH ₂ O
I-Time (inspiratory time)	0.30 to 3.00 sec	0.05 sec	± 0.03 sec	1.00 sec
Max E	0 to 100 cmH ₂ O/L	1 cmH ₂ O/L	N/A	15 cmH ₂ O/L
Max P (AVAPS maximum IPAP pressure)	6 to 40 cmH ₂ O	1 cmH ₂ O	± (2 cmH ₂ O + 4% of target)	25 cmH ₂ O
Max P (PPV maximum pressure limit)	5 to 40 cmH ₂ O	1 cmH ₂ O	± (2 cmH ₂ O + 4% of target)	20 cmH ₂ O
Max R	0 to 50 cmH ₂ O/L/sec	1 cmH ₂ O/L/s	N/A	4 cmH ₂ O/L/s
Max V (PPV maximum volume limit)	200 to 3500 mL	5 mL	± 15%	1000 mL
Min P (AVAPS minimum IPAP pressure)	5 to 30 cmH ₂ O	1 cmH ₂ O	± (2 cmH ₂ O + 4% of target)	10 cmH ₂ O
O ₂ (Oxygen)	21% to 100%	1%	Ventilation: ± 5% HFT: ± 7% (Flow < 15 sL/min) ± 5% (Flow ≥ 15 sL/min)	21%
PPV %	0% to 100%	1%	N/A	30%
Ramp Time	OFF, 5 to 45 min	5 min	< 1 sec	5 min
Rate (respiratory rate)	4 to 60 BPM	1 BPM	± 1 BPM	4 BPM
Rise (rise time)	1 to 5	1	N/A	3
V _T (AVAPS target tidal volume)	200 to 2000 mL BTPS	5 mL	± 15%	500 mL

B.2 Controls Active in V60/V60 Plus Ventilation Modes

	CPAP	S/T	PCV	AVAPS	PPV
Timing		Rate			Rate*
		I-Time			I-Time*
Baseline pressure	CPAP	EPAP			
Inspiratory pressure		IPAP		Max P	Max P
				Min P	IPAP*
Rise time		Rise			Rise*
O ₂					
Volume				V _T	Max V
Ramp feature	Ramp Time				
Mode-specific	C-Flex				PPV%
					Max E
					Max R
* Used in backup only					

B.3 Patient Data

Parameter	Range	Resolution	Accuracy
Patient data window			
Breath phase/trigger Indicator	Spont, Timed, Exhale	Color-coded display: Spont - turquoise Timed - orange Exhale - blue	N/A
PIP	0 to 50 cmH ₂ O	1 cmH ₂ O	± 2 cmH ₂ O
Pt. Leak	0 to 200 L/min BTPS	1 L/min	N/A
Pt. Trig	0% to 100%	1%	± 10%
Rate	0 to 90 BPM	1 BPM	± 1 BPM
T _I /T _{TOT}	0% to 91%	1%	± 5%
Tot. Leak	0 to 200 L/min BTPS	1 L/min	N/A
$\dot{V}_E$	0 to 99.0 L/min BTPS	0.1 L/min	± 15% or 0.3 L/min (whichever is greater)
V _T	0 to 3500 mL BTPS	1 mL	± 15% for volumes above 200 mL <i>Note: Accuracy specification based on use with patient circuit PN 582073.</i>
Waveform window			
P waveform	0 to 50 cmH ₂ O	Time axis: 1 second	N/A
$\dot{V}$ waveform in ventilation	-240 to 240 L/min BTPS	Time axis: 1 second	N/A
$\dot{V}$ waveform in HFT	0 to 90 L/min BTPS	Time axis: 1 second	N/A
V waveform	0 to 3500 mL BTPS	Time axis: 1 second	N/A

B.4 Alarms

Parameter	Range	Resolution	Factory Default
Hi Rate (high rate alarm)	5 to 90 BPM	1 BPM	30 BPM
Lo Rate (low rate alarm)	1 to 89 BPM	1 BPM	10 BPM
Hi V_T (high tidal volume alarm)	200 to 3500 mL BTPS	5 mL	2500 mL
Lo V_T (low tidal volume alarm)	OFF, 5 to 1500 mL BTPS	5 mL	OFF
HIP (high inspiratory pressure alarm)	5 to 50 cmH ₂ O	1 cmH ₂ O	50 cmH ₂ O
LIP (low inspiratory pressure alarm)	OFF, 1 to 40 cmH ₂ O	1 cmH ₂ O	OFF
Lo $\dot{V}_E$ (low minute ventilation alarm)	OFF, 1 to 99 L/min BTPS	1 L/min	OFF
LIP T (low inspiratory pressure delay time alarm)	5 to 60 sec	1 sec	20 sec

B.5 Alarm-Related Specifications

Parameter	Range
Delay time from the onset of the alarm condition to the point that the representation of the alarm condition leaves the signal output port	< 10 ms from onset of the alarm condition to the transmission of the signal < 500 s until alarms received from the ventilator are displayed on the IntelliVue patient monitor. This delay is in addition to the alarm detection and processing delays of the external device
Remote alarm delay time	The time it takes the message to appear on the remote alarm depends on the characteristics of the device.
Maximum time from the alarm condition triggering event to the generation of an alarm signal	All alarms except those listed below: < 10 s • Patient disconnect alarm: 11 s • Proximal pressure line disconnect alarm: 15 s • Low inspiratory pressure (LIP) alarm: user-configurable from 5 to 60 s • Check vent: Blower temperature high: 10 minutes
Mean delay, or the sum of mean delays, from the triggering event to the generation of an alarm signal	All alarms except those listed below: < 5 s • Cooling fan failure alarm: 10 s • Blower temperature alarm: 10 s • ADC wraparound: 6 s
Audio alarm loudness (in accordance with 3rd Edition testing methods)	Highest volume setting: Average sound pressure level is approximately 76 dB(A) Lowest volume setting: Average sound pressure level is approximately 62 dB(A)
High-priority auditory alarm signal sound pressure level range, measured per ISO 3744:2010 ANSI/	Average sound power level is approximately 54 dB(A) measured at the ventilator Average sound pressure level is approximately 46 dB(A) measured 1 m from the ventilator

B.6 Menu Window Settings

Parameter	Range
Brightness	1 to 5
Loudness	1 to 10
Mask/ET selection	ET/Trach, 1, 2, 3, 4, Other
Exhalation port selection (Available exhalation port selections may vary according to software version)	- FEP (Respironics filterable exhalation port) - DEP (Disposable exhalation port) - Whisper Swivel (Whisper Swivel exhalation port) - Other (other exhalation port) - None (no circuit exhalation port)
Vent Info	Includes software options, serial number, software version, power-on hours, date, and time.
Screen Lock	Off, On
Auto-Trak+	Trigger Sensitivity: Normal, +1, +2, +3, +4, +5, +6, +7 Expiratory Cycle Sensitivity: -2, -1, Normal, +1, +2, +3, +4, +5, +6

B.7 Operator-Accessible Diagnostic Mode Functions

Function	Range
Language	English, Nederlands, Français, Deutsch, Italiano, Português, Español, Dansk, Suomi, Norsk, Svenska, Chinese, Japanese, Türkçe
Date/Time	--
Pressure Units	cmH ₂ O, hPa
Restore Default Settings	--
Software Options	--
Baud Rate	9,600, 19,200, 115,200
Alarm Volume Escalation (available in software version 2.30 or later)	Enable, Disable (default)
Significant Event Log	--
Touchscreen Calibration	--

B.8 Physical Characteristics

Parameter	Specification
Dimensions	 33.7 cm/ 13.3 in. 39.4 cm/ 15.5 in. 42.9 cm/ 16.5 in.
Mass (weight) of the V60/V60 Plus ventilator in its most common configuration	12 kg/26 lb) with battery
Installed weight (V60/V60 Plus ventilator on stand, including accessories as listed)	V60/V60 Plus ventilator with backup battery, ventilator stand, O₂ tank holder, two E-cylinders (full), two gauge clusters, O₂ analyzer with mount, humidifier with chamber, water bag and pole, nebulizer, circuit arm with mount, patient circuit with mask, O₂ manifold with hoses, remote alarm cable, and power cord. Weight: 64 kg/142 lb
Maximum load (Mass/weight of the V60/V60 Plus ventilator stand, including its safe working load)	70.5 kg/155 lb

B.9 Environmental Specifications

Parameter	Specification
Temperature	Operating: 5°C to 40°C (41°F to 104°F) Storage/transport: –20°C to 50°C (–4°F to 122°F)
Relative humidity	Operating: 15% to 95% (non-condensing) Storage/transport: 10% to 95% (non-condensing)
Barometric pressure	Operating: 600 mmHg to 765 mmHg (80 kPa to 102 kPa): approximately –61 m to 1951 m (–200 ft to 6400 ft) relative to sea level Storage/transport: 450 mmHg to 765 mmHg (60 kPa to 102 kPa): approximately –61 m to 4267 m (–200 ft to 14000 ft) relative to sea level

B.10 Pneumatic Specifications

Parameter	Specification
High-pressure O ₂ supply	Connector: DISS male, DISS female Pressure: 2.76 to 6.00 bar / 276 to 600 kPa / 40 to 87 psig Flow: 175 SLPM Connector: DISS male, DISS female, NIST, SIS
High-pressure O ₂ supply (using O ₂ manifold)	Connector: DISS male, DISS female Pressure: 3.10 to 6.00 bar / 310 to 600 kPa / 45 to 87 psig Flow: 175 SLPM Connector: SIS Pressure: 3.66 to 6.00 bar / 366 to 600 kPa / 53 to 87 psig Flow: 175 SLPM
Air supply	Integrated blower
Inspiratory outlet (To patient port)	Connector: ISO 15-mm female/22-mm male conical
Maximum limited pressure (P _{LIMmax})	64 cmH ₂ O
Maximum working pressure range (P _{Wmax})	5 to 50 cmH ₂ O ensured by High Inspiratory Pressure (HIP) alarm limit
Subatmospheric pressures generated during exhalation	None

B.11 Accessory Requirements

NOTE

Any part that is added to the patient circuit changes the compliance and resistance of the ventilator breathing system. To achieve the ventilator performance specified in this manual, the ventilator breathing system must meet the following specifications.

These specifications are the required properties of the ventilator breathing system, external to the ventilator. Adhering to these specifications allows the ventilator to maintain the stated accuracies performance specifications of set and monitored volumes and pressures.

Parameter	Specification
Compliance	For volume accuracy requirements, the patient circuit compliance should be 0.98 mL/cmH ₂ O. For all other performance requirements except volume accuracy, the maximum compliance of the circuit can be up to 2.8 mL/cmH ₂ O.
Resistance	Maximum resistance of the breathing circuit and attachments: 2.9 cmH ₂ O at 60 L/min
Bacterial filter	Dead space: 66 ml Bacterial/viral filter efficiency: > 99.99% Resistance (at 0.5 L/s): 0.7 cmH ₂ O (hPa)/L/s Male connector: 15 mm ID/22 mm OD Female connector: 22 mm ID

B.12 Electrical Specifications

Parameter	Specification	
AC voltage	100 to 240 VAC	
AC frequency	50/60 Hz	
AC power	300 VA Nominal wattage: 25 W Maximum wattage: 68 W (charging battery) Nominal amperage: 0.25 A Maximum amperage: 1.0 A (charging battery)	
Battery	14.4 V, 11.0 Ah, 163 Wh Maximum system current draw: 11 A Charge voltage: +16.9 V maximum Operating time: 360 minutes (6 hours) under normal conditions	
Power source indicators		<i>Powered by AC with Battery Present</i> icon: Ventilator powered by AC power, internal battery is installed
		<i>Powered by AC without Battery</i> icon: Ventilator powered by AC power, internal battery is not installed
		<i>Battery Capacity Indicator</i> icon: Ventilator powered by internal battery.

B.13 Other Specifications

Parameter/characteristic	Specification
Expected service life	The expected service life of the V60/V60 Plus ventilator is 10 years. Ventilators in use beyond the expected service life may require more frequent maintenance and/or repair to maintain basic safety and essential performance.
Flow delivery	150 L/min at 40 cmH ₂ O at 1951 m (6400 ft) altitude
Demand flow range	0 to 240 L/min BTPS
Start-up time	Ready to ventilate 9 seconds after power on
Triggering, cycling, and leak Tolerance	Digital Auto-Trak Sensitivity algorithms (see ventilator user manual)
Inspiratory and expiratory pressure drop: measured at patient connection, when the recommended breathing system is in use and normal ventilation is compromised by the total or partial loss of power supply	≤ 2.0 cmH ₂ O (at 60 LPM) ≤ 1.0 cmH ₂ O (at 30 LPM)
Maximum time required for the O ₂ concentration in the delivered volume to change from 21% to 90% using the worst-case ventilator breathing system or using the maximum internal volume ventilator breathing system	The ventilator adjusts O ₂ within one breath FiO ₂ within the gas delivery system and entire breathing circuit adjusts at the following rate: Up to 18 seconds for delivered volume of 500 mL Up to 17 seconds for delivered volume of 200 mL
The 10-s average input flow required by the ventilator for each gas at a pressure of 280 kPa	107 sL/min
The maximum transient input flow averaged for 3 s required by the ventilator for each gas at a pressure of 280 kPa	130 sL/min
Operational acoustics ISO/FDIS 80601-2-12:2010 201.9.6.2.1.101	Average noise level is less than 45 dB(A) when measured 1 meter from the ventilator

C Service Bulletins

Save bulletins in this section.

C.1 Downloading Bulletins from InCenter

If you already have an InCenter account, use this link:

[Philips/InCenter2.0/login](https://philips.mizecx.com/login.html) (or <https://philips.mizecx.com/login.html>).

Once you are logged in:

1. Click on **Service**.
2. Click on **Respiratory Care**.
3. Click on **V60**.
4. Click on the **Reference** tab.

If you do not have an InCenter account:

1. Send an email to PCCI_CS_OPS@philips.com that includes:
 - Subject line: ***Request for access to InCenter Service P&S and Software Downloads for Respiratory Care-Ventilators.***
 - Customer full name
Company/institution
Street address
City, state, postal/zip code
Country
 - Telephone number
 - Email address
 - V60/V60 Plus product serial number (to confirm that the request is from a valid customer).
2. The InCenter team processes your request and emails a temporary password to you within 72 hours.
3. Once you log into InCenter, you can create a new password and access technical content for Hospital Respiratory Care products, including the service manual and operational software.

Index

A

AC inlet
 part number 279, 286
 removal/installation 151

AC power specifications 317

Accept button/nav-ring
 description 48
 removal/installation (front bezel) 186

air delivery test
 procedure 232
 troubleshooting 261

air flow accuracy test
 procedure 238
 troubleshooting 261

air flow sensor, description 38

air inlet collar
 part number 278
 removal/installation 173

air inlet filter
 description 37
 part number 278, 285
 removal/installation 147

air inlet filter housing
 part number 279
 removal/installation 172

air inlet filter retainer
 part number 282
 removal/installation 172

alarm settings, specifications 309

alarm speaker
 part number 284
 removal/installation 162

alarm volume escalation function 89

alarm-related specifications 310

alarms test
 procedure 250
 troubleshooting 263

annual preventive maintenance
 kit part number 282
 procedure 74

Auto-Trak+ settings, specifications 311

Averaging Setup Menu, pneumatic calibration analyzer 211

B

backlight inverter PCBA
 description 48
 part number 281, 286
 removal/installation 194

backlight inverter PCBA cable, part number 278

barbed fitting
 brass, part number 279
 white nylon, part number 279

barometric pressure transducer, description 38

base part numbers 277

battery, internal
 description 42
 part number 277, 285
 removal/installation 148
 specifications 317

battery, real-time clock, removal/installation 170

Baud rate, setting 88

bezel, front
 part numbers 277
 removal/installation 186

bezel, rear
 part numbers 277
 removal/installation 183

block diagram
 MC PCBA 59
 PM PCBA 57
 ventilator voltages 55

blockout plug, part number 14, 281

blower
 description 39
 part number 277, 285
 removal/installation 182

boot kit, part number 277, 285

bottom feet
 part numbers 279, 285
 removal/installation 195
 retention plate part number 281

brackets and bracket kits, part numbers 277

brightness setting, specifications 311

C

cable clamp, part number 278

cable part numbers 278, 285

calibrating the touchscreen 98

capacitor bracket clip, part number 278

caution

- care and maintenance 32
- communications interface 34
- CPU PCBA 145
- definition 22
- first-time installation 33
- general 24
- internal battery 32
- preparing for ventilation 28

cleaning

- approved cleaning agents 72
- exterior and touchscreen 72

clearing the significant event log 131

communication protocols, supported 45

Component Replacement Data Form 202

Configurations Menu, pneumatic calibration analyzer 213

contact information 20, 318

control settings, specifications 306

controls test

- procedure 225
- troubleshooting 260

country-specific label placement 199, 200, 201

CPU PCBA

- caution 145
- description 43
- part number 281, 286
- removal/installation 169

CPU PCBA tray, part number 284

CPU tray cover, part number 278

D

DA PCBA to MC PCBA cable

- part number 278, 285
- removal/installation 154

DA to flow sensors cable, part number 278, 285

data acquisition (DA) PCBA

- description 46
- part number 281, 286
- removal/installation 176
- voltage measurement contacts 116, 117

date and time selection 84

default settings, restoring 85

demand flow specifications 318

diagnostic codes 99

Diagnostic mode 79

- alarm volume escalation 89
- download mode 96
- enable software options 87
- entering 63, 80

flow sensor zero calibration 98

miscellaneous 94

operator-accessible functions 312

output controls 93

pneumatic controls 91

restore default settings 85

set Baud rate 88

set date and time 84

set pressure units 86

significant event log 95

touchscreen calibration 98

touchscreen diagnostics 97

ventilator information 90

diagnostic report (DRPTA) 128

dimensions, ventilator 313

disconnecting all power 146

disinfection

- approved disinfecting agents 73
- exterior and touchscreen 73

Download mode screen 96

downloading service bulletins 319

downloading ventilator software 132, 137

DRPTA (diagnostic report) 128

E

Electrical Safety Data Form 265

electrical safety test

- at installation 64
- procedure 219
- troubleshooting 259

electrical specifications 317

electronics

- description 41
- signal paths 50

EMI shroud

- part numbers 283
- shielding clips part number 283

enabling software options

- Diagnostic mode 87

environmental specifications 314

exterior and touchscreen

- cleaning 72
- disinfection 73

F

- fan
 - associated part numbers 278, 280, 281, 285, 286
 - removal/installation 152
- feet, bottom
 - part numbers 279, 285
 - removal/installation 195
 - retention plate part number 281
- field communications 319
- flow delivery specifications 318
- flow sensor assembly
 - part number 279, 285
 - removal/installation 176
- flow sensor zero calibration 98
 - procedure 236
 - troubleshooting 261
- flow sensor zero calibration report (FSZR) 130
- flow sensors, description 47
- foam kit, sound insulation, part number 279
- front bezel
 - part numbers 277
 - removal/installation 186
- front panel
 - part numbers 279
 - removal/installation 159
- FSZR (flow sensor zero calibration report) 130

G

- gas delivery subsystem (GDS)
 - part number 279
 - removal/installation 172
 - schematic 37
 - tubing kit part number 284, 288
- gas outlet port
 - part number 282
 - removal/installation 160
- gas outlet port to ground cable, part number 278, 285
- gasket part numbers 279, 286
- GDS to ground cable, part number 278, 285
- grommet, blower mount, part number 279
- grommet, transducer, part number 279

H

- hose clamp kit, part number 278, 285

I

- installed weight specification 313
- installing the ventilator 61

- intended use 10

internal battery

- description 42
- part number 277, 285
- removal/installation 148
- specifications 317
- warnings, cautions, and notes 32

internal battery test

- procedure 255
- troubleshooting 263

- Isolator, PCBA mounting bracket, part number 279

K

- Kapton tape part number 284

L**labels**

- country-specific placement 199, 200, 201
- part numbers 280
- removal/installation 197

language selection 82**LCD assembly**

- description 47
- HYDIS LCD removal/installation 188
- NEC LCD, removal/installation 190
- part numbers 280

LCD cable, part number 278, 285**LCD tray**

- part numbers 284
- removal/installation 194

leak tests

- procedure 221
- troubleshooting 260

left side wall

- part numbers 283
- removal/installation 171

locking pin part numbers 281, 286**loudness setting, specifications 311****M**

- machine and pressure transducers, description 38
- machine pressure autozero solenoids (SOL2 and SOL4) 40
- mains power specifications 317
- manifold description 39
- mask/port settings, specifications 311
- maximum load 313

MC PCBA retention bracket
 part number 277
 removal/installation 155

Menu settings
 Auto-Trak+ 311
 brightness 311
 loudness 311
 mask/port 311
 screen lock 311
 Vent Info 311

Miscellaneous screen 94
 motor controller (MC) PCBA
 description 46
 part number 281, 286
 removal/installation 156

N

nav-ring/Accept button
 button part number 277
 description 48
 removal/installation (front bezel) 186

note
 definition 22
 general 24
 internal battery 33
 preparing the ventilator 28

null modem cable
 part number 11
 using non-Philips 137
 nut part numbers 280, 286

O

O₂ accuracy test
 procedure 244
 troubleshooting 262
 O₂ filter element
 cap part number 278
 description 39
 O₂ flow accuracy test
 procedure 241
 troubleshooting 262
 O₂ flow sensor description 39
 O₂ hose part numbers 297
 O₂ inlet filter (GDS)
 description 39
 part number 278, 285
 removal/installation 175

O₂ inlet fitting
 kit part numbers 278, 279
 removal/installation 153
 retention plate part number 281
 O₂ manifold part numbers 298
 O₂ pressure transducer, description 38
 O₂ solenoid valve
 description 39
 part number 284, 288
 part number, mount 280
 removal/installation 178
 retainer clip part number 282
 o-ring part numbers 280, 281, 286
 output controls, Diagnostic mode 93

P

padding, left side wall, part number 281
 parts list
 accessories 297
 complete 277
 O₂ manifolds and hoses 298
 recommended inventory 285
 side panels 297
 V60 ventilator stand 302
 patient circuit part numbers 297
 patient data, specifications 308
 PC setup for service 120
 performance verification
 air delivery test 232
 air flow accuracy test 238
 alarms test 250
 controls test 225
 electrical safety test 219
 Electrical Safety/EST-SST Data Form 266
 flow sensor zero calibration 236
 internal battery test 255
 leak tests 221
 O₂ flow accuracy test 241
 O₂ mix accuracy test 244
 Performance Verification Data Form 267 to 273
 pneumatic calibration analyzer setup 209
 power fail test 252
 preliminary cleaning, inspection, and setup 209
 pressure accuracy test 227
 required tests 205
 S/T performance 248
 test numbering 204
 Performance Verification Data Form 267
 physical specifications 313
 pinout, RS-232 serial port 45

plug kit part numbers 281
 pneumatic calibration analyzer
 Averaging Setup Menu 211
 Configurations menu 213
 setup 209
 Trigger Options 212
 pneumatics
 controls in Diagnostic mode 91
 overview 36
 specifications 315
 power cord
 part numbers 282, 287
 retainer part number 282
 power disconnect, AC and battery 146
 power fail test
 procedure 252
 troubleshooting 263
 power harness cable, part number 278, 285
 power management (PM) PCBA
 description 41
 part number 281, 286
 removal/installation 163
 power supply
 mounting plate part number 281
 part number 282, 287
 removal/installation 165
 power switch overlay
 description 49
 part numbers 281, 286
 removal/installation 184
 power-on hours, reprogramming 140
 preoperational check 64
 Preoperational Check Form 67
 pressure accuracy test
 procedure 227
 troubleshooting 261
 pressure drop, inspiratory and expiratory, specifications 318
 pressure transducer descriptions
 barometric 38
 machine and proximal 38
 O₂ 38
 pressure units selection 86
 preventive maintenance
 annual kit part number 282
 annual PM instructions 74
 schedule 71
 programming the ventilator serial number 140
 programming ventilator power-on hours 141

proximal port to ground cable, part number 278, 285
 proximal pressure autozero solenoids (SOL3 and SOL4) 40
 proximal pressure port
 part number 282
 removal/installation 161
 purge solenoid (SOL1) 40

R

real-time clock battery, removal/installation 170
 rear bezel
 part numbers 277
 removal/installation 183
 recording ventilator information 132
 remote alarm
 cable part numbers 297
 description 44
 repacking and shipping 145
 reprogramming ventilator serial number and power-on hours 140
 restoring default settings 85
 returning the ventilator to operation, following performance verification 257
 right side wall
 part number 283
 removal/installation 174
 ring, vibration dampening, part number 282
 RS-232 port pinout 45

S

S/T performance test
 performance verification 248
 troubleshooting 262
 screen lock, specifications 311
 screw part numbers 282, 283, 287, 288
 selecting a language 82
 selecting pressure units 86
 serial number, reprogramming 140
 serial port pinout 45
 service bulletins 319
 service kit 11
 service PC setup 120
 setting date and time 84
 setting up the service PC 120
 setup, pneumatic calibration analyzer 209
 shipping the ventilator 145
 box part number 277
 side panel part numbers 283

- side wall part numbers 283
- signal paths 50
- significant event log
 - clearing 131
 - description 95
- software download 132, 137
- software options, enabling in Diagnostic mode 87
- SOL1 (purge solenoid) 40
- SOL2 and SOL4 (machine pressure autozero solenoids) 40
- SOL3 and SOL4 (proximal pressure autozero solenoids) 40
- solenoid valves
 - description 40
 - part numbers 283, 288
 - removal/installation 181
 - seal part number 283
- speaker part number 288
- specifications 305
 - alarm settings 309
 - alarm-related 310
 - control settings 306
 - demand flow 318
 - electrical 317
 - environmental 314
 - flow delivery 318
 - inspiratory and expiratory pressure drop 318
 - installed weight 313
 - maximum load 313
 - Menu settings 311
 - operational acoustics 318
 - operator-accessible Diagnostic mode functions 312
 - patient data 308
 - physical 313
 - pneumatic 315
 - startup time 318
 - time required for O₂ concentration change 318
 - triggering, cycling, and leak tolerances 318
 - ventilator dimensions 313
 - ventilator weight 313
- standoff part numbers 284
- startup time specification 318
- switch PCBA
 - description 49
 - part number 281, 286
 - removal/installation 185
- switch PCBA cable, part number 278, 285
- system settings 81

T

- tape, Kapton, part number 284
- test equipment, recommended 11
- theory of operation 35
- time and date selection 84
- tools and supplies 11
- top cover
 - part numbers 278
 - removal/installation 150
- touchscreen
 - calibration 98
 - description 48
 - part number 284, 288
 - removal/installation 186
- Touchscreen Diagnostics screen 97
- trigger options, pneumatic calibration analyzer 212
- troubleshooting
 - battery 118
 - diagnostic codes 99
 - miscellaneous 114
 - miscellaneous tips 114
 - symptom-based 113

U

- UI bezel end cap 278
- UI ground cable, part number 278, 285
- UI PCBA
 - description 49
 - part number 281, 286
 - removal/installation 192
- UI PCBA to LCD cable, part number 278, 285
- UI PCBA to PM PCBA cable, part number 285
- UI retainer
 - part number 282
 - removal/installation 160
- UI to PM PCBA cable, part number 278
- user interface (UI)
 - description 47
 - part numbers 284
 - removal/installation 158, 183

V

- V60/V60 Plus ventilator
 - description 10
 - intended use 10
 - service kit 11
 - theory of operation 35

- ventilator information
 - recording for software download 132
 - Vent Info specifications 311
 - viewing in Diagnostic mode 90
- ventilator software download 132, 137
- voltage measurement contacts on the DA PCBA 116, 117
- VueLink
 - cable part number 297
 - module part number 297

W

- warnings, cautions, and notes
 - alarms and messages 30
 - care and maintenance 31
 - communications interface 34
 - definition 22
 - Diagnostic mode 34
 - general 22
 - internal battery 32
 - operation 29
 - preparing for ventilation 26
- washer part numbers 284, 288
- weight, ventilator 313
- wiring diagram
 - main assembly 51
 - UI assembly 53

