GE Healthcare

9100c Anesthesia Machine
Technical Reference Manual

Software Revision 1.x

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M1207027 **004** **MANUAL−DOC, Technical Reference Manual, Technical Reference Manual for 9100c, English**

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GE Healthcare products have unit serial numbers with coded logic.

which indicates a product group code, the year of manufacture, and a sequential unit number for identification. The serial number can be in one of two formats.

ME**YYMM**1111
The YY represents a number indicating the year the product was manufactured; 10 = 2010, 11 = 2011, etc. The MM represents a number indicating the month the product was manufactured; 01 = Jan, 02 = Feb, etc.

Service Disclaimer

WARNING (EN)	This service manual is available in English only. • If a customer's service provider requires a language other than english, it is the customer's responsibility to provide translation services. • Do not attempt to service the equipment unless this service manual has been consulted and is understood. • Failure to heed this warning may result in injury to the service provider, operator or patient from electric shock, mechanical or other hazards.
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VÝSTRAHA (CS)	Tento provozní návod existuje pouze v anglickém jazyce. • V případě, že externí služba zákazníkům potřebuje návod v jiném jazyce, je zajištění překladu do odpovídajícího jazyka úkolem zákazníka. • Nesnažte se o údržbu tohoto zařízení, aniž byste si přečetli tento provozní návod a pochopili jeho obsah. • V případě nedodržování této výstrahy může dojít k poranění pracovníka prodejního servisu, obslužného personálu nebo pacientů vlivem elektrického proudu, respektive vlivem mechanických či jiných rizik.
ADVARSEL (DA)	Denne servicemanual findes kun på engelsk. • Hvis en kundes tekniker har brug for et andet sprog end engelsk, er det kundens ansvar at sørge for oversættelse. • Forsøg ikke at servicere udstyret uden at læse og forstå denne servicemanual. • Manglende overholdelse af denne advarsel kan medføre skade på grund af elektrisk stød, mekanisk eller anden fare for teknikeren, operatøren eller patienten.

WARNUNG (DE)	Diese Serviceanleitung existiert nur in englischer Sprache. • Falls ein fremder Kundendienst eine andere Sprache benötigt, ist es Aufgabe des Kunden für eine entsprechende Übersetzung zu sorgen. • Versuchen Sie nicht diese Anlage zu warten, ohne diese Serviceanleitung gelesen und verstanden zu haben. • Wird diese Warnung nicht beachtet, so kann es zu Verletzungen des Kundendiensttechnikers, des Bedieners oder des Patienten durch Stromschläge, mechanische oder sonstige Gefahren kommen.
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ATENCION (ES)	Este manual de servicio sólo existe en inglés. • Si el encargado de mantenimiento de un cliente necesita un idioma que no sea el inglés, el cliente deberá encargarse de la traducción del manual. • No se deberá dar servicio técnico al equipo, sin haber consultado y comprendido este manual de servicio. • La no observancia del presente aviso puede dar lugar a que el proveedor de servicios, el operador o el paciente sufran lesiones provocadas por causas eléctricas, mecánicas o de otra naturaleza.
HOIATUS (ET)	See teenindusjuhend on saadaval ainult inglise keeles • Kui klienditeeninduse osutaja nõuab juhendit inglise keelest erinevas keeles, vastutab klient tõlketeenuse osutamise eest. • Ärge üritage seadmeid teenindada enne eelnevalt käesoleva teenindusjuhendiga tutvumist ja sellest aru saamist. • Käesoleva hoiatuse eiramine võib põhjustada teenuseosutaja, operaatori või patsiendi vigastamist elektrilöögi, mehaanilise või muu ohu tagajärjel.

VAROITUS (FI)	Tämä huolto-ohje on saatavilla vain englanniksi. • Jos asiakkaan huoltohenkilöstö vaatii muuta kuin englanninkielistä materiaalia, tarvittavan käännöksen hankkiminen on asiakkaan vastuulla. • Älä yritä korjata laitteistoa ennen kuin olet varmasti lukenut ja ymmärtänyt tämän huolto-ohjeen. • Mikäli tätä varoitusta ei noudateta, seurauksena voi olla huoltohenkilöstön, laitteiston käyttäjän tai potilaan vahingoittuminen sähköiskun, mekaanisen vian tai muun vaaratilanteen vuoksi.
ATTENTION (FR)	Ce manuel d'installation et de maintenance est disponible uniquement en anglais. • Si le technicien d'un client a besoin de ce manuel dans une langue autre que l'anglais, il incombe au client de le faire traduire. • Ne pas tenter d'intervenir sur les équipements tant que ce manuel d'installation et de maintenance n'a pas été consulté et compris. • Le non-respect de cet avertissement peut entraîner chez le technicien, l'opérateur ou le patient des blessures dues à des dangers électriques, mécaniques ou autres.
FIGYELMEZTETÉS (HU)	Ezen karbantartási kézikönyv kizárólag angol nyelven érhető el. • Ha a vevő szolgáltatója angoltól eltérő nyelvre tart igényt, akkor a vevő felelőssége a fordítás elkészíttetése. • Ne próbálja elkezdeni használni a berendezést, amíg a karbantartási kézikönyvben leírtakat nem értelmezték. • Ezen figyelmeztetés figyelmen kívül hagyása a szolgáltató, működtető vagy a beteg áramütés, mechanikai vagy egyéb veszélyhelyzet miatti sérülését eredményezheti.
AÐVÖRUN (IS)	Þessi þjónustuhandbók er aðeins fáanleg á ensku. • Ef að þjónustuveitandi viðskiptamanns þarfnast annas tungumáls en ensku, er það skylda viðskiptamanns að skaffa tungumálaþjónustu. • Reynið ekki að afgreiða tækið nema að þessi þjónustuhandbók hefur verið skoðuð og skilin. • Brot á sinna þessari aðvörun getur leitt til meiðsla á þjónustuveitanda, stjórnanda eða sjúklings frá raflosti, vélrænu eða öðrum áhættum.

AVVERTENZA (IT)	Il presente manuale di manutenzione è disponibile soltanto in lingua inglese. • Se un addetto alla manutenzione richiede il manuale in una lingua diversa, il cliente è tenuto a provvedere direttamente alla traduzione. • Procedere alla manutenzione dell'apparecchiatura solo dopo aver consultato il presente manuale ed averne compreso il contenuto. • Il mancato rispetto della presente avvertenza potrebbe causare lesioni all'addetto alla manutenzione, all'operatore o ai pazienti provocate da scosse elettriche, urti meccanici o altri rischi.
警告 (JA)	このサービスマニュアルには英語版しかありません。 · サービスを担当される業者が英語以外の言語を要求される場合、翻訳作業はその業者の責任で行うものとさせていただきます。 · このサービスマニュアルを熟読し理解せずに、装置のサービスを行わないでください。 · この警告に従わない場合、サービスを担当される方、操作員あるいは患者さんが、感電や機械的又はその他の危険により負傷する可能性があります。
경고 (KO)	본 서비스 매뉴얼은 영어로만 이용하실 수 있습니다 . • 고객의 서비스 제공자가 영어 이외의 언어를 요구할 경우 , 번역 서비스를 제공하는 것은 고객의 책임입니다 . • 본 서비스 매뉴얼을 참조하여 숙지하지 않은 이상 해당 장비를수리하려고 시도하지 마십시오 . • 본 경고 사항에 유의하지 않으면 전기 쇼크 , 기계적 위험 , 또는 기타 위험으로 인해 서비스 제공자 , 사용자 또는 환자에게 부상을 입힐 수 있습니다 .
ĮSPĖJIMAS (LT)	Šis eksploatavimo vadovas yra tik anglų kalba. • Jei kliento paslaugų tiekėjas reikalauja vadovo kita kalba – ne anglų, suteikti vertimo paslaugas privalo klientas. • Nemėginkite atlikti įrangos techninės priežiūros, jei neperskaitėte ar nesupratote šio eksploatavimo vadovo. • Jei nepaisysite šio įspėjimo, galimi paslaugų tiekėjo, operatoriaus ar paciento sužalojimai dėl elektros šoko, mechaninių ar kitų pavojų.
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WAARSCHUWING (NL)	Deze onderhoudshandleiding is enkel in het Engels verkrijgbaar. • Als het onderhoudspersoneel een andere taal vereist, dan is de klant verantwoordelijk voor de vertaling ervan. • Probeer de apparatuur niet te onderhouden alvorens deze onderhoudshandleiding werd geraadpleegd en begrepen is. • Indien deze waarschuwing niet wordt opgevolgd, zou het onderhoudspersoneel, de operator of een patiënt gewond kunnen raken als gevolg van een elektrische schok, mechanische of andere gevaren.
ADVARSEL (NO)	Denne servicehåndboken finnes bare på engelsk. • Hvis kundens serviceleverandør har bruk for et annet språk, er det kundens ansvar å sørge for oversettelse. • Ikke forsøk å reparere utstyret uten at denne servicehåndboken er lest og forstått. • Manglende hensyn til denne advarselen kan føre til at serviceleverandøren, operatøren eller pasienten skades på grunn av elektrisk støt, mekaniske eller andre farer.
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ATENÇÃO (PT-BR)	Este manual de assistência técnica encontra-se disponível unicamente em inglês. • Se outro serviço de assistência técnica solicitar a tradução deste manual, caberá ao cliente fornecer os serviços de tradução. • Não tente reparar o equipamento sem ter consultado e compreendido este manual de assistência técnica. • A não observância deste aviso pode ocasionar ferimentos no técnico, operador ou paciente decorrentes de choques elétricos, mecânicos ou outros.

ATENÇÃO (PT-PT)	Este manual de assistência técnica só se encontra disponível em inglês. • Se qualquer outro serviço de assistência técnica solicitar este manual noutro idioma, é da responsabilidade do cliente fornecer os serviços de tradução. • Não tente reparar o equipamento sem ter consultado e compreendido este manual de assistência técnica. • O não cumprimento deste aviso pode colocar em perigo a segurança do técnico, do operador ou do paciente devido a choques eléctricos, mecânicos ou outros.
ATENȚIE (RO)	Acest manual de service este disponibil doar în limba engleză. • Dacă un furnizor de servicii pentru clienți necesită o altă limbă decât cea engleză, este de datoria clientului să furnizeze o traducere. • Nu încercați să reparați echipamentul decât ulterior consultării şi înțelegerii acestui manual de service. • Ignorarea acestui avertisment ar putea duce la rănirea depanatorului, operatorului sau pacientului în urma pericolelor de electrocutare, mecanice sau de altă natură.
ОСТОРОЖНО! (RU)	Данное руководство по техническому обслуживанию представлено только на английском языке. • Если сервисному персоналу клиента необходимо руководство не на английском, а на каком-то другом языке, клиенту следует самостоятельно обеспечить перевод. • Перед техническим обслуживанием оборудования обязательно обратитесь к данному руководству и поймите изложенные в нем сведения. • Несоблюдение требований данного предупреждения может привести к тому, что специалист по техобслуживанию, оператор или пациент получит удар электрическим током, механическую травму или другое повреждение.
UPOZORNENIE (SK)	Tento návod na obsluhu je k dispozícii len v angličtine. • Ak zákazníkov poskytovateľ služieb vyžaduje iný jazyk ako angličtinu, poskytnutie prekladateľských služieb je zodpovednosťou zákazníka. • Nepokúšajte sa o obsluhu zariadenia, kým si neprečítate návod na obluhu a neporozumiete mu. • Zanedbanie tohto upozornenia môže spôsobiť zranenie poskytovateľa služieb, obsluhujúcej osoby alebo pacienta elektrickým prúdom, mechanické alebo iné ohrozenie.

UPOZORENJE (SR)	Ovo servisno uputstvo je dostupno samo na engleskom jeziku. • Ako klijentov serviser zahteva neki drugi jezik, klijent je dužan da obezbedi prevodilačke usluge. • Ne pokušavajte da opravite uređaj ako niste pročitali i razumeli ovo servisno uputstvo. • Zanemarivanje ovog upozorenja može dovesti do povređivanja servisera, rukovaoca ili pacijenta usled strujnog udara ili mehaničkih i drugih opasnosti.
VARNING (SV)	Den här servicehandboken finns bara tillgänglig på engelska. . • Om en kunds servicetekniker har behov av ett annat språk än engelska, ansvarar kunden för att tillhandahålla översättningstjänster. • Försök inte utföra service på utrustningen om du inte har läst och förstår den här servicehandboken. • Om du inte tar hänsyn till den här varningen kan det resultera i skador på serviceteknikern, operatören eller patienten till följd av elektriska stötar, mekaniska faror eller andra faror.
DIKKAT (TR)	Bu servis kılavuzunun sadece ingilizcesi mevcuttur. • Eğer müşteri teknisyeni bu kılavuzu ingilizce dışında bir başka lisandan talep ederse, bunu tercüme ettirmek müşteriye düşer. • Servis kılavuzunu okuyup anlamadan ekipmanlara müdahale etmeyiniz. • Bu uyarıya uyulmaması, elektrik, mekanik veya diğer tehlikelerden dolayı teknisyen, operatör veya hastanın yaralanmasına yol açabilir.
警告 (ZH-CN)	本维修手册仅提供英文版本。 • 如果客户的维修服务人员需要非英文版本，则客户需自行提供翻译服务。 • 未详细阅读和完全理解本维修手册之前，不得进行维修。 • 忽略本警告可能对维修服务人员、操作人员或患者造成电击、机械伤害或其他形式的伤害。
警告 (ZH-HK)	本服務手冊僅提供英文版本。 • 倘若客戶的服務供應商需要英文以外之服務手冊，客戶有責任提供翻譯服務。 • 除非已參閱本服務手冊及明白其內容，否則切勿嘗試維修設備。 • 不遵從本警告或會令服務供應商、網絡供應商或病人受到觸電、機械性或其他的危險。
警告 (ZH-TW)	本維修手冊僅有英文版。 • 若客戶的維修廠商需要英文版以外的語言，應由客戶自行提供翻譯服務。 • 請勿試圖維修本設備，除非您已查閱並瞭解本維修手冊。 • 若未留意本警告，可能導致維修廠商、操作員或病患因觸電、機械或其他危險而受傷。

Important

The information contained in this Technical Reference Manual pertains only to those models of products which are marketed by GE Healthcare as of the effective date of this manual or the latest revision thereof. This Technical Reference manual was prepared for exclusive use by GE Healthcare service personnel in light of their training and experience as well as the availability to them of parts, proper tools and test equipment. Consequently, GE Healthcare provides this Technical Reference manual to its customers purely as a business convenience and for the customer's general information only without warranty of the results with respect to any application of such information. Furthermore, because of the wide variety of circumstances under which maintenance and repair activities may be performed and the unique nature of each individual's own experience, capacity, and qualifications, the fact that customer has received such information from GE Healthcare does not imply in any way that GE Healthcare deems said individual to be qualified to perform any such maintenance or repair service. Moreover, it should not be assumed that every acceptable test and safety procedure or method, precaution, tool, equipment or device is referred to within, or that abnormal or unusual circumstances, may not warrant or suggest different or additional procedures or requirements.

This manual is subject to periodic review, update and revision. Customers are cautioned to obtain and consult the latest revision before undertaking any service of the equipment. Comments and suggestions on this manual are invited from our customers. Send your comments and suggestions to the Manager of Technical Communications, GE Healthcare, Ohmeda Drive, PO Box 7550, Madison, Wisconsin 53707.

CAUTION Servicing of this product in accordance with this Technical Reference manual should never be undertaken in the absence of proper tools, test equipment and the most recent revision to this service manual which is clearly and thoroughly understood.

Technical Competence

The procedures described in this Technical Reference Manual should be performed by trained and authorized personnel only. Maintenance should only be undertaken by competent individuals who have a general knowledge of and experience with devices of this nature. No repairs should ever be undertaken or attempted by anyone not having such qualifications.

GE Healthcare strongly recommends using only genuine replacement parts, manufactured or sold by GE Healthcare for all repair parts replacements.

Read completely through each step in every procedure before starting the procedure; any exceptions may result in a failure to properly and safely complete the attempted procedure.

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1 Introduction

In this section

This section provides a general overview of the 9100c line of anesthesia machines.

1.1 What this manual includes

Anesthesia Machine

This manual covers the service information for the 9100c anesthesia machine and ventilator. It details the following components:

- Ventilator components
- Gas delivery components
- Breathing system components
- Frame components

Other equipment

Other equipment may be attached to the system mounting arm or the top shelf. Consult separate documentation relative to these items for details.

1.2 Standard service procedures

1.2.1 User's Reference Manual

Some sections of this manual refer you to the User's Reference Manual for the 9100c anesthesia machine. To expedite repairs, you must have and be familiar with the User's Reference Manual.

Refer to the User's Reference Manual for further information about the operation of the system.

1.2.2 Software versions

The revision levels of the software installed on the control sample board, the display monitor board and the alarm MCU are displayed on the main menu of the service mode. This manual includes test and calibration procedures for Revision 1.x.x.x software of the control board, Revision 1.x.x.x software of the display board and Revision 1.x.x.x of the alarm board.

1.2.3 Ventilator tests

Service calibration functions let GE Healthcare trained users and GE Healthcare service personnel perform most ventilator setup functions, tests, calibration, and measurements from the front panel display.

Normal operational tests, calibration, and troubleshooting can be performed on your 9100c ventilator without removing components from the system. Repair may require removing the ventilator components from the anesthesia machine.

WARNING Section 4, "*Service Tests and Service Mode*" must be performed whenever you access any internal component of the ventilator to verify that all critical parts of the ventilator are still operational and within specification.

WARNING After the ventilator has been serviced, you must perform Section 3, "*Checkout Procedure*" to verify the entire Anesthesia System is properly functioning before the system can be returned to clinical use.

1.3 Overview

The 9100c anesthesia machine is a compact, integrated and intuitive anesthesia delivery system. The ventilator portion provides mechanical ventilation to a patient during surgery as well as monitoring and displaying various patient parameters.

The system uses a microprocessor-controlled ventilator with internal monitors, electronic PEEP, Volume Control Mode, Pressure Control Mode, and other optional features.

Note Configurations available for this product depend on local market and standards requirements. Illustrations in this manual may not represent all configurations of the product. The 9100c product is not suitable for use in an MRI environment.

1.4 Configuration options

1.4.1 Standard configuration

The standard configuration includes the following items:

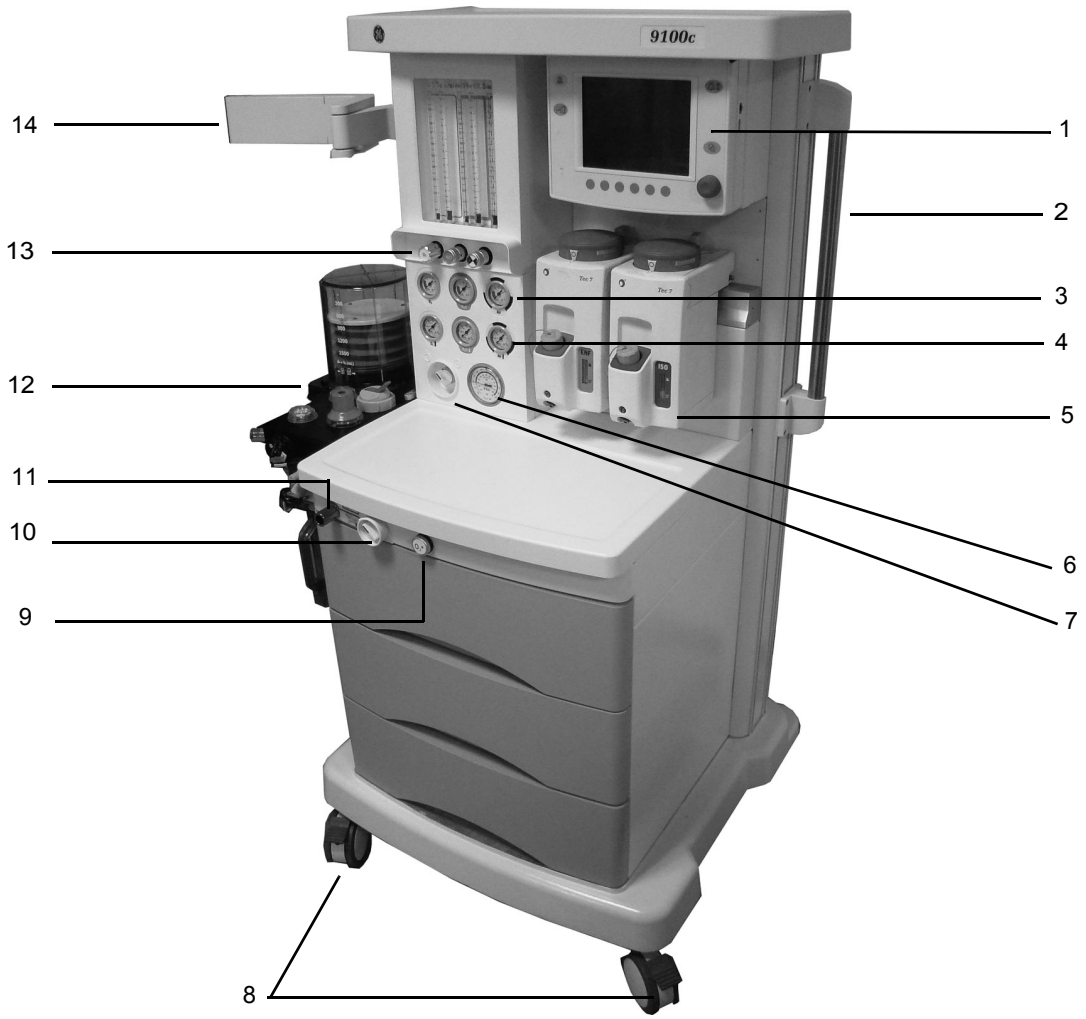
- Ventilator
- Breathing system
- Three large drawers
- Vaporizer manifold (2 Vaporizer mounts)

1.4.2 Options

Options include the following items:

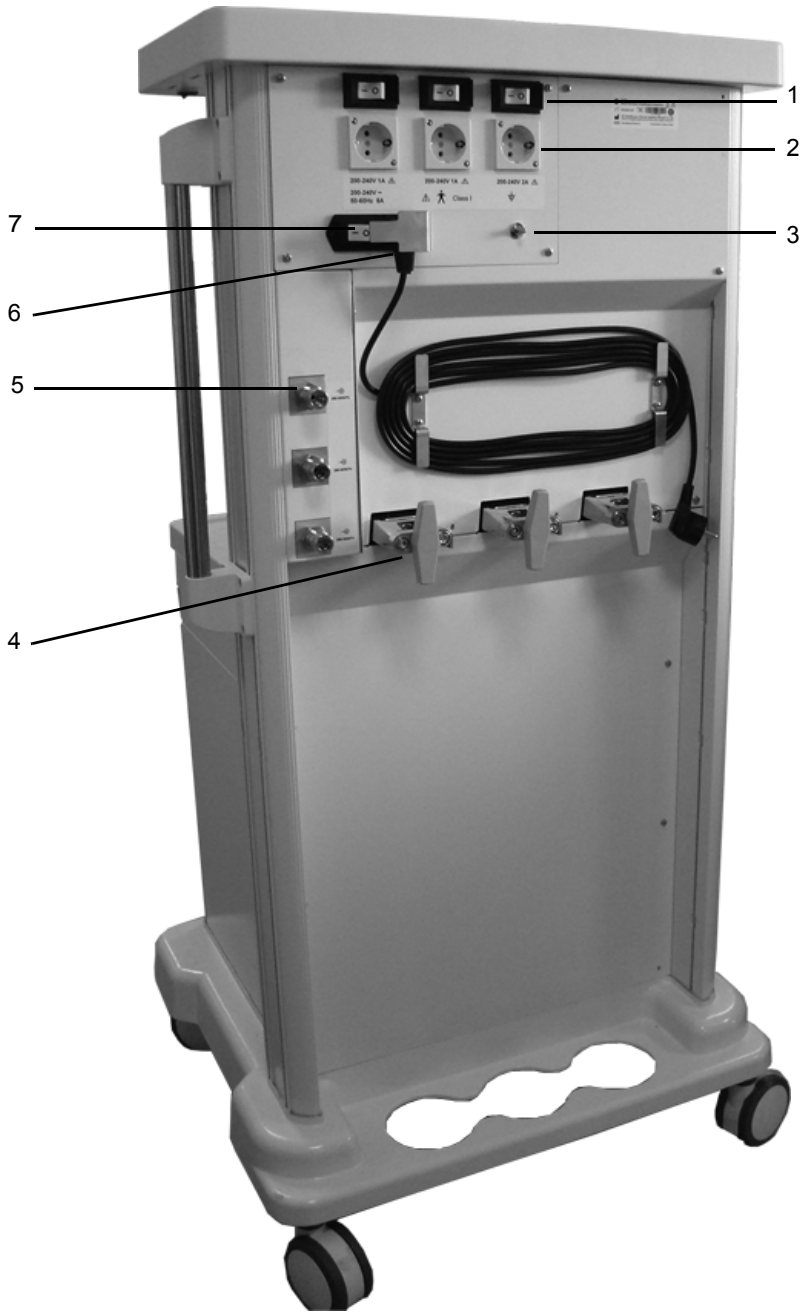
- Selected software features
- O_2 monitoring
- Auxiliary Common Gas Outlet (ACGO)
- Pipeline configurations (O_2/N_2O, O_2/Air or O_2/N_2O/Air)
- Gas cylinder configurations (O_2, O_2/N_2O, O_2/Air, O_2/O_2, $O_2/O_2/N_2O$, O_2/O_2/Air, O_2/N_2O/Air)
- EZchange Canister (CO_2 Bypass)
- Gas scavenging (active, adjustable or passive)
- Localized isolated electrical power outlets
- Mounting arm

1.5 System components



1. Ventilator display
2. Handle
3. Pipeline pressure gauge(s) (upper row)
4. Cylinder pressure gauge(s) (lower row)
5. Vaporizer
6. Paw pressure gauge
7. System switch
8. Caster with brake
9. O_2 flush button
10. ACGO switch (option)
11. ACGO (option)
12. Breathing system
13. Flow controls
14. Mounting arm (option)

Figure 1-1 • Front View



1. Outlet circuit breaker (option)
2. Electrical outlet (option)
3. Equipotential stud
4. Cylinder inlet (option)
5. Pipeline inlet
6. Mains supply inlet
7. System circuit breaker

Figure 1-2 • Rear view

1.6 Symbols used in the manual or on the equipment

Symbols replace words on the equipment, on the display, or in GE Healthcare manuals. No one device or manual uses all the symbols.

Warnings and Cautions tell you about dangerous conditions that can occur if you do not follow all instructions in this manual:

- Warnings tell about a condition that can cause injury to the operator or the patient.
- Cautions tell about a condition that can cause damage to the equipment.

Read and follow all warnings and cautions.

	On (power)		Off (power)
	On (system on)	O_2+	O_2 flush button
	Off (system standby)		ACGO
	AC on and battery charging		Battery on
	Dangerous voltage		Type B equipment
	Direct current		Frame or chassis ground
	Caution, consult accompanying documents		Alternating current
	Consult instructions for use		Attention, refer to product instructions, IEC 60601-1
	Pneumatic inlet	EXHAUST	Exhaust
SN	Serial number	REF	Stock number
	Equipotential		Lamp, lighting, illumination


Protective earth ground


Earth ground


Variability

Max

Plus, positive polarity

Minus, negative polarity

Bag position/manual ventilation


Mechanical ventilation


Inspiratory flow


Expiratory flow


Movement in one direction


Movement in two directions


Lock

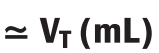

Unlock


Isolation transformer


Low pressure leak test

Autoclavable

Not autoclavable



Bellows volumes are approximate

O_2 cell connection

APL settings are approximate

Anesthetic Gas Scavenging System


Pinch hazard


Read to top of float

EZchange Canister (CO_2 bypass)

Caution: federal law prohibits dispensing without prescription


Alarm silence touch key


Menu touch key

End case touch key

Alarm limit setup key

USB port

Cylinder

Systems with this mark agree with the European Council Directive (93/42/EEC) for Medical Devices when they are used as specified in their User's Reference manuals. The xxxx is the certification number of the Notified Body used by GE Healthcare's Quality Systems.

Authorized representative in the European Community

Manufacturer name and address

Date of manufacture

Indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of equipment.

GOST R Russian certification

This way up

Positive pressure of flow sensor

Pneumatic Output

Negative pressure of flow sensor

2 Theory of Operation

In this section

2.1 Theory overview

This section describes:

- The flow of gas through the anesthesia machine.
- The flow of gas through the breathing system.
- Electrical signals between the anesthesia machine, including the breathing system, and the ventilator.
- Ventilator mechanical subsystems.

2.2 Gas flow through the anesthesia machine

2.2.1 Overview

Refer to Figure 2-1.

Gas Supplies

Gas comes into the system through a pipeline or cylinder connection. All connections have indexed fittings, filters, and check valves (one-way valves). Gauges show the cylinder and pipeline pressures.

A regulator decreases the cylinder pressures to the appropriate system pressure. A pressure relief valve helps protect the system from high pressures.

To help prevent problems with the gas supplies:

- Install yoke plugs on all empty cylinder connections.
- When a pipeline supply is adequate, keep the cylinder valve closed.

O_2 Flow

Pipeline or regulated cylinder pressure supplies O_2 directly to the ventilator (O_2 Ventilator). A secondary regulator decreases the pressure for the flush valve.

The flush valve supplies high flows of O_2 to the common gas outlet when you push the flush button. The flush switch uses pressure changes to monitor the position of the flush valve.

A secondary regulator supplies a constant O_2 pressure to the flow control valve.

An electrical switch monitors the O_2 supply pressure. If the pressure is too low, an alarm appears on the ventilator display.

Air and N_2O Flow

A balance regulator controls the flow of N_2O to the flow control valve. Oxygen pressure at a control port adjusts the output of the regulator. This stops flow during an O_2 supply failure and ensures that the hypoxic gas pressures decrease with the O_2 supply pressure. Changes in O_2 pressure do not affect Air.

A gear link system on the N_2O and O_2 flow controls helps keep the O_2 concentration higher than approximately 21% at the common gas outlet.

Pipeline or regulated cylinder pressure directly supply Air to the ventilator (Air Ventilators). A secondary regulator supplies the air flow control valve. Because there is no balance regulator, air flow continues at the set rate during an O_2 supply failure.

Mixed Gas

The mixed gas goes from the flowmeter outlet, through the vaporizer manifold and vaporizer that is ON, to the common gas outlet, and into the breathing system. A pressure relief valve limits the maximum outlet pressure.

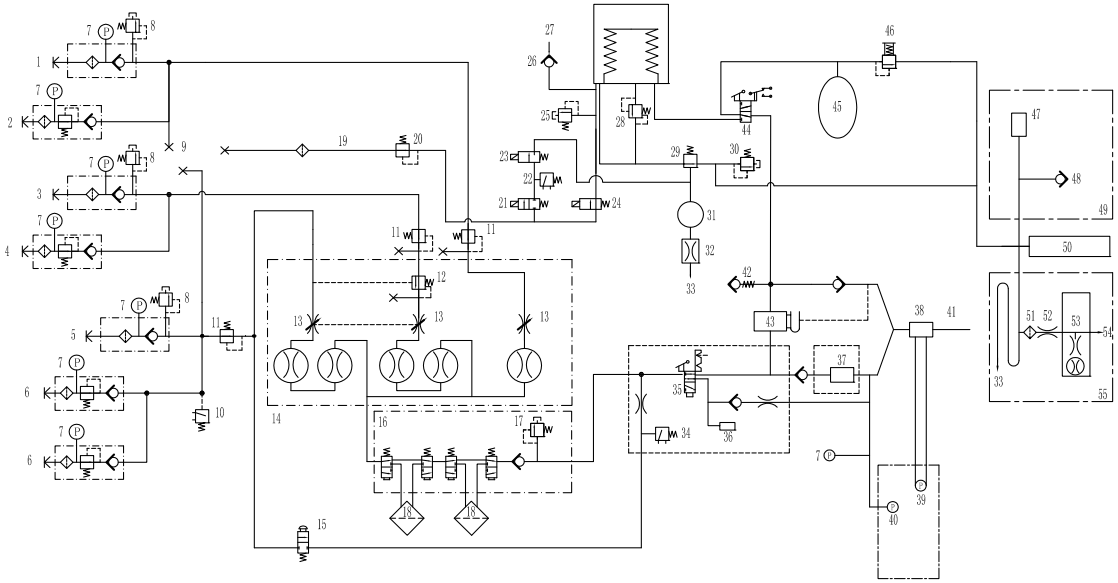


Figure 2-1 • Pneumatic diagram

Key to Numbered Components

1. Air pipeline inlet
2. Air cylinder inlet (optional)
3. N_2O pipeline inlet
4. N_2O cylinder inlet (optional)
5. O_2 pipeline inlet
6. O_2 cylinder inlet (optional)
7. Pressure gauge
8. Safe pressure relief valve
9. Ventilator drive gas select
10. O_2 supply switch
11. Regulator
12. N_2O balance regulator
13. Gas throttles
14. Flowmeter module
15. O_2 flush
16. Vaporizer manifold
17. 37.9 kPa relief valve
18. Vaporizer
19. 0-120 L/min flow
20. Regulator
21. PEEP safety valve
22. Pressure sense switch
23. PEEP control valve
24. Inspiratory flow valve
25. Mechanical overpressure relief
26. Free breathing check valve
27. Atmosphere
28. Pop-off valve
29. Exhalation valve
30. Scavenging pressure relief valve
31. Reservoir 200 mL
32. Bleed resistor
33. Room air
34. Pressure switch
35. ACGO select valve
36. ACGO port
37. O_2 sensor
38. Flow sensor
39. Flow transducer
40. Paw sensor
41. Patient lung
42. Negative pressure relief valve
43. Absorber canister
44. BTV switch
45. Bag
46. APL valve
47. 30mm-connect scavenging system
48. 0.05 kPa inlet
49. Passive AGSS interface
50. Scavenging base
51. Filter
52. High or low restrictor
53. Flow indicator
54. To disposal system
55. Active AGSS interface

2.2.2 Physical connections

Figure 2-2 shows the physical path that the gas takes.

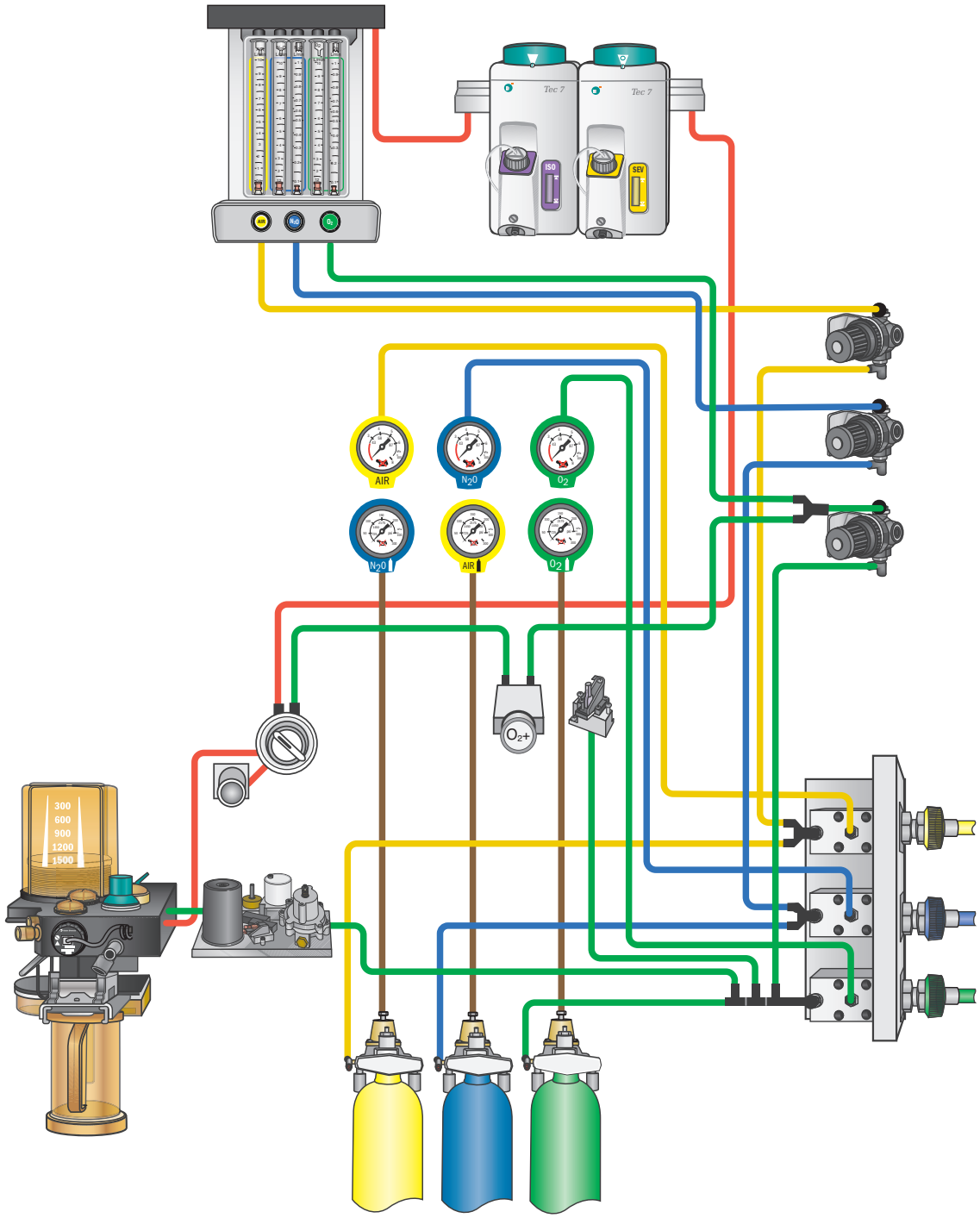


Figure 2-2 • Typical tubing connections - pictorial

2.2.3 Flow control

Needle valves (one for each gas) adjust gas flow. Clockwise rotation decreases flow. Counterclockwise increases flow. A hypoxic guard system sets the maximum ratio of N_2O to O_2.

WARNING The hypoxic guard sets a minimum O_2 concentration in the common gas stream.

Hypoxic guard system

The hypoxic guard is an internal system that is not serviceable. It helps control an approximate minimum 1 to 3 ratio of flow between O_2 and N_2O. When engaged, the O_2 and N_2O knobs turn together:

- An increase in N_2O flow causes an increase in O_2 flow.
- A decrease in O_2 flow causes a decrease in N_2O flow.

Higher concentrations of O_2 are possible when the hypoxic guard is not engaged: either by reducing the N_2O flow below the point of engagement or by increasing O_2 flow above the point of engagement.

When the N_2O flow is below the point of engagement, increasing the N_2O flow turns the O_2 sprocket without changing the O_2 flow. Once the guard is engaged, turning the N_2O flow control counterclockwise (increase in N_2O flow) also turns the O_2 knob counterclockwise (increase in O_2 flow) to maintain a nominal 25% minimum O_2 concentration.

Decreasing the N_2O flow from the engagement point rotates the O_2 sprocket away on the O_2 knob, increasing the O_2 concentration.

2.3 Flow through the breathing system

2.3.1 Overview of flow paths

This section looks at three types of flow paths.

- **Ventilation paths:** How gas flows from the drive source (bag or bellows) to and from the patient.
- **Fresh gas paths:** Common gas can flow from the machine interface directly to the patient through the inspiratory check valve, or through the absorber into the expiratory flow.
- **Scavenged gas paths:** APL or pop-off valve.
- **Flow through the optional EZchange Canister:** EZchange ON and EZchange OFF (CO_2 bypass).

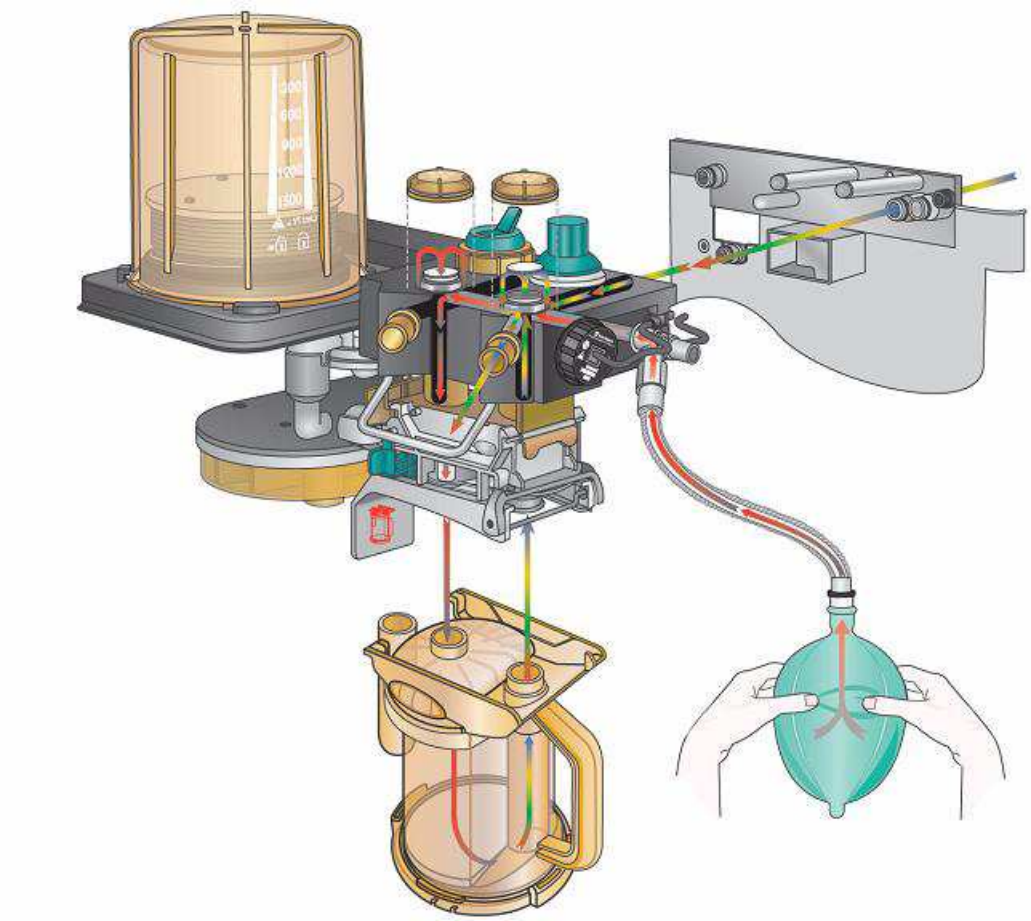
2.3.2 Manual ventilation

Manual inspiration

The Bag/Vent switch on the breathing system closes the ventilator path.

Gas flows from the bag into the breathing circuit module, through the absorber, and through a unidirectional valve (inspiratory check valve) to the patient.

During inspiration, common gas flows from the machine into the inspiratory limb, upstream of the inspiratory check valve.

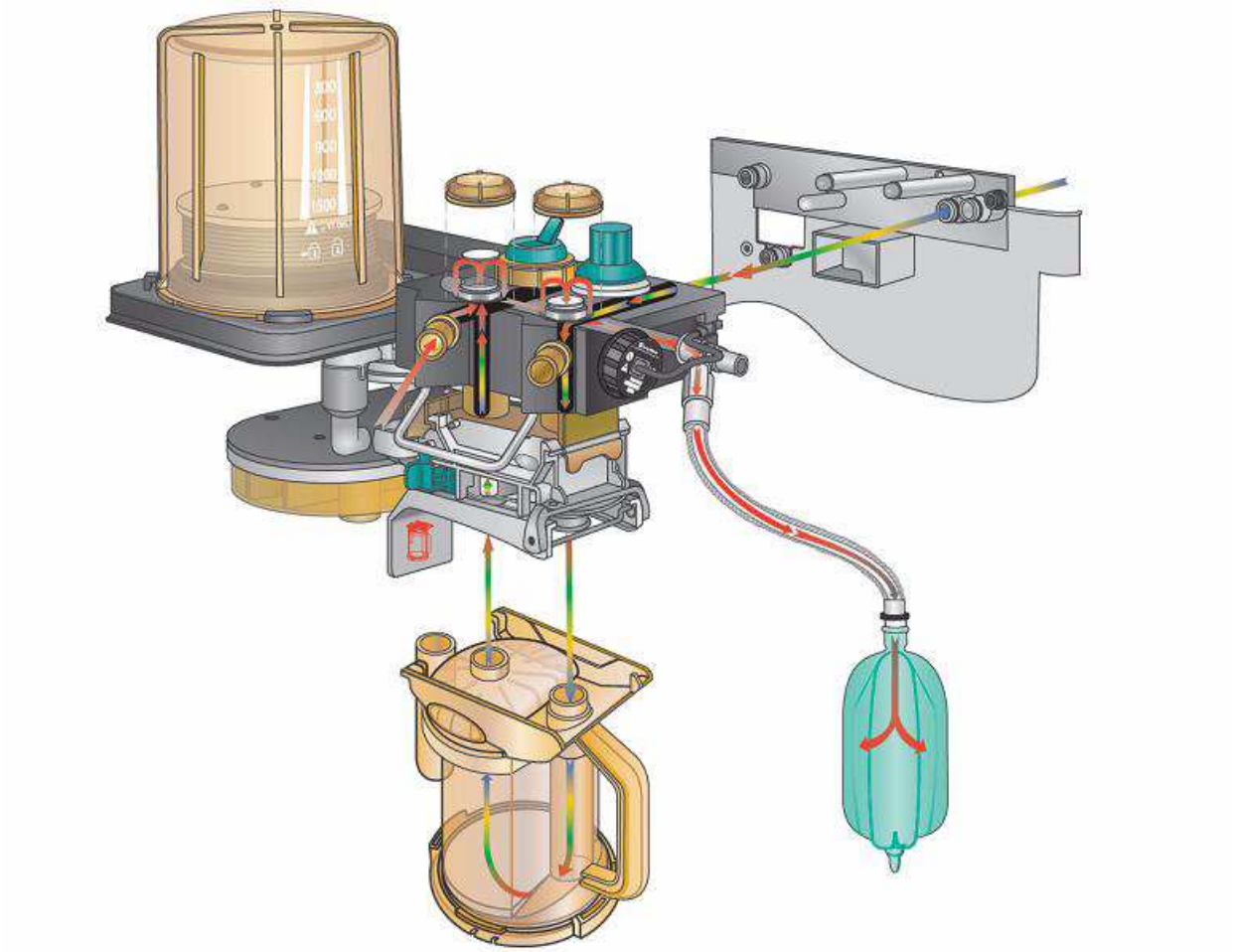


Manual expiration

The Bag/Vent switch keeps the ventilator path closed.

Gas flows from the patient, through a unidirectional valve (expiratory check valve), and into the bag.

During exhalation, common gas flows backwards through the absorber into the expiratory limb, downstream of the expiration check valve.



APL Valve

The APL valve sets a pressure limit for manual ventilation.

As you turn the APL knob, it puts more or less force on the APL disc and seat. As circuit pressure approaches the pressure placed on the APL disc, any additional pressure will cause the disc to lift and gas vents to the scavenging system.

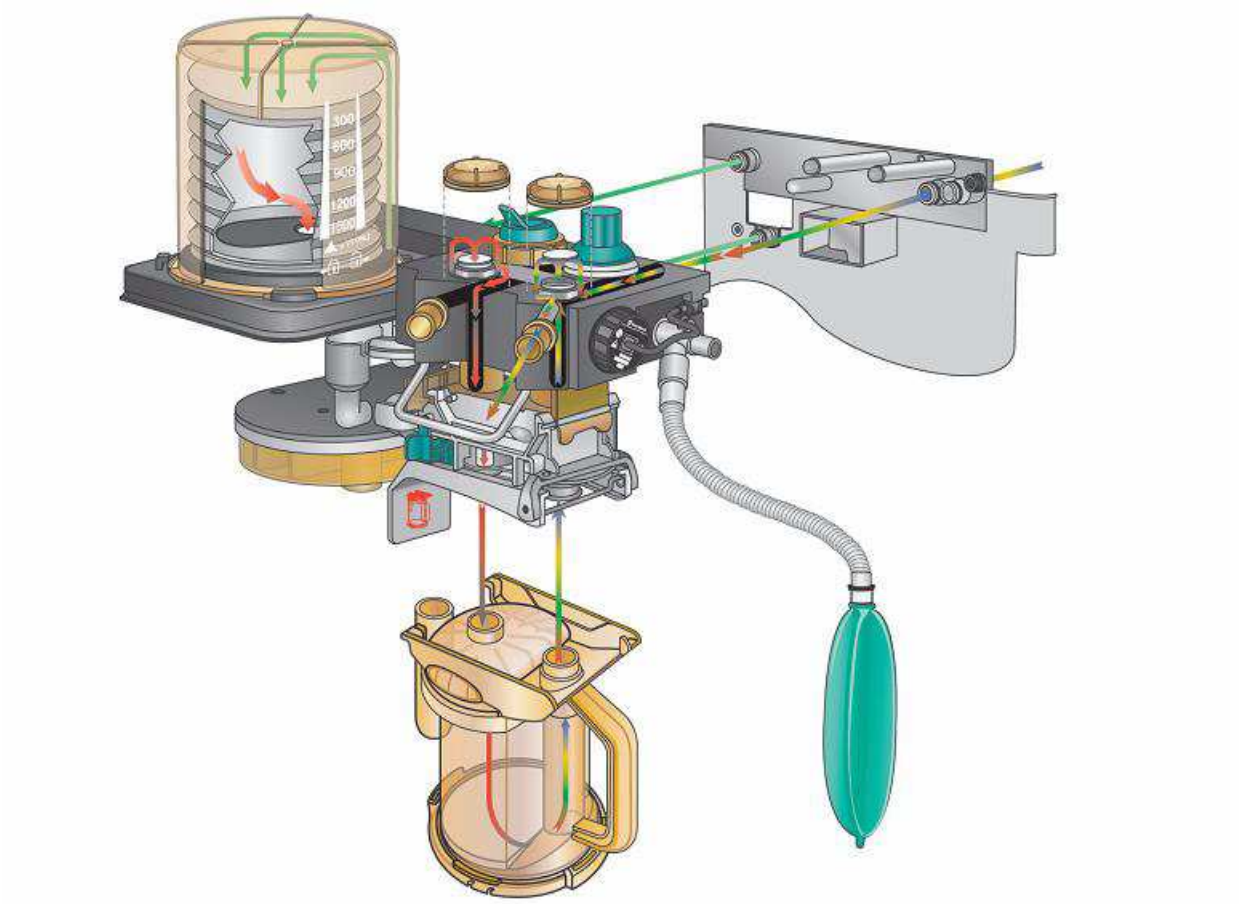
2.3.3 Mechanical ventilation

Mechanical inspiration

The Bag/Vent switch closes the manual path. Pilot pressure closes the exhalation valve.

Drive gas pushes down on the bellows. Gas flows from inside the corrugated bellows, through the absorber where the CO_2 is removed, through a unidirectional valve (inspiratory check valve) to the patient.

During inspiration, common gas flows into the inspiratory limb, upstream of the inspiratory check valve.

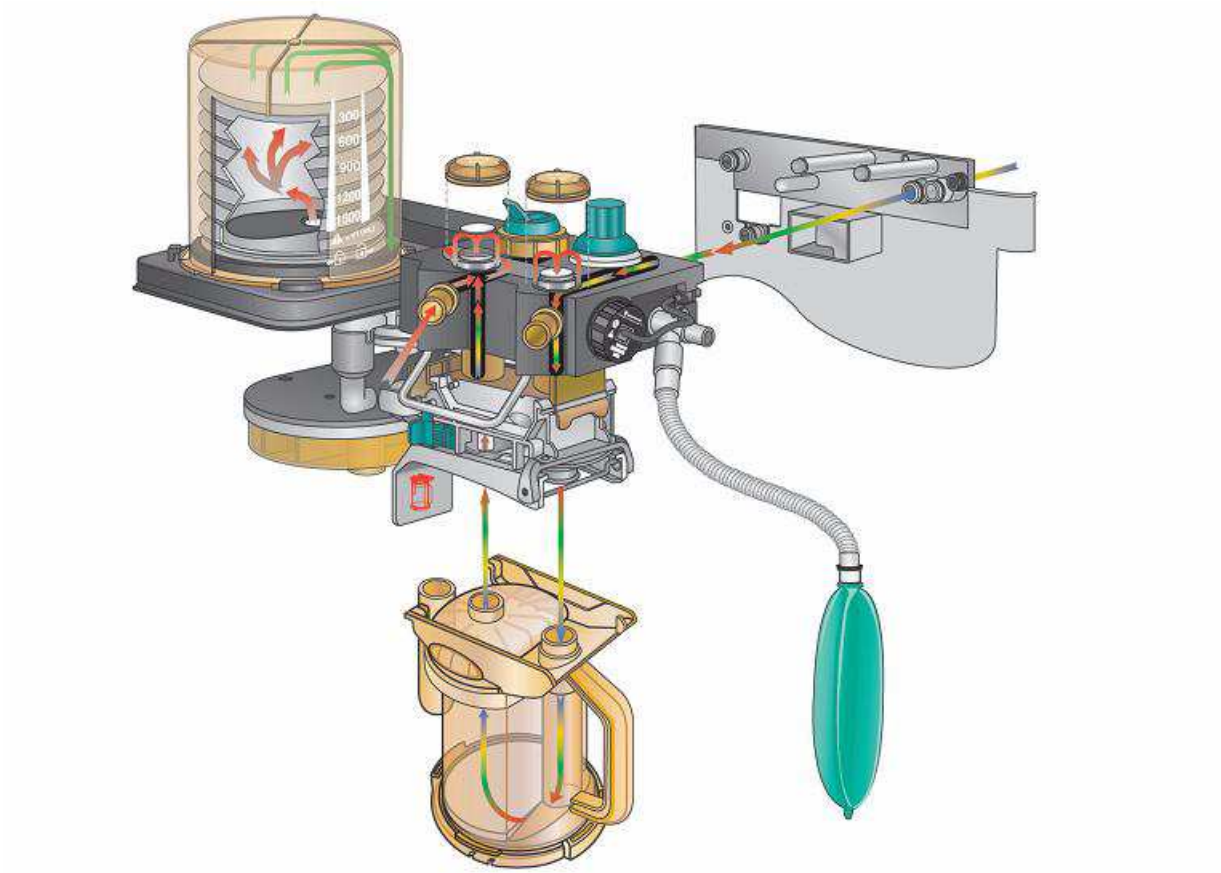


Mechanical expiration

Drive gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient, through a unidirectional valve (expiratory check valve) and into the bellows. Residual drive gas flows out of the bellows to the scavenging system.

If PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level.

During exhalation, common gas flows backwards through the absorber into the expiratory limb, downstream of the expiratory check valve.



Mechanical inspiration (EZchange ON)

The Bag/Vent switch closes the manual path. Pilot pressure closes the exhalation valve.

Drive gas pushes down on the bellows. Gas flows from the bellows, through the absorber, the EZchange, and through a unidirectional valve (inspiratory check valve) to the patient.

During inspiration, common gas flow into the inspiratory limb, upstream of the inspiratory check valve.

Mechanical expiration (EZchange ON)

Drive gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient, through a unidirectional valve (expiratory check valve) and into the bellows. Residual drive gas flows out of the bellows to the scavenging system.

If PEEP is selected, static pressure on the pilot of the exhalation valve sets the PEEP level.

During exhalation, common gas flow backwards through the EZchange and absorber into the expiratory limb, downstream of the expiratory check valve.

Mechanical inspiration (EZchange OFF)

The Bag/Vent switch closes the manual path. Pilot pressure closes the exhalation valve.

Drive gas pushed down on the bellows. Gas flows from the bellows, through the EZchange module bypassing the absorber, and through a unidirectional valve (inspiratory check valve) to the patient.

During inspiration, common gas flows into the inspiratory limb, upstream of the inspiratory check valve.

Mechanical expiration (EZchange OFF)

Drive gas flow stops and the exhalation valve opens. Exhaled gas flows from the patient, through a unidirectional valve (expiratory check valve) and into the bellows. Residual drive gas flows out of the bellows to the scavenging system.

If PEEP is selected, static pressure on the pilot port of the exhalation valve sets the PEEP level.

During exhalation, common gas flows backwards through the EZchange module bypassing the absorber and into the expiratory limb, downstream of the expiratory check valve.

Pop-off Valve

The pop-off valve limits the pressure inside the bellows to 2.5 cm H_2O above the drive gas pressure. This normally occurs when the bellows reaches the top of the housing at the end of the exhalation.

Excess gas vents to the scavenging system through the pop-off valve and the exhalation valve.

2.4 General Description

The 9100c ventilator is a microprocessor based, electronically-controlled, pneumatically-driven ventilator with built-in monitoring systems for airway pressure and exhaled volume. The ventilator is designed to be used as a medical device assisting in the delivery of anesthesia and is part of the 9100c Anesthesia Machine.

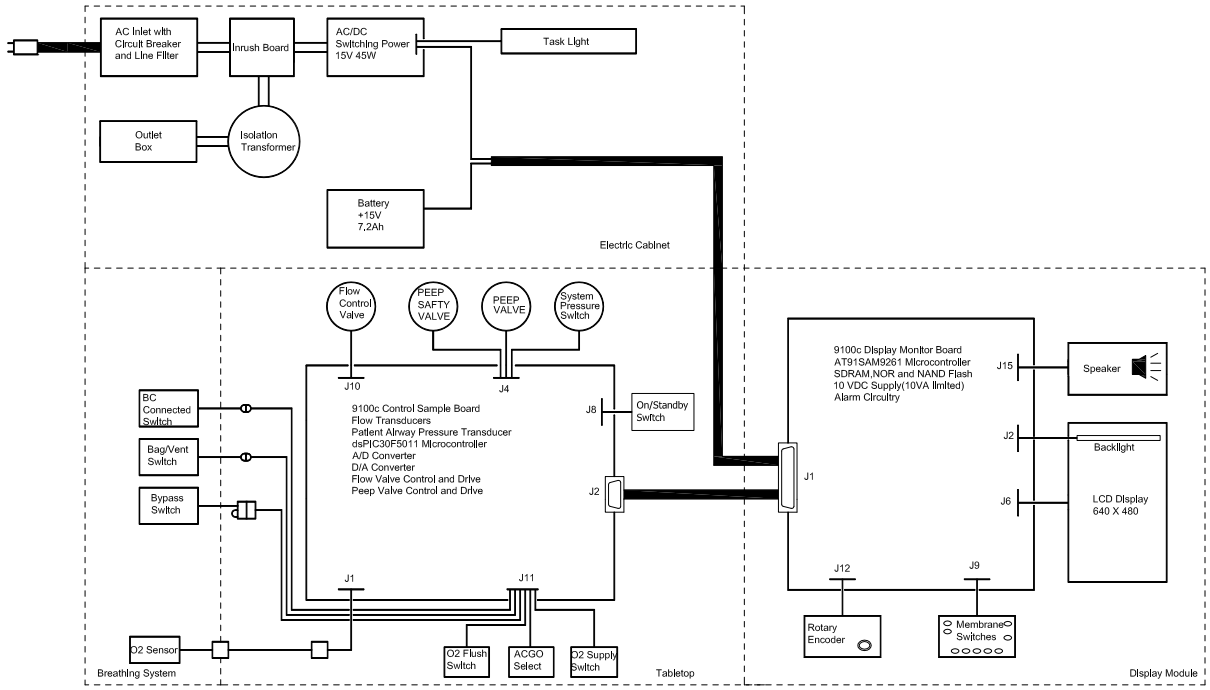


Figure 2-3 • 9100c Ventilator functional block diagram

2.5 9100c Ventilator features

- Sensors in the breathing circuit are used to control and monitor patient ventilation and measure inspired oxygen concentration. This lets the ventilator compensate for compression losses, fresh gas contribution, valve and regulator drift and small leakages in the breathing absorber, bellows and system.
- Positive End Expiratory Pressure (PEEP) is generated electronically. PEEP is not active when mechanical ventilation is off.
- User settings and microprocessor calculations control breathing patterns. User interface settings are kept in non-volatile memory.
- Mechanical ventilation is started with the Bag/Vent switch on the breathing system.
- The 9100c ventilator has minimum monitoring and alarms managed on the ventilator panel (there is no other display for safety relevant alarm management, etc.).
- Ventilator hardware is regularly monitored by software tests.
- An exhalation valve modulates flow in the pressure control mode.
- Pressure and volume control modes are selectable by the operator.
- Exhausted drive gas and bellows pressure relief valve gases are mixed and go through the ventilator exhalation valve.
- The exhalation valve block is autoclavable.
- Excess fresh gas released from the bellows and ventilator drive gas are transferred from the exhalation valve to the Anesthesia Gas Scavenging System (AGSS).
- Optimized for service with a low number of components.

2.5.1 Safety features

- Airway overpressure protection, linked to the P_{max} setting.
- Volume over-delivery limits and protection
- Proprietary hose connections and fixed manifolds.
- Proven mechanical components used.
- 10 VA electrical power limiting to potential oxygen enriched environment.
- 105 psi burst overpressure protection.

2.6 9100c Ventilator components

Major components of the 9100c ventilator are found in different locations of the anesthesia machine.

The ventilator package consists of:

1. Display Module – The Display Module includes:
   - Display Monitor Board
   - LCD Display
   - Keyboard (with rotary encoder switch)
2. Control Sample Board (under tabletop).
3. Vent Engine (under tabletop).

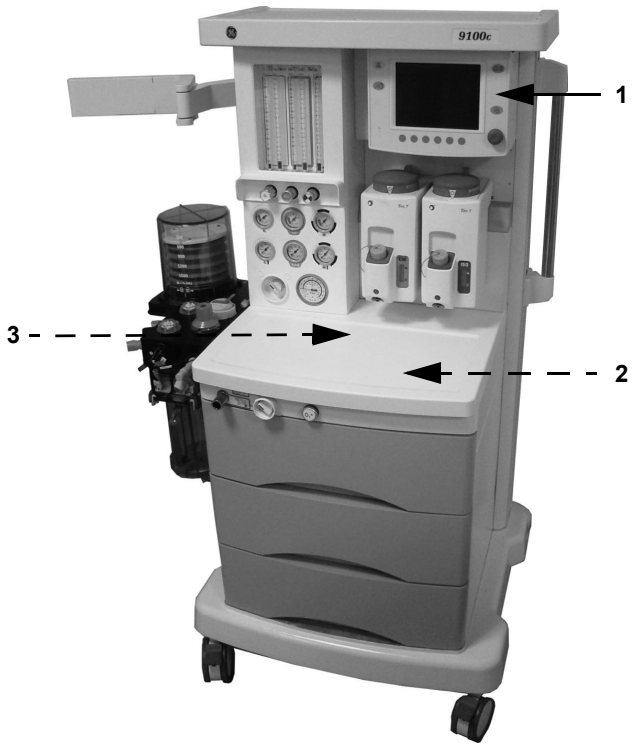


Figure 2-4 • Location of 9100c ventilator components

2.6.1 Display Module

The display module includes:

1. Inverter
2. Display Monitor Board (DMB)
3. Speaker
4. LCD display
5. Keyboard front panel
6. Rotary encoder

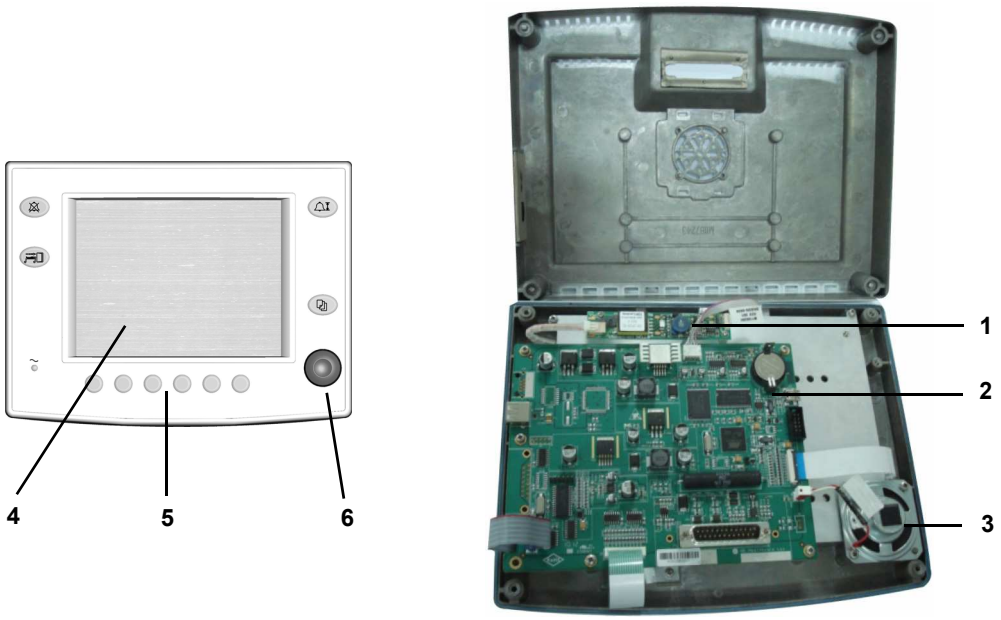
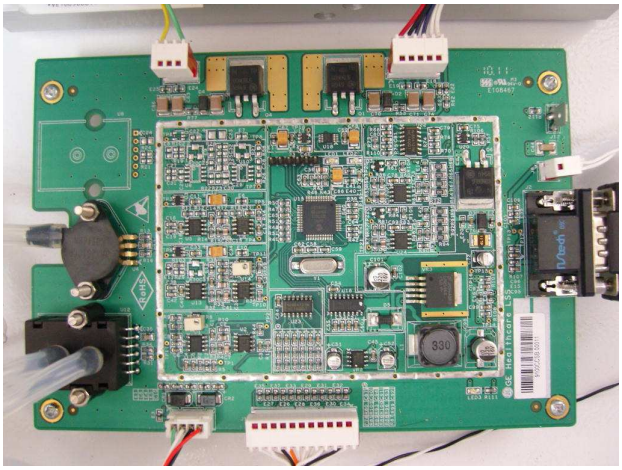


Figure 2-5 • 9100c Display Module

2.6.2 Control Sample Board

The Control Sample Board (CSB) is located underneath the tabletop.



2.6.3 Pneumatic Vent Engine

The pneumatic vent engine is located under the tabletop.

The pneumatic Vent Engine consists of the hardware that drives the ventilator bellows. It includes:

- 2-micron inlet filter
- Pressure regulator
- Inspiratory flow valve
- Mechanical overpressure relief valve
- Free breathing check valve
- PEEP safety valve
- Supply pressure sense switch
- PEEP control valve
- 200 mL reservoir
- Calibrated bleed orifice

2.7 Electronic and electrical components

2.7.1 9100c ventilator functional blocks

The 9100c ventilator electronic/electrical subassemblies or modules includes:

- **System switch** to set the system to On or Standby;
- **Power Supply** for operation under line power and a **backup battery** for limited operation in case of power failure;
- **Control Sample Board** to preprocess patient circuit parameters and to channel the breathing system switch states.
- **Front Panel Assembly** that includes an LCD display for display of all ventilation and monitoring parameters and a **keyboard** for operator input;
- **Display Monitor Board** with digital, and power circuits to manage all operations of the ventilator;

2.7.2 Power supply

The power supply receives AC input from the machine's AC Inlet Module. The power supply is a universal 45 watt switching supply that outputs DC voltage. The DC voltage is routed to the Display Monitor Board where it is further regulated to produce the power requirements for the 9100c ventilator system.

- **Input:**
  90~264 VAC
- **Output:**
  15.0 VDC (±2%) at 0–3 A

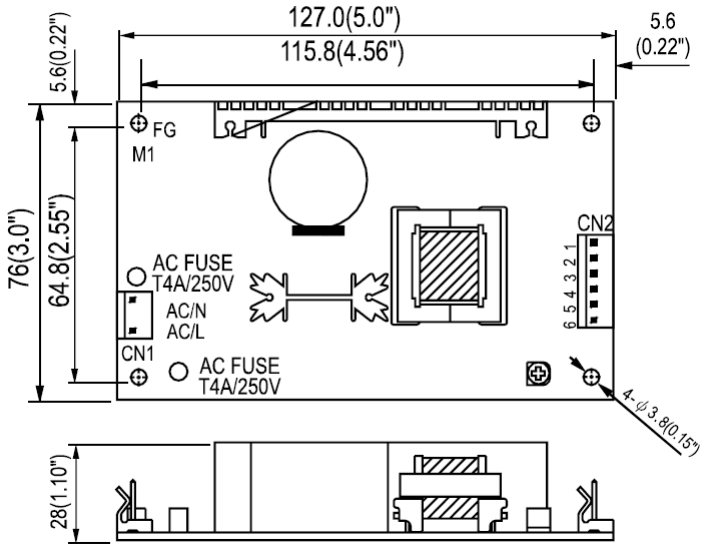


Figure 2-6 • 9100c Ventilator power supply

2.7.3 Sealed Lead Acid Battery

A sealed lead acid battery supplies battery backup for the 9100c ventilator.

The battery provides:

- capacity to operate ventilator system for 30 minutes (fully charged);
- the battery is internally fused (auto-resettable).

Input: Normally 15 VDC at 25 °C during charge.

Output: +0.3 to 2 Amps during discharge.

2.7.4 System switch

The system switch has two positions: On and Standby.

In the Standby position

The switch turns off the ventilator (electrical).

In the On position

The switch turns on the ventilator (electrical).

2.7.5 Control Sample Board

The Control Sample Board (CSB) contains all of the major circuit functions necessary to control ventilator operation.

The Control Sample Board comprises three functional circuit types:

- Power circuits,
- Analog circuits,
- Digital circuits.

The Control Sample Board's functions include:

- Voltage regulation
- Switch interface
- RS232C serial I/O
- Oxygen sensor interface
- Patient airway transducer
- Flow transducer
- Flow valve control
- PEEP valve drive and PEEP safety valve drive

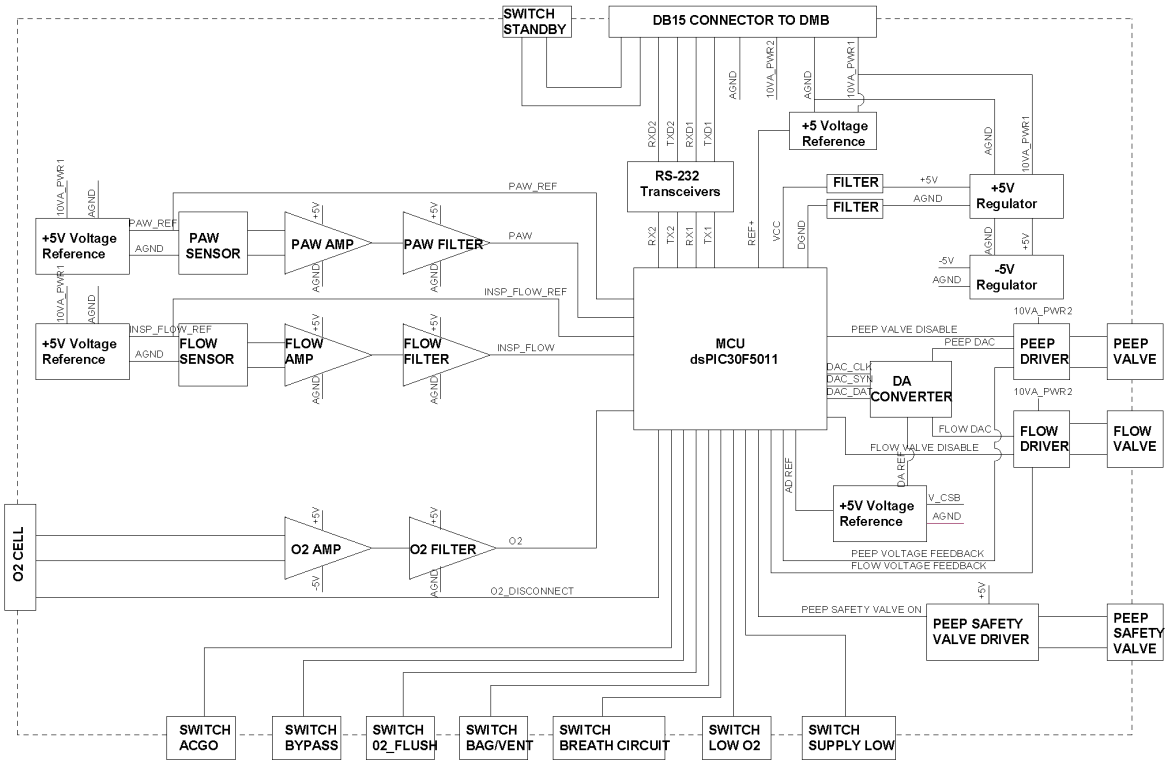


Figure 2-7 • Control Sample Board block diagram

2.7.6 Display Monitor Board

The Display Monitor Board (DMB) provides the power supply to the Control Sample Board (CSB), and the interface to the LCD display. A microprocessor in the DMB is used to communicate with the CSB.

It includes:

- Microprocessor
- Voltage regulators
- RS232C serial I/O
- Clocks and timers for the system
- System On/Standby
- Battery monitor and protect circuits
- Power supply monitor
- System memory
- Front panel interfaces
- Rotary encoder interface
- Inverter interface
- Universal Serial Bus (USB) interface
- Alarm audio circuit

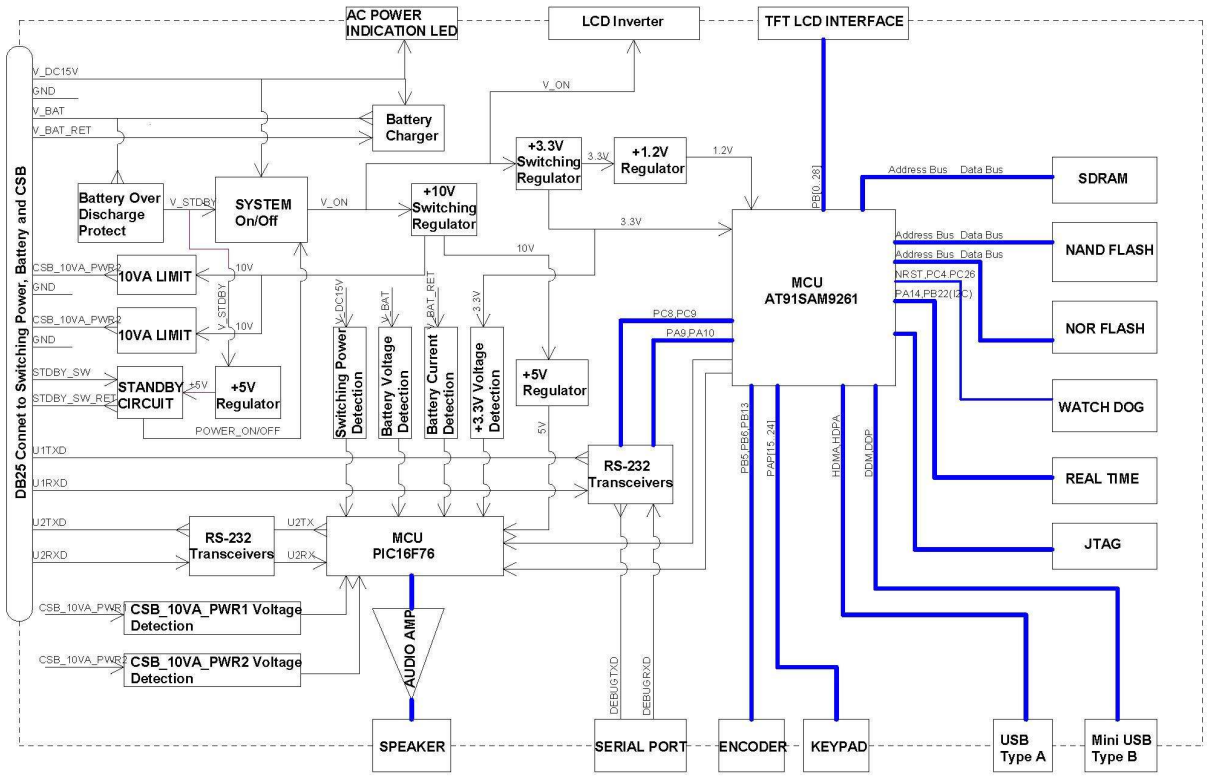


Figure 2-8 • Display Monitor Board block diagram

2.8 Ventilator mechanical subsystems

Refer to Figure 2-1, “*Pneumatic Circuit Diagram*”, in Section 2.2 for the complete pneumatic/ mechanical subsystem.

The mechanical subsystems include:

Pneumatic Vent Engine

1. Supply gas pressure regulator
2. Drive gas inlet filter
3. Inspiratory flow control valve
4. Mechanical Overpressure Valve (MOPV)
5. Free breathing valve
6. Reservoir and bleed resistor
7. PEEP control valve
8. PEEP safety valve
9. Supply pressure switch

Exhalation valve

Bellows assembly

Breathing circuit flow sensor

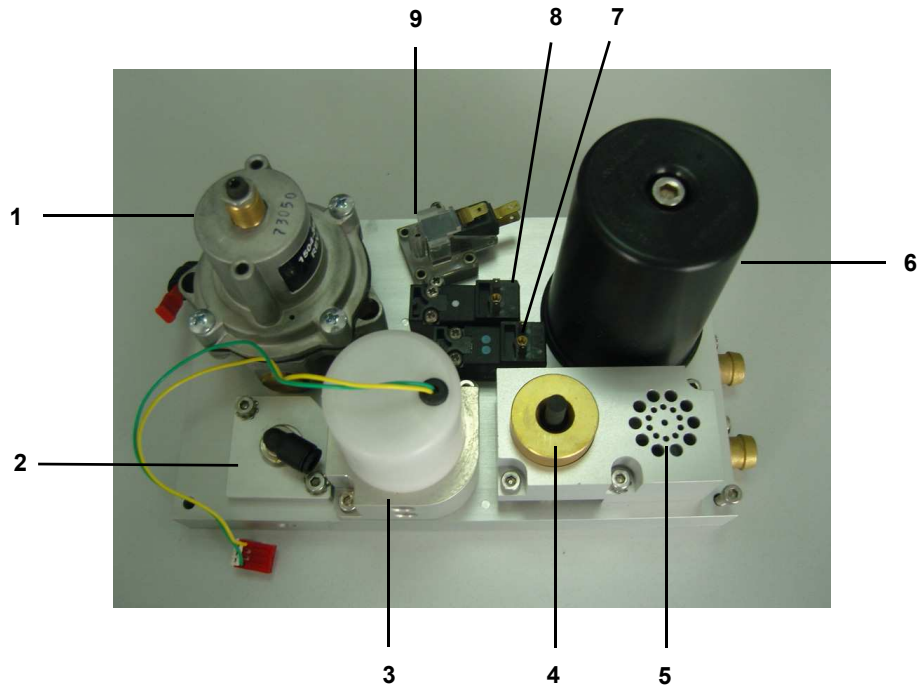


Figure 2-9 • 9100c Vent Engine

2.8.1 Drive gas

Drive gas (O_2) enters the Vent Engine at a pressure of 241 to 690 kPa (35 to 100 psi) through a 2-micron filter (**2**) that is located under the gas inlet fitting.

2.8.2 Pressure Regulator

The pressure regulator (**1**) is a non-relieving pressure regulator that regulates high pressure filtered supply gas down to 172 kPa (25 psi).

2.8.3 Inspiratory flow control valve

The inspiratory flow control valve (**3**) is cycled by the control sample board to supply drive gas to the outer chamber of the bellows assembly at a rate determined by ventilator settings and sensor signals. The control valve modulates the incoming 172 kPa (25 psi) drive gases to an output from 0 to 70 liters per minute at pressures ranging from 0 to 100 cm H_2O.

2.8.4 Exhalation (PEEP) Control

The exhalation valve contains an elastomeric diaphragm that is used to control the pressures in the breathing circuit. The exhalation valve includes one male port on the bottom for:

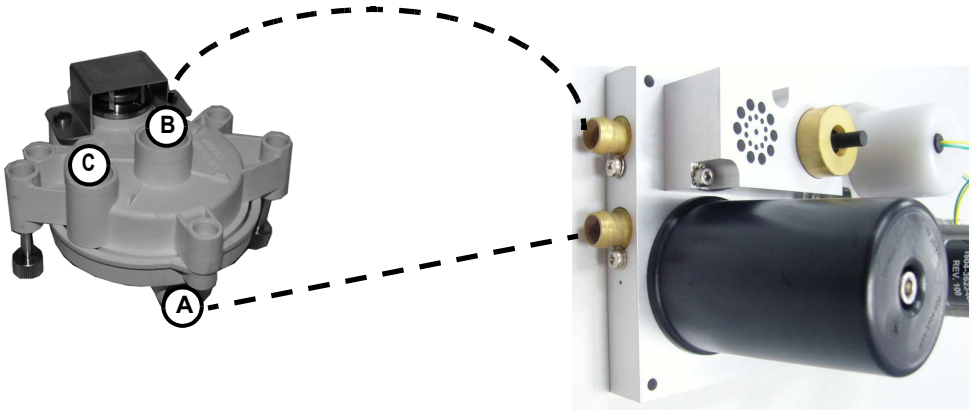
- Exhalation valve pilot (**A**) - (manifold pressure)

The exhalation valve includes two ports on top that connect to the bellows base manifold:

- Bellows drive gas (**B**)
- APL exhaust flow to scavenging (**C**)

A port at the back of the exhalation valve connects to the down tube that directs all the exhaust flows to the scavenging receiver.

The exhalation valve is normally open. When the exhalation port is open, gas flows from the bellows housing to the scavenging port. Approximately 2 cm H_2O of pilot pressure is necessary to close the valve. Pilot control of the exhalation valve is done with PEEP Control Valve (**7**), Supply Pressure Switch (**9**), and the PEEP Safety Valve (**8**).



2.8.5 Reservoir and bleed resistor

The reservoir (**10**) is a 200 mL chamber that dampens the manifold (pilot) pressure pulses to the exhalation valve.

The bleed resistor (**11**) is a “controlled leak” from 0 to 10 L/min in response to circuit pressures from 0 to 100 cm H_2O. The small quantity of pneumatic flow exhausting through the bleed resistor permits control of the exhalation valve's pilot pressure by modulation of the valve output. The bleed resistor exhausts only clean drive gas and must not be connected to a waste gas scavenging circuit. The output is routed away from the electrical components to make sure that systems using oxygen drive gas meet the 10VA limitation requirement for oxygen enrichment.

2.8.6 Bellows pressure relief valve

The Bellows assembly is the interface between drive gas and the patient circuit in the breathing system. The pressure relief valve (or pop-off valve) (**12**) in the bellows assembly limits pressure in the patient circuit. Excess fresh gas is discharged through the exhalation valve into the gas scavenging system.

The pressure relief valve is normally closed, maintaining approximately 1.5 cm H_2O in the breathing circuit in a no flow condition, enough to keep the bellows inflated. It is piloted closed during inspiration and remains closed until the bellows is refilled during exhalation. If the pressure in the patient circuit exceeds 4 cm H_2O, the pop-off valve opens to exhaust excess fresh gas flow at a rate up to 4 L/min.

Figure 2-10 • Bellows pressure relief valve

2.8.7 Mechanical Overpressure Valve

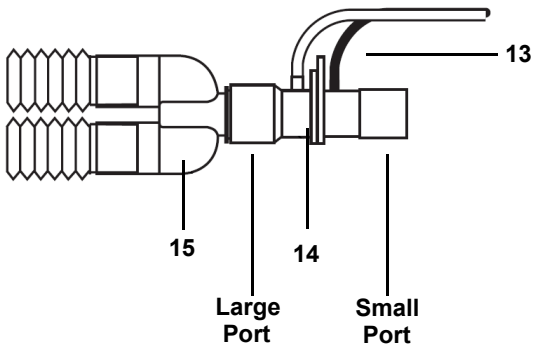
The Mechanical Overpressure Valve (MOPV) is a mechanical valve (**4**) that operates regardless of electrical power. It functions as a third level of redundancy to the ventilator's pressure limit control functions, supplying pressure relief at approximately 110 cm H_2O.

2.8.8 Free Breathing Valve

The free breathing valve (**5**) helps assure the patient can spontaneously breathe. The ventilator is programmed to supply a specified number of breaths per minute to the patient. If, in between one of these programmed cycles, the patient initiates a breath (spontaneous), the free breathing valve permits the patient to inhale. The free breathing valve is closed on mechanical inspiration.

2.8.9 Breathing Circuit Flow Sensor

The flow sensor (**14**) is installed at the patient's Y-piece connector (**15**). The flow sensor measures the expired V_T. When gas flows through the flow sensor, a pressure difference is generated between the two sides of the sensor diaphragm. The pressure difference is measured and interpreted on the control sample board in order to calculated the V_T value. The sensing tubes must be connected correctly to the ports at the side panel of the machine for accurate readings. The tube closest to the patient connection (**13**) must be connected to the port labeled "ΔP+".



3 Checkout Procedure

In this section

WARNING After any repair or service of the 9100c system, complete all tests in this section.

Before you do the tests in this section:

- Complete all necessary calibrations and subassembly tests. Refer to the individual procedures for a list of necessary calibrations.
- Completely reassemble the system.

If a test failure occurs, make appropriate repairs and test for correct operation.

3.1 Ventilator post-service checkout

After servicing the 9100c ventilator, perform the following service mode Calibrations:

- O_2 Cell calibration
- Paw Zero
- Paw Gain
- PEEP Valve
- Flow Zero
- Inspiratory Flow Valve
- Flow Sensor Negative
- Flow Sensor Positive

Then, complete the checkout procedure for the entire machine in the following sections.

3.2 Inspect the system

CAUTION The upper shelf weight limit is 25 kg (55 lb).

WARNING Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

Before testing the system, ensure that:

- The equipment is not damaged.
- Components are correctly attached.
- The breathing circuit is correctly connected, not damaged.
- Pipeline gas supplies are connected.
- Cylinder valves are closed.
- Models with cylinder supplies have a cylinder wrench attached to the system.
- Models with cylinder supplies have a reserve supply of O_2 connected to the machine during system checkout.
- The casters are not loose and the brakes are set and prevent movement.
- The power cord is connected to a wall outlet. The mains indicator comes on when AC Power is connected.

3.3 Pipeline and cylinder tests

CAUTION To prevent damage:

- Open the cylinder valve slowly.
- Do not force the flow controls.

If your system does not use cylinder supplies, do not do steps 3 and 5.

1. Set the system switch to On.
2. Disconnect the pipeline supplies and close all cylinder valves (if equipped). If the pipeline and the cylinder pressure gauges are not at zero, bleed all gases from the system.
   - Connect an O_2 supply.
   - Set the flow controls to mid range.
   - Make sure that all gauges but O_2 are at zero.
   - Disconnect the O_2 supply.
   - Make sure that the O_2 gauge goes to zero. As pressure decreases, alarms for low O_2 supply pressure should occur.
3. Make sure that the cylinder are full:
   - Open each cylinder valve.
   - Make sure that each cylinder has sufficient pressure. If not, close the applicable cylinder valve and install a full cylinder.
4. Set the system switch to Standby.
5. Test one cylinder at a time for high pressure leaks:
   - Turn the flow control knobs fully clockwise to stop gas flow.
   - Open the cylinder.
   - Record the cylinder pressure.
   - Close the cylinder valve.
   - Record the cylinder pressure after one minute. If the pressure decreases more than indicated below, there is a leak.
     — **5000 kPa (725 psi)** for ventilator drive gas.
     — **690 kPa (100 psi)** for non ventilator drive gas.
     Install a new cylinder gasket and do this step again.
   - Repeat step 5 for all cylinders.

WARNING Do not leave gas cylinder valves open if the pipeline supply is in use. Cylinder supplies could be depleted, leaving an insufficient reserve supply in case of pipeline failure.

6. Connect the pipeline supplies one at a time and ensure that the corresponding gauge indicates pipeline pressure.

3.4 Flow control tests

If the system includes O_2 monitoring, complete the flow control tests in Section 3.4.1, “With O_2 monitoring”.

If the system does not include O_2 monitoring, complete the flow control tests in Section 3.4.2, “Without O_2 monitoring”.

3.4.1 With O_2 monitoring

WARNING Nitrous oxide (N_2O) flows through the system during this test. Use a safe and approved procedure to collect and remove it.

1. Set up the gas scavenging system.
   - Attach a patient circuit and plug the patient port.
   - Attach a bag to the bag port (or plug the bag port).
   - Adjust the APL valve to minimum.
2. Connect the pipeline supplies or slowly open the cylinder valves.
3. Turn all flow controls fully clockwise (zero flow).
4. If equipped, set the ACGO selector switch to Breathing System.
5. Set the system switch to On and set the Bag/Vent switch to Bag.
6. Adjust O_2 flow to 0.5 L/min.
7. Confirm that the O_2 sensor measures 21% in room air and 100% in pure O_2. If not, calibrate the O_2 sensor.
8. Set the flow controls to mid range of each flowtube the flowtube.

Note If the system does not include N_2O, skip steps 9 and 10.

9. Check the proportioning system concentration (increasing N_2O flow). Observe the following precautions:
   - Start with all valves at the minimum setting.
   - Adjust only the N_2O flow control.
   - Increase the N_2O flow as specified in the following table and make sure the O_2 concentration is in range.
     Note: Allow the O_2 monitor to stabilize. At the lower flows, the O_2 monitor may take up to 90 seconds to stabilize.
   - If you overshoot a setting, turn the O_2 flow control clockwise until the N_2O flow decreases to the previous setting before continuing the test.

Set the N_2O flow (L/min)	Measured O_2
0.2	21% minimum
1.0	21% to 33%
3.0	21% to 33%
5.0	21% to 33%
9.0	21% to 33%

10. Check the proportioning system concentration (decreasing O_2 flow). Observe the following precautions:
    - Start with the N_2O valve at the maximum setting.
    - Adjust only the O_2 flow control.
    - Decrease the O_2 flow as specified in the table and make sure the O_2 concentration is in the allowed range.
      Note: Allow the O_2 monitor to stabilize. At the lower flows, the O_2 monitor may take up to 90 seconds to stabilize.
    - If you overshoot a setting, turn the N_2O flow control counterclockwise until the O_2 flow increases to the previous setting before continuing the test.

Set the O_2 flow (L/min)	Measured O_2
5.0	21% to 33%
3.0	21% to 33%
1.0	21% to 33%
0.2	21% minimum

3.4.2 Without O_2 monitoring

WARNING The following procedure will test for any significant malfunction of the Link system but it will not confirm proper calibration.

Nitrous oxide (N_2O) flows through the system during this test. Use a safe and approved procedure to collect and remove it.

1. Set up the gas scavenging system.
   - Attach a patient circuit and plug the patient port.
   - Attach a bag to the bag port (or plug the bag port).
   - Adjust the APL valve to minimum.
2. Connect the pipeline supplies or slowly open the cylinder valves.
3. Turn all flow controls full clockwise (zero flow).
4. If equipped, set the ACGO selector switch to Breathing System.

5. Turn on the system.
6. Set the system switch to On and set the Bag/Vent switch to Bag.
7. Set the flow controls to mid range of each flowtube.

Note If the system does not include N_2O, skip steps 8 and 9.

8. Check the proportioning system concentration (increasing N_2O flow). Observe the following precautions:
   - Start with all valves at the zero setting.
   - Adjust only the N_2O flow control.
   - Increase the N_2O flow as specified in the following table and make sure the O_2 flow is as specified.
   - If you overshoot a setting, turn the O_2 flow control clockwise until the N_2O flow decreases to the previous setting before continuing the test.

Set the N_2O flow (L/min)	The O_2 flow must be greater than (L/min)
0.8	0.2
2	0.5
4	1.0
10	2.5

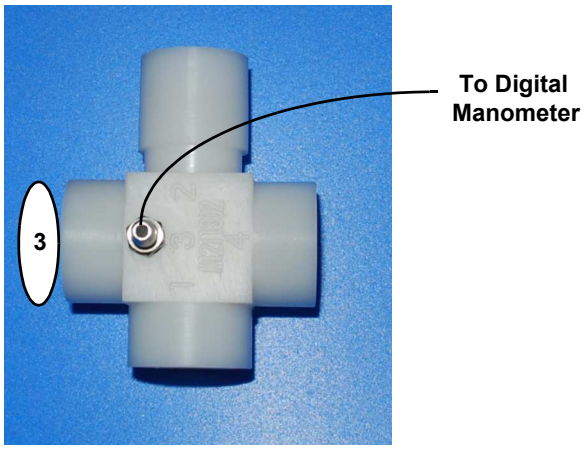
9. Check the proportioning system concentration (decreasing O_2 flow). Observe the following precautions:
   - Set the N_2O flow to 9.0 L/min.
   - Set the O_2 flow to 3.0 L/min or higher.
   - While reducing the O_2 flow, set the N_2O flow to the rates shown in the table. The O_2 flow must be greater than the minimum limits.
   - If you overshoot a setting, turn the N_2O flow control counterclockwise until the O_2 flow increases to the previous setting before continuing the test.

Set the N_2O flow (using the O_2 flow control) to (L/min)	The O_2 flow must be greater than (L/min)
8.0	2.0
4.0	1.0
0.8	0.2

3.5 Pressure relief test

To check the pressure relief valve (vaporizer manifold outlet).

1. Turn all flow controls fully clockwise (zero flow).
2. Remove the breathing system (refer to Section 9.12).
3. Set the ACGO selector switch to the breathing system, if equipped.
4. Connect the test adapter port **3** to the common gas outlet.
5. Connect the tubing from test adapter to a digital manometer.



6. Adjust the O_2 flow to 0.5 L/min.
7. Verify that the test device reading stabilizes within the following range:
   31- 60 kPa, 230- 450 mm Hg, 4.5- 8.5 psi.
   Note: Hold the test adapter to the common gas outlet to avoid loosening.
8. Remove the test device and the adapter.
9. Replace the breathing system.

3.6 O_2 supply alarm test

1. Set the system to On.
2. Set all flow controls to 3 L/min.
3. Disconnect the O_2 pipeline supply or close the cylinder valve.
4. Make sure that:
   - The “No O_2 Pressure” alarm occurs.
   - The N_2O (if equipped) and O_2 flows stop. The O_2 flow stops last.
   - Air (if equipped) flow continues.
   - The “No drive gas” alarm occurs as well on the ventilator if the ventilator uses O_2 as the drive gas.
5. Turn all of the flow controls fully clockwise (zero flow).
6. Reconnect the O_2 pipeline supply.

3.7 Flush flow test

1. Set the Bag/Vent switch to Vent.
2. Attach a patient circuit and plug the patient port.
3. If equipped, set the ACGO selector switch to Breathing System.
4. Ensure that the bellows is completely collapsed.
5. Measure the amount of time it takes to fill the bellows when the O_2 flush button is fully and continuously depressed.
6. Repeat the above measurement two more times (deflate bellows by removing the plug from the patient port).
7. The bellows should fill in approximately 3.0 seconds.

Possible Cause of Failure

- Large leak (if long filling time).
- The output of the pressure regulator is incorrect.
- The pressure regulator is incorrectly connected.

3.8 Vaporizer back pressure test

WARNING Anesthetic agent vapor comes out of the common gas outlet during this test. Use a safe, approved procedure to remove and collect the agent.

1. Set up the gas scavenging system.
   - Attach a patient circuit and plug the patient port.
   - Attach a bag to the bag port (or plug the bag port).
   - Adjust the APL valve to minimum.
2. If equipped, set the ACGO selector switch to Breathing System.
3. Set the Bag/Vent switch to Bag.
4. Set the system switch to On.
5. Set the O_2 flow to 6 L/min.
6. Make sure that the O_2 flow stays constant and the float moves freely.
7. Adjust the vaporizer concentration for each step from 0 to 1%. The O_2 flow must not decrease more than 1 L/min through the full range. If the O_2 flow decreases more than 1 L/min:
   - Install a different vaporizer and try this step again.
   - If the O_2 flow decreases less than 1 L/min with a different vaporizer, the malfunction is in the first vaporizer.
   - If the O_2 flow also decreases more than 1 L/min with a different vaporizer, the malfunction is probably in the 9100c system. Do not use the system until it is serviced (repair vaporizer manifold port valve).
8. Complete steps 5 through 7 for each vaporizer and vaporizer position.
9. Set the system switch to Standby.
10. Turn all of the flow controls fully clockwise (closed).

3.9 Low-pressure leak test

Note Perform either the “Negative low-pressure leak test” or the “ISO or BSI standard low-pressure leak test.” It is not necessary to perform both tests.

WARNING Do not use a system with a low-pressure leak. Anesthetic gas will go into the atmosphere, before reaching the breathing circuit.

3.9.1 Negative low-pressure leak test

With ACGO

1. Test the leak test device:
   - Put your hand on the inlet of the leak test device. Push hard for a good seal.
   - Squeeze the bulb to remove all air from the bulb.
   - If the bulb completely inflates in less than 60 seconds, replace the leak test device.
2. Turn off all vaporizers.
3. Test the anesthesia machine for low-pressure leaks:
   - Set the ACGO selector switch to ACGO.
   - Turn all flow controls fully clockwise (zero flow). Do not overtighten.
   - Connect the leak test device to the ACGO outlet.
   - Compress and release the bulb until it is empty.
   - The vacuum causes the floats to move. This is usual. If the bulb completely inflates in 30 seconds or less, there is a leak in the lowpressure circuit.
4. Test each vaporizer for low-pressure leaks:
   - Set the vaporizer to 1%.
   - Repeat step 3.
   - Set the vaporizer to OFF.
   - Test the remaining vaporizers.
5. Disconnect the test device.

WARNING Agent mixtures from the low-pressure leak test stay in the system. Always flush the system with O_2 after the low-pressure leak test (1 L/min for one minute).

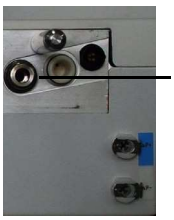
Turn off all vaporizers at the end of the low-pressure leak test.

6. Flush the system with O_2:

- Set the O_2 flow to 1 L/min.
- Continue the O_2 flow for one minute.
- Turn the O_2 flow control fully clockwise (closed).

Without ACGO

1. Test the leak test device:
   - Put your hand on the inlet of the leak test device. Push hard for a good seal.
   - Squeeze the bulb to remove all air from the bulb.
   - If the bulb completely inflates in less than 60 seconds, replace the leak test device.
2. Turn off all vaporizers.
3. Test the anesthesia machine for low-pressure leaks:
   - Remove the breathing system.
   - Turn all flow controls fully clockwise (zero flow). Do not overtighten.
   - Connect the test adapter port **1** to the common gas outlet.
   - Connect the leak test device to the test adapter port **2**



   - Compress and release the bulb until it is empty.
   - The vacuum causes the floats to move. This is usual. If the bulb completely inflates in 30 seconds or less, there is a leak in the lowpressure circuit.
4. Test each vaporizer for low-pressure leaks:
   - Set the vaporizer to 1%.
   - Repeat step 3.
   - Set the vaporizer to Off.
   - Test the remaining vaporizers.
5. Disconnect the test device.
6. Replace the breathing system.

WARNING Agent mixtures from the low-pressure leak test stay in the system. Always flush the system with O_2 after the low-pressure leak test (1 L/min for one minute).

Turn off all vaporizers at the end of the low-pressure leak test.

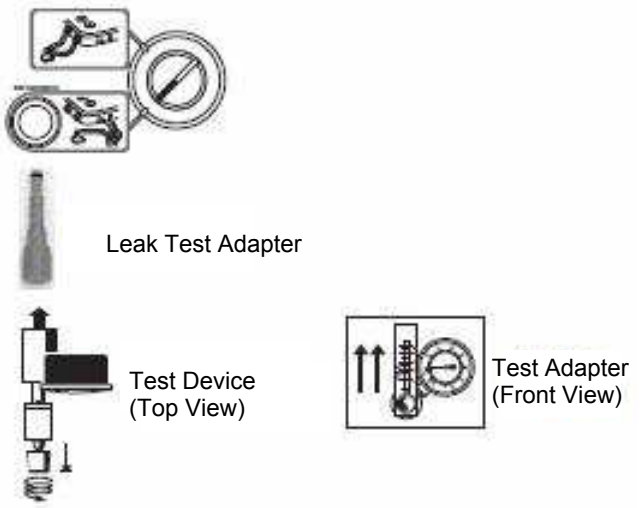
7. Flush the system with O_2:
   - Set the O_2 flow to 1 L/min.
   - Continue the O_2 flow for one minute.
   - Turn the O_2 flow control fully clockwise (closed).

3.9.2 Positive low-pressure leak test

CAUTION Do the positive pressure leak test at the common gas outlet only.

With ACGO

1. Set the ACGO selector switch to ACGO.
2. Turn all flow controls fully clockwise (closed).
3. Using the positive pressure leak test adapter, connect the positive low-pressure leak test device to the ACGO outlet. Push the adapter into the ACGO outlet throughout the test to get a good seal.



4. Keep the flowmeter of the test device vertical for accurate results.
5. Fully open the needle valve on the test device (counterclockwise).

CAUTION If the needle valve is not fully open, this test can damage the pressure gauge on the test device.

6. Open the O_2 flow control and set a total flow of 0.4 L/min through the flowmeter on the test device.
7. Make sure that the pressure gauge on the test device reads zero and that all other flow controls are fully closed.
8. Close the needle valve on the test device until the test gauge reads:

   ISO 5358 (1001-8976-000) 3 kPa
9. If the flow through the test device is less than 0.35 L/min, there is a low-pressure leak in the anesthesia machine.
10. Fully open the needle valve on the test device to decrease the back pressure.
11. Test each vaporizer for low-pressure leaks:
    - Set the vaporizer to 1%.
    - Repeat steps 5 through 10.
    - Turn the vaporizer Off.
12. Remove test tool.
13. Replace the breathing system.

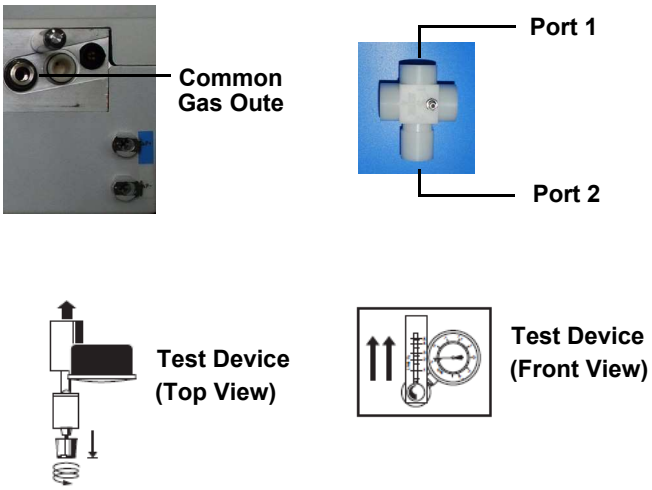
WARNING Agent mixtures from the low-pressure leak test stay in the system. Always flush the system with O_2 after the low-pressure leak test (1 L/min for one minute).

Turn Off all vaporizers at the end of the low-pressure leak test.

14. Flush the system with O_2:
    - Set the O_2 flow to 1 L/min.
    - Continue the O_2 flow for one minute.
    - Turn the O_2 flow control fully clockwise (closed).

Without ACGO

1. Turn all flow controls fully clockwise (closed).
2. Remove the breathing system.
3. Connect the test adapter port **1** to the common gas outlet.
4. Connect the test device to the test adapter port **2**.



5. Keep the flowmeter of the test device vertical for accurate results.
6. Fully open the needle valve on the test device (counterclockwise).

CAUTION If the needle valve is not fully open, this test can damage the pressure gauge on the test device.

7. Open the O_2 flow control and set a total flow of 0.4 L/min through the flowmeter on the test device.
8. Make sure that the pressure gauge on the test device reads zero and that all other flow controls are fully closed.
9. Close the needle valve on the test device until the test gauge reads:

   ISO 5358 (1001-8976-000) 3 kPa

10. If the flow through the test device is less than 0.35 L/min, there is a low-pressure leak in the anesthesia machine.
11. Fully open the needle valve on the test device to decrease the back pressure.
12. Test each vaporizer for low-pressure leaks:
    - Set the vaporizer to 1%.
    - Repeat steps 5 through 10.
    - Turn the vaporizer Off.
13. Remove test tool.
14. Replace the breathing system.

WARNING Agent mixtures from the low-pressure leak test stay in the system. Always flush the system with O_2 after the low-pressure leak test (1 L/min for one minute).

Turn Off all vaporizers at the end of the low-pressure leak test.

15. Flush the system with O_2:
    - Set the O_2 flow to 1 L/min.
    - Continue the O_2 flow for one minute.
    - Turn the O_2 flow control fully clockwise (closed).

3.10 Alarm tests

1. Connect a test lung to the patient connection.
2. Set the system switch to On.
3. Set the controls:
   - Ventilation Mode: Volume control (select from main menu)
   - Ventilator:
     – Tidal Vol: 400 mL
     – Rate: 12
     – I:E Ratio: 1:2
     – P_{max}: 40 cm H_2O
     – PEEP: OFF (if equipped)
   - Anesthesia Machine:
     – O_2 flow: zero flow
     – All other gases: OFF
     – If equipped, ACGO selector switch to the breathing system.
4. Push O_2 flush to fill the bellows.
5. Set the Bag/Vent switch to Bag and back to Vent.
6. Make sure that:
   - Mechanical ventilator starts.
   - A subatmospheric pressure alarm does not occur.
     Note: With active gas scavenging, too much scavenging flow can cause subatmospheric alarm.
   - The ventilator displays the correct data.
   - The bellows inflate and deflate during mechanical ventilation.
7. Set the O_2 flow control to 5 L/min.
8. Make sure that:
   - The end expiratory pressure is approximately 2 cm H_2O.
     Note: Positive end expiratory pressure when PEEP is off may indicate that the scavenging system is not removing enough gas, if the PEEP option is enabled.
   - The ventilator displays the correct data.
   - The bellows inflate and deflate during mechanical ventilation.
9. Test the low minute volume alarm:
   - Go to alarms menu.
   - Set the alarm limit for low minute volume to 6.0 L/min.
   - Make sure that a low minute volume alarm occurs.
   - Go to the alarms menu.
   - Set the low minute volume alarm to 0.1 L/min.
10. Test the high airway pressure alarm:
    - Set P_{max} to less than the peak airway pressure.
    - Make sure that the high airway pressure alarm occurs.
    - Set P_{max} to correct level.
11. Test the apnea and low airway pressure alarms:
    - Turn all flow controls fully clockwise.
    - Set the Bag/Vent switch to Bag.

- Remove the test lung from the patient connection.
- Other alarms such low minute volume can occur.
- Make sure that the low airway pressure and apnea alarms occur. The apnea alarm occurs after 15 seconds.

12. Test the sustained airway pressure alarm:
    - Set the controls:
      – APL valve: Closed (70 cm H_2O)
    - Mechanical ventilation stops when the Bag/Vent switch is set to Bag.
    - Occlude the bag port connector with a test plug.
    - Close the patient connection using the test plug located on the side of patient Y-piece connector and push the O_2 flush button.
    - Make sure that the sustained pressure alarm occurs after approximately 15 seconds at the sustained pressure limit (10 cm H_2O).

Note If the system does not include O_2 monitor, skip step 13 and 14.

13. Test the O_2 monitor and alarms
    - Remove the O_2 sensor from the breathing system.
    - Make sure the sensor measures approximately 21% O_2 in room air.
    - Set the low O_2 alarm to 50%. Make sure a low O_2 alarm occurs.
    - Set the low O_2 alarm back to 21% and make sure that alarm cancels.
    - Put the O_2 sensor back in circuit.
    - Remove the test lung from the patient connection.
    - Set the High O_2 alarm to 50%.
    - Push the O_2 flush button to fill the breathing system.
    - Set the O_2 flow control to 5 L/min.
    - Make sure the high O_2 alarm comes On.
    - Set the high O_2 alarm back to 100% and make sure that alarm cancels.
    - After 2 minutes in pure O_2, the O_2 display reads approximately 100%.
    - Turn the O_2 flow control fully clockwise (zero flow).
14. Set the system switch to Standby.

3.11 Breathing system tests

WARNING Objects in the breathing system can stop gas flow to the patient. This can cause injury or death. Do not use a test plug that is small enough to fall into the breathing system.

1. Verify that AGSS is operating if equipped. For systems that have a flow indicator on the side, make sure that the flow indicator shows a flow in the green (normal) region.
2. Zero the pressure gauge (Section 5.4.1).

Check valves

3. Make sure that the check valves on the breathing circuit module work correctly:
   - The Inspiratory check valve rises during inspiration and falls at the start of expiration.
   - The Expiratory check valve rises during expiration and falls at the start of inspiration.

Ventilator bellows

4. Ventilator bellows test:
   - Set the Bag/Vent switch to Vent.
   - Set the system switch to Standby.
   - Turn all flow controls fully clockwise (zero flow).
   - Use the test plug or your hand to close the breathing circuit at the patient connection.
   - Push the O_2 flush button to fill the bellows.
   - The pressure must not increase to more than 15 cm H_2O on the pressure gauge.
   - If the bellows falls more than 150 mL/min (top of indicator), it has a leak.

Service Mode Tests

5. Enter the Service Mode: Push and hold the adjustment knob on the ventilator's display and set the system switch to On.
   - Select and confirm "Service Mode".
   - From the "Diagnostic Test/Tools", select "Breathing System Leak Test".
   - Follow the instructions on the screen.
   - The leak rate should be less than 200 mL/min.

Bag circuit

6. Test the bag or manual circuit for leaks:
   - Set the system switch to On.
   - Set the Bag/Vent switch to Bag.
   - Plug the bag port (use your hand or the approved test plug).
   - Close the APL valve (70 cm H_2O)
   - Set the O_2 flow to 0.25 L/min.
   - Close the patient connection (using a hand or the approved test plug) and pressurize the bag circuit with the O_2 flush button to approximately 30 cm H_2O.
   - Release the O_2 flush button. The pressure must not

decrease. A pressure decrease large enough to see on the gauge indicates an unacceptable leak.

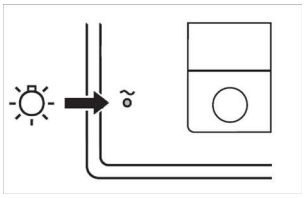
APL valve

7. Test the APL valve:
   - Fully close the APL valve (70 cm H_2O).
   - Set the total fresh gas flow to approximately 3 L/min and make sure that the value on the inspiratory pressure gauge does not exceed 85 cm H_2O. Some pressure fluctuation is normal.
   - Fully open the APL valve (to the MIN position).
   - Set O_2 flow to 3 L/min. Turn any other gases off.
   - Make sure that the value on the inspiratory pressure gauge is less than approximately 5 cm H_2O.
   - Push the O_2 flush button. Make sure that the value on the inspiratory pressure gauge stays less than 10 cm H_2O.
   - Set the O_2 flow to zero and make sure that the value on the inspiratory pressure gauge does not decrease below 0 cm H_2O.
8. Remove your hand or the test plug from the patient connection.
9. Turn all flow controls fully clockwise (closed).
10. Set the system switch to Standby.

WARNING Make sure that there are no test plugs or other objects caught in the breathing system.

3.12 Power failure test

1. Connect the power cord to a mains outlet. The mains indicator on the display comes on when AC Power is connected.



   If the indicator is not on, the display assembly is not receiving AC power.
   - Verify AC power to the machine (reset circuit breaker).
   - Check the AC inlet assembly.
2. Set the system switch to On.
3. Unplug the power cord with the system turned on.
4. Make sure that the power failure alarm comes on.
5. Make sure the following message is on the ventilator display:
   - “On Battery - Power OK?”
6. Connect the power cord again.
7. Make sure the alarm cancels.

3.13 Electrical safety tests

Make sure the system is completely assembled and all accessory devices are connected to electrical outlets.

1. Connect an approved test device (e.g. UL, CSA, or AAMI) and verify that the leakage current is less than:

Voltage	Max. Leakage Current
100/120 VAC	300 μAmps
220/240 VAC	500 μAmps

2. Make sure that the resistance to ground is less than 0.2Ω between an exposed metal surface and the ground pin on the power cord.

4 Service Tests and Service Mode

WARNING Post-Service Checkout is required after you complete this section. You must perform Section 3.1 Post-service checkout after performing any maintenance, service or repair. Failure to do so may result in patient injury.

In this section

To ensure proper operation, the 9100c Ventilator includes several tests that run automatically (self tests) and a series of menu pages that a qualified service person can use to test, calibrate, or troubleshoot ventilator related components in the 9100c anesthesia machine (Service Mode).

4.1 Self tests

The 9100c Ventilator software includes self tests that determine whether or not the operating software is functioning properly and whether or not the electronic circuits on the circuit boards are functional.

The self tests include:

- powerup tests
- continuous tests
- periodic tests

Powerup tests

The following list of the tests run at powerup:

- CSB and DMB communication
- CSB and alarm CPU communication
- Paw sensor reference voltage
- Flow sensor reference voltage
- DMB 3.3 V voltage
- PEEP valve DAC and voltage feedback
- Flow valve DAC and voltage feedback
- 10 VA of PEEP and flow valve

If one or more of these tests fail, the display provides a readout of the problem.

Continuous tests

These tests are run continuously during normal operation and alarms are associated with each test. A failure causes an alarm to display on the screen in the alarm display area.

- Supply voltage checks
- Battery voltage checks

Periodic tests

These tests are run periodically during normal operation.

Tests that run every 1 second include:

- DMB 3.3 V voltage
- 10 VA of PEEP and flow valve

Tests that run every 2 seconds include:

- CSB and DMB communication
- CSB and alarm MCU communication

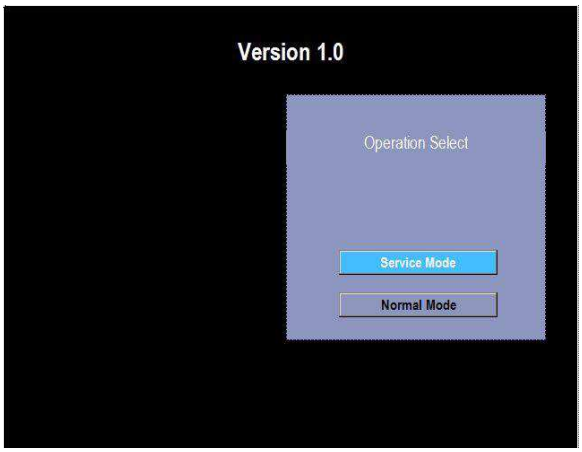
If one or more of these tests fail, the display provides a readout of the problem.

4.2 Service Mode

The ***Service Mode*** is used to test, calibrate, or troubleshoot ventilator related components in the anesthesia machine.

The way to enter the service mode is:

- With the system switch in Standby, push and hold in the adjustment knob while setting the system switch to On. Hold the adjustment knob pushed in until the “Operation Select” menu appears. Use the adjustment knob to highlight “Service Mode”, then push the adjustment knob to confirm the selection.

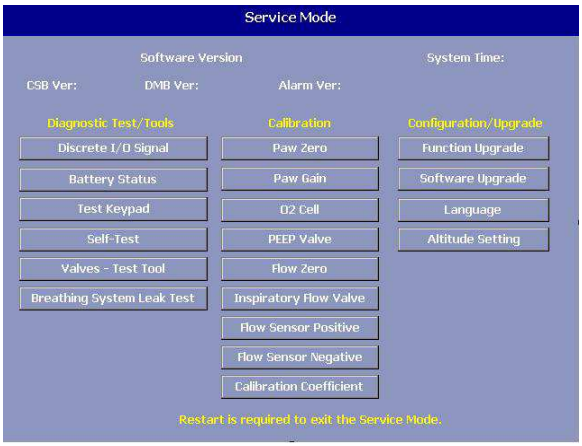


From this menu you can:

- Go to the ***Service Mode***
- Return to ***Normal Mode***

Service Mode Menu

The ***Service Mode*** main menu displays the non-selectable ventilator information and the service tests you can select.



The selectable service tests are displayed in categorical order. But you can select the service test from this menu in any order. The following sections in this manual are sequenced in the order that they appear on the screen.

4.3 Ventilator Information

The Ventilator information in the “Service Mode” main menu identifies the current software loaded into the ventilator and displays the system time.

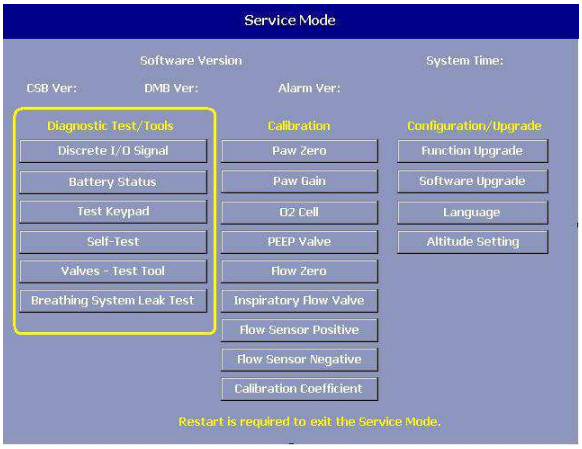
The Software Version includes:

- CSB Version
- DMB Version
- Alarm Version

The “System Time” displays the time set in the ventilator screen.

4.4 Diagnostic Test/Tools

The Diagnostic Tests/Tools menu includes a selection of items that look at individual subsystems of the 9100c Ventilator.



4.4.1 Discrete I/O Signal

The ***Display Discrete I/O Signal*** menu displays discrete binary **Signal** associated with machine switch positions **Status**.

There are several types of switches in the machine:

- some switches are mechanically operated,
- some switches are pneumatically operated,
- some switches are electronic.

Mechanical switches

- ACGO Switch — Vent or Aux CGO (machine equipped with ACGO)
- Canister Status — Closed or Open (Closed by default if Canister Release switch not installed)
- Bag/Vent Status — Vent or Bag

Pneumatic

- O_2 Supply Pressure — Pressure or No Pressure
- O_2 flush — On or Off

Electronic switches

- O_2 Sensor Status — Connected or Disconnected
- Breathing Circuit — Connected or Disconnected

4.4.2 Display Battery Status

The ***Display Battery Status*** menu displays the battery charge status.

Battery Status

"Battery Charging" — Battery is charging.

"Battery is ON - Power is OK??" — System is running on battery.

4.4.3 Test Keypad

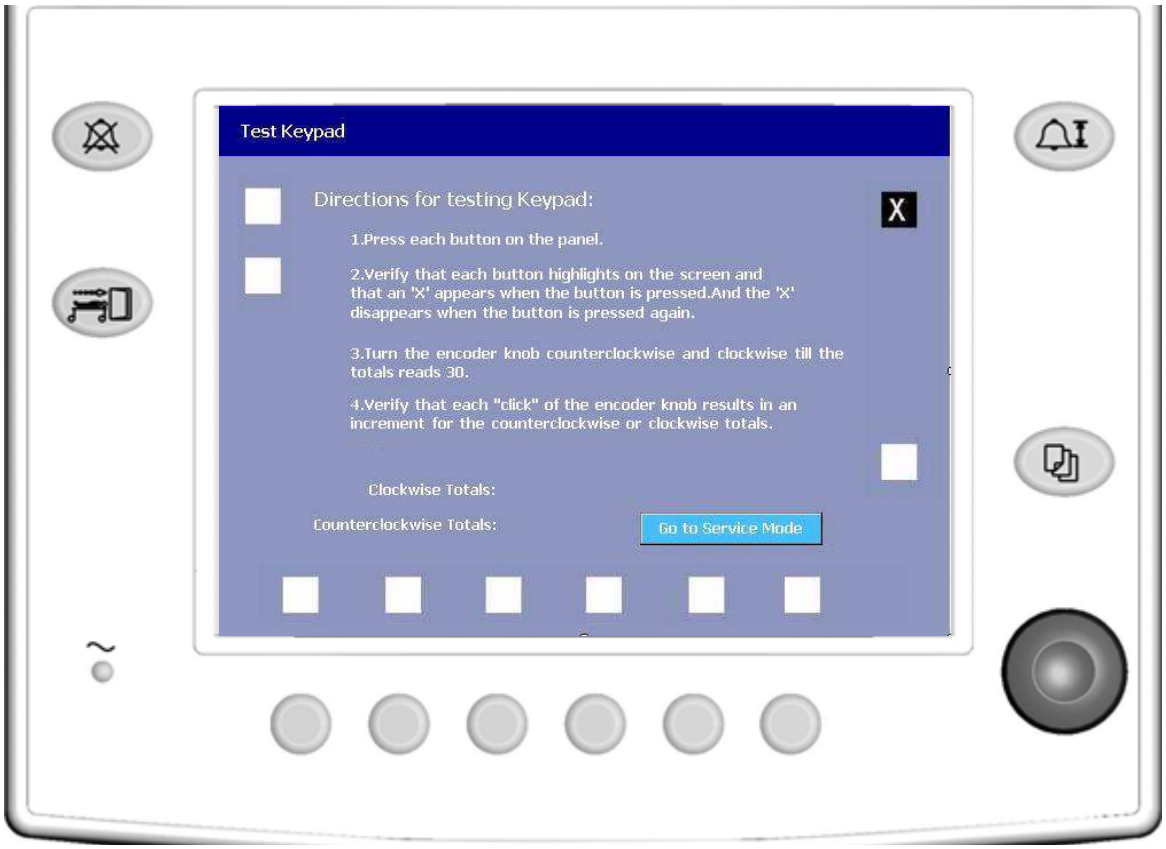
In the ***Test Keypad*** menu the software is set up to receive keyboard button presses and rotary encoder turns.

Press each button on the panel and the control knob.

- When a button is pressed and released, the icon on the screen next to the button should be highlighted and filled with a checkmark “X”.
- When the button is pressed and released again, the checkmark “X” should disappear.

As you turn the encoder knob, verify that:

- each click of the encoder in the clockwise direction increments the clockwise total. The total number is “30”.
- each click of the encoder in the counterclockwise direction increments the counterclockwise total. The total number is 30.



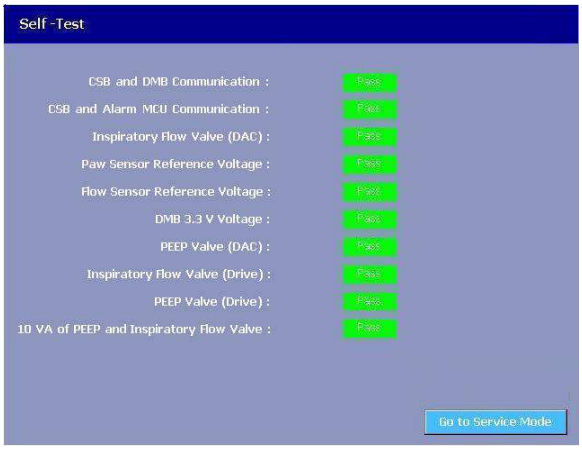
Remarks

If any of the select buttons test fails, replace the front panel keyboard assembly.

If the encoder knob test fails, replace the rotary encoder assembly.

4.4.4 Self - Test

The ***Self-Test*** menu allow you to observe the self tests and the results on the screen.



The Self-Test shows:

- CBD and DMB Communication — Pass or Fail
- CSB and Alarm MCU Communication — Pass or Fail
- Inspiratory Flow Valve (DAC) — Pass or Fail
- Paw Sensor Reference voltage — Pass or Fail
- Flow Sensor Reference voltage — Pass or Fail
- DMB 3.3 V voltage — Pass or Fail
- PEEP Valve (DAC) — Pass or Fail
- Inspiratory Flow valve voltage — Pass or Fail
- PEEP Valve (Drive) — Pass or Fail
- 10 VA of PEEP and Flow Valve — Pass or Fail

When the result is “Pass”, the icon background should be green.
When the result is “Fail”, the icon background should be red.

Remarks

If one or more of these tests fail, please check the CSB, DMB, Vent Engine and the harnesses.

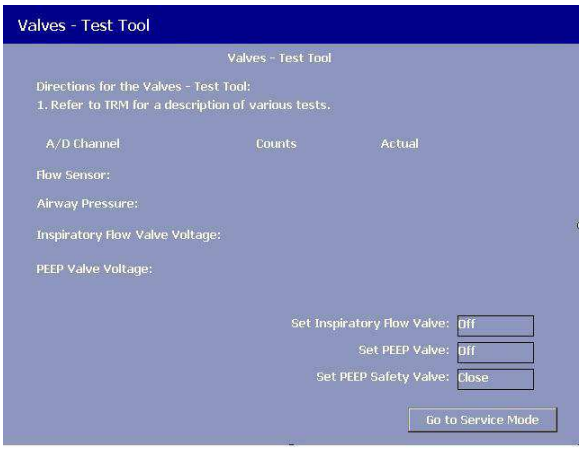
4.4.5 Valve - Test Tool

The ***Valves - Test Tool*** menu allows you to manually control the Inspiratory Flow Valve, the PEEP Valve, and the PEEP Safety Valve, and observe key pressure and flow measurements on the same screen.

Note This is not the actual calibration of those components.

This menu is mainly used to test the drive gas circuit or to supply drive gas flow for several tests:

- It is used to test the mechanical overpressure valve as detailed in Section 6.4, "Adjust drive gas regulator".
- It is used to adjust the drive gas regulator as detailed in Section 6.5, “MOPV pressure relief valve test”.
- It is used to check primary regulators as detailed in Section 5.1.2.



Note The ***Inspiratory Flow Valve Calibration*** and ***PEEP Valve Calibration*** should be performed before you ***Set Inspiratory Flow Valve*** and ***Set PEEP Valve***.

Set Inspiratory Flow Valve

The flow through the Inspiratory Valve can be set:

- from **Off** to **100 L/min** in 1 L/min increments.

Set PEEP Valve

The PEEP Valve can be set:

- from **Off** to **100 cm H_2O** in 1 cm H_2O increments.

Set PEEP Safety Valve

The PEEP Safety Valve can be set:

- **Closed** or **Open**

Remarks

When setting the Inspiratory Valve or the PEEP Valve:

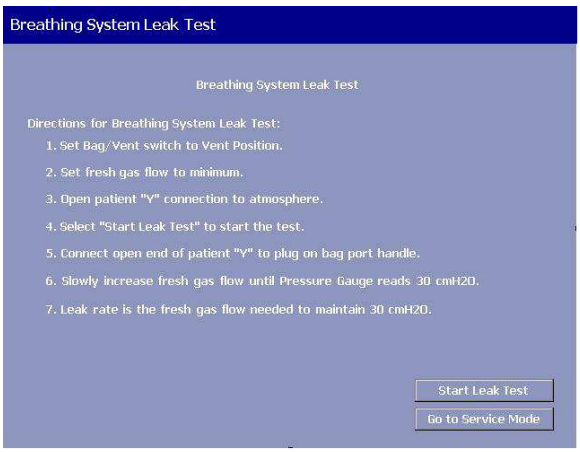
- Turn the encoder clockwise to increase the values.
- Turn the encoder counterclockwise to decrease the values.

4.4.6 Breathing System Leak Test

You can estimate how much of a leak there is in the ventilator portion of the breathing system by closing the patient circuit, inflating the bellows, and observing how quickly they fall on their own weight (part of machine checkout procedure).

The ***Breathing System Leak Test*** allows you to more precisely test the ventilator portion of the breathing system for leaks.

Note The ***Inspiratory Flow Valve Calibration*** and ***PEEP Valve Calibration*** should be performed before you do the ***Breathing System Leak Test***.



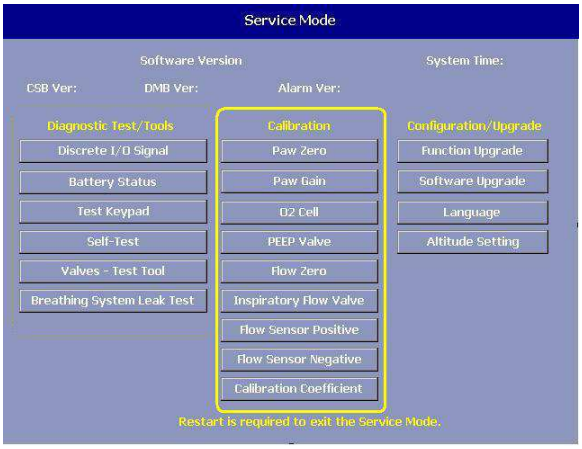
Note The regarding plug is located on the breathing system bag port.

Remarks By using the patient circuit to establish a closed loop, you can measure the leak rate.

- The leak rate is the fresh gas flow needed to maintain 30 cm H_2O.
- The system should have a leak rate < 200 mL/min.

4.5 Calibration

The ***Calibration*** menu includes service level calibrations of components that need periodic adjustment to maintain specified accuracy.



Remarks These procedures require you to disassemble and reassemble parts of the breathing system. Accordingly, the procedures are arranged to minimize the disassembly and reassembly process.

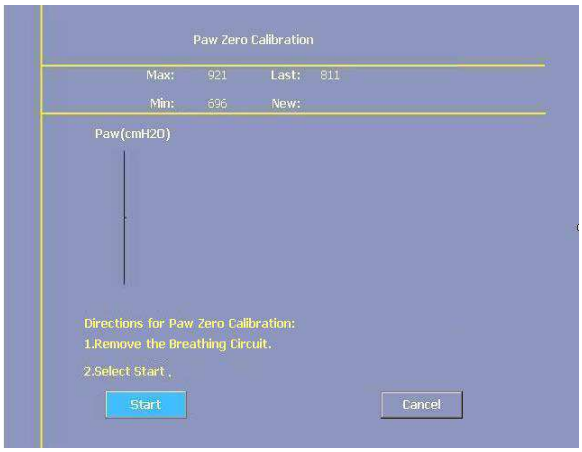
4.5.1 Paw Zero

The ***Paw Zero*** procedure

- zeros any offset in the amplifier for the airway pressure sensor.

It does so by reading the value for airway pressure when the breathing system has been removed.

- If the calibration passes, the calibration value can be stored in the EEPROM.
- If the calibration value is not within the correct tolerance, the calibration fails.



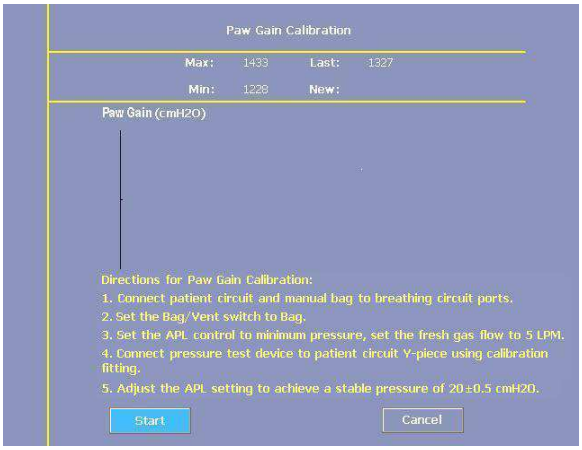
Remarks

Ensure that the breathing system is removed.

“Fail” indicates a problem in the CSB (Airway pressure transducer)

4.5.2 Paw Gain

The ***Paw Gain*** procedure calculates a gain coefficient for the airway pressure transducer.



Calibration setup

1. Connect the patient circuit to the inspiratory and expiratory port and connect a manual bag to the bag port.
2. Set the Bag/Vent switch to Bag position.
3. Set the APL valve to minimum.
4. Set the fresh gas flow to 5 Lpm.
5. Connect the calibration fitting (See Section 10.1.2) to the patient circuit Y-piece.
6. Connect the tube from the calibration fitting to pressure test device.
7. Adjust the APL setting to achieve a stable pressure of 20 ± 0.5 cm H_2O.
8. Remove the pressure test device, test adapter, patient circuit and the manual bag.
9. Set the fresh gas flow to zero upon the completion of calibration

Remarks

“Fail” indicates a problem in the CSB (Airway pressure transducer).

4.5.3 O_2 Cell

The ***O_2 Cell Calibration*** takes into account the altitude setting. Before starting the calibration, ensure that the altitude setting (in “Altitude Setting” menu) is set to the appropriate altitude for the machine location.

For the “21% O_2 Calibration” software reads the A/D value for the O_2 sensor when the O_2 sensor is exposed to room air (21% O_2).

- If this A/D value is not within the tolerance, the calibration fails.
- If the calibration passes, the A/D value can be stored in the EEPROM.

The sensor must be calibrated at 21% O_2 before calibration at 100% O_2.

Remarks

Remove the O_2 sensor from the breathing system and expose it to room air. The displayed reading should be 21% ± 2% to pass the calibration requirements.

Place the sensor that passed the 21% test in the breathing system and expose it to 100% O_2.

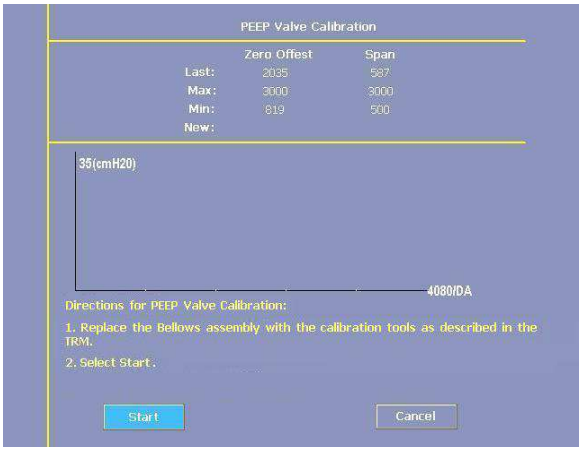
“Fail” incidents a problem in the O_2 Cell. Replace if necessary.

4.5.4 PEEP Valve

The ***PEEP Valve Calibration*** should be performed:

- when the machine is first put into service.
- at prescribed, planned maintenance intervals.
- after the pneumatic vent engine has been serviced.

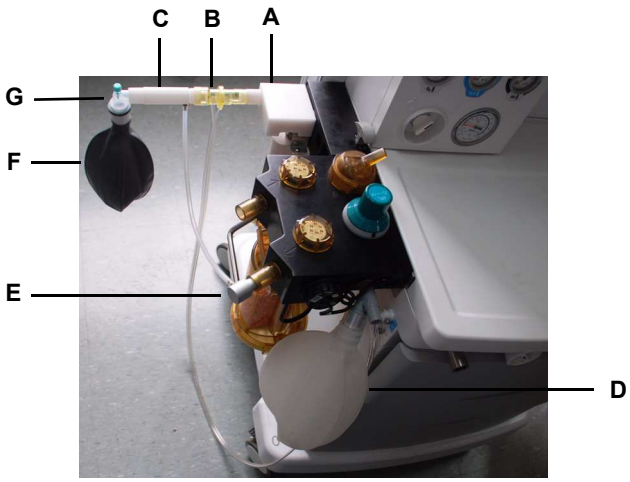
Note The ***Paw Zero*** and ***Paw Gain*** must be calibrated before the ***PEEP Valve Calibration***.



Calibration Setup

1. Remove the bellows assembly, remove the AGSS if equipped.
2. Connect the calibration fixture (**A**) to the drive gas outlet.
3. Connect the flow sensor (**B**) to the calibration fixture.
4. Connect the calibration pipe (**C**) to the flow sensor.
5. Connect a manual bag (**D**) to the bag port.
6. Connect the calibration fitting (**E**) to the inspiratory flow port.
7. Connect the tube from calibration pipe to the calibration fitting.
8. Connect the pediatric bag(1L) (**F**) to the calibration pipe using elbow fitting (**G**).

Ensure that the test tubing is leak free.



Calibration Procedure

1. To start the PEEP Valve Calibration, select “Start”.
2. Reassemble the bellows assembly upon the completion of calibration.

Note: This calibration procedure may take up to 10 minutes.

The calibration status is displayed in the screen.

Remarks

The calibration routine opens the PEEP valve stepwise and reads the resulting airway pressure. The accumulated values represent the output linearity curve for this particular PEEP valve. The accumulated data includes the PEEP Valve Curve.

The data is stored in EEPROM and is used during normal operation to compensate for the individual valve’s output characteristics.

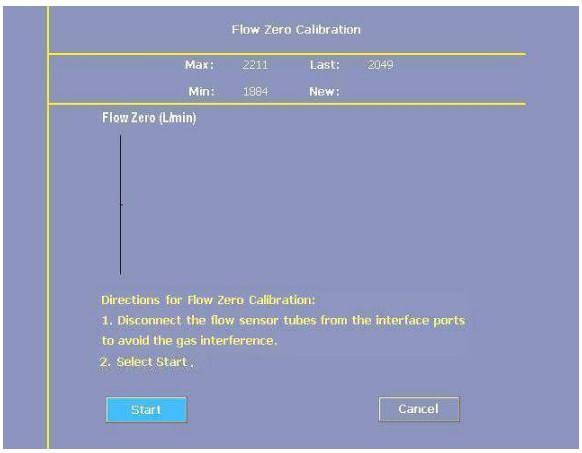
4.5.5 Flow Zero

The ***Flow Zero Calibration*** procedure

- determines the zero value for the inspiratory flow and expiratory flow measurement differential pressure transducers.

It does so by reading the value for inspiratory flow and expiratory flow measurement differential pressure.

- If the calibration passes, the offset and zero values are stored in the EEPROM.
- If the value is not within the correct tolerance the calibration fails.



Remarks

Ensure that the flow sensor tubes are disconnected from the interface ports marked “ΔP+” and “ΔP-”.

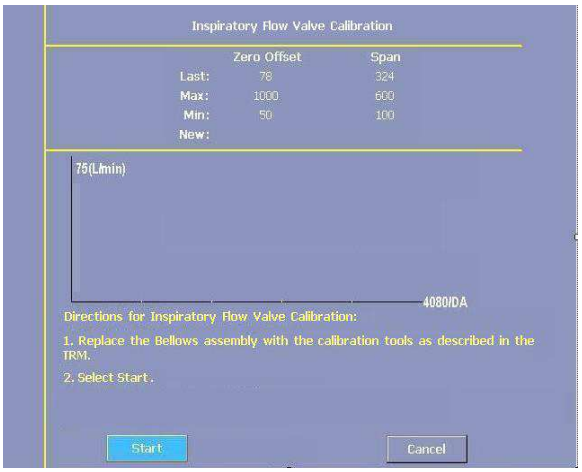
If the calibration procedure fails, it indicates a problem in the flow measurement differential pressure transducers of the CSB.

4.5.6 Inspiratory Flow Valve

The ***Inspiratory Flow Valve Calibration*** should be performed:

- when the machine is first put into service.
- at prescribed, planned maintenance intervals.
- after the pneumatic vent engine has been serviced.

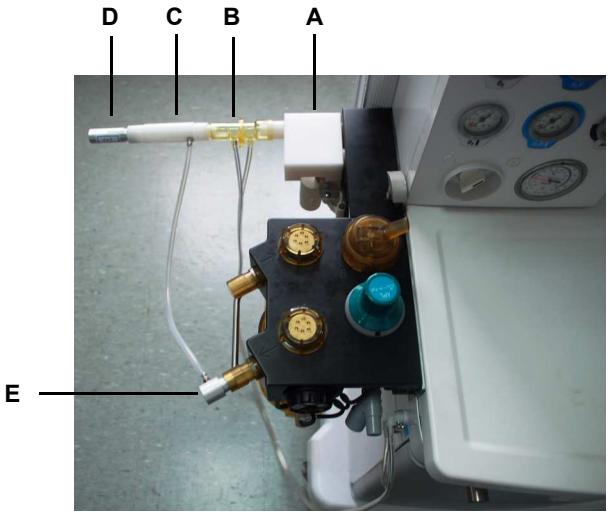
Note The ***Paw Zero*** and ***Paw Gain*** must be calibrated before the ***Inspiratory Valve Calibration***. Select the ***Calibration Coefficient*** menu, set the calibration coefficient as marked on the calibration orifice before the ***Inspiratory Valve Calibration.***



Calibration Setup

1. Remove the bellows assembly, then connect the calibration fixture (**A**) to the drive gas outlet.
2. Connect the large port of flow sensor (**B**) to the calibration fixture.
3. Connect the calibration pipe (**C**) to the small port of flow sensor.
4. Connect the calibration orifice (**D**) to the calibration pipe.
5. Connect the calibration fitting (**E**) to the inspiratory flow port.
6. Connect the tubing from calibration pipe to the calibration fitting.

Ensure that the test tubing is leak free and the flow sensor tubes are connected.



Calibration Procedure

1. To start the Inspiratory Flow Valve Calibration, select “Start”.
2. Reassemble the bellows assembly upon the completion of calibration.

Remarks

With the bellows assembly removed, the output from the inspiratory valve is routed through the calibration tools to the Airway Pressure transducer. The calibrated orifice provides a precise restriction to the flow.

The calibration routine opens the Inspiratory valve stepwise and reads the resulting pressure at the airway pressure transducer. The inspiratory flow displayed on the screen for this test is a calculation of the pressure measured by the airway pressure transducer times a constant (based on the size of the orifice in the test tool).

The accumulated values represent the output linearity curve for this particular Inspiratory valve.

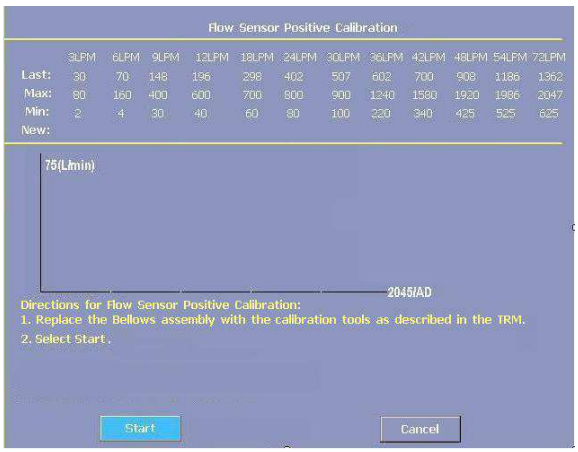
The data is stored in EEPROM and is used during normal operation to compensate for the individual valve’s output characteristics.

4.5.7 Flow Sensor Positive

The ***Flow Sensor Positive Calibration*** should be preformed:

- when the machine is first put into service.
- at prescribed, planned maintenance intervals.
- after the pneumatic vent engine has been serviced.
- whenever the flow sensor is replaced.

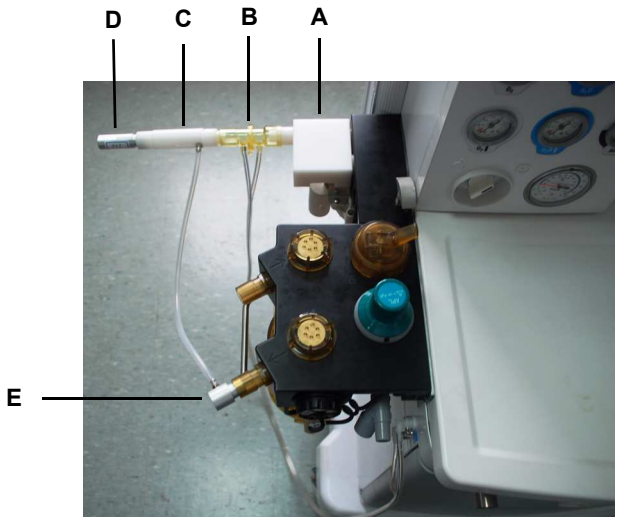
Note The ***Paw Zero***, ***Paw Gain***, ***Flow Zero*** must be calibrated before the ***Flow Sensor Positive Calibration***. Select the ***Calibration Coefficient*** menu, set the calibration coefficient as marked on the calibration orifice before the ***Flow Sensor Positive Calibration.***



Calibration Setup

1. Remove the bellows assembly, connect the calibration fixture (**A**) to the drive gas outlet.
2. Connect the large port of flow sensor (**B**) to the calibration fixture.
3. Connect the calibration pipe (**C**) to the small port of flow sensor.
4. Connect the calibration orifice (**D**) to the calibration pipe.
5. Connect the calibration fitting (**E**) to the inspiratory flow port.
6. Connect the tubing from calibration pipe to the calibration fitting.

Ensure that the test tubing is leak free.



Calibration Procedure

1. To start the Flow Sensor Positive Calibration, select “Start”.
2. Reassemble the bellows assembly upon the completion of calibration.

Remarks

Ensure the flow sensor is correctly connected as detailed in the calibration setup. The small port is the port closest to the patient connection. The large port is the port closest to the patient circuit Y-piece (Section 2.8.9).

The data is stored in EEPROM and is used during normal operation to compensate for the individual flow sensor output characteristics.

4.5.8 Flow Sensor Negative

The ***Flow Sensor Negative Calibration*** should be preformed:

- when the machine is first put into service.
- at prescribed, planned maintenance intervals.
- after the pneumatic vent engine has been serviced.
- Whenever the flow sensor is replaced.

Note The ***Paw Zero***, ***Paw Gain***, ***Flow Zero*** must be calibrated before the ***Flow Sensor Negative Calibration***. Select the ***Calibration Coefficient*** menu, set the calibration coefficient as marked on the calibration orifice before the ***Flow Sensor Negative Calibration.***

Calibration Setup

To perform the flow sensor negative calibration, connect the calibration tools as in the Flow Sensor Positive calibration but reverse the direction of the flow sensor by connecting the small port to the calibration fixture and the large port to the calibration pipe.

Ensure that the test tubing is leak free.

Calibration Procedure

1. To start the Flow Sensor Negative Calibration, select “Start”.
2. Reassemble the bellows assembly upon the completion of calibration.

Remarks

The data is stored in EEPROM and is used during normal operation to compensate for the individual flow sensor output characteristics.

4.5.9 Calibration Coefficient

The ***Calibration Coefficient*** value should be entered:

- Before the Inspiratory Flow Valve Calibration.
- Before the Flow Sensor Positive Calibration.
- Before the Flow Sensor Negative Calibration.

Remarks

The Calibration Coefficient is marked on the calibration orifice.

The data is stored in EEPROM and is used during the calibration to compensate for the individual calibration orifice characteristics.

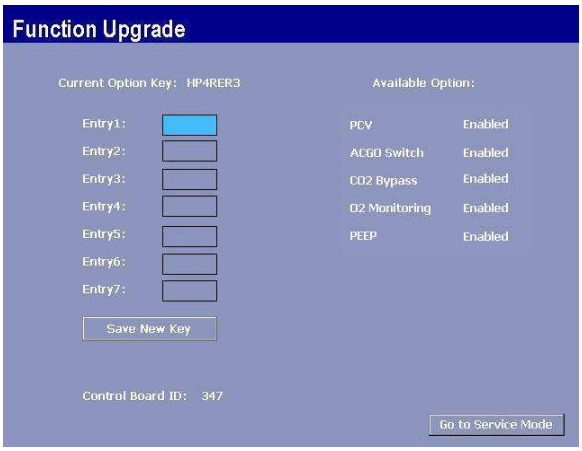
4.6 Configuration/Upgrade

The ***Configuration/Upgrade*** menu includes the ***Function Upgrade***, ***Software Upgrade*** and ***Languages*** selection.

4.6.1 Function Upgrade

The ***Function Upgrade*** menu shows which features are currently available in the ventilator's software.

The ventilator can be upgraded to include additional features by entering the upgrade "Key Code" that the customer has purchased.



Remarks

Select each "digit" in each Entry field and rotate the control knob to select the corresponding digit in the Key Code.

When you have entered all the digits, select "Save New Key".

After verifying the Key Code match to the Control Board ID, the menu will display the newly installed features.

Note

The "Control Board ID" here refers to the Display Monitor Board of the 9100c system.

If the ventilator "Key Code" is changed, the new code should be recorded on the display module side panel label.

4.6.2 Software Upgrade

The ***Software Upgrade*** menu shows the directions for software upgrade.

WARNING Ensure the USB disk is inserted during the upgrade. If the USB disk is removed during the upgrade, that may result in the failure of the display monitor board.

Remarks Ensure the AC power is ON during the upgrade.

4.6.3 Language

The text shown in the normal mode of operation is language sensitive. However, the Service Confirmation menu (except for text “Normal Operation”) and all the Service Modes menus are shown only in English.

The Language menu is used to set the specific language for normal operation.

The 9100c ventilator supports the following languages. The language selections appear in language specific text.

- Chinese
- English
- Russian
- Korean
- French
- Spanish
- Portuguese

The language setting is stored in EEPROM with the default setting as English.

4.6.4 Altitude Setting

The ***Altitude Setting*** menu shows the altitude that is tailored to the specific machine.

The accuracy of some of the ventilator measurements is altitude sensitive. To ensure the specified accuracy, the altitude setting should be set to the specific altitude where each machine is located.

Altitude settings range from -400 to 3600 meters in increments of 100 meters.

Remarks The setting is saved in EEPROM; the default value is 0 meter.

5 Calibration

WARNING After adjustments and calibration are completed, always perform the checkout procedure. Refer to Section 3 of this manual.

In this section

This section covers calibration procedures for components of the 9100c anesthesia machine.

5.1 Cylinder Regulators

Follow the procedure in Section 5.1.1 to gain access to the regulators. Then, in Section 5.1.2, select the test that is appropriate for the regulator you are testing.

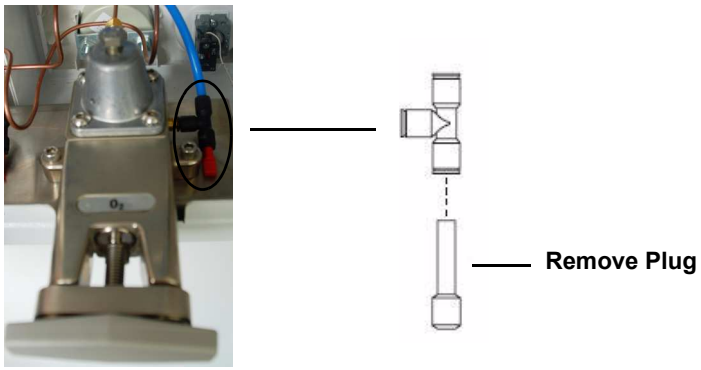
WARNING When testing/adjusting N_2O regulators, nitrous oxide flows through the system. Use a safe and approved procedure to collect and remove it.

5.1.1 Test setup

WARNING Wear safety glasses while test device is connected to the test port.

CAUTION Be careful not to plug the output of the cylinder regulator without having a pressure relief valve in the output circuit.

1. Set the system switch to Standby.
2. Disconnect all pipeline supplies.
3. Remove the upper rear panel (Section 9.2.1).
4. Install a full cylinder in the cylinder supply to be tested. It is essential that the cylinder be within 10% of its full pressure.
5. Remove the plug from the test port and connect a test device capable of measuring 689 kPa (100 psi).



5.1.2 Test Cylinder Regulators

There are two variations of the test procedure for the cylinder regulators:

- **Test A** — For cylinder regulators that supply drive gas to the ventilator.
- **Test B** — For all gases not used to supply drive gas to the ventilator.

Test A

For cylinder regulators that supply drive gas to the ventilator (O_2 or Air):

Under low flow conditions, the output pressure of a properly adjusted/ functioning regulator should fall within specifications listed in step 3. Under high flow conditions, the output pressure should not drop below the specifications in step 6.

1. Remove the bellows assembly.
2. Slowly open the cylinder valve.
3. **Low Flow Test:** Set the fresh gas or O_2 flow to 0.1 L/min.
   - Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder gauge (upper limit of the red band). The flow may be temporarily increased to facilitate the decay.
   - At the time that the cylinder pressure reaches 2068 kPa (300 psi), close the O_2 or Air flow control valve.
   - Within one minute, the test device must stabilize between 310 - 341 kPa (45.0 - 49.5 psi).
     — If the test device pressure does not stabilize within one minute, replace the cylinder supply.
     — If the test device pressure stabilizes within one minute, ut the readings are not within specifications, readjust the regulator (Section 5.1.3).
4. Slowly open the cylinder valve.
5. Set the system switch to On and enter the Service Mode.
6. Follow the menu structure outlined below to reach the adjustment for the inspiratory flow valve. Select and confirm at each step.
   - “Diagnostic Tests/Tools” - “Valves - Test Tool”
   - “Set Inspiratory Flow Valve”
7. **High Flow Test:** Rotate adjustment knob clockwise to obtain 65 (L/min):
   - While watching the test device press the knob to confirm.
   - After 2 seconds, select “Go to Service Mode” and press confirm to stop the gas flow.
   - The minimum test device reading observed must be greater than 207 kPa (30 psi).Repeat this step three times.
     — If the test device reading under “high flow” conditions is less than specified, readjust the regulator per the procedure in Section 5.1.3; however, set the regulated pressure higher by the difference you noted in this step plus 7 kPa (1 psi). This adjusts the “low flow” regulated output to the high side of the specification so that the

"high flow" regulated pressure can fall within the specification.

— If the regulator subsequently fails the "low flow" specification (Step 3) because the reading is too high, replace the cylinder supply.

8. Set the system switch to Standby.
9. Close the cylinder valve.
10. Bleed the system of all pressure (Section 9.1)
11. Disconnect the test device and plug the test port (pull on the plug to make sure it is locked in the fitting).
12. Replace the bellows assembly.
13. After the last regulator has been tested, perform the checkout procedure (Section 3).

Test B

For all gases not used to supply drive gas to the ventilator:

Under low flow conditions, the output pressure of a properly adjusted and functioning regulator should fall within specifications listed in step 3. Under high flow conditions, the output pressure should not drop below the specifications in step 6.

1. If the cylinder supply being tested is N_2O, connect a source of O_2 to pressurize the balance regulator and allow N_2O to flow.
2. Slowly open the cylinder valve for the regulator being tested.
3. **Low Flow Test:** Set the fresh gas or O_2 flow to 0.1 L/min.
   - Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder gauge (upper limit of the red band). The flow may be temporarily increased to facilitate the decay.
   - At the time that the cylinder pressure reaches 2068 kPa (300 psi), close the O_2 or Air flow control valve.
   - Within one minute, the test device must stabilize between 310 – 341 kPa (45.0 – 49.5 psi).
     — If the test device pressure does not stabilize within one minute, replace the cylinder supply.
     — If the test device pressure stabilizes within one minute, but the readings are not within specifications, readjust the regulator (Section 5.1.3).
4. Slowly open the cylinder valve.
5. Set the system switch to On.
6. **High Flow Test:** Set the flow control valve to the maximum indicated flow on the flow tube.
   - The test device reading must be greater than 221 kPa (32.0 psi).
     — If the test device reading under "high flow" conditions is less than specified, readjust the regulator per the procedure in Section 5.1.3; however, set the regulated pressure higher by the difference noted in this step plus 7 kPa (1 psi). This adjusts the "low flow" regulated output to

the high side of the specification so that the “high flow” regulated pressure can fall within the specification.

— If the regulator subsequently fails the “low flow” specification (step 3) because the reading is too high, replace the cylinder supply.

7. Set the system switch to Standby.
8. Close the cylinder valve.
9. Bleed the system of all pressure (Section 9.1)
10. Disconnect the test device and plug the test port (pull on the plug to make sure it is locked in the fitting).
11. Replace the large rear upper panel.
12. Perform the checkout procedure (Section 3).

5.1.3 Adjusting Cylinder Regulators

Important: Cylinder supplies in a 9100c machine must have all high-pressure regulators set to the same pressure range. If a regulator is replaced, the replacement regulator must be set (as required) to the same specification as the one removed.

Important: Install a full cylinder in the cylinder supply to be adjusted. It is essential that the cylinder be within 10% of its full pressure.

If the cylinder supply being adjusted is N_2O, connect a source of O_2 and set the O_2 flow control to the minimum stop (pilot pressure for low-pressure regulator).

To adjust the cylinder regulators, follow the procedure in Section 5.1.1 to gain access to the regulators.

Do not attempt to adjust without flow.

1. Slowly open the cylinder valve.
2. Set and maintain the fresh gas or O_2 flow of the gas being tested to 0.1 L/min.
3. Close the cylinder valve and allow the pressure to decay to 2068 kPa (300 psi) as indicated on the cylinder gauge (upper limit of the red band). The flow may be temporarily increased to facilitate the decay.
4. When the cylinder gauge reaches the upper limit of the red band, adjust the regulator output pressure to 327 to 341 kPa (47.5 to 49.5 psi).

Note It may be necessary to open the cylinder valve and repeat steps 4 and 5 a number of times to achieve the above setting.

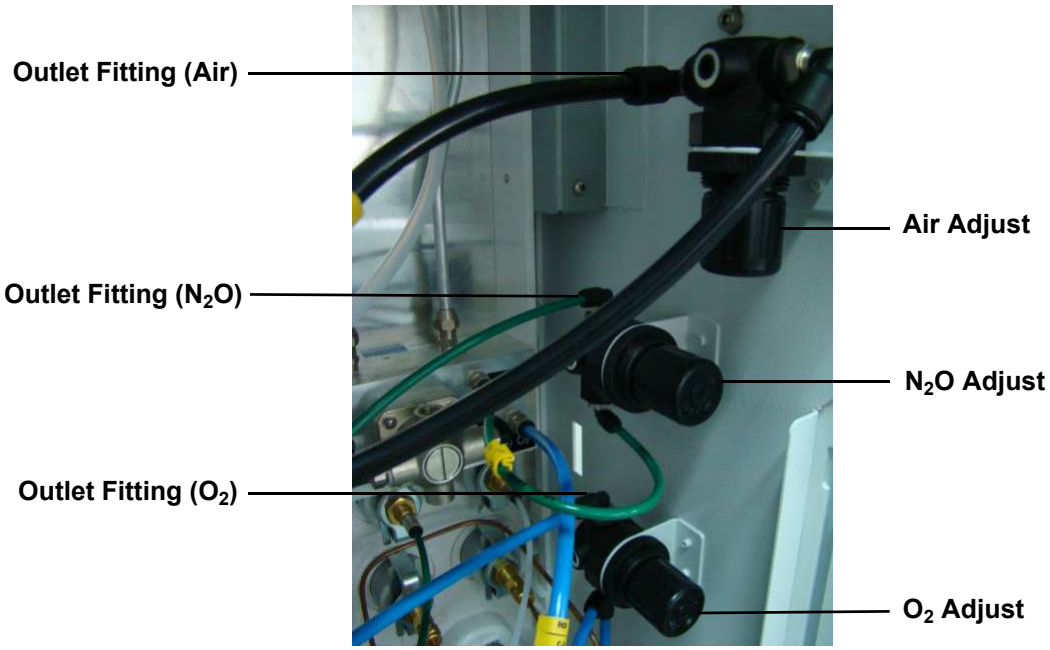
5. Test the regulator setting per the appropriate test in Section 5.1.2:
   - **Test A** — For cylinder regulators that supply drive gas to the ventilator.
   - **Test B** — For all gases not used to supply drive gas to the ventilator.

5.2 Low-pressure Regulators

WARNING When testing N_2O regulators, nitrous oxide flows through the system. Use a safe and approved procedure to collect and remove it.

5.2.1 Testing/ Adjusting Low-pressure Regulators

1. Bleed the system of all pressure (Section 9.1).
2. Remove the upper rear panel (Section 9.2.1).
3. Connect a pressure meter to the regulator outlet port.
4. Connect the pipeline supplies or open the cylinder valve.



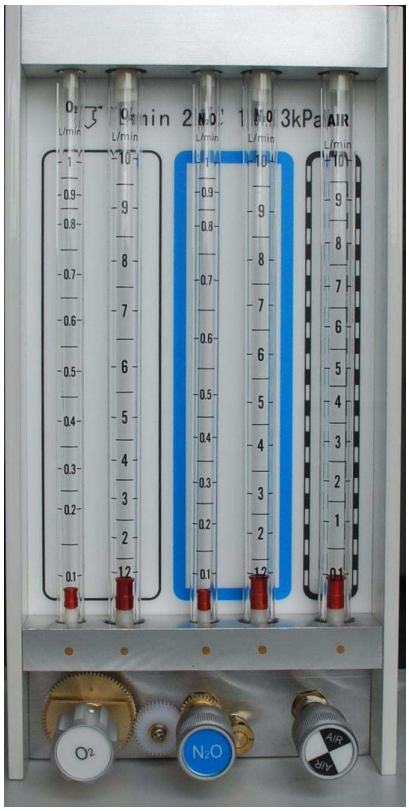
5. Verify that the output of the tested regulator is within the range listed in the chart.

Regulator	Output
N_2O	200 kPa ± 7 kPa
Air	200 kPa ± 7 kPa
O_2	200 kPa ± 7 kPa

6. If required, adjust the N_2O, Air and O_2 regulators to meet the above specifications.
7. Repeat Step 1, 4 and 5 to confirm the adjustment specifications.
8. Disconnect the pressure meter and reconnect the tubings.
9. After all regulators have been tested, perform the Post-service checkout (Section 3).

5.3 Hypoxic Guard

The hypoxic guard is an internal system that is not serviceable. If the hypoxic guard is out of calibration or is malfunctioning, replace the entire flow control assembly.



5.4 Airway Pressure Gauge

5.4.1 Zero the pressure gauge

1. Attach a patient circuit to the Breathing System. Leave the patient end open.
2. Set the Bag/Vent switch to Bag.
3. Adjust the APL valve to maximum.
4. Remove the lens from the pressure gauge:
   - Apply a slight pressure with your thumb and finger tips around the outer edge of the lens.
   - Turn the lens counterclockwise to remove it.
5. Adjust the pressure gauge to zero.
6. Plug the patient circuit.
7. Press and release the O_2 flush button to sweep the needle across the pressure gauge.
8. Remove the plug from the patient circuit to relieve the pressure in the circuit and recheck the zero setting of the pressure gauge.
9. If required, repeat zero and span procedure (Section 5.4.1 and 5.4.2).
10. Replace the lens cover.

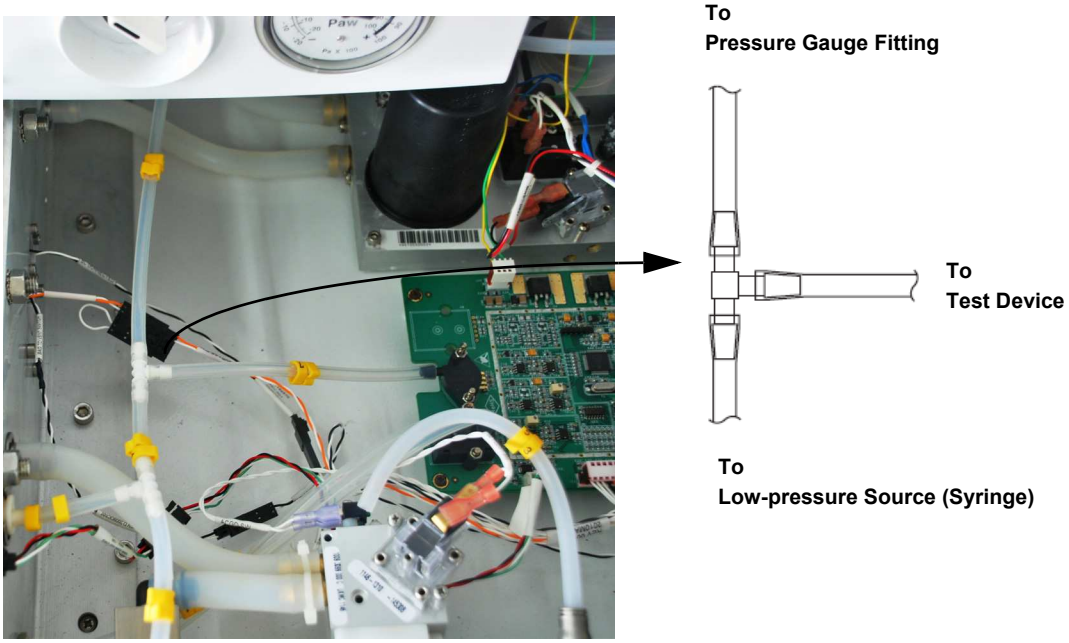
5.4.2 Checking the pressure gauge accuracy

The accuracy of the airway pressure gauge can be checked by using the following:

- a low-pressure test device (digital manometer or test gauge) with an accuracy of ±2% of reading.
- a low-pressure supply source (typically a syringe).
- and an airway pressure gauge test adapter.

1. Ensure that the pressure gauge is zeroed (Section 5.4.1).
2. Remove the table top.
3. Remove the existing tube to the airway pressure transducer on the control sample board and connect a low pressure test device to the remaining open tube.
4. Remove the existing tube to the common gas port and connect a low-pressure supply source (syringe) to the remaining open tube.
5. Adjust the pressure source to the following pressures as read on the airway pressure gauge. The test device gauge should read within the values indicated.

Airway Pressure Gauge	Test Device
0 cm H_2O	0±1 cm H_2O
40 cm H_2O	40±2 cm H_2O
-5 cm H_2O	-5±2 cm H_2O



6 Installation and Maintenance

WARNING This section covers the regular maintenance procedures (minimum requirements) needed to make sure that the 9100c Anesthesia Machine — including the ventilator — operates to specifications.

In this section

6.1 9100c Installation Checklist

Serial Number:	Date: (YY/MM/DD)
Hospital:	Performed by:

☐ 1. Unpack and assemble the 9100c System.
Note: install the AGSS first if equipped.

☐ 2. If necessary, access the ***Service Mode – Languages*** menu and select the correct language.

3. Access the ***Service Mode – Configuration/Upgrade*** menu.

☐ a. Enter the site ***Altitude*** in increments of 100 meters.

☐ b. ***Enable – Disable*** installed optional monitoring and ventilation features purchased by the customer (PCV mode, ACGO switch, CO_2 bypass, O_2 monitoring, PEEP).

4. Access the ***Service Mode – Calibration*** menu. Perform the following calibrations:

☐ a. set ***Calibration coefficient*** (Section 4.5.9).

☐ b. ***Paw Zero*** (Section 4.5.1).

☐ c. ***Paw Gain*** (Section 4.5.2).

☐ d. ***O_2 Cell*** (Section 4.5.3).

☐ e. ***PEEP Valve*** (Section 4.5.4).

☐ f. ***Flow Zero*** (Section 4.5.5).

☐ g. ***Inspiratory Flow Valve*** (Section 4.5.6).

☐ h. ***Flow Sensor Positive*** (Section 4.5.7).

☐ i. ***Flow Sensor Negative*** (Section 4.5.8).

5. Exit the ***Service Mode*** and go to ***Normal Mode***.

6. Complete the System Checkout by performing the following steps:

☐ a. Inspect the system (Section 3.2).

☐ b. Pipeline and cylinder tests (Section 3.3).

☐ c. Flow control test (Section 3.4).

☐ d. Pressure relief tests (Section 3.5).

☐ e. O_2 supply alarm test (Section 3.6).

- ☐ f. Flush flow test (Section 3.7).
- ☐ g. Vaporizer back pressure test (Section 3.8).
- ☐ h. Low-pressure leak test (Section 3.9).
- ☐ i. Alarm tests (Section 3.10).
- ☐ j. Breathing system tests (Section 3.11).
- ☐ k. Power failure test (Section 3.12).
- ☐ l. Electrical safety tests (Section 3.13).

6.2 9100c Planned Maintenance

Serial Number:	Date: (YY/MM/DD)
Hospital:	Performed by:
☐ 12 months ☐ 24 months	☐ _____

This section covers the regular maintenance procedures (minimum requirements) needed to make sure that the 9100c anesthesia machine — including the ventilator — operates to specifications.

6.2.1 Every twelve (12) months

Perform the following steps every 12 months.

For details, refer to the sections listed.

Parts Replacement

☐ Replace the vaporizer port o-rings (Section 9.10).

Machine Checks and Tests

Refer to the 9100c User's Reference Manual.

Perform the following steps:

☐ 1. User maintenance listed below. Including disassembly, inspection, cleaning and parts replacement as required.
- Breathing Circuit Maintenance (Section 7.5)
- Bellows Assembly Maintenance (Section 9)
- Bellows Assembly Tests (Section 9)
- O_2 Sensor Calibration (Section 9)

Refer to listed sections in this manual.

Perform the following steps:

☐ 1. MOPV pressure relief valve test (Section 6.5).

☐ 2. Exhalation valve reilef valve test (Section 6.6).

☐ 3. From the Service Mode, perform the following:
- ***Display Discrete I/O Signals*** (Section 4.4.1)
  Verify proper operations of all circuit boards and switches.
- ***Adjust Drive Gas Regulator*** (Section 6.4)
- ***PAW Zero*** (Section 4.5.1)
- ***PAW Gain*** (Section 4.5.2)
- ***PEEP Valve*** (Section 4.5.4)
- ***Flow Zero*** (Section 4.5.5)
- ***Inspiratory Flow Valve*** (Section 4.5.6)
- ***Flow Sensor Positive*** (Section 4.5.7)
- ***Flow Sensor Negative*** (Section 4.5.8)

☐ 4. Inspect the system (Section 3.2)

☐ 5. Pipeline and cylinder tests (Section 3.3)

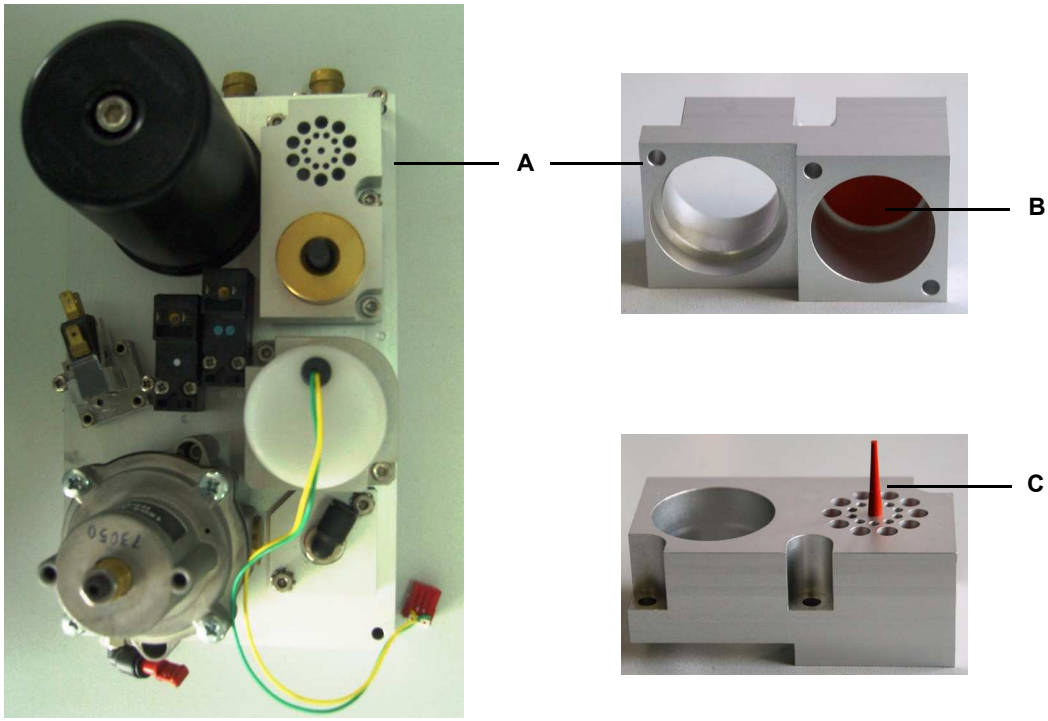
- ☐ 6. Flow control tests (Section 3.4)
- ☐ 7. Pressure relief tests (Section 3.5)
- ☐ 8. Vaporizer back pressure test (Section 3.8)
- ☐ 9. Low-pressure leak test (Section 3.9)
- ☐ 10. Airway pressure gauge accuracy check (Section 5.4)
- ☐ 11. Alarm tests (Section 3.10)
- ☐ 12. Breathing system tests (Section 3.11)
- ☐ 13. Power failure test (Section 3.12)
- ☐ 14. Electrical safety tests (Section 3.13)

6.2.2 Every twenty-four (24) months

In addition to the 12-month requirements, replace the following parts every 24 months. All machine and ventilator parts should be replaced before performing the checks, tests, and calibrations.

- ☐ 1. Replace the free breathing flapper valve.
- ☐ 2. Replace the free breathing valve o-ring.

6.3 Free breathing valve maintenance



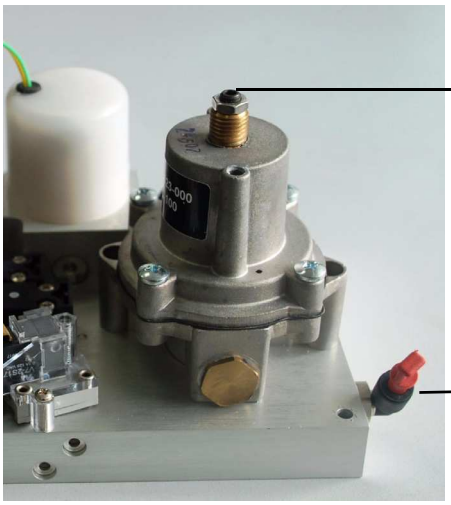
Refer to Section 9.16 to access the Pneumatic Vent Engine.

1. Unscrew the valve seat (**A**) from the vent engine manifold.
2. Inspect the new flapper (**B**) and valve seat for nicks, debris and cleaniness.

To replace the flapper valve

3. If necessary, clean the new flapper valve with alcohol.
4. Pull the tail (**C**) of the new free breathing valve flapper through the center of the valve sear until it locks in place.
5. Trim the tail flush with outside surface of the valve seat (refer to the removed flapper).
6. Scissor the tail, ensure the tail is not longer than 3 mm.
7. Reassemble the system.
8. Perform the Preoperative Checkout Procedure. (refer to the 9100c User's Reference manual).

6.4 Adjust drive gas regulator



1. Set the system switch to Off.
2. Disconnect all pipeline supplies.
3. Remove the plug on the test fitting, and attach pressure test device to the test fitting.
4. Remove the bellows assembly and exhalation valve.
5. Connect the pipeline supplies.
6. Set the system switch to On.
7. Enter the ***Service Mode***. From the “Diagnostic Tests/Tools” menu, select “Valve - Test Tool”.
8. Select “Set Inspiratory FLow Valve” and activate a flow of 15 L/min.
9. Adjust regulator until pressure test device reads 172 kPa (25 psi).
10. Set the system switch to Standby when regulator is adjusted.
11. Reassemble exhalation valve and bellows assembly when adjustment complete.

Remarks

The drive gas regulator should provide a constant gas input pressure of 172 kPa (25 psi).

You can verify this pressure by attaching a pressure test device to the regulator pressure port (shown below) and adjusting the regulator to 172 ±1.72 kPa (25 ±0.25 psi).

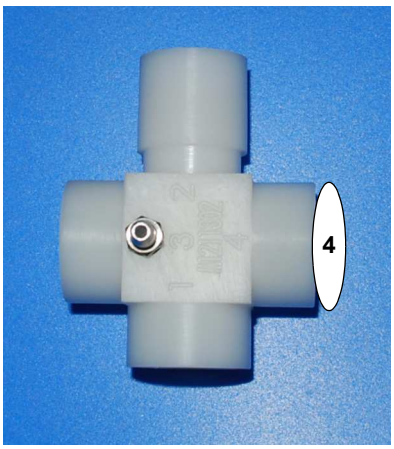
6.5 MOPV pressure relief valve test

WARNING Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

6.5.1 Test setup

1. Remove the breathing system.
2. Plug the drive gas outlet with the test adapter port 4.

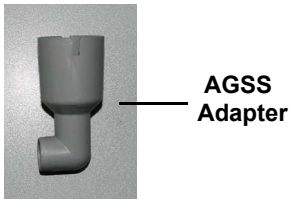


6.5.2 Test procedure

1. Enter the ***Service Mode***. From the “Diagnostic Tests/Tools” menu, select “Valve - Test Tool”.
2. Select “Set Inspiratory Flow Valve” and activate a flow of 10 L/ min.
3. Carefully listen for the MOPV relief weight to be relieving and “popping off” from its seat (a purring sound). This indicates the valve is functioning correctly.
4. Set the system switch to Standby.
5. Remove the test adapter from the common gas outlet.
6. Reassemble the system.
7. Perform the Preoperative Checkout Procedure (refer to the 9100c User’s Reference Manual).

6.6 Exhalation valve relief valve test

1. Connect the open end of the patient Y-piece to the bag port handle.
2. Occlude the bag port.
3. Remove the scavenger receiver, reservoir and side cover, if equipped.
4. Connect the AGSS adapter to the down tube located under the exhalation valve.



5. Occlude the AGSS adapter with a stopper (M1210946).
6. Set the APL valve to minimum and Bag/Vent switch to Bag position.
7. Adjust the O_2 flow to 6 L/min.
8. After 1 minute, observe the Patient Airway on the vent display and/or airway pressure gauge. The pressure should indicate a pressure rise of less than 10 cm H_2O.
   Note: If the pressure rise is more than 10 cm H_2O, replace the 10 cm H_2O dead weight and seat. Repeat the test procedure after the replacement.
9. Remove the occlusions from the down tube and bag port. Remove the patient Y-piece from the bag port handle.
10. Reassemble in reverse order.
11. Perform the Preoperative Checkout Procedure (refer to the 9100c User's Reference Manual).

7 Troubleshooting

In this section

7.1 General Troubleshooting

WARNING Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

Problem	Possible Cause	Action
High Pressure Leak	Pipeline leak	Use a leak detector or Snoop to check for source of leak. Repair or replace defective parts.
	O_2 flush valve	Use a leak detector or Snoop to check for source of leak. Make sure tubing connections are tight. Replace valve if defective.
	Cylinder not installed properly	Make sure cylinder is correctly aligned. Verify that T-handles are tight.
	Cylinder gauges	Use a leak detector or Snoop to check for source of leak. Replace gauge if defective.
	Cylinder gaskets	Use a leak detector or Snoop to check for source of leak. Replace gasket if defective.
	Relief valves	Use a leak detector or Snoop to check for source of leak. Replace valve if defective.
Low Pressure Leak (with vaporizer mounted)	Vaporizer not installed properly	Reseat vaporizer if not installed properly.
	Missing or damaged o-ring on vaporizer manifold	Check condition of o-ring. Replace if missing or damaged.
	Loose fill port	Check fill port. Tighten if loose.
Low Pressure Leak (with or without vaporizer)	Leaking port valve on vaporizer manifold	Use the Vaporizer Manifold Valve Tester to check for leak. See Section 9.10 for instructions. If test fails, tighten, repair, or replace as needed.
	Leak at flowmeter head	If vaporizer manifold passed previous tests: Remove tubing from input side of head and occlude the ports. Perform leak test. If test fails, replace flowmeter assembly.
		Note: An alternate method is to pressurize the system and use a leak detector or Snoop to check for source of leak.
	Leaking relief valve on vaporizer manifold	Remove relief valve. Occlude opening. Perform leak test. If test passes, replace valve.
	Leaking flush valve	Attach pressure measuring device on common gas outlet. Replace valve if device shows increased pressure.
Bellows leak	Pop-off valve diaphragm not sealing properly	Disassemble pop-off valve; inspect and clean seats; reseat; reassemble.
	Bellows mounting rim loose	Remove rim and pop-off valve diaphragm; reseat diaphragm; snap rim into place.
	Bellows improperly mounted or has a hole or tear	Check that only the last bellows convolution is mounted to the rim and that the ring roll is in the groove under the rim. Inspect the bellows for damage; replace.

Problem	Possible Cause	Action
Breathing System Leak	Absorber canister not installed properly	Install canister properly.
	Damaged/missing canister o-ring	Check/replace o-ring.
N_2O flow does not decrease with O_2 flow	Defective flowmeter assembly	Verify low pressure regulator calibration. Replace flow control assembly.
Unable to begin mechanical ventilation	No O_2 supply	Check O_2 supply.
	Defective Manual/Mechanical ventilation switch	Check Manual/Mechanical ventilation switch.

7.2 Breathing System Leak Test Guide

Note Always perform the low-pressure leak test (Section 3.9) on the machine before proceeding with these breathing system leak tests.

The procedure in Section 7.2.1 helps you isolate the leak: to Bag Mode components, to Vent Mode components, or to components that are common to both modes.

- If you have a similar leak in both the bag mode and the ventilator mode, you must consider the Flow Sensor Module, the Circuit Module, the Absorber Canister area, and the bulkhead components (including CGO tubing). Carefully inspect the circuit module for damaged seals or misassembly, and the seating of the O_2 sensor (if equipped).
- If you have a larger leak in one area than the other (Vent or Bag), the leak is most likely NOT in the flow sensor module, the circuit module, the Absorber Canister area, or the bulkhead ports.

The procedures in Section 7.2.1 test specific components of the breathing system for leaks.

WARNING Objects in the breathing system can stop gas flow to the patient. This can cause injury or death:

- Do not use a test plug that is small enough to fall into the breathing system.
- Make sure that there are no test plugs or other objects caught in the breathing system.

7.2.1 Breathing system leak test

This test checks for leaks in Vent Mode and Bag Mode components. It is part of the overall checkout procedure, Section 3.11 “Breathing system tests.” It is repeated here for testing convenience.

1. Verify that AGSS is operating if equipped. For systems that have a flow indicator on the side, make sure that the flow indicator shows a flow in the green (normal) region.
2. Zero the pressure gauge (Section 5.4.1).

Check valves

3. Make sure that the check valves on the breathing circuit module work correctly:
   - The Inspiratory check valve rises during inspiration and falls at the start of expiration.
   - The Expiratory check valve rises during expiration and falls at the start of inspiration.

Ventilator bellows

4. Ventilator bellows test:
   - Set the Bag/Vent switch to Vent.
   - Set the system switch to Standby.
   - Turn all flow controls fully clockwise (closed).
   - Use the test plug or your hand to close the breathing circuit at the patient connection.
   - Push the O_2 flush button to fill the bellows.
   - The pressure must not increase to more than 15 cm H_2O on the pressure gauge.
   - If the bellows falls more than 150 mL/min (top of indicator), it has a leak.

Service Mode Tests

5. Enter the Service Mode: Push and hold the adjustment knob on the ventilator’s display and set the system switch to On.
   - Select and confirm “Service Mode”.
   - From the “Diagnostic Test/Tools”, select “Breathing System Leak Test”.
   - Follow the instructions on the screen.
   - The leak rate should be less than 200 mL/min.

Bag circuit

6. Test the bag or manual circuit for leaks:
   - Set the system switch to On.
   - Set the Bag/Vent switch to Bag.
   - Plug the bag port (use your hand or the approved test plug).
   - Close the APL valve (70 cm H_2O)
   - Set the O_2 flow to 0.25 L/min.
   - Close the patient connection (using a hand or the approved test plug) and pressurize the bag circuit with the O_2 flush button to approximately 30 cm H_2O.
   - Release the O_2 flush button. The pressure must not decrease. A pressure decrease large enough to see on the gauge indicates an unacceptable leak.

APL valve

7. Test the APL valve:
   - Fully close the APL valve (70 cm H_2O).
   - Set the total fresh gas flow to approximately 3 L/min and make sure that the value on the inspiratory pressure gauge does not exceed 85 cm H_2O. Some pressure fluctuation is normal.
   - Fully open the APL valve (to the MIN position).
   - Set O_2 flow to 3 L/min. Turn any other gases off.
   - Make sure that the value on the inspiratory pressure gauge is less than approximately 5 cm H_2O.
   - Push the O_2 flush button. Make sure that the value on the inspiratory pressure gauge stays less than 10 cm H_2O.
   - Set the O_2 flow to minimum and make sure that the value on the inspiratory pressure gauge does not decrease below 0 cm H_2O.
8. Remove your hand or the test plug from the patient connection.
9. Turn all flow controls fully clockwise (closed).
10. Set the system switch to Standby.

WARNING Make sure that there are no test plugs or other objects caught in the breathing system.

7.3 Troubleshooting guide

Symptom	Probable cause	Action
• **Shut down mode**	1. Cable from CSB to DMB. 2. CSB 3. DMB	1. Check cable connection. 2. Replace CSB. 3. Replace DMB.
The system will check the connection between CSB and DMB when it is power on.		

Symptom	Probable cause	Action
• **AC LED not lit** (Power cord plugged into live receptacle; AC Inlet circuit breaker On) (The problem is most likely in the +15V supply or in the LED circuit.)	1. Universal power supply 2. Front panel keyboard (LED is part of it) 3. DMB	1. Check power supply output (Section 2.7.2). 2. Check ribbon cable connection; replace front panel keyboard. 3. Replace DMB.
The LED is powered by the +15V supply from the universal power supply. Turn system switch to On. If ventilator operates from the main supply, check 1. If ventilator operates from backup battery, check 2 and 3.		

Symptom	Probable cause	Action
• **Nothing happens when System switch is turned On** (The problem is most likely somewhere between the system switch and the control sample board.)	1. Cable from J8 of CSB to system switch. 2. Cable from CSB to DMB.	1. Check/jumper cable connection; replace cable. 2. Check cable connection; replace cable.
Turning the system switch to On should connect the power to the system. It is a physical connection for the power supply.		

Symptom	Probable cause	Action
• **No display** (System switch On; LED lit) (The problem is most likely in the Display Module.)	1. Ribbon cable, DMB to LCD display 2. LCD display 3. DMB	1. Check cable connection. 2. Replace LCD display. 3. Replace DMB.
The lit LED indicates that AC power is getting to the power supply. The power supply is most likely OK since it's supplying the 15V to power the LED.		

Symptom	Probable cause	Action
• **No alarm audio** (Alarm messages OK) (The problem is most likely the speaker or control board.)	1. Speaker cable 2. Speaker 3. DMB	1. Ensure cable is plugged in. 2. Replace speaker. 3. Replace DMB.
Power for the speaker comes from the Power Section of the DMB. Drive for the speaker comes from the Digital Section of the DMB board.		

7.4 Alarm and Shutdown messages

Alarm Message

Shutdown Message

This section covers the Alarm messages (not shaded) and Shutdown messages (shaded) experienced by the ventilator system.

If a User Alarm persists after the recommended action has been performed, the message indicates the probable component and related circuit that needs repair. Use the Service Mode tests to isolate the fault. The items in the Service Repair column indicate the path from the named component to the control board.

Message	Alarm/ Shutdown	Cause	User Action/ Concerns	Service Repair
10VA of PEEP and Flow Valve Power Failure	Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable.	Replace: • CSB • DMB • PEEP Valve • Inspiratory Flow Valve
Apnea	User Alarm Middle	No mechanical breaths or spontaneous breaths > 5 mL in last 15 seconds.	Monitoring resumes after first breath (mechanical) or 2 breaths within 30 sec (nonmechanical).	
Connect O_2 sensor?	User Alarm Middle	The O_2 sensor is not connected to the cable.	Connect the O_2 sensor	If persists, check: • O_2 sensor cable • CSB
CSB and Alarm MCU Communication Failure	Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable	Replace: • DMB • CSB • Cable from DMB to CSB
CSB and DMB Communication Failure	Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable	Replace: • DMB • CSB • Cable from DMB to CSB
DMB 3.3V voltage Failure	Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable	Replace: • DMB
Flow Sensor Reference Voltage Failure	Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable	Replace: • CSB
Inspiratory Flow Valve (DAC) Failure	Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is not reliable	Replace: • CSB
Inspiratory Flow Valve (Drive) Failure	Shutdown	Ventilator malfunction.	Ventilate manually. Monitoring is still available.	Check/Replace: • Flow Valve • Flow Valve harness • CSB
Low battery voltage	User Alarm High	Voltage is <11V while using battery power for 0.5 seconds.	Manually ventilate the patient to save power. Is the mains indicator light on? Make sure power is connected and circuit breakers are closed.	

Message	Alarm/ Shutdown	Cause	User Action/ Concerns	Service Repair
MVexp high	User Alarm Middle	The minute volume is greater than the set high limit. This alarm is suspended for 9 breaths after you change the ventilator settings.	Check patient for spontaneous breathing. Adjust control settings.	
MVexp low	User Alarm Middle	Exhaled minute volume less than low limit alarm setting. This alarm is suspended for 9 breaths after you change the ventilator settings.	Check patient condition. Check tubing connections. Check alarm settings.	
Negative airway pressure	User Alarm High	Subatmospheric pressure (<-10 cm H2O).	Check patient condition, spontaneous activity? Increase fresh gas flow. Look for high flow through gas scavenging.	If persists, check: • Paw Zero • Paw Gain • CSB
No breathing circuit	User Alarm High	Breath circuit switches do not detect breathing circuit module	Check the breathing circuit installation	If persists, check: • Breathing circuit installation microswitch • CSB
No CO_2 absorption	User Alarm Middle	CO_2 bypass selected	User setting. Close the canister release to remove CO_2 from exhaled gas.	
No drive gas	User Alarm Middle	The ventilator does not detect supply pressure.	Manually ventilate the patient. Make sure that the appropriate gas supplies (O_2 or Air) are connected and pressurized.	
No O_2 pressure	User Alarm High	The O_2 supply has failed.	Air flow will continue. Ventilate manually if necessary. Connect a pipeline supply or install an O_2 cylinder.	
O_2 flush stuck on?	User Alarm Middle	The pressure switch that detects flush flow has seen a very long flush (≥30 sec).	This alarm occurs if you hold down the Flush button for more than 30 seconds.	If persists, check: • O_2 flush switch • Harness to CSB • CSB
O_2% high	User Alarm Middle	O_2% > alarm high limit setting.	Is the limit set correctly? What is the O_2 flow? Did you just push Flush? Does the sensor see 21% O_2 in room air? Calibrate O_2 sensor. Replace O_2 sensor.	
O_2% low	User Alarm Middle	O_2% less than alarm low limit setting.	Is the limit set correctly? Is the O_2 flow sufficient? Does the sensor see 21% O_2 in room air? Calibrate O_2 sensor. Replace O_2 sensor. As sensors wear out, the measured% O_2 decreases.	

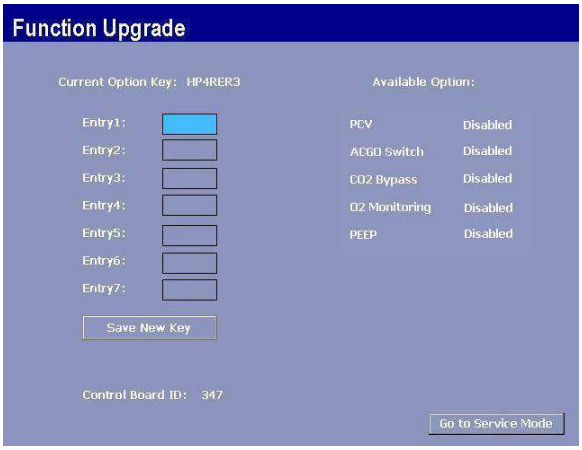
Message	Alarm/ Shutdown	Cause	User Action/ Concerns	Service Repair
On battery, power ok?	User Alarm Middle	The mains supply is not connected or has failed and the system is using battery power.	Ventilate manually to save power. At full charge, the battery permits approximately 30 minutes of mechanical ventilation. Make sure power is connected and circuit breakers are closed.	
Paw high	User Alarm Middle	Paw is greater than Plimit. The ventilator cycles to expiration.	Are Plimit and other controls set correctly? Look for blockages. Check patient connection.	
Paw low	User Alarm Middle	Paw does not rise at least 4 cm above Pmin during the last 20 sec.	Are circuit connections OK? Look at the Paw gauge on the absorber. Look for circuit disconnection.	
Paw Sensor Reference Voltage Failure	Shutdown	Indicates a failure of the airway pressure transducer	Ventilate manually. Monitoring is not reliable.	Replace: • CSB
PEEP Valve (DAC) Failure	Shutdown	Indicates a failure of the control circuit for the PEEP Valve.	Ventilate manually.	Replace: • CSB
PEEP Valve (Drive) Failure	Shutdown	Indicates a problem with the PEEP Valve or the connections to the PEEP Valve	Ventilate manually.	Check/Replace: • PEEP Valve • PEEP Valve harness • CSB
Sustained Paw high	User Alarm High	Paw is greater than sustained pressure limit for 15 seconds.	Check tubing for kinks, blockages, disconnects. Calibrate the flow sensors.	
TVexp high	User Alarm Middle	Exhaled tidal volume is greater than high alarm limit. This alarm is suspended for 9 breaths after you change the ventilator settings.	Check patient for spontaneous breathing. Check ventilator and alarm settings.	
TVexp low	User Alarm Middle	Exhaled tidal volume less than low limit alarm setting. This alarm is suspended for 9 breaths after you change the ventilator settings.	Check patient condition. Check tubing connections. Check alarm settings.	

8 Software Installation

In this section

8.1 Before replacing the Display Monitor Board

When new Display Monitor Board is installed, the Function Upgrade options are reset to “not installed” (Section 4.6.1).



To help ensure that, after repair or software replacement, the 9100c system will include all features that are currently installed and enabled, record the current Function Upgrade options installed.

The Function Upgrade options are presented in all machines:

- ***PCV***: Enabled or Disabled.
- ***ACGO Switch***: Enabled or Disabled.
- ***CO_2 Bypass***: Enabled or Disabled.
- ***O_2 Monitoring***: Enabled or Disabled.
- ***PEEP***: Enabled or Disabled.

8.1.1 Key/BID label (Key Code)

The replacement Display Monitor Board includes a Key/BID label that is appropriate for machines that include all of the optional features. If the machine includes only some of the optional features, access the Key Code Generator web site to obtain the appropriate optional features Key Code.

1. Gather the following information (* denotes Required Information):

Requestor Information	
* Email Address	
* Full Name	
* Organization	
End User Information	
Hospital Name	
Address 1	
Address 2	
City	
Postal Code	
Country	
Telephone	
Information from the EXISTING Control Board being REMOVED	
* Control Board ID number	
* Control Board Key Code	
Information from the REPLACEMENT Control Board being INSTALLED	
* Control Board ID Number	

Note The Control Board here only refer to the replacement Display Monitor Board for the 9100c system. The replacement Control Sample Board doesn't need the appropriate optional features Key Code.

2. Access the Key Code Generator on the following web site.
   - http://www.docodes.com
3. Enter the required information and Submit the Request.

An e-mail with the replacement Display Monitor Board Key Code will be immediately sent to the e-mail address provided (due to delays in some firewalls and internet traffic, responses can take up to 24 hours to receive).

Note: For traceability, the Global Service and Support Helpdesk is copied on the email.

8.2 After replacing the DMB (Display Module)

1. Activate the appropriate options on the ***Function Upgrade*** menu (Section 4.6.1) following the steps below.
   - Enter the ***Service Mode***.
   - Select ***Function Upgrade***.
   - Enter the appropriate Key Code to restore the original Function Upgrade options
2. Record the new (web site generated) Key Code on a sticker. .
3. Affix the BID label provided in the replacement Display Monitor Board kit (or on the Display Module) and the Key Code sticker to the left side panel of the Display Module.

8.3 After replacing the CSB

Load the appropriate software revision (Section 8.4) using software USB disk that matches the software revision of the replaced Control Sample Board (CSB).

8.4 Software Installation

1. Set the system switch to On.
2. Enter the ***Service Mode***.
3. Select the "***Software Upgrade***" from the ***Configuration/ Upgrade*** menu.
4. Follow the instructions on the screen to complete the installation.
5. Set the system switch to Standby.
6. Remove the Software USB disk.
7. On the ***Function Upgrade*** menu (Section 4.6.1) of the ***Service Mode***, enter the options Key Code found on the side of the display module to restore the original Upgrade Options.
8. On the Altitude Setting menu of the Service Mode, reset the Altitude (Section 4.6.4).
9. Perform the preoperative checkout procedure.

9 Repair Procedure

In this section

WARNING To prevent fires:

- Use lubricants approved for anesthesia or O_2 equipment, such as Krytox.
- Do not use lubricants that contain oil or grease; they bum or explode in high O_2 concentrations.

Obey infection control and safety procedures. Used equipment may contain blood and body fluids.

A moveable part or a removable component may present a pinch or a crush hazard. Use care when moving or replacing system parts and components.

When servicing the ventilator, extreme care must be taken to avoid introducing foreign debris, particularly metal chips generated by screw threads, into the pneumatic flow passages of the ventilator. Failure to do so can result in damage to the flow valve and possible injury to the patient.

Some internal parts have sharp edges and can cause cuts or abrasions. Use care when servicing internal components.

After repairs are completed, always perform the checkout procedure before returning the system to clinical use. Refer to Section 3 of this manual.

9.1 How to bleed gas pressure from the machine

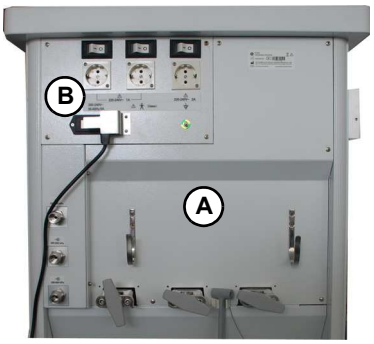
Before disconnecting pneumatic fittings, bleed all gas pressure from the machine.

1. Close all cylinder valves and disconnect all pipeline supplies from the source.
   Note: If the machine includes N_2O, do not disconnect the O_2 pipeline.
   If pipeline O_2 is not available, open the O_2 cylinder valve.
2. Turn the flow controls for all gases (except O_2) at least one turn counterclockwise.
3. Make sure that all cylinder and pipeline gauges read zero before proceeding.
   - For machines with N_2O, disconnect the O_2 pipeline supply from the source (or close the O_2 cylinder valve).
   - Push the O_2 flush button to bleed O_2 from the system.

9.2 How to remove the rear panels

You must remove the rear panels to repair or replace many of the machine's components.

9.2.1 To remove the upper rear panels



1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Disconnect all electrical cables.
4. To remove the large upper rear panel (**A**), fully loosen the eight screws that hold the panel in place.

5. Remove the small upper rear panel (**B**) to access the access the electrical enclosure.

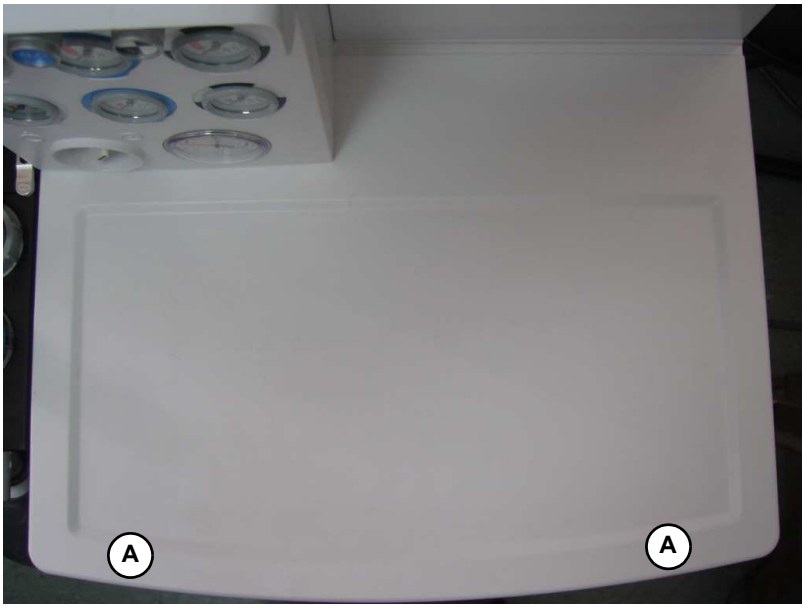
9.2.2 To remove the lower access panel

You must remove the lower access panel to repair or replace the transformer assembly if equipped.

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. If present, remove the inboard cylinders.
4. To remove the lower access panel, fully loosen the six screws that hold the panel in place.

9.3 How to remove the tabletop

The tabletop is held in place with two captive screws along the periphery of the pan assembly (access from below the rim of the tabletop).

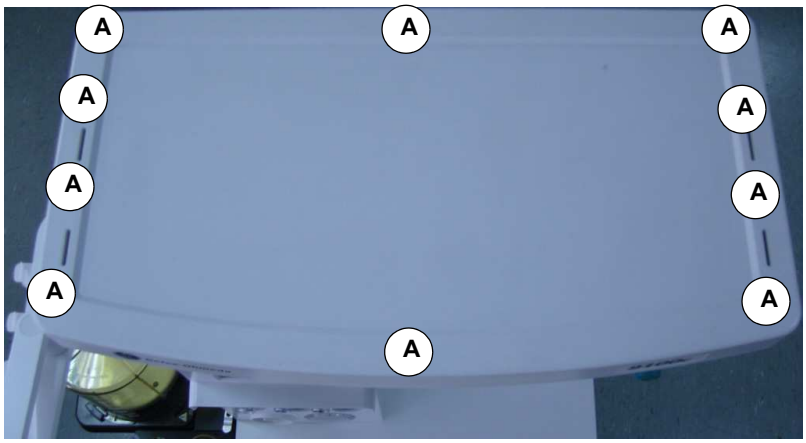


To remove the tabletop:

1. Loosen the two screws (**A**).
2. Slide the tabletop forward and lift to remove.

9.4 How to remove the upper shelf

The upper shelf is held in place with ten screws (B) along the periphery of the pan assembly.



To remove the upper shelf:

1. Loosen the ten screws (**A**).
2. Lift the upper shelf.

9.5 Service the pipeline inlet manifold components

The pipeline inlet filter and the inlet check valve can be replaced without removing the pipeline manifold from the machine.

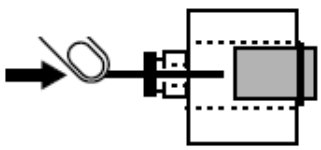
9.5.1 Replace pipeline inlet filter

1. Remove the pipeline inlet fitting.
2. Pull the pipeline inlet filter out of the fitting. The o-ring should come out with the filter.

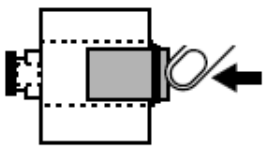
3. Install the new pipeline inlet filter in the pipeline inlet fitting. The new filter comes with an o-ring.

9.5.2 Replace pipeline inlet check valve

1. Remove the rear upper panel (Section 9.2).
2. Remove the pipeline inlet fitting.
3. The Air and O_2 pipeline manifolds include a drive gas connection at the back of the manifold. Remove the drive gas tube or plug to access the check valve.
4. From the back of the pipeline manifold, use a thin tool to push out the check valve.
   (For an N_2O manifold, you will have to carefully apply pressure at the outlet of the manifold — with a syringe for example — to gently force the check valve out of the manifold).



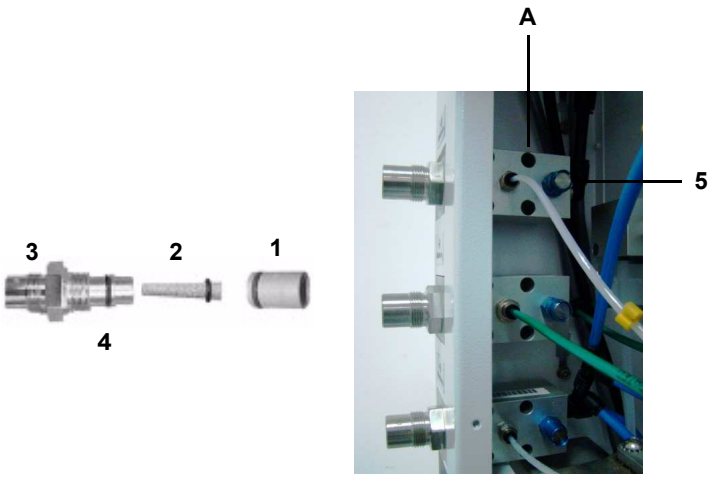
5. Push the new check valve into the opening, using the same thin tool. The new check valve includes an o-ring — orient it toward the pipeline inlet. **Note:** Make sure to push the new check valve all the way back into the opening until it bottoms out on the shoulder.



6. Install the pipeline inlet fitting.

9.5.3 Replace the inlet manifold

1. Remove the rear upper panel (Section 9.2).
2. Disconnect the tubing from the manifold outlet(s).
3. Remove the four screws (**A**) that hold the manifold to the side extrution.



4. Transfer the following item to the replacement manifold or install new as required.
   - pipeline check valve (**1**)
   - inlet filter (**2**)
   - inlet fitting (**3**) and o-ring (**4**)
   - relief valve (**5**)
5. To reassemble, perform the previous steps in reverse order.
6. Perform the checkout procedure (Section 3).

9.6 Service the cylinder supply modules

WARNING Be careful not to expose internal components to grease or oil (except Krytox or equivalent).

9.6.1 Tightening procedure for high-pressure tube fittings

The cylinder pressure gauge is connected to the cylinder supply through a copper tube with fittings at both ends. Use the following tightening procedure whenever you are replacing a cylinder supply or a cylinder pressure gauge.

1. Insert the tubing into the fitting until the ferrule seats in the fitting.
2. Tighten the nut by hand.
3. Continue tightening the nut with a wrench until it reaches the original position (about 1/4 turn). You will feel an increase in resistance at the original position.
4. After reaching the original position, tighten the nut just slightly.

Note If you are installing a new tube that has not been tightened before, tighten the nut with a wrench an additional 3/4 of a turn after the nut is finger tight.

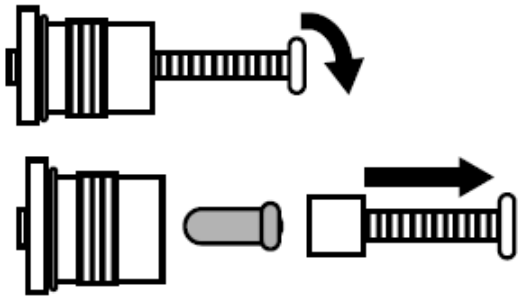
9.6.2 Replace cylinder regulator module (complete replacement)

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the rear upper panel (Section 9.2).
4. Disconnect the high-pressure cylinder gauge fitting.
5. Disconnect the output tube fitting.
6. Remove the three mounting screws and lock washers.
7. To reassemble, perform the previous steps in reverse order.
   - Tighten the high-pressure fitting as detailed in Section 9.6.1.
   - Pull on the cylinder output fitting to ensure it is locked in place.
8. Check the output of the regulator BEFORE you install the rear upper panel. Adjust if necessary (Section 5.1).
9. Perform the checkout procedure (Section 3).

9.6.3 Replace cylinder inlet filter

1. Open the cylinder yokes.
2. Remove the inlet adapter from the cylinder yoke, using a 4 mm hex wrench.
   Note: A brass retaining ring keeps the filter inside the inlet adapter.
3. Thread a 6-mm screw (two turns only) into the brass retaining ring and pull it out.

CAUTION Be careful not to crush the filter. Do not thread in the screw more than two full turns.



4. Remove the filter.
5. Install the new filter and brass retaining ring.
6. Install the inlet adapter in the cylinder yoke.
7. Perform the checkout procedure (Section 3).

9.6.4 Replace cylinder check valve

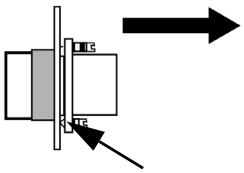
The cylinder check valve is not a replaceable item. If the check valve is defective, you must replace the complete cylinder supply module.

9.7 Replace system switch assembly

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Disconnect all electrical cables.
4. Remove the rear upper panel (Section 9.2).

Front View

Rear View



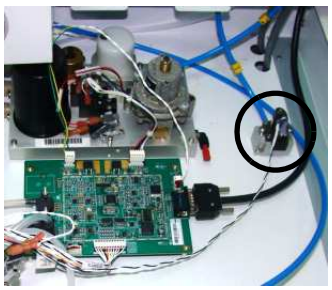
Gauge Panel

5. Loosen the two outside sewers and disconnect the wires from the system switch.
6. Back out the system switch mounting screws just enough to allow the knob collar to be released.
7. While holding the switch assembly, push in the knob and turn it counterclockwise.
8. Pull the knob and collar out from the front and remove the switch assembly.
9. Install the replacement switch assembly:
   - Insert the wires in the electrical module and tighten the screws.
   - Pull the wires on the electrical module to ensure that there is a good connection.
   - Turn back the system switch mounting screws until their tips recede.
   - Install the switch assembly through the gauge panel.
   - Push the knob collar in with the indicator up and turn it clockwise until it locks.

- Tighten the mounting screws. Make sure that the top edge of the switch assembly is parallel to the top edge of the gauge panel.

10. Test the replacement switch assembly:
    - Connect the power cable to an electrical outlet.
    - Set the power switch to On.
    - Set the system switch to On.
    - Make sure that the display comes On.
    - Set the system switch to Standby.
    - Make sure that the display turns Off.
11. Reinstall the rear panel.
12. Perform the checkout procedure (Section 3).

9.8 Replace O_2 supply switch

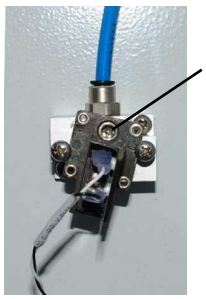


The O_2 supply switch is located under the tabletop.

1. Remove the tabletop (Section 9.3).
2. Remove the two mounting screws from the O_2 supply switch.
3. Pull the O_2 supply switch out of the manifold.
4. Install the replacement O_2 supply switch.
5. Tighten the screws.
6. Disconnect the leads from the old switch and reconnect them to the new switch.
7. Adjust the alarm threshold for the new O_2 supply switch, as explained in the checkout procedure below (Section 9.8.1).
8. Replace the tabletop.
9. Perform the checkout procedure (Section 3).

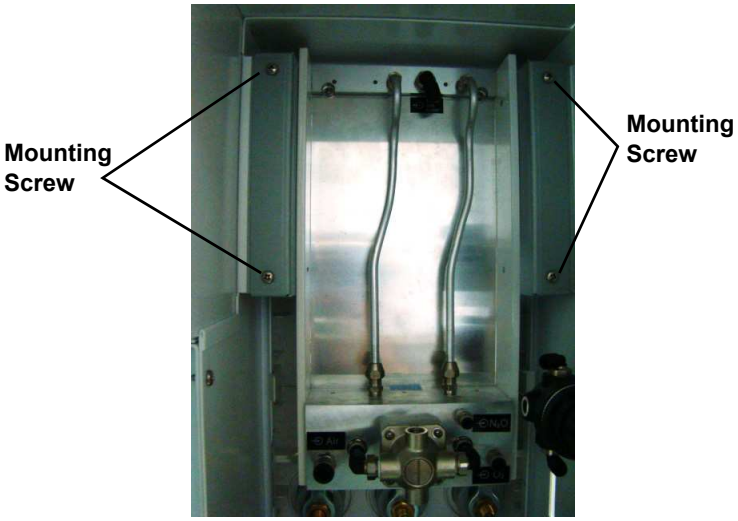
9.8.1 Checkout procedure for O_2 supply switch

1. Remove the tabletop (Section 9.3).
2. Remove the remove the large upper rear panel (Section 9.2).
3. Disconnect all pipeline hoses from the wall and the machine, close all gas cylinders.
4. Attach a gauge to the O_2 primary regulator test port. (On pipeline only machines, attach the gauge to a 6-mm O_2 port).
5. Zero the O_2 flow.
6. Install an O_2 cylinder and open the cylinder valve (for pipeline only, connect O_2 pipeline source).
7. Set the system switch to On.
8. Close the cylinder valve (disconnect pipeline from source) and watch the test gauge as the O_2 pressure bleeds down slowly. **Note**: The “No O_2 pressure” alarm should occur between descending pressure of 221–193 kPa (32–28 psi).
9. If adjustment is required, set the adjustment screw so that the “No O_2 pressure” alarm occurs at 207 ±7 kPa (30 ±1 psi).
10. Disconnect the gauge and plug the test port.
11. To reassemble, perform the previous steps in reverse order.
12. Perform the checkout procedure (Section 3).

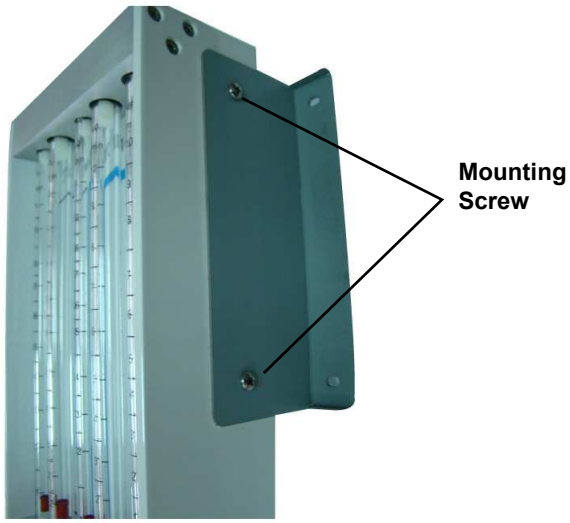


9.9 Replace the flowmeter module

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the rear upper panel (Section 9.2.1).
4. Disconnect the tubings at the rear of the flowmeter module.
5. Remove the four mounting screws from the manifold.



6. Pull the flowmeter module backward slowly.
7. Remove the four screws from the side panels.
   Note: Two screws from each side panel.

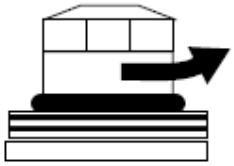


8. To reinstall, perform the previous steps in reverse order.
9. Perform the checkout procedure (Section 3).

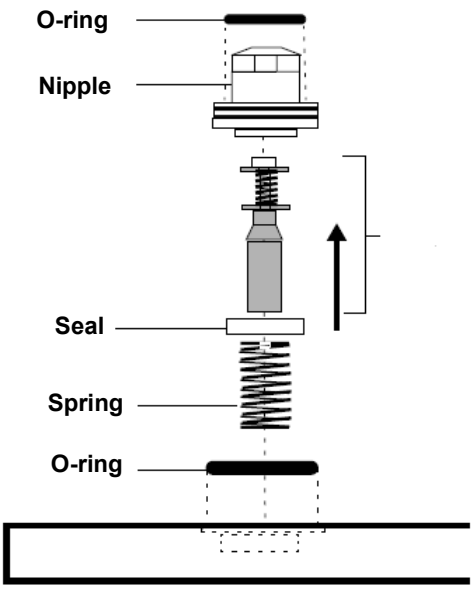
9.10 Service vaporizer manifold parts

9.10.1 Repair manifold port valve

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the vaporizers from the vaporizer manifold.
4. Using a 14-mm wrench, carefully remove the valve nipple (threaded).



5. Disassemble as necessary to replace parts. The following illustration shows the parts.



6. When installing a new valve cartridge assembly into the vaporizer manifold, put a light coat of Krytox on the bottom of the cartridge. The bottom portion of the cartridge is defined as the brass surface that is inserted in the lower spring. **Note:** Do not apply krytox to the valve seal.
7. Verify that the parts are free of dust and dirt.
8. To reassemble, perform the previous steps in reverse order.
9. Complete the port valve checkout procedure described below (Section 9.10.2).

9.10.2 Checkout procedure for manifold port valve

Use the Vaporizer Manifold Valve Test Tool to perform the checkout procedure for the manifold port valve. This tool and test procedure are intended for use only when the valve cartridge assembly is replaced.

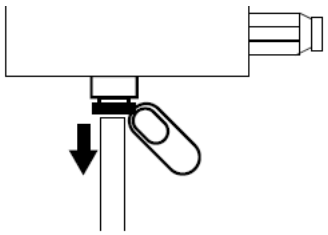
Note This replacement and test procedure is a service action and is not part of the maintenance program.

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. After replacing the valve cartridge assembly, remove the vaporizer port o-ring.
4. Attach the valve testers to the top of the valve by sliding the bottom of the tester onto the o-ring groove.
5. Tighten the tester screw down onto the valve until the screw bottoms out on the top of the valve. The tester o-ring should create a seal with the top of the valve.
6. Remove the rear upper panel (Section 9.2).
7. Remove the inlet tube from the vaporizer manifold.
8. Test the negative low-pressure leak-test device:
   a. Put your hand on the inlet of the leak-test device. Push hard for a good seal.
   b. Remove all air from the bulb.
   c. The bulb should not inflate in less than 60 seconds.
9. Attach the negative low-pressure leak-test device to the common gas outlet using the test adapter (Section 3.9.1).
10. Remove all air from the bulb. The bulb should not inflate in less than 45 seconds.
11. Remove the valve tester.
12. Reassemble the inlet tube, vaporizer port o-ring, and the upper rear panel.
13. Conduct a negative low-pressure leak test on the system (Section 3.9.1).

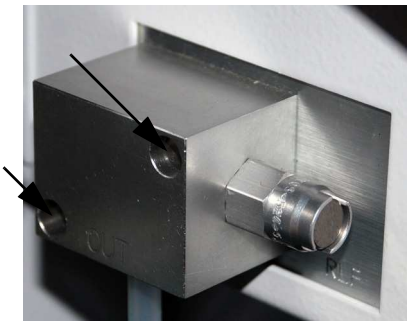
WARNING If the valve test tool is not removed before flowing gas through the system, pneumatic head damage could result.

9.10.3 Replace vaporizer manifold check valve

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the vaporizers from the vaporizer manifold.
4. Remove the upper rear panel. (Section 9.2)
5. Disconnect the tubing from bottom of the valve block.

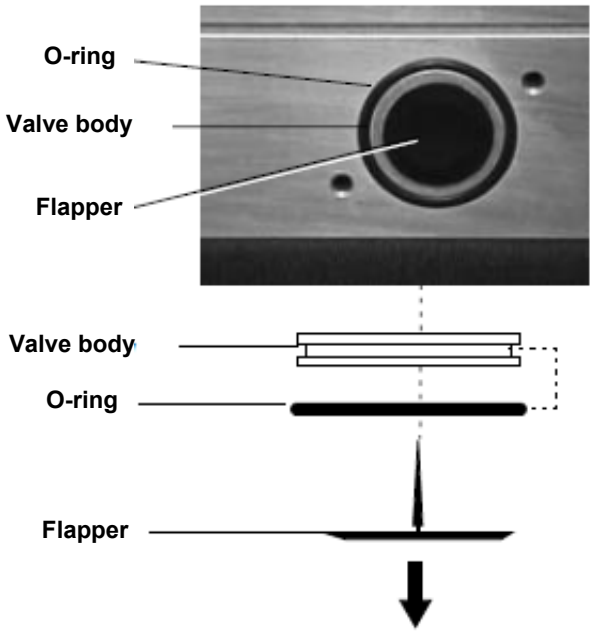


6. Loosen the two screws to remove the valve block.



Note The valve body, o-ring, and flapper do not come out with the block. They stay intact at the back of the vaporizer manifold.

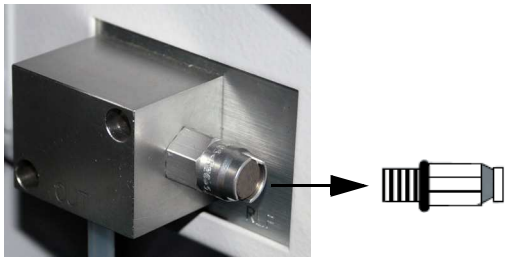
7. Pull the flapper out of the valve body.



8. Using a hex wrench, put the wrench through one of the holes of the valve body and pull out to remove the valve body and o-ring.
9. Verify that parts are free of dust and dirt.
10. Replace the flapper by inserting the flapper stem and gently pulling the stem until the flapper secures to the valve body.
11. Lightly lubricate the o-ring with Krytox.
12. Place the lubricated o-ring on the valve body port at the back of the manifold.
13. Gently install the valve body in the manifold:
    - Check that the o-ring makes a good seal between the manifold and the valve body.
    - Check that the flapper valve makes solid contact with the valve body.
14. Install the valve block.
15. Reconnect the tubing to the valve block. Pull on the tube to ensure that it is locked in the fitting.
16. Install the vaporizer front panel.
17. Perform the checkout procedure (Section 3).

9.10.4 Replace vaporizer pressure relief valve

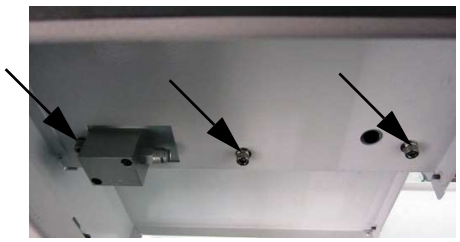
1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the vaporizers from the vaporizer manifold.
4. Remove the rear upper panel. (Section 9.2)
5. Disconnect the tubing from the valve block.
6. Using a 13mm open ended wrench, remove the vaporizer pressure relief valve by turning counterclockwise.



7. Verify that the parts are free of dust and dirt.
8. Install a new vaporizer pressure relief valve.
9. To reassemble, perform the previous steps in reverse order.
10. Perform the checkout procedure (Section 3).

9.10.5 Replace vaporizer manifold

1. Bleed all gas pressure from the machine (Section 9.1).
2. Ensure that all cylinder and pipeline gauges read zero before proceeding.
3. Remove the vaporizers from the vaporizer manifold.
4. Remove the rear upper panel. (Section 9.2)
5. Disconnect the tubing from the valve block.
6. While holding the vaporizer manifold, remove the three screws at the right-hand extrusion to release the manifold.



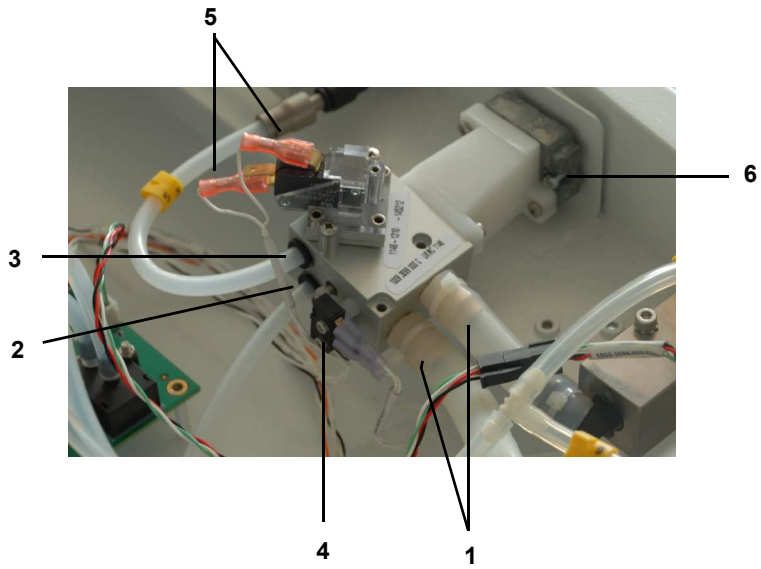
7. Reassemble the machine in reverse order.
8. Perform the checkout procedure (Section 3).

9.11 Service ACGO switch

9.11.1 Replace ACGO switch

Removal

1. Remove the tabletop (Section 9.3)
2. Clip the tie wraps (**1**) from the outlet barb fittings at the side of the switch.

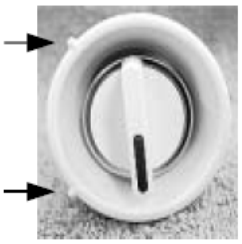


3. Disconnect the fresh gas (**2**) and flush (**3**) tubes at the back of the switch.
4. Disconnect the wires from the ACGO mode microswitch (**4**) at the back of the selector switch.
5. Disconnect the wires from the flush pressure switch (**5**) on top of the selector switch.
6. Set the ACGO selector switch to Breathing System.
7. Back out the selector switch mounting screws (**6**) until the tips are flush with the face of the mounting casting.
8. While pushing the selector knob toward the machine and holding it steady, push the valve body toward the knob and rotate it counterclockwise to separate the valve body from the knob assembly.
9. Remove the knob assembly and protective shroud from the machine.
10. Remove the valve from the silicone output tubes.

Replacement

1. Remove the knob assembly from the valve body.
2. Back out the selector switch mounting screws until the tips are flush with the face of the mounting casting.
3. Guide the outlet fittings of the valve body into their respective silicone tubes.
4. Hold the selector knob with the indicator mark facing down. Turn the chrome collar to its maximum counterclockwise position (as viewed from the front).

5. Place the shroud over the knob and guide the assembly into the pan opening.
6. Ensure that the indicators on the shroud align with label on the pan and the alignment tab mates with the alignment hole in the pan.



7. While holding the knob assembly steady against the pan, place the valve assembly over the knob actuator. Using moderate force press the two assemblies together. The knob should rotate to the ACGO position.

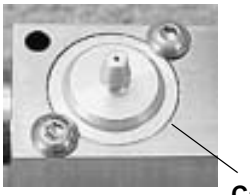
8. While continuing to force the assemblies together, rotate the knob assembly to the Breathing System position. The assemblies should snap into place.
9. Verify proper alignment of the knob with the setting indicators. Tighten the mounting screws evenly to secure the switch assembly to the pan.
10. Secure the outlet tubing with tie wraps.
11. Connect the fresh gas and flush gas tubing. Pull on the tubing to ensure that it is locked in the fitting.
12. Reconnect the wires to the ACGO mode microswitch at the back of the valve (top two terminals).
13. Reconnect the wires to the flush pressure switch at the top of the valve(upper and lower terminals).
14. Replace the tabletop.

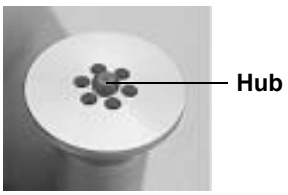
Test Procedure

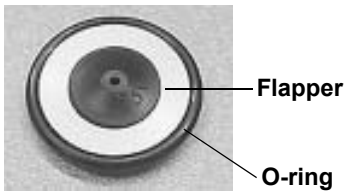
1. Confirm that flush flow and 5 L/min fresh gas flow are diverted to the ACGO port and the Breathing System in the respective knob positions.
2. Confirm that the ventilator display indicates ACGO mode when the valve is set in the ACGO position.
3. Test the function of the flush pressure switch. (Section 4.4.1, "*Discrete I/O Signal*")
4. Perform the low-pressure leak test (Section 3.9).
5. Perform the checkout procedure (Section 3).

9.11.2 Clean or replace ACGO port flapper valve

1. Remove the tabletop (Section 9.3).
2. Remove the ACGO cap mounting screws.
3. Remove the cap.
4. Examine the flapper and disk for obstructions or debris. Clean with isopropyl alcohol if necessary; retest.
5. If leak persists, replace the flapper.
   - Remove the flapper from the check valve disk.
   - Clean the new flapper with isopropyl alcohol.
   - Apply a drop of isopropyl alcohol to the center hub of the new flapper.
   - Before the alcohol evaporates, align the center hub of the new flapper with the center hole of the check valve disc.
   - While pressing the flapper against the disc, use your fingernail to help pull the hub through the disc from the other side.
6. Lubricate the o-ring sparingly with Krytox (do not get Krytox on the flapper).
7. Insert the flapper assembly into the ACGO outlet with the flapper up.
8. Replace the cap.



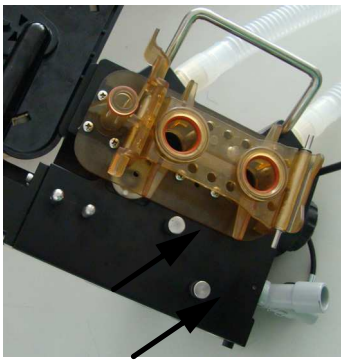




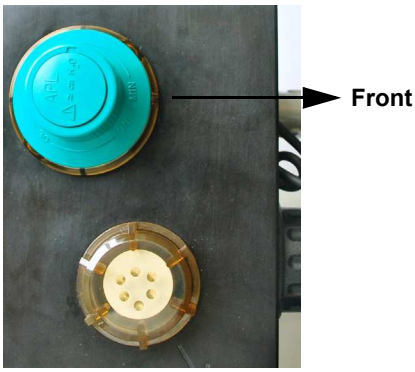
9.12 Replace the breathing system components

9.12.1 Replace APL valve

1. Remove the breathing system.
2. Remove the absorber canister and the EZchange module if equipped.
3. Loosen the two thumbscrews that hold the APL to the breathing system.



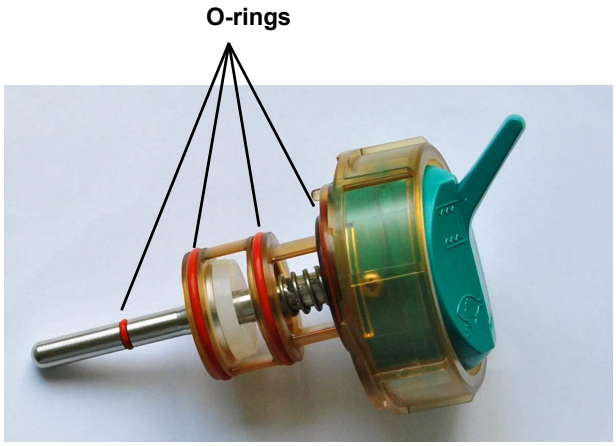
4. Place the new APL valve into position with the setting indicator facing to the front of the machine.
5. Reassemble in reverse order.
6. Reinstall the breathing system.
7. Perform the checkout procedure (Section 3).



9.12.2 Replace Bag/Vent switch assembly

1. Remove the breathing system.
2. Rotate the Bag/Vent switch fixing lock (**A**) counterclockwise to release the Bag/Vent switch.

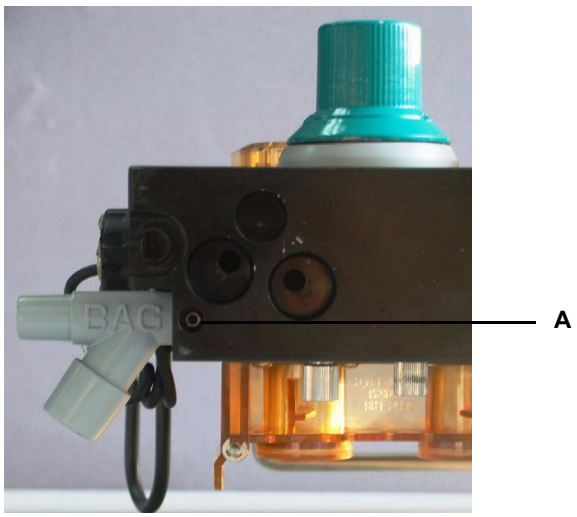
3. Lift out the Bag/Vent switch from the manifold.
4. Replace the o-rings as necessary. Lubricate o-rings sparingly with Krytox.



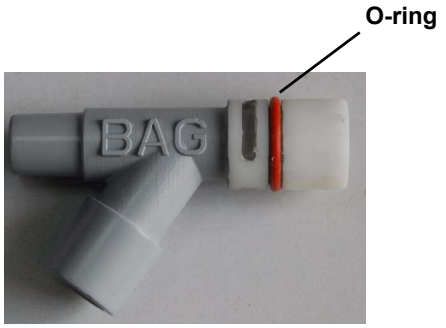
5. Replace the Bag/Vent in reverse order.
6. Reinstall the breathing system.
7. Perform the checkout procedure (Section 3).

9.12.3 Replace the Bag port

1. Remove the breathing system.
2. Fully loosen the screw (**A**) to release the bag port.



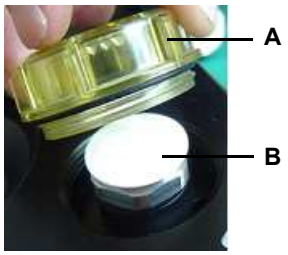
3. Pull out the bag port from the manifold.
4. Replace the o-ring as necessary. Lubricate the o-ring sparingly with Krytox.



5. Replace the bag port in reverse order.
6. Reinstall the breathing system.
7. Perform the checkout procedure (Section 3).

9.12.4 Replace the disc seat of inspiratory/expiratory check valves

1. Remove the transparent covers (**A**) from the inspiratory and expiratory check valves on the breathing system, and take off the ceramic disc.
2. Remove the disc seat (**C**) by using a wrench.
3. If required, replace the disc seat and the o-ring (**D**).
4. Install the new disc seat into place.
5. If required, install a new ceramic disc (**B**).
6. Reinstall the transparent covers.
7. Perform the checkout procedure (Section 3).



Check valve test

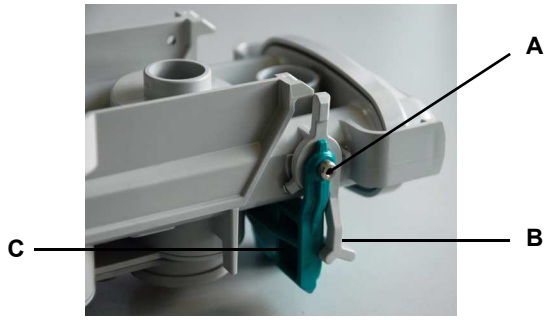
In normal operation, observe the check valve whether it can rise and fall normally within transparent cover.

- The expiratory check valve rises during the expiration and falls at the start of inspiration.
- The inspiratory check valve rises during inspiration and falls at the start of expiration.

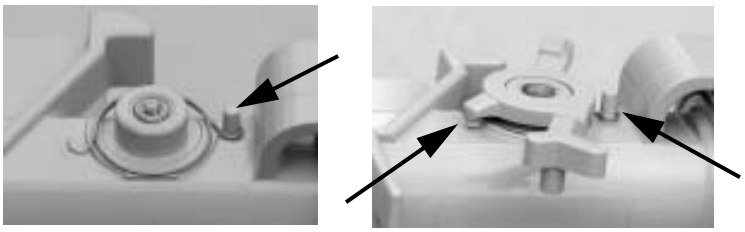
Perform the post-service checkout procedure.

9.12.5 EZchange Canister spring replacement

1. Detach the EZchange module from the machine.
2. Remove the two M3 shoulder screws (**A**) that fasten the canister latch lever (**C**).



3. Remove the latch lever, the switch actuator lever (**B**) and the spring; discard the spring.
4. Place the new spring on the module (as shown below). Position the switch actuator lever over the spring. Ensure the spring hooks are fully engaged into the posts on the manifold and the actuating lever.



5. Clean any residual Loctite debris from the M3 shoulder screws removed in Step 3.
6. Place the canister latch lever in position. Apply Loctite 242 to the threads of the two M3 shoulder screw threads and secure the canister latch level.
7. Check the switch actuator lever to ensure free movement. If sticking is observed, loosen the M3 shoulder screw approximately 1/8 of a turn until free movement of the switch actuator lever is observed.
8. Install the module cover.
9. Install the EZchange module.
10. Verify that the 'No CO2 absorption' message appears on the screen when the absorber canister is released.
11. Perform the Preoperative Checkout Procedure (refer to the 9100c User's Reference manual).

9.13 Replace casters

WARNING Replacing a caster requires at least two people to maneuver and tip the machine. Personal injury and/or machine damage is possible if one person attempts this procedure alone.

1. Disconnect all pipeline hoses from the wall and the machine, close all gas cylinders and unplug the power cord.

CAUTION Remove the vaporizers before tipping the machine. If a vaporizer is inverted, it must be set to 5% and purged for 30 minutes with a 5 L/min flow. The interlock system prevents purging more than one vaporizer at a time.

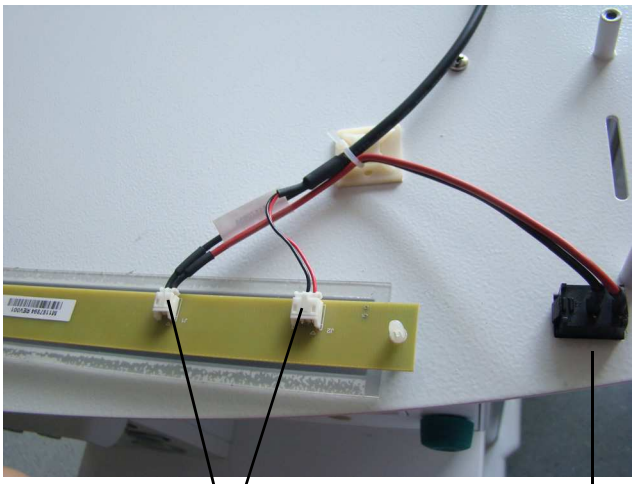
2. Remove the absorber, the vaporizers, gas cylinders, drawers and all auxiliary equipment.

CAUTION To prevent damage, do not tip the 9100c machine more than 10 degrees from vertical.

3. Block the opposite wheels; then, block up the machine until there is enough room to remove the defective caster. To block up the machine, tip and slide blocks under the caster base. Raise both sides evenly until the unit is high enough to remove the caster.
4. The casters are threaded into the base and held with a Loctite compound. Remove the caster with an appropriately sized open-end wrench.
5. If required, clean the threads of the new caster with denatured alcohol.
6. Apply Loctite 242 to the threads of the new caster. Install the caster securely into place.
7. Make sure the caster turns freely.
8. Carefully lower the machine to the floor.
9. Perform the checkout procedure (Section 3).

9.14 Replace task light switch

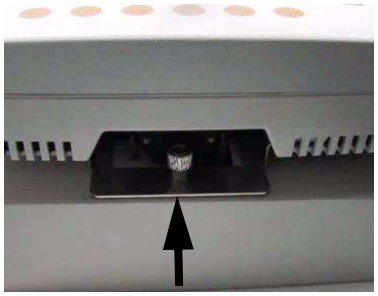
1. Remove the upper shelf. (Section 9.4)
2. Using a small needle-nose pliers, disconnect the switch harnesses of the task-light circuit board connectors.
3. Remove the switch from the top shelf using the small needle-nose pliers.
4. To replace the switch, reassemble in reverse order.



9.15 Replace display and cable

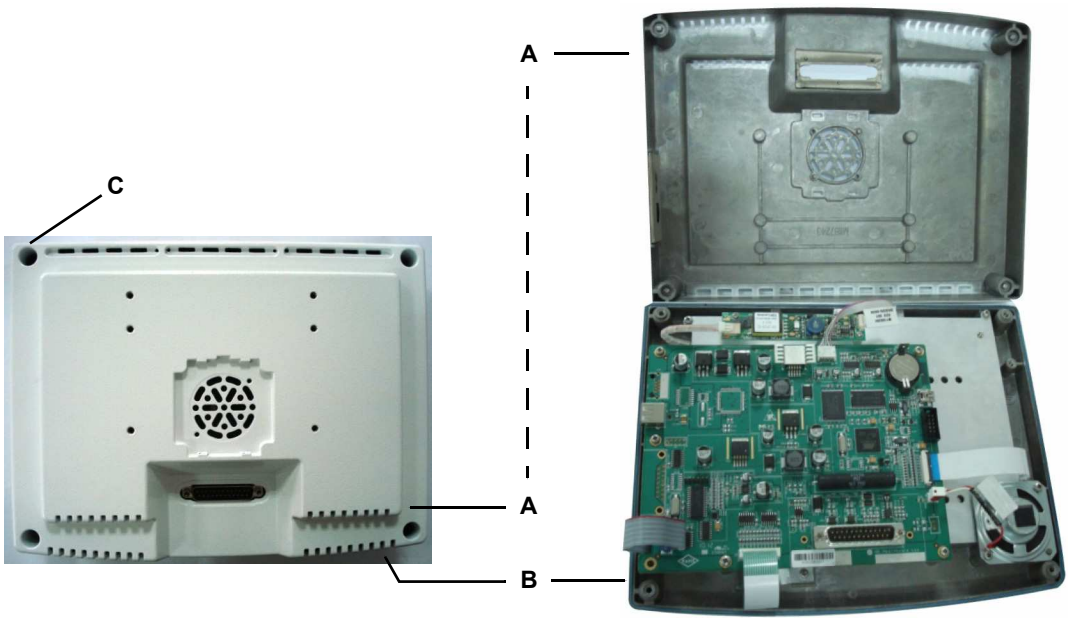
The display module is mounted above the vaporizer manifold. In addition to the power supply, signals between the DMB and CSB are sent through one cable that passes through the back of the machine and connects to the rear of the display module.

1. Remove the thumbscrew that secures the display mounting bracket to the no-vap manifold.
2. Move the display slightly right to disengage the mounting pins.
3. Lower the display face down on the work surface.
4. Disconnect the cable, replace the display module and reassembly in reverse order.
5. **To replace the cable,** remove the thumbscrew and feed the cable to the back of the machine,
6. As required to access the particular cable routing for replacement, remove either (or all):
   - the rear upper panel (Section 9.2),
   - the AC inlet access panel (Section 9.2),
   - the tabletop (Section 9.3).



9.16 Service the Display Module

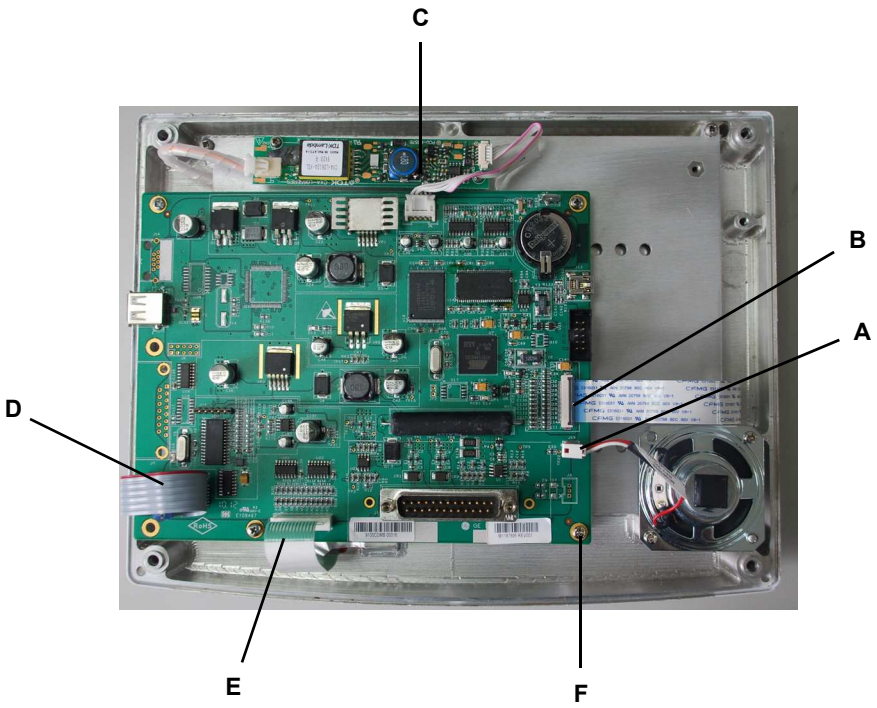
The display module consists of two enclosures: the rear enclosure (**A**) and the front enclosure (**B**). To access components within each enclosure, separate the two halves.



9.16.1 Open the display module

1. Place the display module face down on a protected surface.
2. Loosen the screws (**C**) that hold the two enclosures together (one in each corner).
3. Carefully separate the rear enclosure (**A**) from the front enclosure (**B**).

9.16.2 Display Monitor Board



CAUTION The circuit boards are electrostatic sensitive. Use an anti-static workstation and wear a wrist grounding strap when handling a circuit board

To replace the Display Monitor Board

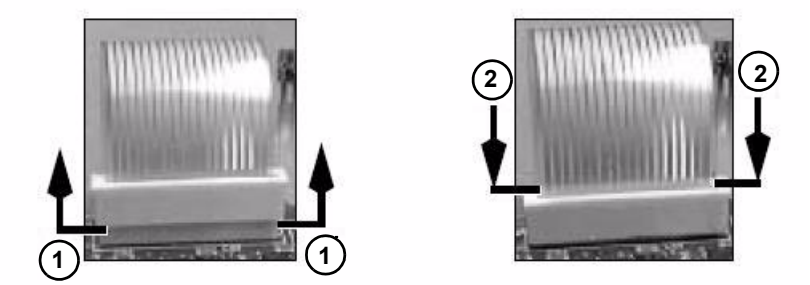
1. Disconnect the remaining cables at the four edges of the display monitor board.
   - (**A**) Two-wire harness to speaker
   - (**B**) Flex cable to LCD display (**refer to Note**)
   - (**C**) Five-wire harness to back light inverter
   - (**D**) Ribbon cable to rotary encoder
   - (**E**) Flex cable to front panel keyboard (**refer to Note**)
2. Remove the five screws (**F**) that hold the display monitor board to the front enclosure.
3. Carefully lift the display monitor board from the front enclosure. Guide the cables through the slotted openings at the four edges of the display monitor board.
4. Reassemble in reverse order.
5. Refer to Section 8.4 for installing software and attaching the display monitor configuration label.

Note The flex cable (**B**) for the LCD display inserts into a ZIF (zero insertion force) connector on the DMB.

To release the flex cable (1), insert a thin slotted screwdriver at the base of the connector and twist it slightly to pry up on the outer shell of the connector.

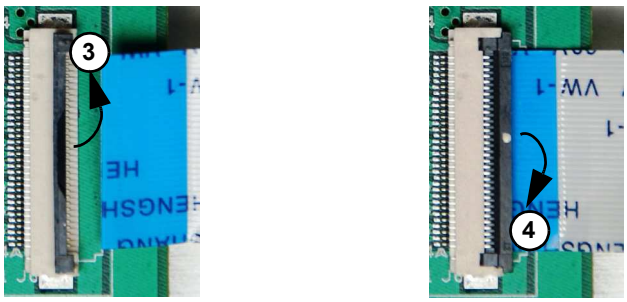
To insert the flex cable (2), hold the outer shell in the released position. Carefully insert the cable until all the “fingers” are below the surface of the shell. Push the shell to the locked position.

ZIF Connector (Type A)



Note The flex cable (**E**) for the front panel keyboard inserts into the ZIF (zero insertion force) connector type B on the DMB.

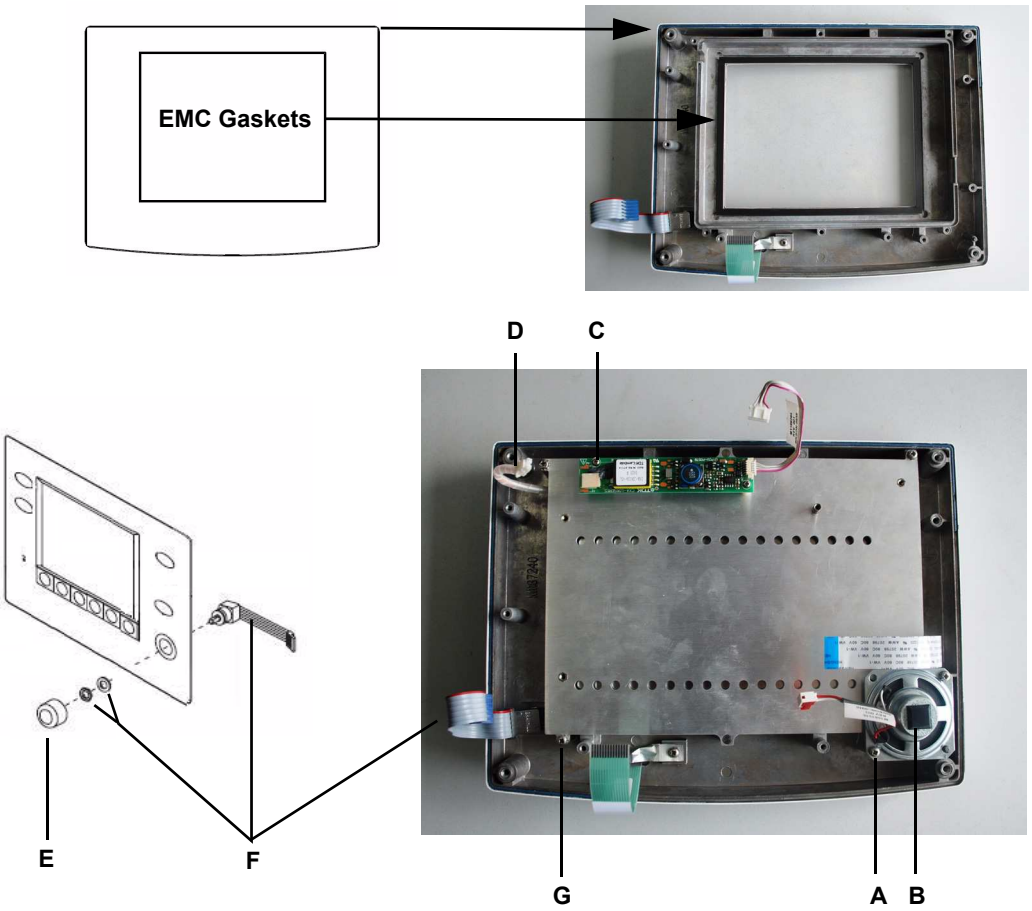
ZIF Connector (Type B)



To release the flex cable (3), insert a thin slotted screwdriver at the base of the connector and twist it slightly to pry up on the shell of the connector.

To insert the flex cable (4), hold the outer shell in the released position. Carefully insert the cable until all the “fingers” are below the surface of the shell. Push the shell to the locked position.

9.16.3 Front enclosure with DMB removed



To replace the speaker

Remove the two screws (**A**) that hold the speaker assembly (**B**) to the front enclosure.

To replace the backlight inverter

1. Disconnect the harness (**D**) to the LCD display.
2. Remove the two screws (**C**) that hold the back light inverter to the front enclosure.
3. Replace the back light inverter in reverse order.

To replace the rotary encoder

1. Pull the knob (**E**) off the shaft of the encoder (**F**).
2. Remove the nut and washer that hold the encoder to the keyboard.
3. Replace the encoder switch in reverse order (note the orientation of the attached ribbon cable).

To replace the front enclosure

1. Remove the four screws (**G**) that hold the LCD assembly to the front enclosure. Set the assembly aside.
2. Transfer the EMC gaskets (or install new) to the new enclosure.
3. Attach the LCD assembly to the new enclosure.
4. Transfer the remaining components to the new enclosure (speaker, encoder, inverter).
5. Reassemble in reverse order.

To replace the LCD display

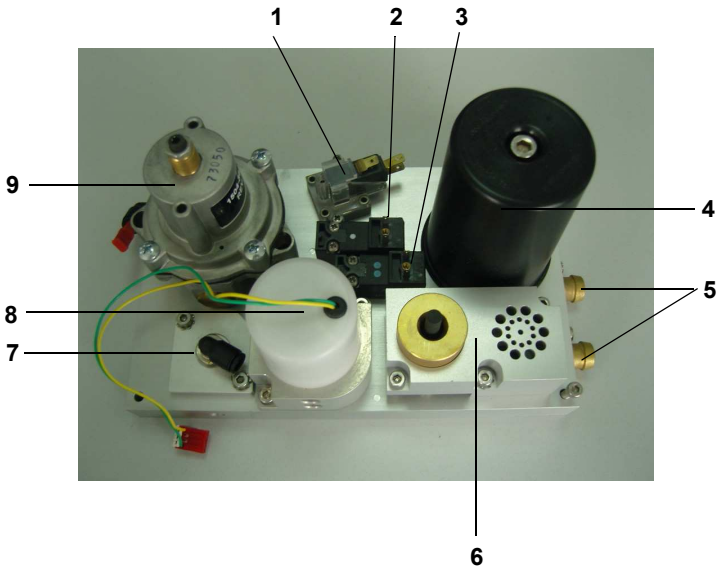
1. Remove the four screws (**H**) at each corner of the display mounting bracket that hold the LCD display to the mounting bracket.
2. If required, clean the enclosure window (if new, remove the protective film).
3. Reassembly in reverse order.

9.17 Service the Vent Engine

The Vent Engine is located underneath the tabletop.

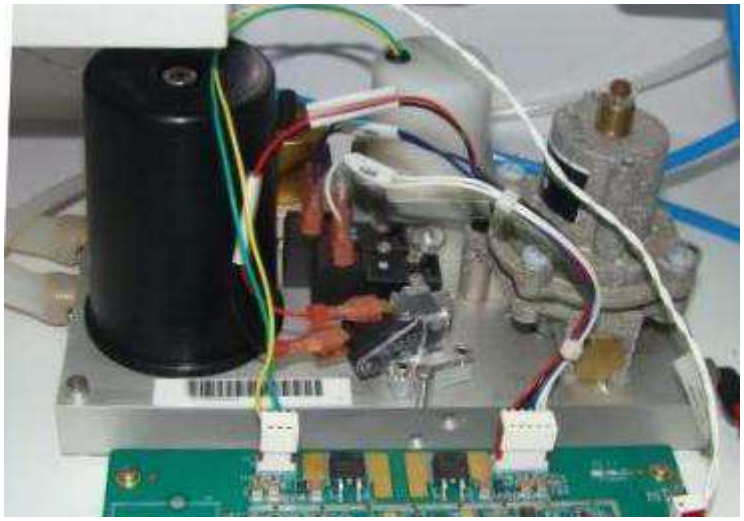
The Vent Engine includes the following subassemblies.

- Supply Pressure Switch (**1**)
- PEEP Safety Valve (**2**)
- PEEP Control Valve (**3**)
- Reservoir (**4**)
- Drive Gas Ports (**5**)
- MOPV and Free Breathing Valve Seat (**6**)
- Inlet Filter - located under the gas inlet valve (**7**)
- Flow Control Valve (**8**)
- Drive Gas Regulator (**9**)



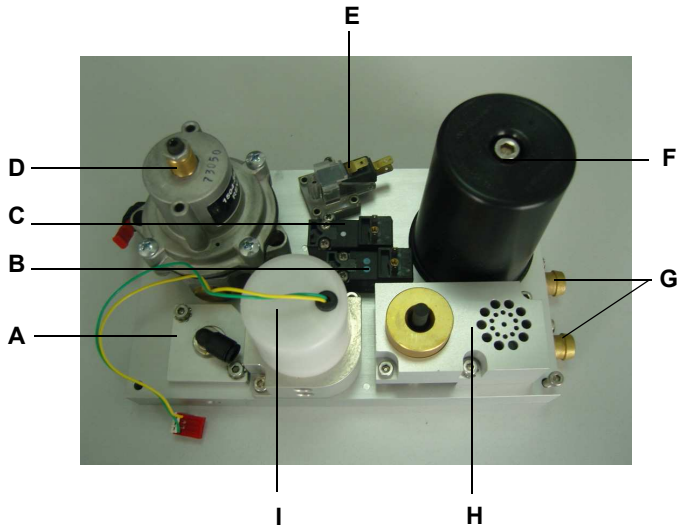
9.17.1 To remove the Vent Engine

1. Disconnect pipeline supplies; close cylinder valves; bleed off pressure (Section 9.1).
2. Remove the tabletop (Section 9.3)
3. Disconnect the Vent Engine harnesses.
4. Disconnect the tube.
5. Disconnect the drive gas hose.
6. Loosen the four screws to remove the Vent Engine.
7. To replace the Vent Engine, reassemble in reverse order.



9.17.2 Replacing Vent Engine components

Refer to section 6 for Vent Engine components that are to be serviced under regular maintenance. Most of the components on the Vent Engine can be replaced by removing the mounting screws and reusing them to secure the replacement part.



Inlet Filter (A)

Install the filter (with the coarse side DOWN) into the recess in the manifold. Place the o-ring into its groove.

PEEP Control Valve (B)

Ensure the valve you are installing (two blue dots) is in this location.

PEEP Safety Valve (C)

Ensure the valve you are installing (white dot) is in this location.

Regulator (D)

Also inspect the two o-rings that seal it to the manifold. Replace as necessary.

Supply Pressure Switch (E)

Also inspect the o-ring that seals it to the manifold. Replace as necessary.

Transfer harness wire to top and middle tabs; bottom tab open.

Reservoir (F)

Inspect the two o-rings: reservoir to manifold, reservoir to screw head. Replace as necessary.

Note: Do not over tighten the screw securing the reservoir. Over tightening could result in cracking the reservoir.

Drive Gas Ports (G)

Inspect the o-ring that seal it to the manifold. Replace as necessary. Lubricate o-rings sparingly with Krytox.

MOPV and Free Breathing Valve Seat (H)

Replace if necessary.

Inspiratory Flow Valve (I)

Note orientation of the flow valve. Also inspect the two o-rings that seal it to the manifold. Replace as necessary.

10 Illustrated Parts

In this section

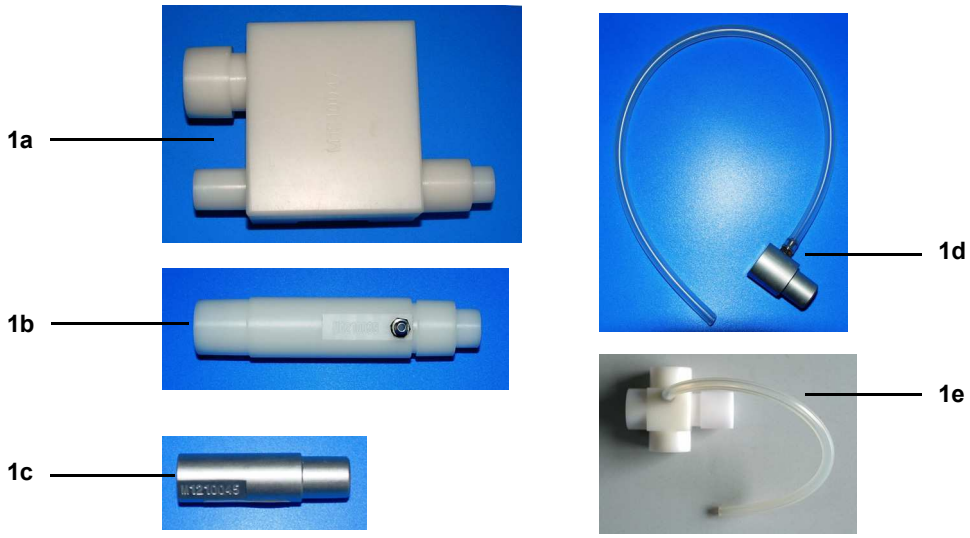
10.1 Service Tools

Item	Description		Stock number
1	Software USB Disk	SW Revision 1.0	M1216014

10.1.1 Test Devices

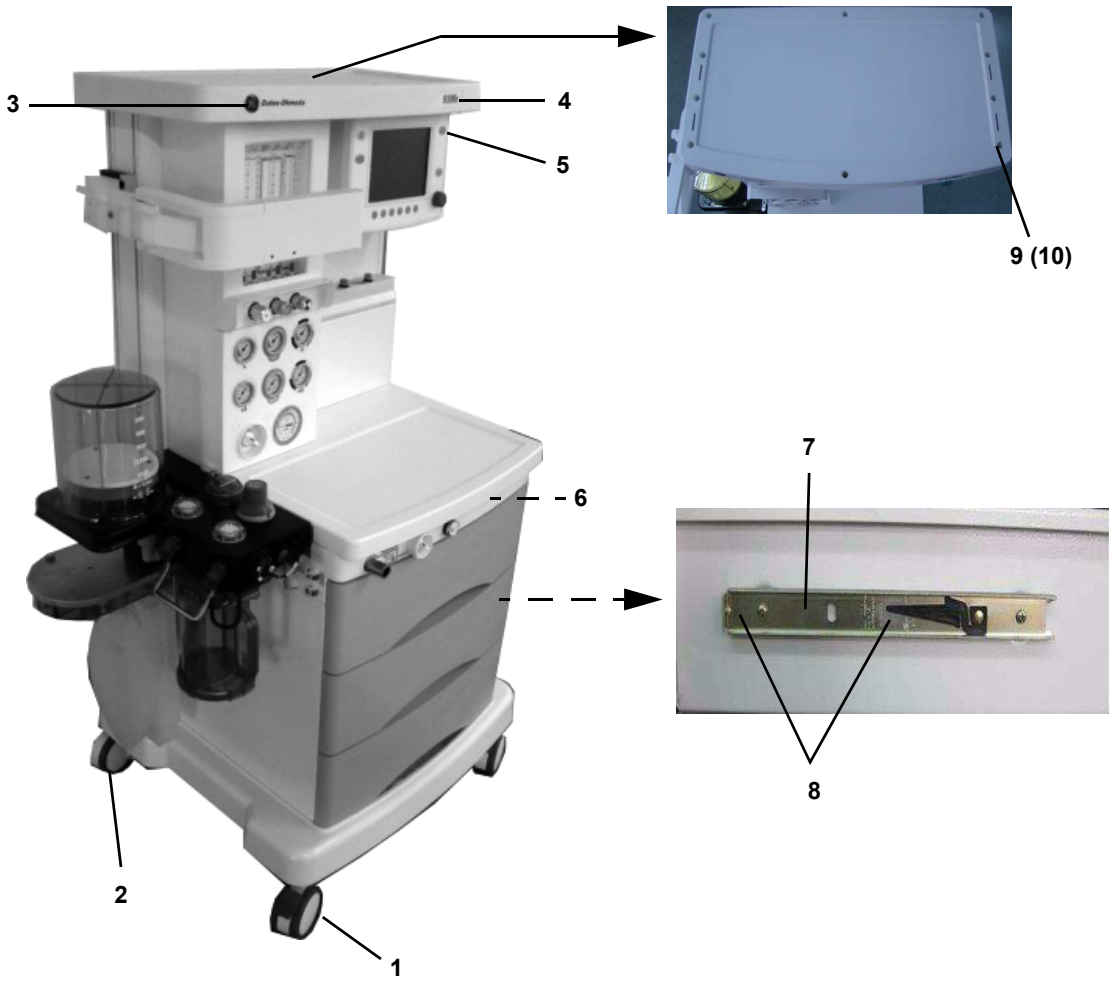
Not Shown	Description		Stock number
	Low-pressure Leak Test Device	(negative pressure)	0309-1319-800 Refer to section 3.9.1
	Low-pressure Leak Test Device	(positive pressure)	1001-8976-000 Refer to section 3.9.2
	Leakage current test device		Refer to section 3.13
	Test device capable of measuring 689 kPa (100 psi)		Refer to section 5.1
	Low-pressure test device (digital manometer or test gauge) with an accuracy of ±2% of reading		Refer to section 5.4.2

10.1.2 Test Tools



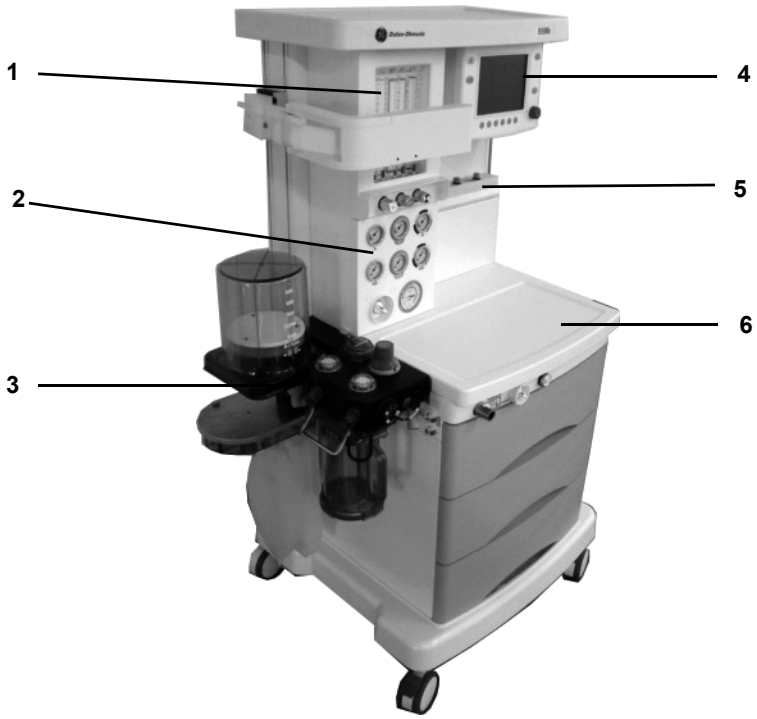
Item		Description	Stock number
1		Calibration Tool Kit	M1210038
	1a	Calibration fixture	M1210047-S
	1b	Calibration pipe	M1211912
	1c	Calibration flow orifice	M1210045-S
	1d	Calibration fitting with 1/4 inch tubing	M1211913
	1e	Test adapter with 1/4 inch tubing	M1212246
2		Adapter, AGSS	M1192895-S
3		Vaporizer manifold valve test tool	1006-3967-000
4		Adapter, positive low-pressure leak test	1009-3119-000
Not Shown			
		Plug, stopper	Refer to Section 6.6 M1210946
		Tool to help disconnect tubing from Legris fittings	2900-0000-000
		Test lung	0219-7210-300

10.2 External components - front view



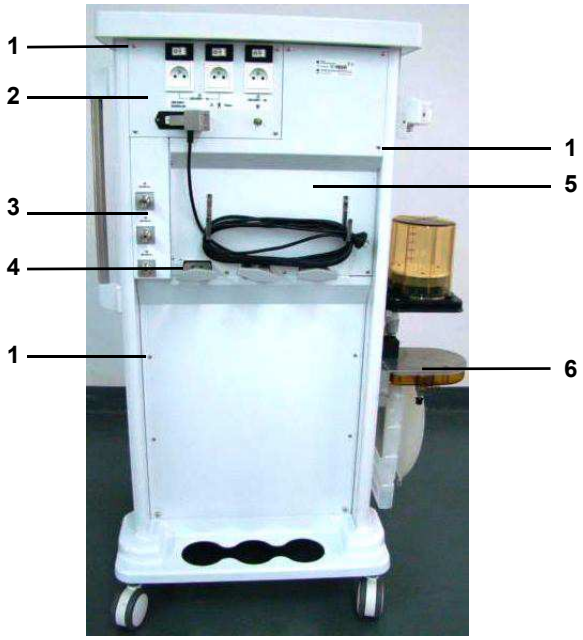
Item	Description	Stock number	Qty
1	Caster, 125-mm with brake	M1186243-S1	(2)
2	Caster, 125-mm (rear)	M1186245-S1	(2)
3	Label, GE Datex-Ohmeda	M1163818-S	
4	Label, 9100c	M1187012-S	
5	Task light switch	M1170954-S	
	Label, task light	M1172137-S	
6	Screw, ST4.2x13, GB/T845-1985, Fe/Ep Ni	M1168734-S	(2)
7	Slide, drawer	1009-3084-000	
8	Screw, M4x8 Nyloc	1009-3183-000	(2)
9	Sticker, shelf top	M1162712-S	(10)
10	Screw with washer, M4x10	M1168760-S	(10)

10.3 External components - front view references



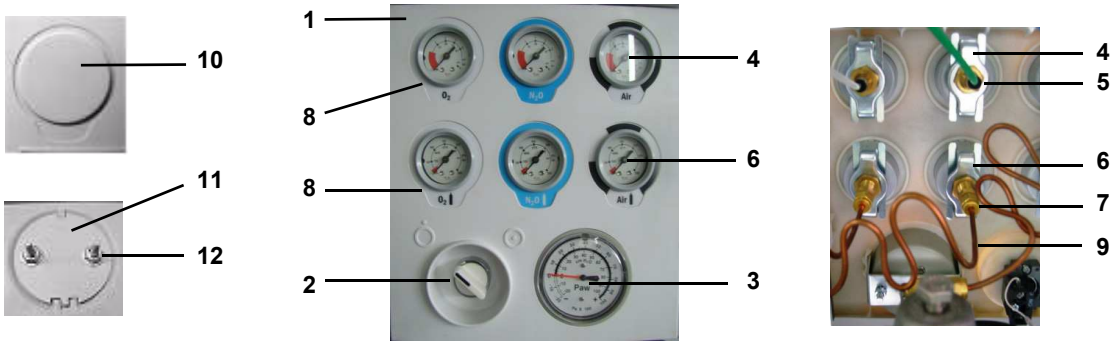
Item	Description	Stock number
1	“Flowmeter Module”	Refer to section 10.11
2	“Front panel, gauges and system switch”	Refer to section 10.5
3	“Breathing System”	Refer to section 10.14
4	“Display Module”	Refer to section 10.16
5	“Vaporizer manifold”	Refer to section 10.10
6	“Tabletop pan components”	Refer to section 10.12

10.4 External components - rear view



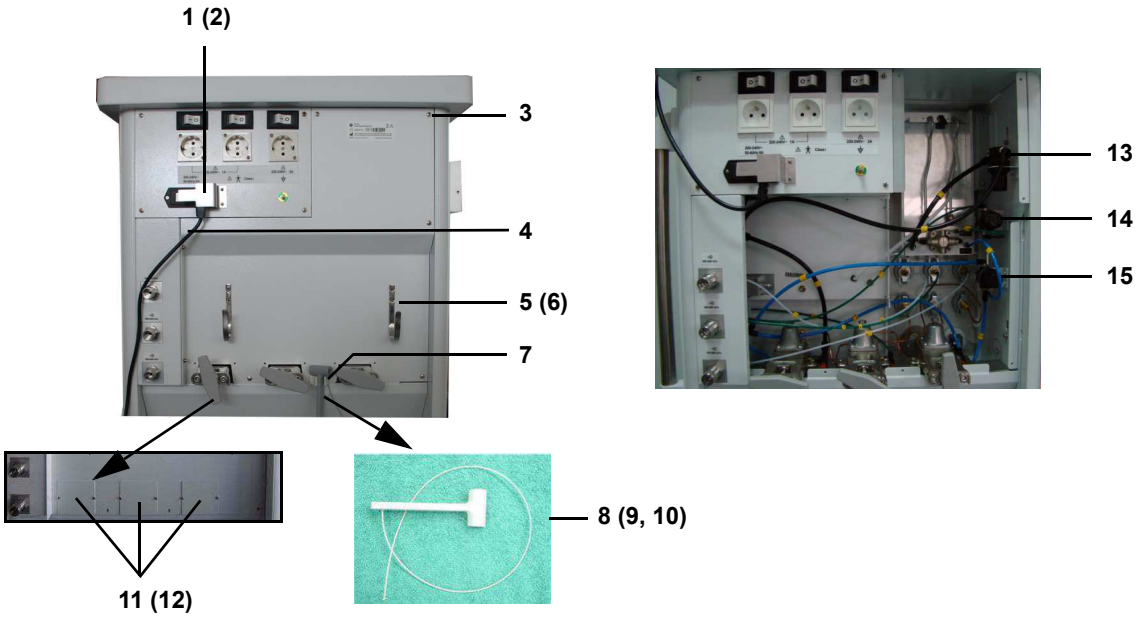
Item	Description	Stock number
1	Screw with washer, M4x10	M1168760-S
2	“AC Power components”	Refer to section 10.7
3	“Pipeline inlet fittings”	Refer to section 10.8
4	“Cylinder gas supplies”	Refer to section 10.9
5	“Rear panel components”	Refer to section 10.6
6	“Anesthetic Gas Scavenging System - AGSS”	Refer to section 10.21

10.5 Front panel, gauges and system switch



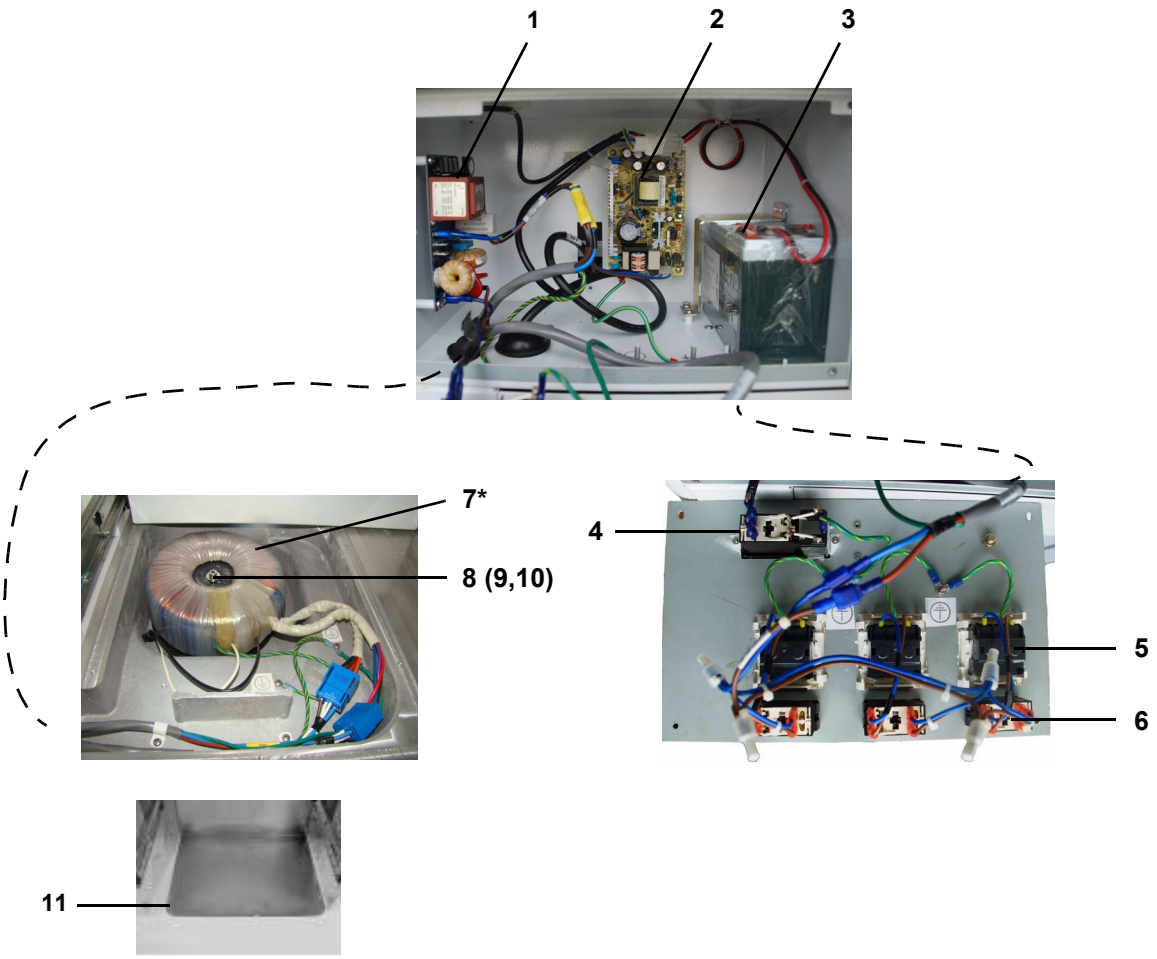
Item	Description	Stock number	Stock number (pipeline)	Stock number (cylinder)
1	Panel, gauge front	M1186907-S		
2	System switch	----------		
	Contact switch w/o knob	M1198995-S		
3	Gauge, airway pressure (includes mounting hardware)	1009-3034-000		
4	Gauge, low pressure (includes mounting hardware)		1009-3079-000	
5	Connector, 1/8 inch Legris to 10-32, O_2 and Air		1006-3711-000	
	Elbow connector, 4mm legris, N_2O		M1170208-S	
6	Gauge, high pressure (includes mounting hardware)			1009-3080-000
7	Connector, 1/8 inch copper tube to 5/16-24			1006-3712-000
8	Label, gauge			
		O_2 ANSI	1009-3081-000	1009-3199-000
		N_2O ANSI	1009-3082-000	1009-3201-000
		Air ANSI	1009-3083-000	1009-3200-000
		O_2 ISO	1009-3202-000	1009-3204-000
		N_2O ISO	1009-3082-000	1009-3201-000
		Air ISO	1009-3203-000	1009-3205-000
		O_2 Neutral	1009-3234-000	1009-3237-000
		N_2O Neutral	1009-3235-000	1009-3238-000
		Air Neutral	1009-3236-000	1009-3239-000
9	Tubing, OD.125IN HPO_2 Wall. 032IN LG 450mm CP			1006-3716-000
10	Plate, gauge blanking	1009-3045-000		
11	Plate, gauge blank backing	1009-3147-000		
12	Palnut	1009-3090-000		

10.6 Rear panel components

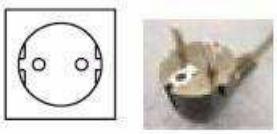


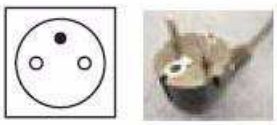
Item	Description	Stock number	Qty
1	Clamp, power cord retainer	M1195153-S	
2	Screw, M3x6	M1169246-S	(2)
3	Screw with washer, M4x10	M1168760-S	(8)
4	Power Cord	----------	
	China, 220-240 VAC AS 3112	M1053942	
	Peru, 220-240 VAC NEMA	1006-3882-000	
	EURO and France, 220 VAC CEE 7/7	1001-3380-000	
	India and South Africa, 220-240 VAC BS546	1006-3885-000	
	US, 110-120 VAC NEMA	1006-3907-000	
5	Cable hook	M1166519-S	
6	Screw, M4x8	M1168645-S	(2)
7	Wrench holder	M1169624-S	
8	Wrench, Pin Index cylinder (with cable and ferrule)	0219-3415-800	
9	Cable	1010-3049-000	
10	Ferrule, cylinder wrench cable retainer	1001-3708-000	
11	Cover, regulator yoke (if no regulator)	1009-3121-000	
12	Screw, M3x6	M1169246-S	(2)
13	Air regulator valve assembly	M1198714-S	
	Adapter, Air inlet and outlet	M1173113-S	
14	N_2O regulator valve assembly	M1198713-S	
	Adapter, N_2O inlet and outlet	M1169131-S	
15	O_2 regulator valve assembly	M1198712-S	
	Adapter, O_2 inlet	M1169127-S	
	Adapter, O_2 outlet	M1169128-S	

10.7 AC Power components

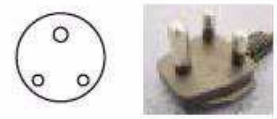



AS 3112/GB2099
China


CEE 7/7
Euro


CEE 7/4
France

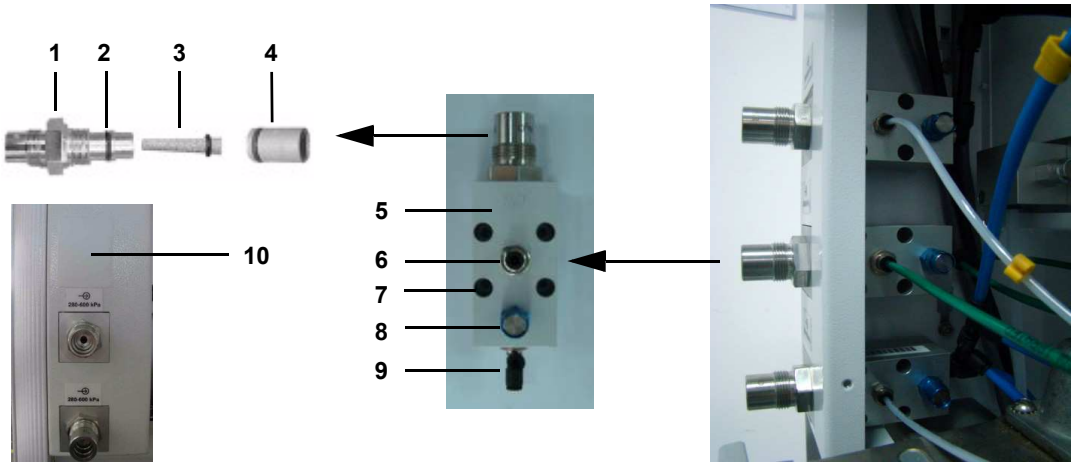

Nema 5-15
NA


BS 546
India and South Africa

Item	Description	Stock number
1	Circuit board. universal inrush	M1074099
2	Power supply, AC-DC	M1169274-S
3	Battery, Lead-Acid 12V 7Ah, sealed	M1168045-S
4	Inlet, 100/120 AC, with line filter and 15 A circuit breaker	1009-5698-000
	Inlet, 220/240 AC, with line filter and 8 A circuit breaker	1009-5757-000
5	Outlet Receptacle, China, AS 3112	1001-3305-000
	Outlet Receptacle, NA, Nema 5-15	1006-3555-000
	Outlet Receptacle, EURO, CEE 7/7	1202-3551-000
	Outlet Receptacle, France, CEE 7/4	1006-4421-000
	Support Frame, snap in	1006-4422-000
	Outlet Receptacle, India and South Africa, BS 546	1006-3805-000
6	Circuit Breaker, 1A, Rocker	1009-5722-000
	Circuit Breaker, 2A Rocker	1009-5721-000
	Circuit Breaker, 3A Rocker	1009-5720-000
7*	Toroid, 100-240V	1009-5692-000
	Heatshrink tubing	1202-3268-000
8	Screw, M6x70	0144-2131-923
9	Lockwasher, M6	9213-0560-003
10	Washer	0402-1107-500
11	Screw, M4x8 (for transformer cover)	M1168622-S
12	Stud, Equal Potential, 6 mm	0208-0070-300

* Apply heatshrink tubing to terminals of black and white wires if not being used.

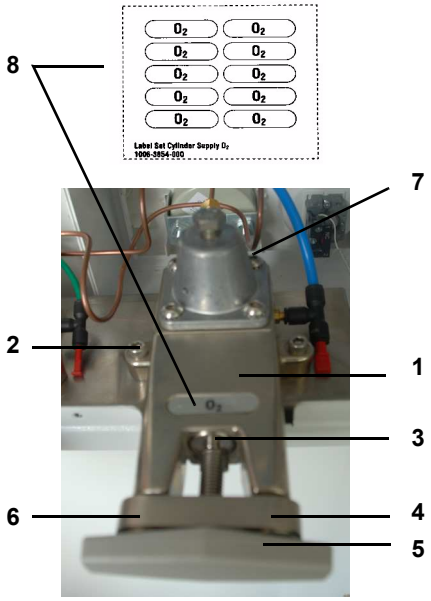
10.8 Pipeline inlet fittings

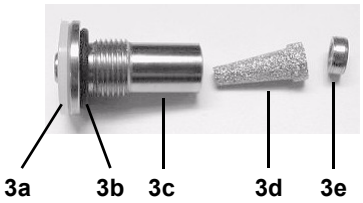


Item	Description	Stock number
1	**Pipeline inlet - O_2 fittings**	----------
	Body, O_2 DISS	M1164436-S
	Body, O_2 NIST	M1166464-S
	Body, O_2 DIN	1006-5161-000
	Body, O_2 G 3/8 BSPP	1006-5170-000
1	**Pipeline inlet - N_2O fittings**	----------
	Body, N_2O DISS	M1164438-S
	Body, N_2O NIST	M1166459-S
	Body, N_2O DIN	1006-5162-000
	Body, N_2O G 3/8 BSPP	1006-5171-000
1	**Pipeline inlet - Air fitting**	----------
	Body, Air DISS	M1195166-S
	Body, Air NIST	M1195164-S
	Body, Air DIN	1006-5163-000
	Body, Air G 3/8 BSPP	1006-5172-000
2	O-ring, bore seal	M1168803-S
3	Sintered metal filter	M1167401-S
	O-ring	M1168797-S
4	Pipeline check valve with o-ring	M1169175-S
5	Gas Inlet Manifold (replacement)	----------
	O_2	M1164430-S
	N_2O	M1164426-S
	Air	M1195162-S
6	Adapter, pressure gauge (with o-ring)	----------
	O_2 and Air	M1169184-S
	N_2O	M1169131-S
7	Screw, M4x12	M1168460-S
8	Relief valve, 758 kPa (110 psi)	1011-3049-000
9	Adapter, low-pressure regulator (with o-ring)	----------
	O_2	M1169128-S
	N_2O	M1169133-S
	Air	M1173113-S
	*Legris fitting 8 mm - 6 mm, Air drive gas	M1210021-S
10	Label, pipeline inlet blank	1009-3197-000

* If Air is selected as drive gas, the legris fitting will be connected to the Air adapter. Replace as necessary.

10.9 Cylinder gas supplies

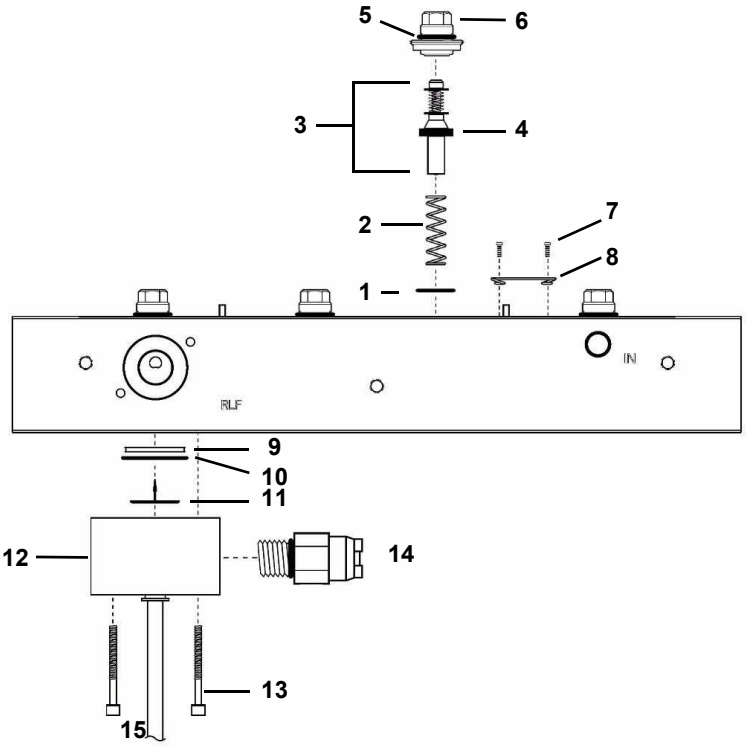




Item		Description	Stock number
1		Gas supply O_2, Pin Index	1006-3201-000
		Gas supply N_2O, Pin Index	1006-3225-000
		Gas supply Air, Pin Index	1006-3203-000
2		Screw, M6x25 socket head cap (3 per supply)	M1168570-S
		Lockwasher, M6 external (for above screw)	9213-0560-003
3		Cylinder inlets (Pin Index)	----------
	3a	Gasket	0210-5022-300
	3b*	O-ring	9221-3013-116
	3c	Adapter, inlet	1001-4075-000
	3d	Filter, sintered bronze	9914-6380-000
	3f	Retaining ring, filter	1001-5954-000
4		Clamp, yoke	1001-4076-000
5		Tee handle beige	0219-3372-600
6		Spacer, gas block (2)	1001-4077-000
		Screw, M8 x 25 long socket head cap (2)	9211-0680-253
7		Elbow fitting for cylinder pressure gauge (copper tube connection of gas supply)	1006-3713-000
8		Label Set, cylinder supply, O_2	1006-3854-000
		Label Set, cylinder supply, N_2O	1006-3855-000
		Label Set, cylinder supply, Air	1006-3856-000

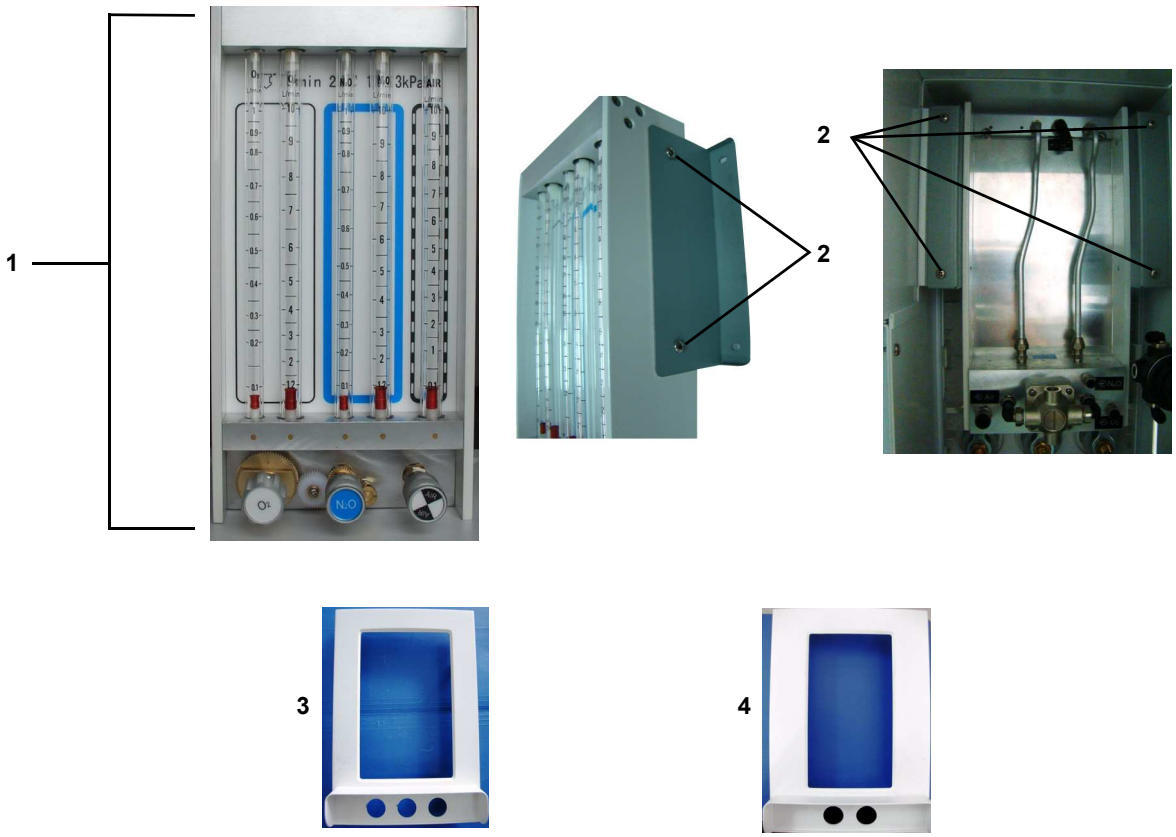
* Lubricate sparingly with Krytox

10.10 Vaporizer manifold



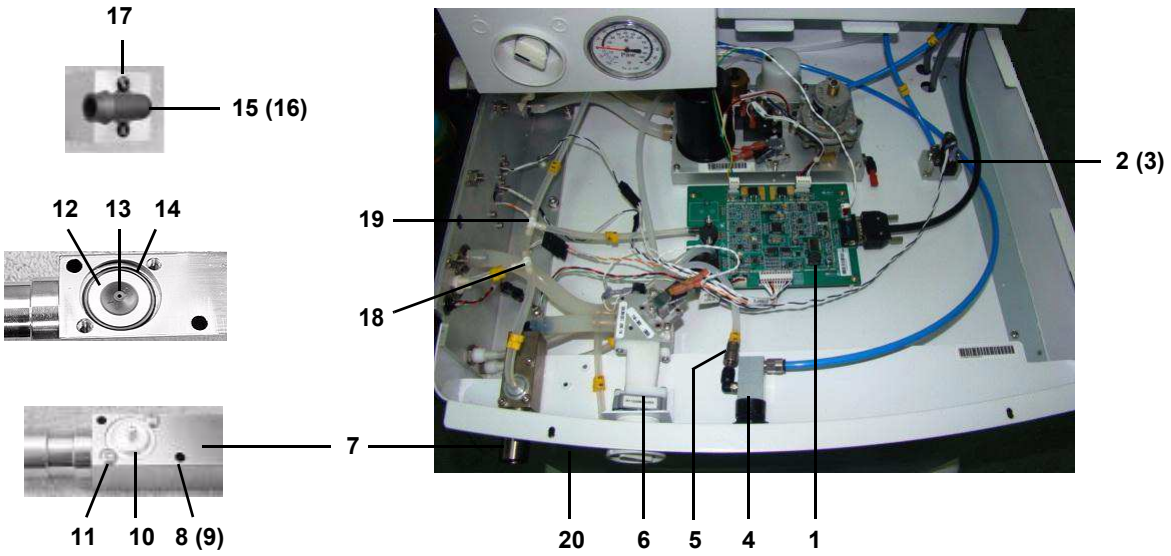
Item	Description	Stock number
	Vaporizer Manifold assembly	M1180332-S
1	O-ring, 0.687 inch ID 0.812 inch OD	0210-0544-300
2	Spring, compression	1006-3736-000
3	Valve kit, includes seal	1006-8373-000
4	Seal	1006-3690-000
5	O-ring, 14.3 mm ID (Package of 6 o-rings)	1102-3043-000 1102-3016-000
6	Nipple, vaporizer port (New Style)	1006-4215-000
7	Screw, M2.5x8	M1168643-S
8	Spring, Dzus	1102-3056-000
9	Seat, check valve	1006-1352-000
10	O-ring 27.1 OD 21.89 mm ID	1006-3866-000
11	Flapper	0211-1451-100
12	Housing	M1168331-S
13	Screw, M4 x 30, cap head	M1168479-S
14	Valve, relief, 5.5 psi, 7/16-20 THD	1006-4128-000
15	Flexible tubing, 1/4 inch, mixed gas	1001-3064-000

10.11 Flowmeter Module



Item	Description		Stock number	Qty
1	Flowhead Module		----------	
		ISO	----------	
	O_2 N_2O Air five flowtubes, ISO		M1177712-S	
	O_2 Air four flowtubes, ISO		M1177710-S	
	N_2O O_2 four flowtubes, ISO		M1164286-S	
		ANSI	----------	
	O_2 N_2O Air five flowtubes, ANSI		M1177719-S	
	O_2 Air four five flowtubes, ANSI		M1177717-S	
	N_2O O_2 five flowtubes, ANSI		M1164287-S	
		Neutral	----------	
	O_2 N_2O Air five flowtubes, Neutral		M1169299-S	
	O_2 Air four five flowtubes, Neutral		M1177725-S	
	N_2O O_2 four five flowtubes, Neutral		M1169288-S	
2	Screw, M4x8		M1168622-S	(8)
3	Flowhead panel, for 3 gases		M1186905-S	
4	Flowhead panel, for 2 gases		M1186901-S	

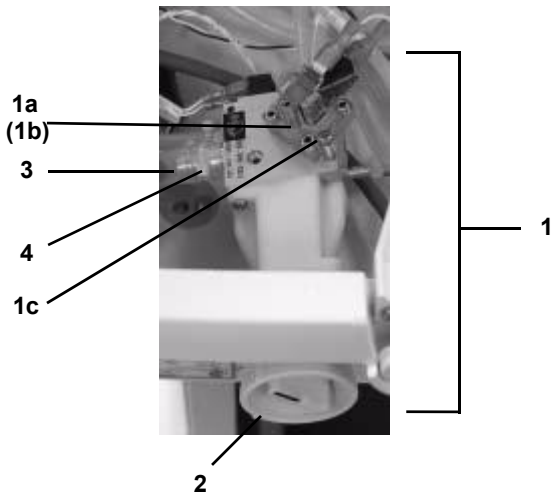
10.12 Tabletop Pan components



Item	Description	Stock number	Qty
1	Control Sample Board	M1187893-S	
2	O_2 supply switch	1006-3623-000	
	O-ring, 0.250 inch ID 0.375 inch OD	0210-0687-300	
	Screws, M4x12 Pozidriv PAN	0140-6226-111	(2)
3	Manifold, O_2 supply switch	M1195025-S	
	Screw, M4x8	M1168622-S	(2)
4	O_2 flush valve	M1180330-S	
5	Fitting, 6 mm 1/4 inch	M1192489-S	
6	ACGO Selector Valve	Refer to section 10.12.1	
7	Port, ACGO body	1009-3096-000	
8	Screw, M4x30	9211-0640-304	
9	Lockwasher, M4	9213-0540-003	
10	Cap, ACGO check valve	1009-3095-000	
11	Screw, M4x8	9211-1040-069	
12	Disk, ACGO check valve	1009-3062-000	
13	Flapper, ACGO check valve	1009-3097-000	
14*	O-ring	0210-0543-300	
15	Fitting, elbow barbed	1009-3160-000	
16*	O-ring	0210-0691-300	
17	Screw, M3x6	9211-1030-055	
18	Legris Tee connector A	Refer to section 10.18	
19	Legris Tee connector B	Refer to section 10.18	
20*	Blank label (for machines without ACGO)	M1203029-S	

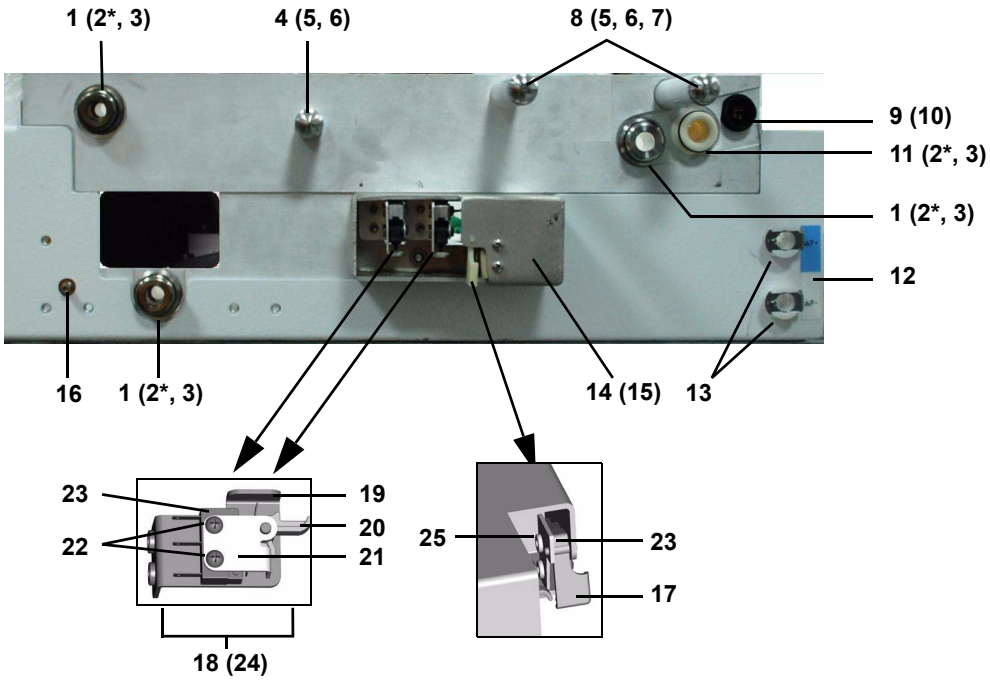
* Lubricate sparingly with Krytox.

10.12.1 ACGO Selector Switch



Item		Description	Stock number
1		ACGO Selector Switch (without guard - item 2)	1009-3099-000
	1a	Flush pressure switch	1006-3972-000
	1b	O-ring	1006-3213-000
	1c	Screws, M3x20	0144-2124-201
2		Guard	1009-3140-000
3		Tubing, silicone	1009-3164-000
4		Tie wrap	0203-5915-300

10.13 Breathing system interface

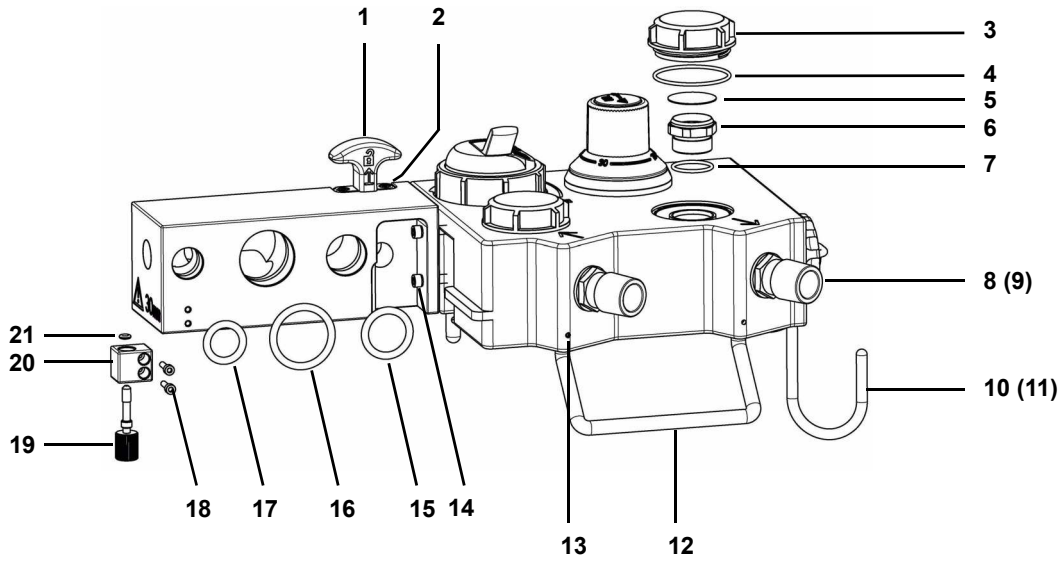


Item	Description	Stock number	Qty
1	Common gas outlet Drive gas port Pilot pressure port	M1207613-S	
2*	Seal, U-Cup 12.7 ID 19.05 OD BCG EPR	1407-3320-000	
3	Ring, retaining 15.88 Shaft Dia Type E SST	1406-3446-000	
4	Pin, lock BS	M1188143-S	
5	Nut, lock BS	M1198763-S	
6	Washer, 65Mn/Ep Ni, lock washers external teeth 8	M1198766-S	
7	Orientation Pin	M1188079-S	
8	Cover, Orientation Pin	M1188083-S	
9	Connector, bulkhead O_2 Cell, with harness	1009-5586-000	
10	Ring, retaining 9.53 Shaft Dia Type E SST	1406-3277-000	
11	Port, sample gas	1407-3318-000	
12	Label, flow sensor connector	M1202930-S	
13	Flow sensor connector	M1171749-S	
14	Frame, microswitch	M1187393-S	
15	Screw, M4x12	M1168460-S	(3)
16	Fitting, Mount Panel 3.18 HOSE BARB UNION	1504-3014-000	
17	Swing, Bypass switch	M1187399-S	
18	Microswitch component	M1198837-S	
19	Bracket	1407-3319-000	
20	Lever	1407-3325-000	
21	Bracket	1407-3324-000	
22	Screw, M2.5x10	1009-3153-000	
23	Switch, subminiature w/QDISC terminals	1406-3285-000	
24	Screw, M3x12	M1168429-S	(2)
25	Bracket Paddle Hinge	M1187404-S	

* Lubricate sparingly with Krytox.

10.14 Breathing System

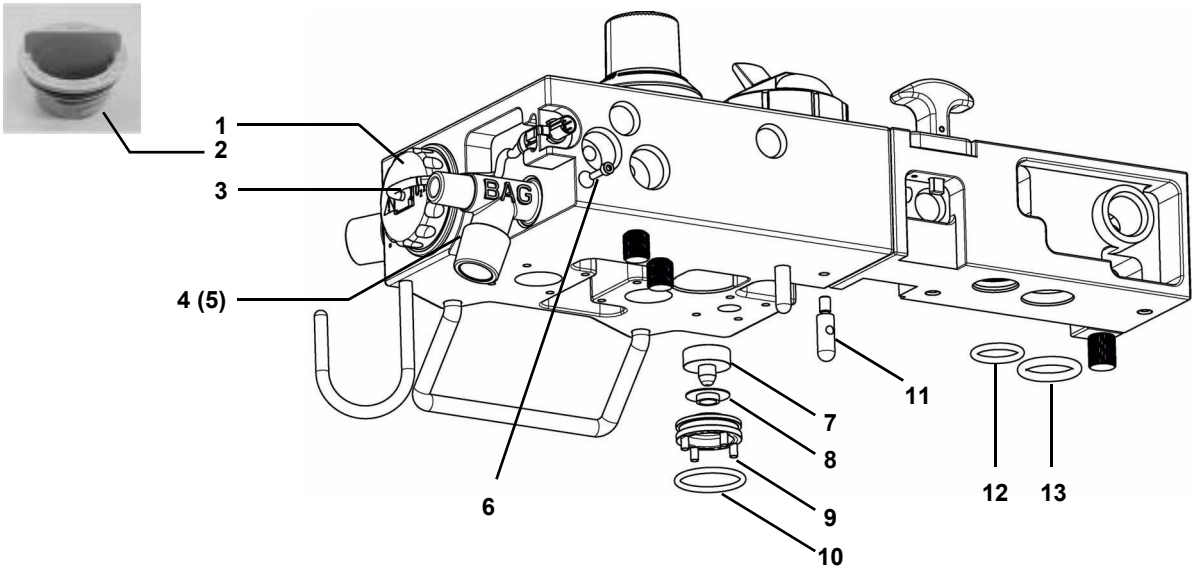
10.14.1 Breathing system - front view



Item	Description	Stock number	Qty
	Breathing system assembly		
1	Latch, breathing system	M1197144-S	
2	Screw, M3x16, flat countersunk head, SST, Cross recess	M1198764-S	(2)
3	Cover, check valve	M1207632-S	
4	O-ring, 40 ID 43.6 OD	M1168795-S	
5	Ceramic disc, Check valve	M1167404-S	
6	Disc seat, Check valve	M1165447-S	
7	O-ring, 20 ID 23.6 OD	M1168789-S	
8	Port, cone M20 transparent	M1198736-S	
9	O-ring, 20 ID 23.6 OD	M1168789-S	
10	Hook	M1166917-S	
11	Screw, M2x8, Hook Install	M1168578-S	
12	Handle, breathing system	M1195395-S	
13	Screw, M3x16	M1208611-S	(2)
14	Screw, M4x16	M1168467-S	(3)
	Washer, 65Mn/Ep Ni, Single coil spring lock washer 4	M1168766-S	(3)
15*	O-ring, 22 ID 30 OD	M1169929-S	
16*	O-ring, 30 ID 38 OD	M1198744-S	
17*	O-ring, 17 ID 25 OD	M1198743-S	
18	Screw, M3x12	M1168429-S	(2)
19	Thumbscrew, Bellows	M1208558-S	
20	Lock seat, Bellows	M1208731-S	
21	O-ring, 2.9 ID 6.46 OD 1.78 W EP 70 DURO	1407-3409-000	

* Lubricate sparingly with Krytox.

10.14.2 Breathing system - rear view

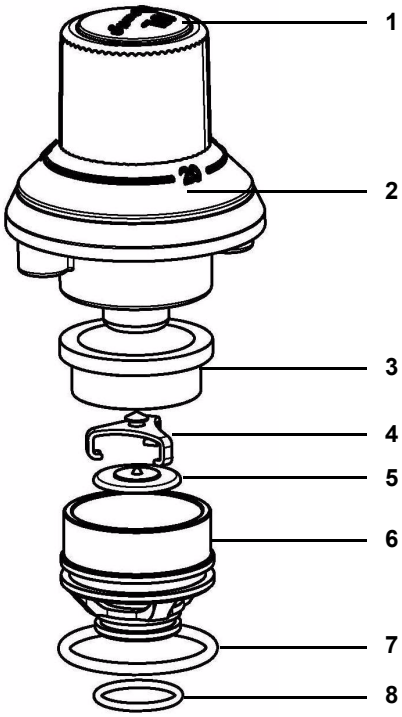


Item	Description	Stock number
1*	O_2 Cell (includes o-ring)	6050-0004-110
	O-ring, cell	1406-3466-000
2*	Plug with o-ring (for units without circuit O_2 sensing)	1503-3857-000
	O-ring, plug	1406-3466-000
3*	Cable, O_2 Cell	1009-5570-000
4	Bag port	M1195401-S
5**	O-ring, Bag port, 18 ID 23.3 OD	M1198742-S
6	Screw, M3x12	M1168429-S
7	Weight, dead 10 cm H_2O, breathing system negative relief valve	1407-3406-000
8	Seal, breathing system negative relief valve	1407-3407-000
9	Valve Seat, breathing system negative relief valve	M1187820-S
10**	O-ring, 1.049 ID 1.255 OD	1407-3408-000
11	Stick	M1187981-S
12**	O-ring, 19 ID 25 OD	M1198745-S
13**	O-ring, 22 ID 30 OD	M1169929-S

* The O_2 cell (or plug) and the cell cable are not included in the breathing system module.

** Lubricate sparingly with Krytox.

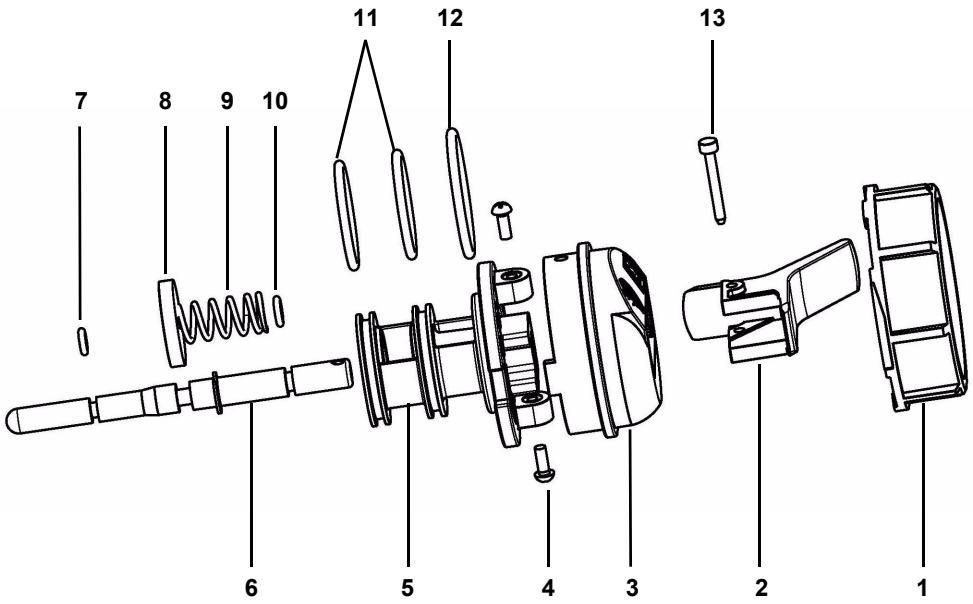
10.14.3 APL Valve



Item	Description	Stock number	Qty
1	Crown, APL	M1209071-S	
2	Manifold assembly, APL	M1209899-S	
3	Diaphragm, APL	M1205630-S	
4	Cage, APL	M1205628-S	
5	Poppet, APL	M1192905-S	
6	Port, APL	M1192911-S	
7*	O-ring, 31.5 ID 36.8 OD	M1198747-S	
8*	O-ring, 17 ID 20.6 OD	M1198751-S	
9	Handspike bolt	M1192913-S	(2)
10	O-ring, 3.55 ID 7.15 OD	M1168817-S	(2)

* Lubricate sparingly with Krytox.

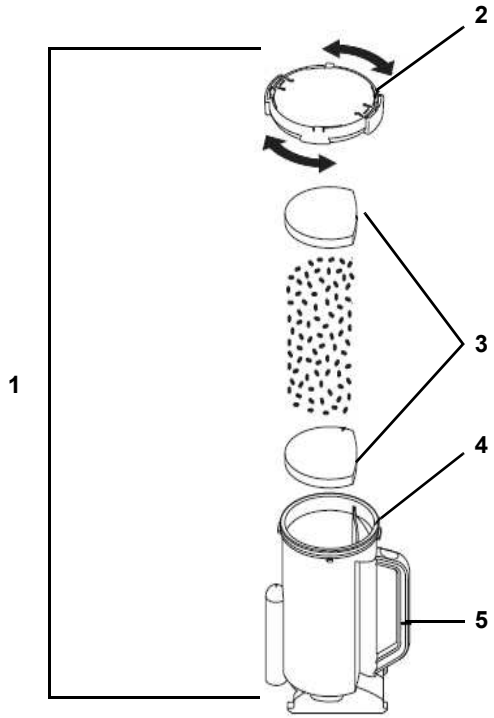
10.14.4 Bag/Vent Switch



Item	Description	Stock number	Qty
	Bag/Vent Switch	M1197143-S	
1	Fixing, BTV	M1195413-S	
2	Swing, BTV	M1187373-S	
3	Cover, BTV	M1187371-S	
4	Screw, M3x8	M1168599-S	(2)
5	Shelf, BTV	M1187369-S	
6	Shaft, BTV	M1187375-S	
7*	O-ring, 4 ID 7.6 OD	M1198749-S	
8	Seal, BTV	M1187377-S	
9	Spring, BTV	M1187379-S	
10*	O-ring, 5 ID 8.6 OD	M1198746-S	
11*	O-ring, 26 ID 31 OD	M1198748-S	(2)
12*	O-ring, 31.5 ID 36.8 OD	M1198747-S	
13	Pin, BTV	M1187381-S	

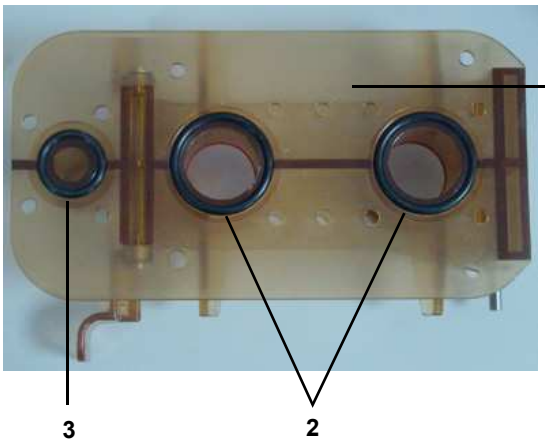
* Lubricate sparingly with Krytox.

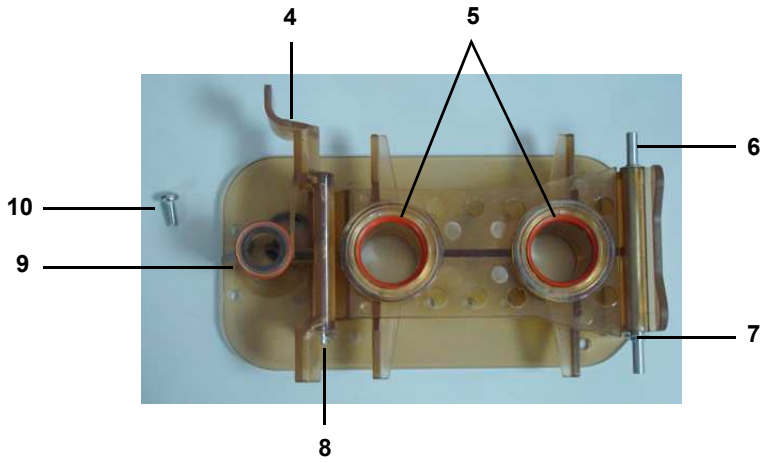
10.14.5 Absorber canister



Item	Description	Stock number
1	Multi absorber, reusable (includes 40 pack of foam) (does not include absorbent)	1407-7004-000
2	Cover assembly, CO_2 canister	1009-8240-000
3	Foam, CO_2 canister (pack of 40)	1407-3201-000
4	O-ring	1407-3204-000
5	Canister, CO_2 with handle	1407-3200-000

10.14.6 Shelf canister interface

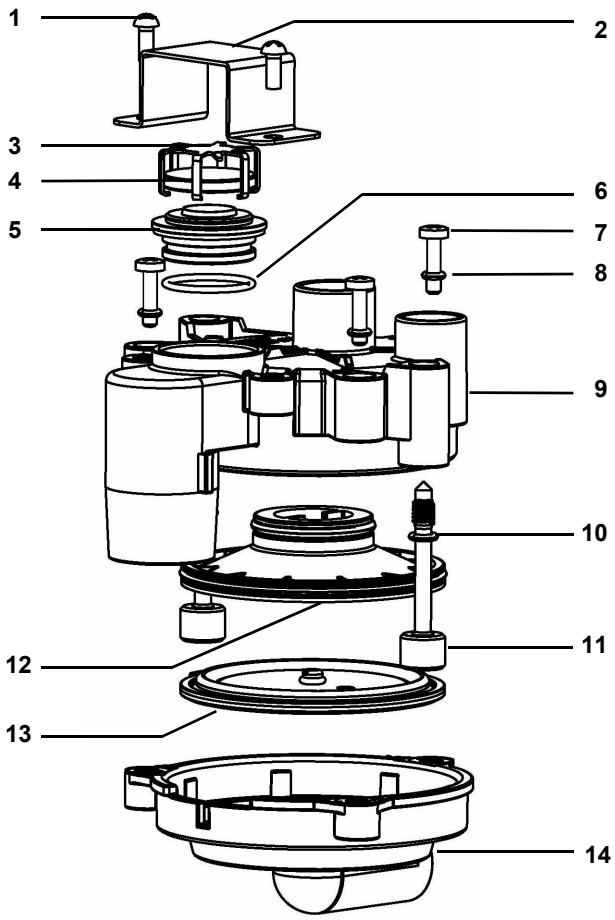




Item	Description	Stock number	Qty
	Shelf canister interface module	M1172138-S1	
1	Shelf	M1170491-S	
2	O-ring, 25 ID 30.3 OD	M1169932-S	(2)
3	O-ring, 15 ID 20.3 OD	M1169931-S	
4	Release pin	M1159525-S	
5*	O-ring, 22 ID 30 OD	M1169929-S	(2)
6	Shaft hook, 85mm	M1165449-S	
7	Washer	M1168758-S	(4)
8	Shaft hook, 61mm	M1165452-S	
9*	O-ring, 12.37 ID 17.61 OD	M1169930-S	
10	Screw, M4x10	M1168626-S	(10)

* Lubricate sparingly with Krytox.

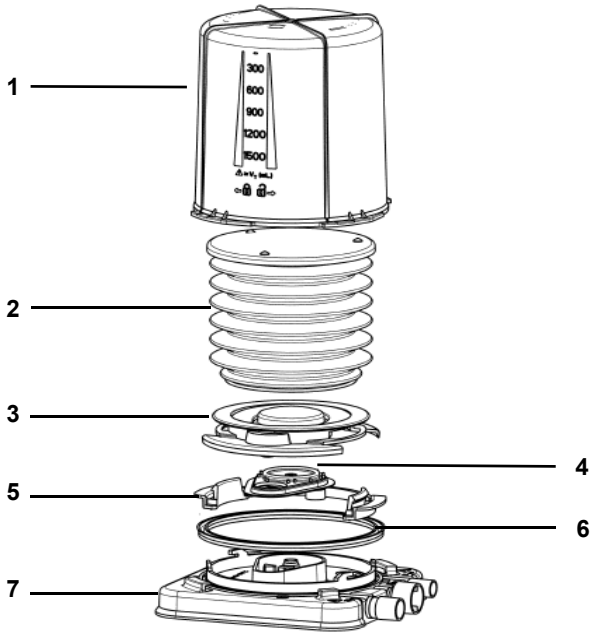
10.14.7 Exhalation Valve



Item	Description	Stock number	Qty
	Exhalation valve assembly	M1197141-S	
1	Screw, M4x10	M1168626-S	(2)
2	Cover, relief valve	M1187367-S	
3	Retainer, disk 26.97D 12.7H 0.76T SST flutter	1400-3017-000	
4	Weight, dead 10 cm H_2O	1406-3572-000	
5	Seat, relief valve	M1187360-S	
6*	O-ring, 22.4 ID 26 OD	M1168810-S	
7	Screw, M4x16 PH PAN HD	9211-0440-163	(3)
8	O-ring, 2.9 ID 6.46 OD	1407-3409-000	(3)
9	Cover, exhalation valve	M1187363-S	
10	O-ring, 4.47 ID x8.03 OD	1407-3703-000	(2)
11	Thumbscrew, M6x43 10mm head	1406-3306-000	(2)
12	Seat, exhalation valve	1407-3704-000	
13	Diaphragm assembly	1503-8121-000	
14	Base, exhalation valve	M1187365-S	

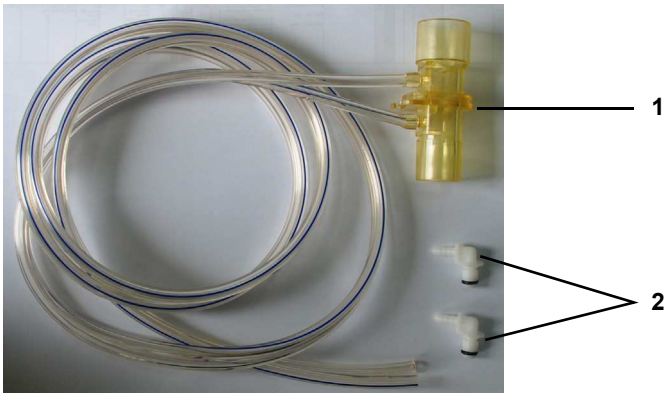
* Lubricate sparingly with Krytox.

10.14.8 Bellows



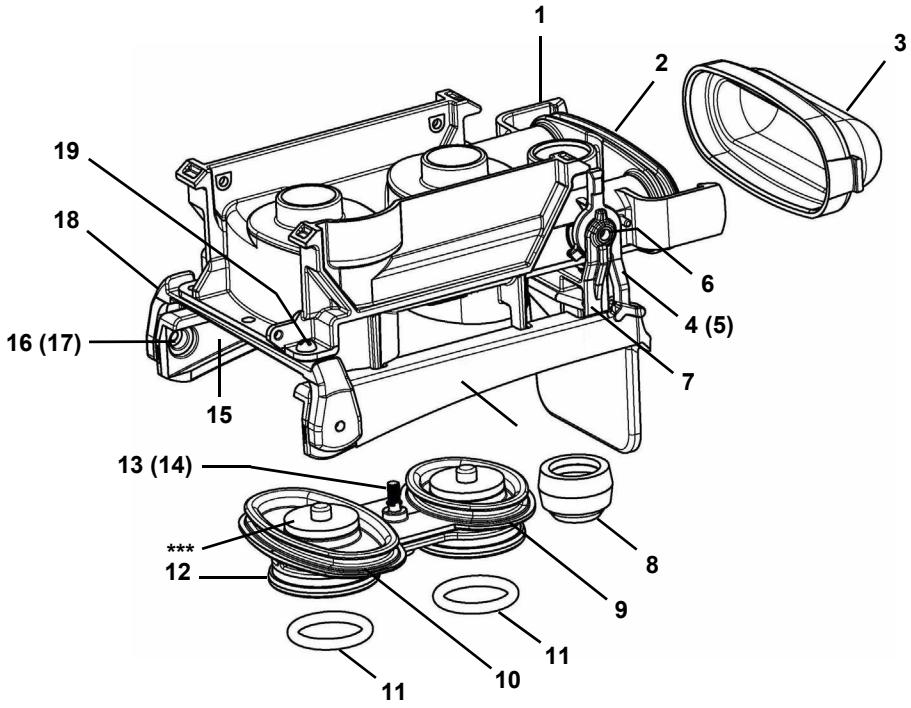
Item	Description	Stock number
1	Bellows housing	1500-3117-000
2	Bellows	1500-3378-000
3	Rim	1500-3351-000
4	Pressure relief valve assembly	1500-3377-000
5	Latch, rim	1500-3352-000
6	Manifold, bellows base	1500-3350-000
7	Seal, base	1500-3359-000

10.14.9 Flow Sensor



Item	Description	Stock number
1	Flow sensor assembly	M1174442-S1
2	Elbow connector	M1171751-S

10.14.10 EZchange Canister System (CO_2 Bypass)



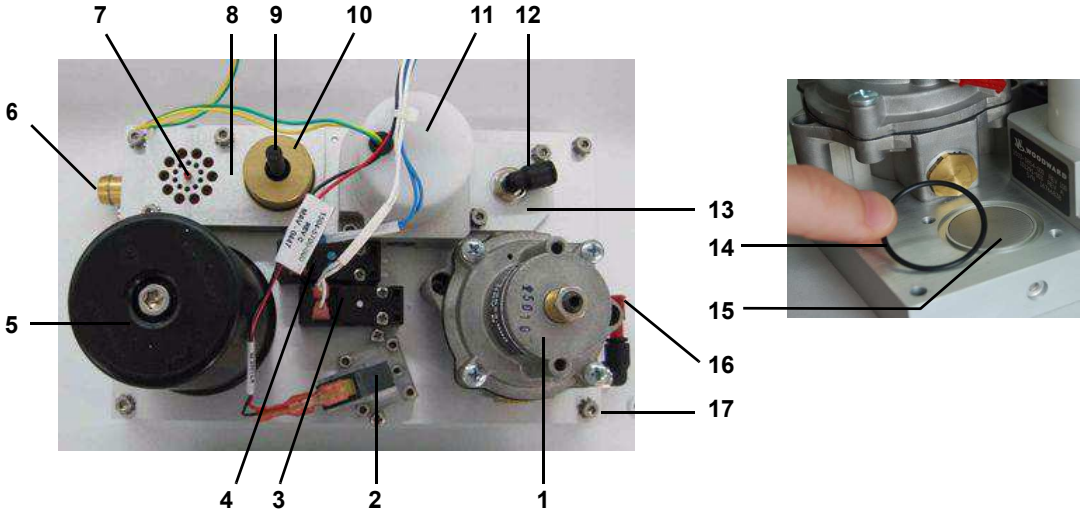
Item	Description	Stock number	Qty
	EZchange Canister Module	M1202535-S	
1	Manifold, Bypass	1407-3113-000	
2**	O-ring, 59.92 ID 66.98 OD 3.53 W SIL 50 DURO	1407-3142-000	
3	Cap, Manifold	1407-3130-000	
4	Lever, Switch Actuator	1407-3116-000	
5	Spring, Torsion Switch Actuator Lever	1407-3117-000	
6*	Screw, M3x0.5 Shoulder 4 DIA X 4 L SST	1407-3915-000	(2)
7	Lever, Canister Latch	1407-3115-000	
8	Seal, Drain	1407-3121-000	
9**	O-ring, 37.69 ID 44.75 OD 3.53 W SIL 50 DURO	1407-3129-000	
10**	O-ring, 50.39 ID 57.45 OD 3.53 W SIL 50 DURO	1407-3143-000	
11**	O-ring, OD30 ID 22 4W SIL 40 DURO	1407-3104-000	(2)
12***	Valve, Housing Assembly Bypass	1407-3126-000	
13	Screw, Thumb M4 Shoulder	1407-3410-000	
14	Ring, Retaining 3.96 Shaft DIA SST	1407-3411-000	
15	Cradle Canister	1407-3118-000	
16	Screw, M4x10 CSK SKT HD SST TYPE	0140-6226-119	(2)
17**	Spacer, Shoulder 6.8 DIA x4.1 L	1407-3120-000	(2)
18	Support, Cradle Pivot	1407-3119-000	
19	Screw, M4x8 Sems BT SKT HD SST 316	0144-2436-108	(3)

* Apply Loctite 242.

** Lubricate sparingly with Krytox.

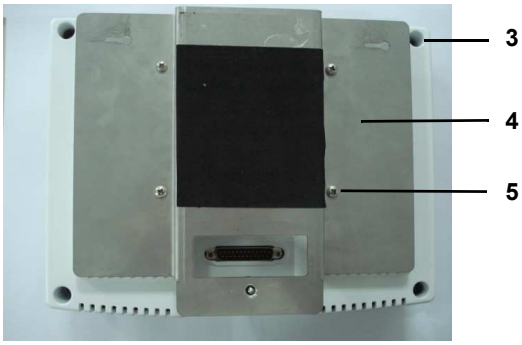
*** Rubber valve seats can not be removed from assembly (**Item 12**).

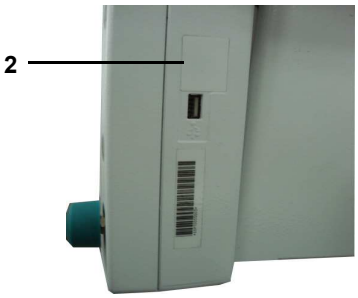
10.15 Vent Engine



Item	Description	Stock number	Qty
	Vent Engine assembly	M1198710-S	
1	Regulator	1504-3623-000	
	O-ring, 9.25 ID x 12.8 OD	1503-3056-000	(2)
2	Pressure Sense Switch	1504-3607-000	
	O-ring, 3.63 ID x 8.87 OD	1006-4156-000	
	Screw, M3x16	M1168595-S	
3	PEEP Safety Valve (white dot)	1504-3608-000	
4	PEEP Valve (blue dots)	1504-3610-000	
5	Reservoir, pneumatic engine	1504-3704-000	
	O-ring, base, 56.87 ID x 60.43 OD	1504-3614-000	
	O-ring, screw head, 0.219 ID x 0.344 OD	0210-0686-300	
	Screw, M6x90	1504-3004-000	
6	Drive gas and pilot pressure port	M1184241-S	(2)
	O-ring, 12.5 ID x 16.1 OD	M1168806-S	(2)
	Screw, M4x10	M1168760-S	(2)
7	Valve, flapper	0211-1454-100	
	O-ring, 30 ID x 33.6 OD	M1168794-S	
8	Seat, MOPV and free breathing valve	M1184062-S	
	Screw, M4x25	M1168479-S	(3)
9	Seal, Mechanical overpressure valve	1503-3016-000	
10	Mechanical overpressure valve	M1184243-S	
	Mechanical overpressure valve port	M1184245-S	
	Screw, M4x10	M1168760-S	
	O-ring	M1168788-S	
11	Inspiratory Flow Control Valve	1503-3854-000	
	O-ring, 9.25 ID x 12.8 OD	1503-3056-000	(2)
	Harness, valve switches	1504-5700-000	
12	Elbow male G1/8 6-mm Drive Gas	M1169127-S	
13	Retainer, filter	M1172714-S	
	Screw, M4x12	M1168460-S	
	Washer, M4	M1168751-S	
14	O-ring, 28.24 ID x 33.48 OD	M1173359-S	
15	Filter, 2-micron (**install course side DOWN**)	1504-3708-000	
16	Plug, 6 mm	M1169143-S	
17	Screw, M4x20	M1168565-S	(4)
	Washer, M4	M1168751-S	(4)

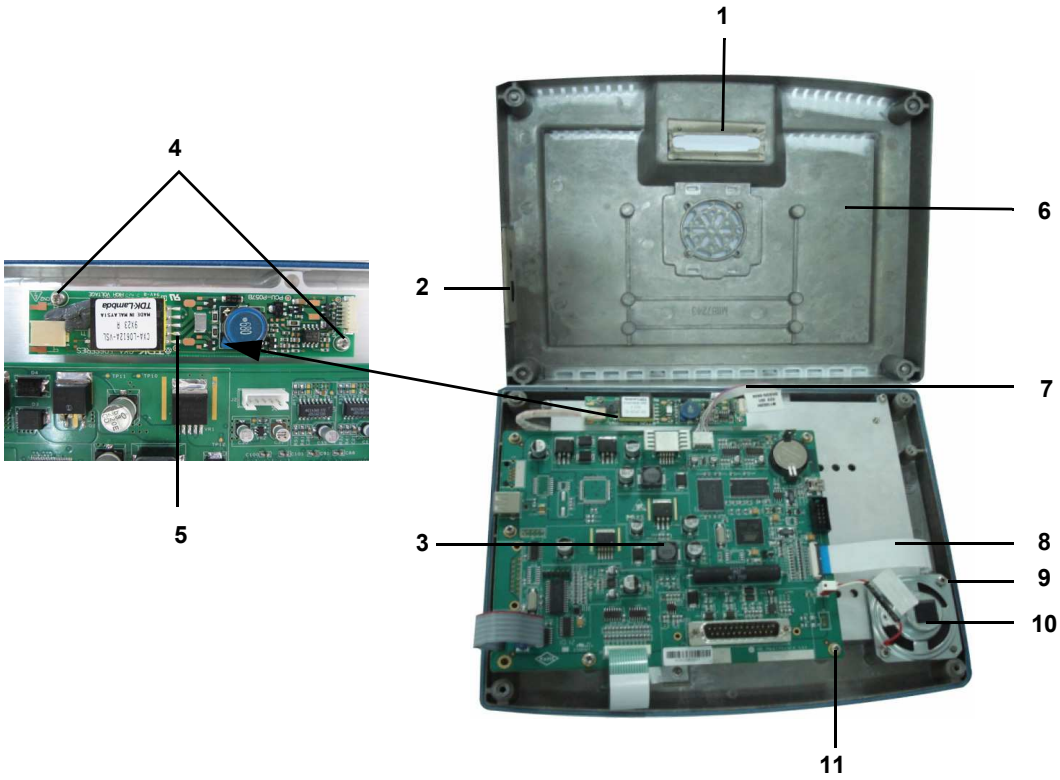
10.16 Display Module





Item	Description	Stock number	Qty
	Display Module assembly	M1188647-S	
1	Keyboard, Front Panel	M1187773-S	
2	Blank Cover Label	M1198389-S	
3	Screw, relieved M4x12	1504-3001-000	(4)
4	Bracket, Display Back	M1187294-S	
5	Screw, M4x8, pan head, SST, Cross recess	M1168622-S	(4)

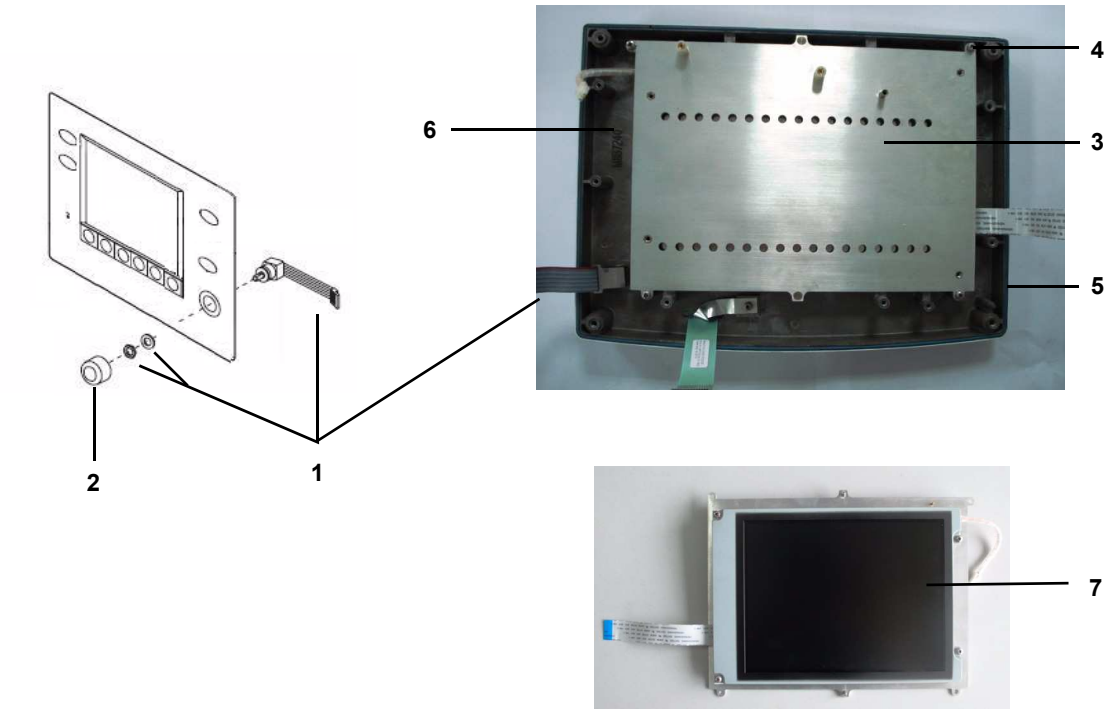
10.16.1 Display components



Item	Description	Stock number	Qty
1	Gasket, Back connection	M1195146-S	
2	Gasket, Right Connection	M1195144-S	
3*	Display Monitor Board	M1187892-S	
4	Screw, M2x4	M1081612-S	(2)
5	DC To AC Inverter 5W for one bulb	M1197808-S	
6	Rear enclosure	M1187243-S	
7	Harness, Back Light	M1188284-S	
8	Harness, LCD to DMB	M1197820-S	
9	Screw, M3x6	0140-6219-128	(2)
10	Speaker, with harness	M1081516-S	
11	Screw, M3x6	0140-6219-128	(5)

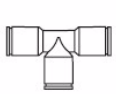
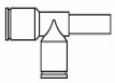
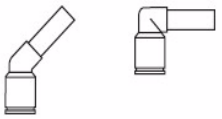
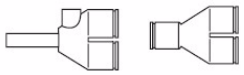
* Refer to Section 8.2 for instructions regarding a replaced DMB or Display Module

10.16.2 Display Keyboard and LCD assembly



Item	Description	Stock number	Qty
1	Rotary Encoder, switch	1503-3012-000	
2	Knob, soft touch	M1081590-S	
3	Fixture display LCD enclosure	M1187245-S	
4	Screw, M3x6	0140-6219-128	(4)
5	Gasket, EMC 2.2 OD hollow RND (per enclosure)	M1120773-S	
6	Front Enclosure	M1187240-S	
7	LCD with protect spiral wrap	M1197817-S	

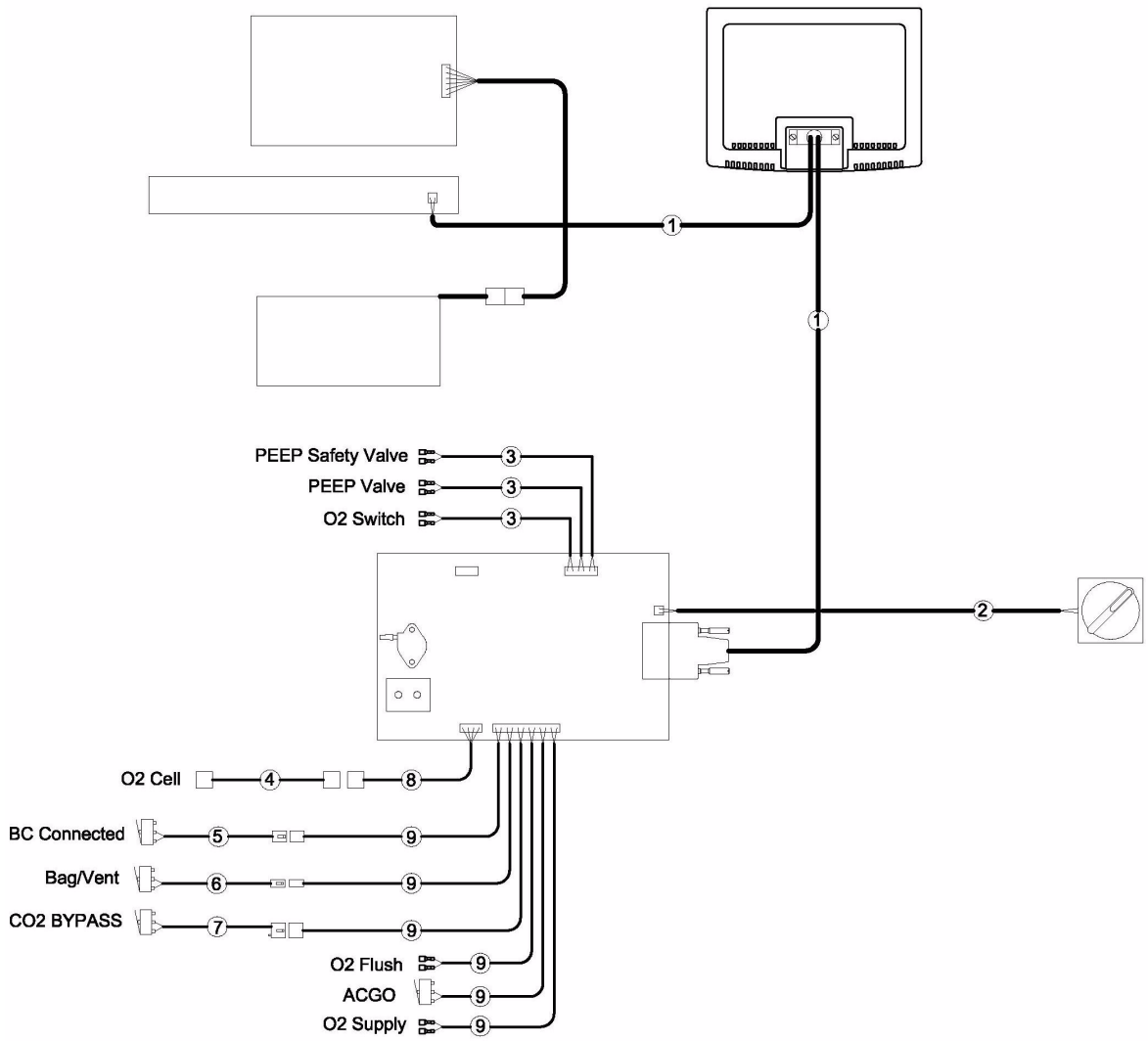
10.17 Legris quick-release fittings

	Item	Description	Stock number
	1	**Tees - (tube/tube/tube)**	
		4mm (N_2O)	1202-3653-000
		6mm (O_2)	1006-3544-000
		8mm (Air)	1006-3545-000
	2	**Tees - (tube/tube/standpipe)**	
		6mm (O_2)	1006-3862-000
		8mm (Air - Drive gas)	1009-3370-000
	3	**Elbow - (tube/standpipe)**	
		8mm (Air)	1006-3535-000
	4	**Y**	
		8mm Y with tailpiece	1009-3360-000
	5	**Plug**	
		4mm (N_2O)	1006-3530-000
		6mm (O_2)	1006-3531-000
		8mm (Air)	1006-3532-000

10.18 Tubings

Item	Description	Tube NO.	Length – Size	Stock number
	O_2			
1	O_2 PLINE – O_2 REG IN	91	500 mm - 6 mm	M1167496-S
2	O_2 PLINE – Vent	92	450 mm - 6 mm	M1167496-S
3	O_2 REG OUT – O_2 flowhead	93	350 mm - 6 mm	M1167496-S
4	O_2 REG OUT – O_2 Flush	94	1100 mm - 6 mm	M1167496-S
5	O_2 PLINE – O_2 supply sensor	95	340 mm - 6 mm	M1167496-S
6	O_2 CLY – O_2 PLINE	96	500 mm - 6 mm	M1167496-S
7	O_2 2nd CLY – O_2 PLINE	97	330 mm - 6 mm	M1167496-S
8	O_2 flush – CGO valve	98	290 mm - 6 mm	M1167496-S
9	O_2 PLINE – O_2 low-pressure gauge	54	535 mm - 1/8 inch	1006-3718-000
	N_2O			
10	N_2O PLINE – N_2O REG IN	81	540 mm - 4 mm	M1167498-S
11	N_2O REG OUT – N_2O flowhead	82	250 mm - 4 mm	M1167498-S
12	N_2O CLY – N_2O PLINE	83	370 mm - 4 mm	M1167498-S
13	N_2O PLINE – N_2O low-pressure gauge	84	480 mm - 4 mm	M1167498-S
	Air			
14	Air PLINE – REG IN	71	550 mm - 8 mm	1009-3296-000
15	Air REG OUT – Air flowhead	72	360 mm - 8 mm	1009-3296-000
16	Air CLY – Air PLINE	73	310 mm - 8 mm	1009-3296-000
17	Air PLINE – Air low-pressure gauge	55	535 mm - 1/8 inch	1006-3718-000
	Mixed Gas			
18	Flowhead OUT – VAP IN	51	500 mm - 1/4 inch	1001-3064-000
19	VAP OUT – ACGO	52	900 mm - 1/4 inch	1001-3064-000
20	ACGO – O_2 Flush	53	170 mm - 1/4 inch	1001-3064-000
21	VAP OUT – CGO valve	56	900 mm - 1/4 inch	1001-3064-000
	Sample Gas			
22	AGSS Gas OUT – BS Interface (Refer to section 10.13 **ITEM 17**)	60	240 mm - 1/4 inch	1605-1001-000
23	ΔP+ Connector– Control Sample Board	61	240 mm - 1/4 inch	1605-1001-000
24	ΔP - Connector– Control Sample Board	62	240 mm - 1/4 inch	1605-1001-000
25	Legris Tee A – ACGO	63	100 mm - 1/4 inch	1605-1001-000
26	Legris Tee A – Sample gas port	64	50 mm - 1/4 inch	1605-1001-000
27	Legris Tee A – Legris Tee B	65	130 mm - 1/4 inch	1605-1001-000
28	Legris Tee B – Airway pressure gauge	66	370 mm - 1/4 inch	1605-1001-000
29	Legris Tee B – Control sample board	67	150 mm - 1/4 inch	1605-1001-000
30	Legris Tee B – Sample gas port	69	185 mm - 1/4 inch	1605-1001-000
31	BS Interface (Refer to section 10.13 **ITEM 17**)– AGSS Flowhead	68	380 mm - 1/4 inch	1605-1001-000
	DRIVE GAS AND WASTED GAS			
32	ACGO – CGO Valve	1	67 mm - 1/4 inch	1009-3164-000
33	ACGO – BS Interface CGO	2	145 mm - 1/4 inch	1009-3164-000
34	Vent drive gas OUT – BS Interface pilot pressure port	3	175 mm - 1/4 inch	1009-3164-000
35	Vent pilot pressure OUT – BS Interface drive gas port	4	210 mm - 1/4 inch	1009-3164-000
36	CGO Valve – BS interface CGO	5	135 mm - 1/4 inch	1009-3164-000

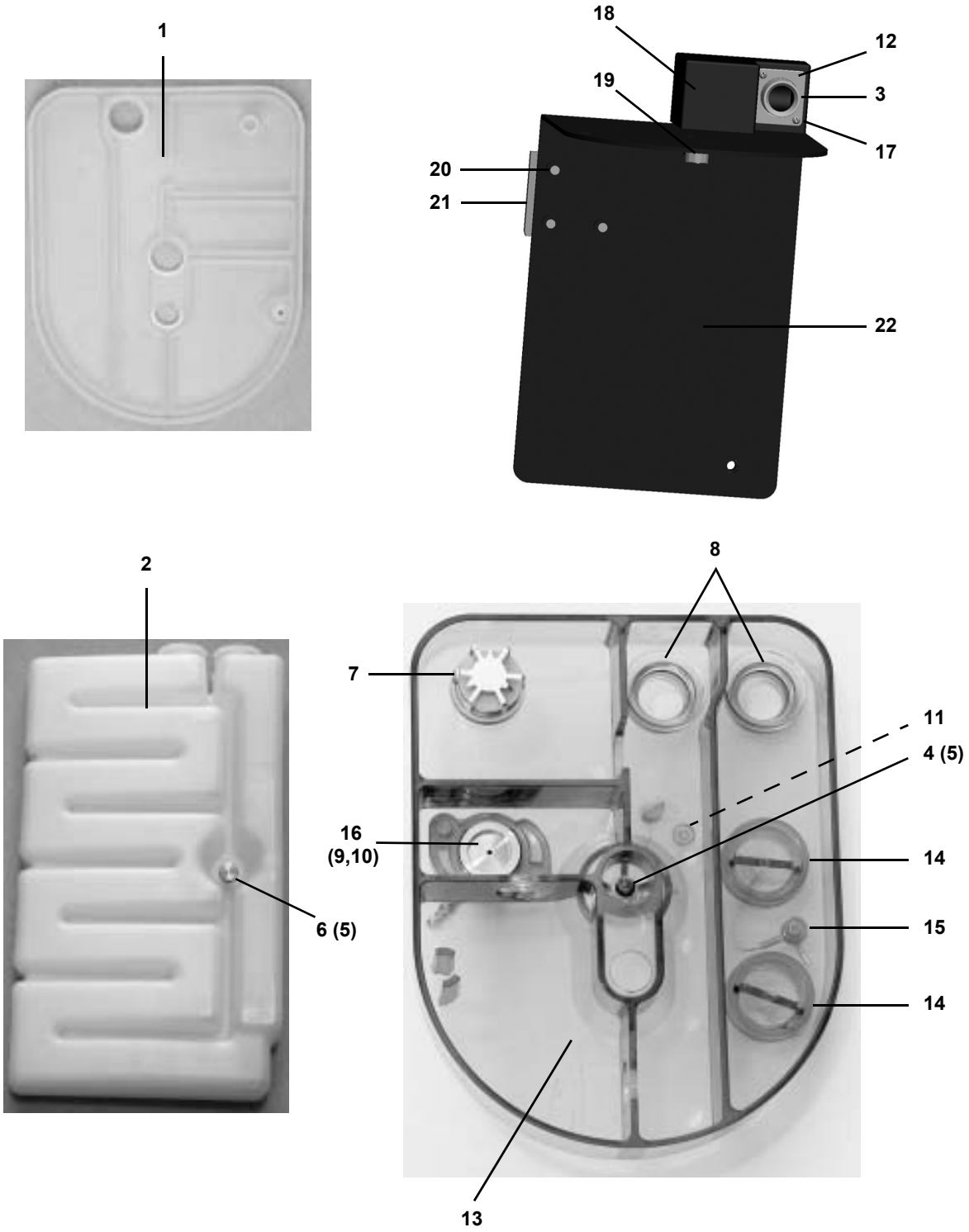
10.19 Cables and harnesses



Item	Description	Stock number
1	Harness, CSB to DMB	M1188282-S
2	Harness, system switch to CSB	M1194565-S
3	Harness, valve switches	1504-5700-000
4	Harness, O_2 cell	1009-5586-000
5	Harness, Breathing system connect	M1194570-S
6	Harness, Bag/Vent switch	1009-5585-000
7	Harness, CO_2 bypass	1407-3144-000
8	Harness, O_2 cell to CSB	M1194573-S
9	Harness, CSB to Breathing system interface	M1194577-S

10.20 Anesthetic Gas Scavenging System - AGSS

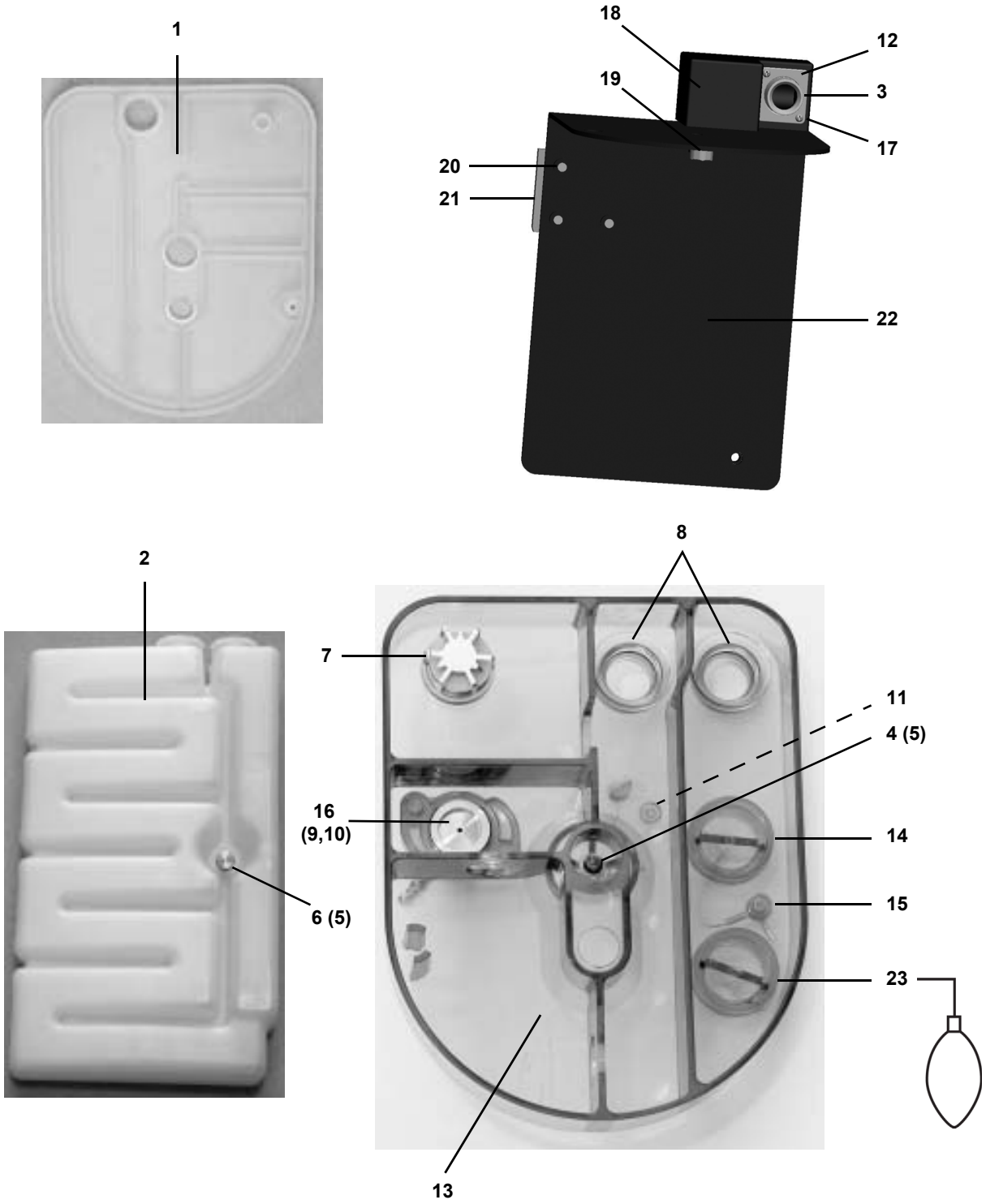
10.20.1 Passive AGSS



Item		Description	Stock number	Qty
1		Seal, Receiver body	1407-3901-000	
2		Reservoir	1407-3903-000	
3		Connector, AGSS	M1192891-S	
4		Thumbscrew, M6x25	M1193413-S	
5		O-ring, 4.47 ID, 8.03 OD	1407-3703-000	(2)
6		Thumbscrew, M6x43	1406-3304-000	
7		Valve, unidirectional (negative pressure relief)	----------	
	7a	Seat,Valve,Negative Pressure	1406-3396-000	
	7b	Retainer,disc	1400-3017-000	
	*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
	7d	Disc, check-valve	0210-5297-100	
8*		O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*		O-ring, 21.95 ID, 23.90 OD	1406-3558-000	
10		Screw M4x8	9211-0640-083	(2)
11		Cap, 3.18 barb, silicone	1406-3524-000	
12		Connector plate, AGSS	M1192893-S	
13		Receiver, passive/adjustable	1407-3908-000	
14		Plug Assembly, tethered	1407-3909-000	(2)
15		Screw, shoulder M3	1407-3915-000	
16		Connector, 30-mm ISO, male	1406-3555-000	
17		Screw, M3x6	M1169246-S	(2)
18		Body valve, AGSS	M1192889-S	
19		Pin, AGSS	M1193409-S	
20		Screw, M6x20	M1189745-S	(3)
21		Hook, AGSS	M1192883-S	
22		Receiver cover, AGSS	M1192887-S	

* Lubricate sparingly with krytox.

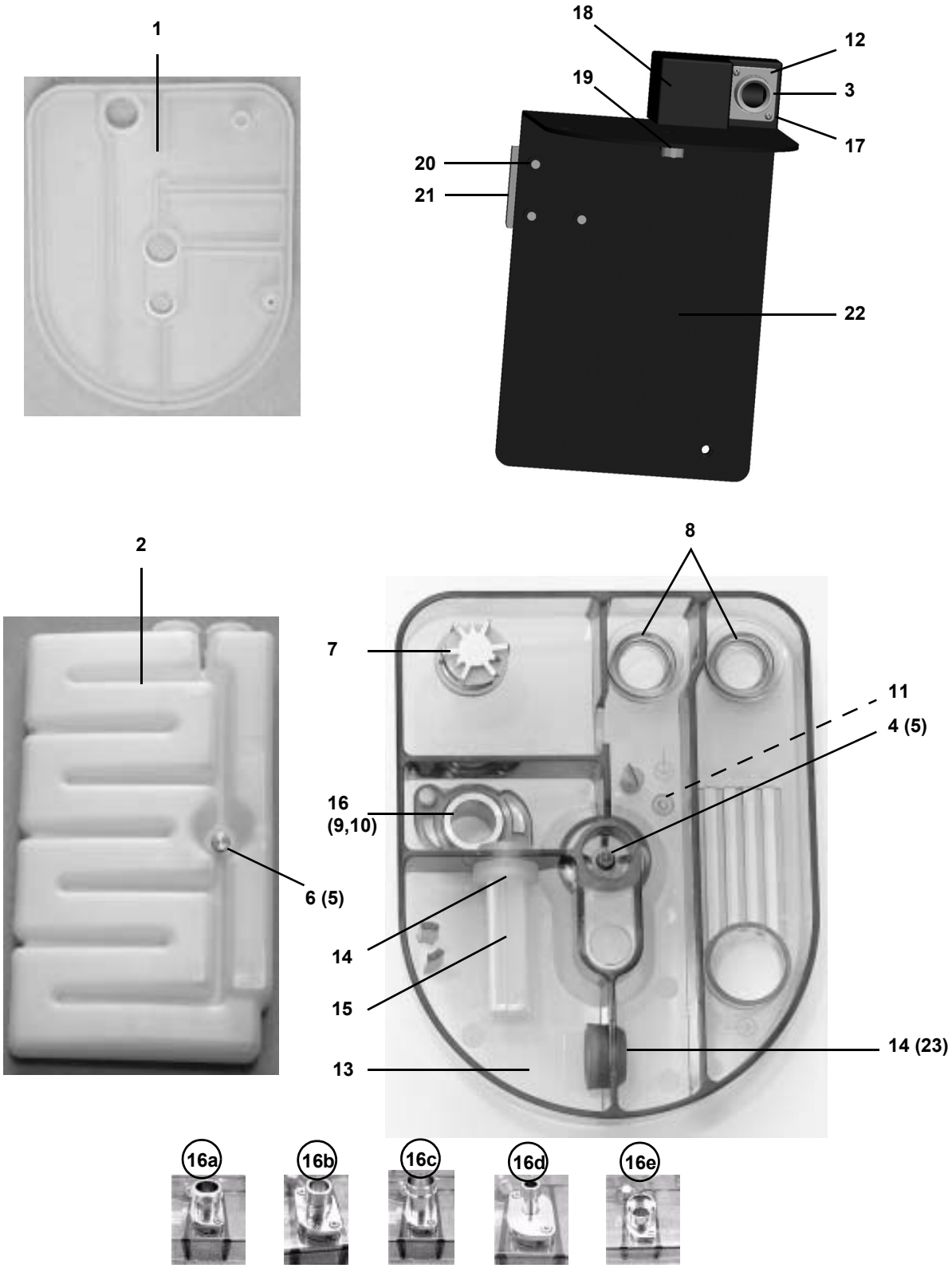
10.20.2 Adjustable AGSS



Item		Description	Stock number	Qty
1		Seal, Receiver body	1407-3901-000	
2		Reservoir	1407-3903-000	
3		Connector, AGSS	M1192891-S	
4		Thumbscrew, M6x25	M1193413-S	
5		O-ring, 4.47 ID, 8.03 OD	1407-3703-000	(2)
6		Thumbscrew, M6x43	1406-3304-000	
7		Valve, unidirectional (negative pressure relief)	----------	
	7a	Seat,Valve,Negative Pressure	1406-3396-000	
	7b	Retainer,disc	1400-3017-000	
	*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
	7d	Disc, check-valve	0210-5297-100	
8*		O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*		O-ring, 21.95 ID, 23.90 OD	1406-3558-000	
10		Screw M4x8	9211-0640-083	(2)
11		Cap, 3.18 barb, silicone	1406-3524-000	
12		Connector plate, AGSS	M1192893-S	
13		Receiver, passive/adjustable	1407-3908-000	
14		Plug Assembly, tethered	1407-3909-000	
15		Screw, shoulder M3	1407-3915-000	
16		Needle valve assembly (with DISS EVAC connector)	1407-3918-000	
17		Screw, M3x6	M1169246-S	(2)
18		Body valve, AGSS	M1192889-S	
19		Pin, AGSS	M1193409-S	
20		Screw, M6x20	M1189745-S	(3)
21		Hook, AGSS	M1192883-S	
22		Receiver cover, AGSS	M1192887-S	
23		Bag with 30mm male connector	8004460	

* Lubricate sparingly with krytox.

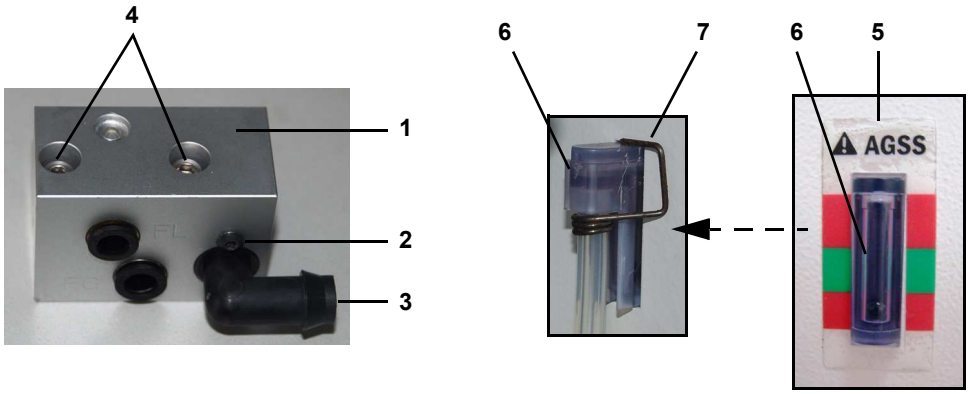
10.20.3 Active AGSS



Item	Description	Stock number	Qty
1	Seal, Receiver body	1407-3901-000	
2	Reservoir	1407-3903-000	
3	AGSS connector	M1192891-S	
4	Thumbscrew, M6X25	M1193413-S	
5	O-ring, 4.47 ID, 8.03 OD	1407-3703-000	(2)
6	Thumbscrew, M6x43	1406-3304-000	
7	Valve, unidirectional (negative pressure relief)	----------	
7a	Seat,Valve,Negative Pressure	1406-3396-000	
7b	Retainer,disc	1400-3017-000	
*7c	O-ring, 20.35 ID, 23.90 OD	1406-3397-000	
7d	Disc, check-valve	0210-5297-100	
8*	O-ring, 22 ID, 30 OD silicone	1407-3104-000	(2)
9*	O-ring, 21.95 ID, 23.90 OD	1406-3558-000	
10	Screw M4x8	9211-0640-083	(2)
11	Cap, 3.18 barb, silicone	1406-3524-000	
12	Connector plate, AGSS	M1192893-S	
17	Screw, M3x6	M1169246-S	(2)
18	Body valve, AGSS	M1192889-S	
19	Pin, AGSS	M1193409-S	
20	Screw, M6x20	M1189745-S	(3)
21	Hook, AGSS	M1192883-S	
22	Receiver cover, AGSS	M1192887-S	
Active AGSS specific parts			
13	Receiver, with air brake	1407-3900-000	
14	Seal, for filter and orifice	1407-3902-000	(2)
15	Filter	1406-3521-000	
Active High Flow specific parts			
16a	Connector, high flow M30 thread	1406-3557-000	
23	Orifice, high flow	1407-3920-000	
Active Low Flow with EVAC connector specific parts			
16b	Connector, low flow EVAC	1406-3597-000	
23	Orifice, low flow	1407-3919-000	
Active low flow with 25 mm connector specific parts			
16c	Connector, low flow 25 mm	1406-3573-000	
23	Orifice, low flow	1407-3919-000	
Active low flow with 12.7 mm hose barb connector specific parts			
16d	Connector, low flow 12.7 mm (1/2 inch)	1406-3574-000	
23	-none-		
Active low flow with 30mm taper connector specific parts			
16e	Connector, 30-mm ISO, male	1406-3555-000	
23	Orifice, low flow	1407-3919-000	

* Lubricate sparingly with krytox.

10.21 CGO Valve, AGSS Installation, AGSS Flowtube



Item	Description	Stock number	Qty
	CGO Assembly *	M1202905-S	
1	CGO seat assembly	M1203676-S	
2	Screw, M3x6	9211-1030-055	(2)
3	Fitting, elbow barbed	1009-3160-000	
	O-ring	0210-0691-300	
4	Screw, M4x25	M1168479-S	(2)
	AGSS Flowtube	----------	
5	Label, flow indicator AGSS	1406-3527-000	
	Label, blank (for machines without flow indicator)	1009-3241-000	
6	Flowtube, AGSS	1406-3560-000	
7	Spring, AGSS flowtube	M1093853	

* For machines without ACGO, CGO assembly will be installed.

11 Schematics and Diagrams

In this section

Schematics are subject to change without notice.

Circuit boards are available only as complete assemblies.

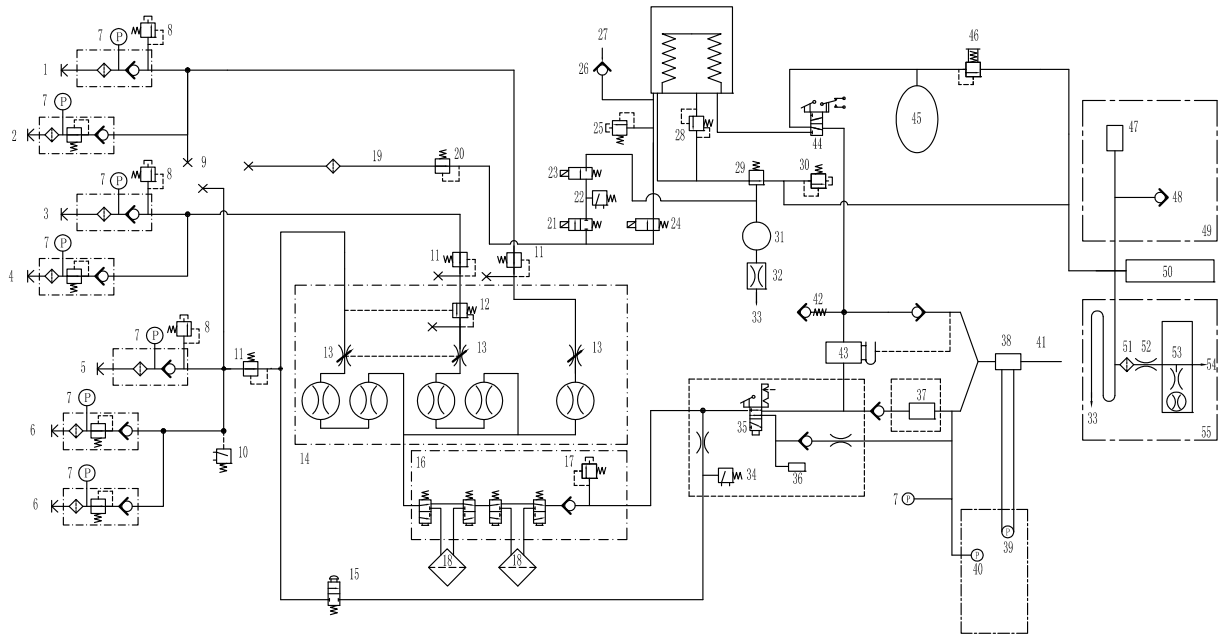
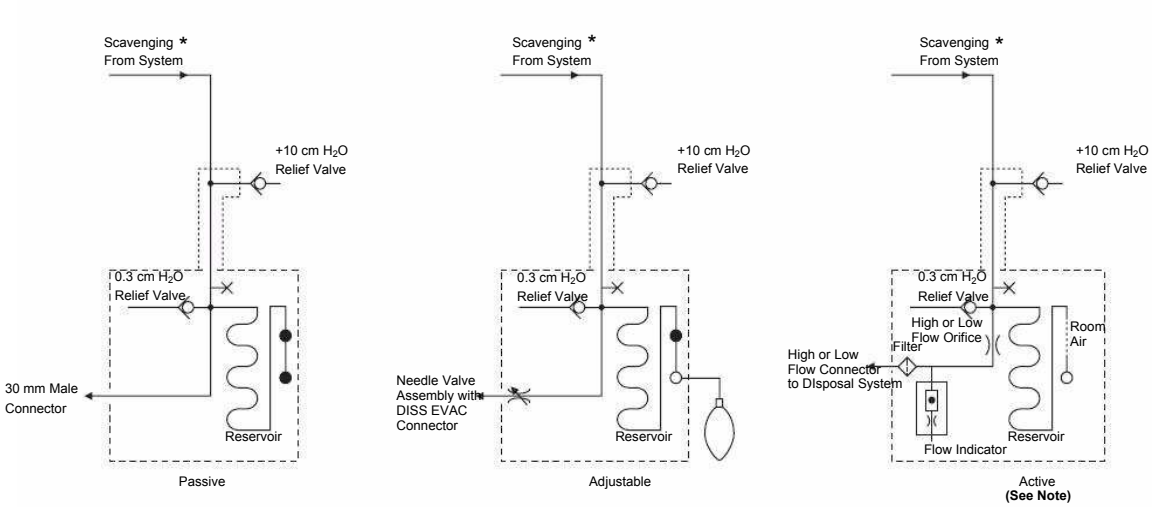


Figure 11-1 • System connection block diagram

1. Air pipeline inlet
2. Air cylinder inlet (optional)
3. N_2O pipeline inlet
4. N_2O cylinder inlet (optional)
5. O_2 pipeline inlet
6. O_2 cylinder inlet (optional)
7. Pressure gauge
8. Safe pressure relief valve
9. Ventilator drive gas select
10. O_2 supply switch
11. Regulator
12. N_2O balance regulator
13. Gas throttles
14. Flowmeter module
15. O_2 flush
16. Vaporizer manifold
17. 37.9 kPa relief valve
18. Vaporizer
19. 0-120 L/min flow
20. Regulator
21. PEEP safety valve
22. Pressure sense switch
23. PEEP control valve
24. Inspiratory flow valve
25. Mechanical overpressure relief
26. Free breathing check valve
27. Atmosphere
28. Pop-off valve
29. Exhalation valve
30. Scavenging pressure relief valve
31. Reservoir 200 mL
32. Bleed resistor
33. Room air
34. Pressure switch
35. ACGO select valve
36. ACGO port
37. O_2 sensor
38. Flow sensor
39. Flow transducer
40. Paw sensor
41. Patient lung
42. Negative pressure relief valve
43. Absorber canister
44. BTV switch
45. Bag
46. APL valve
47. 30mm-connect scavenging system
48. 0.05 kPa inlet
49. Passive AGSS interface
50. Scavenging base
51. Filter
52. High or low restrictor
53. Flow indicator
54. To disposal system
55. Active AGSS interface



Key to Symbols

- ✕ = Plugged port (1/8 inch) for sample gas return.
- ● = Plugged port (30 mm) for auxiliary breathing system scavenging.
- ○ = Open port (30 mm) for auxiliary breathing system scavenging.
- ✱ = Zero to 10 L/min drive gas; zero to 10 L/min patient and fresh gas; zero to 20 L/min total typical flow.

Note: Active AGSS systems with a 12.7 mm connector do not include the Flow Orifice and the Flow indicator.

Figure 11-2 • Gas scavenging circuits

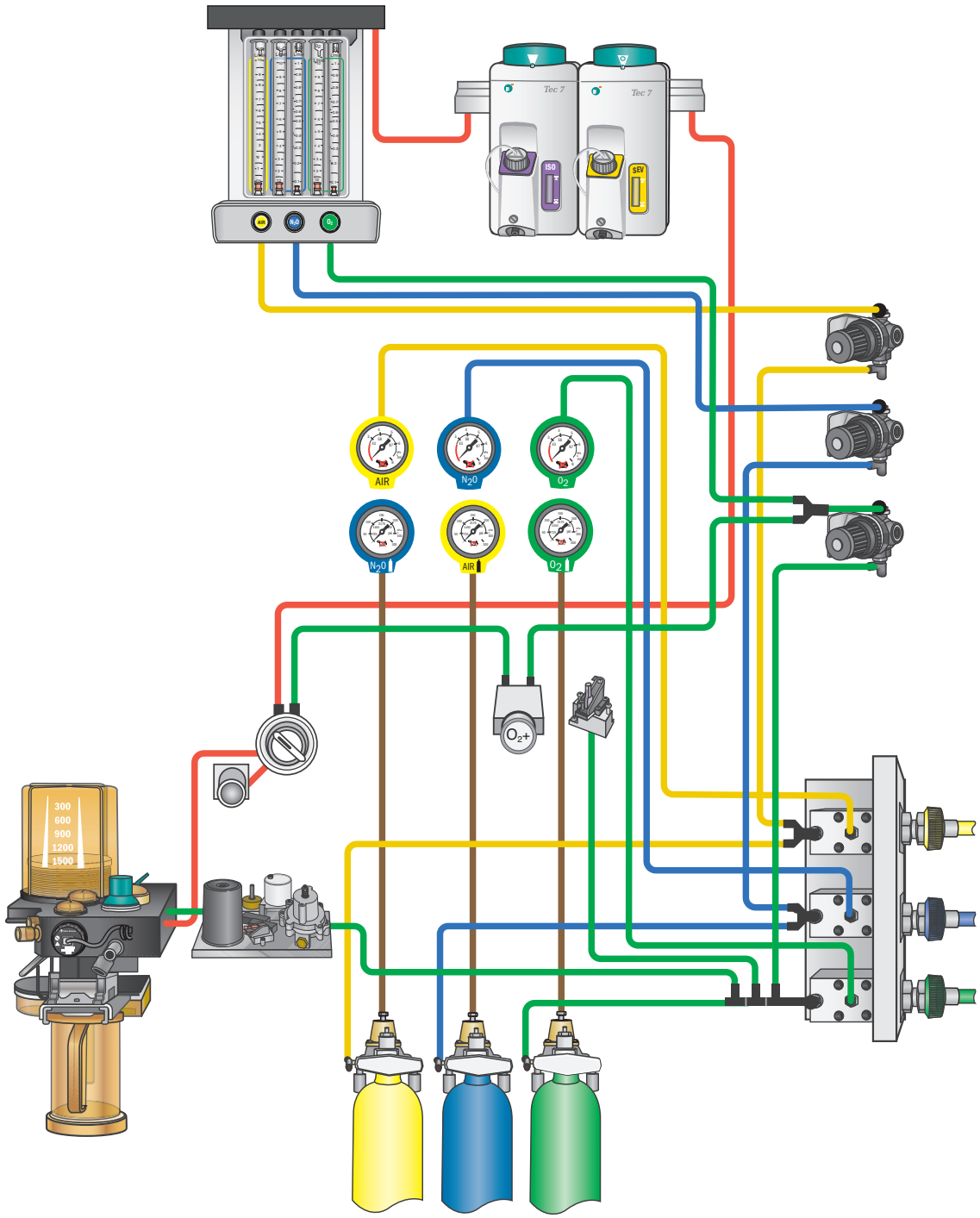


Figure 11-3 • Tubing

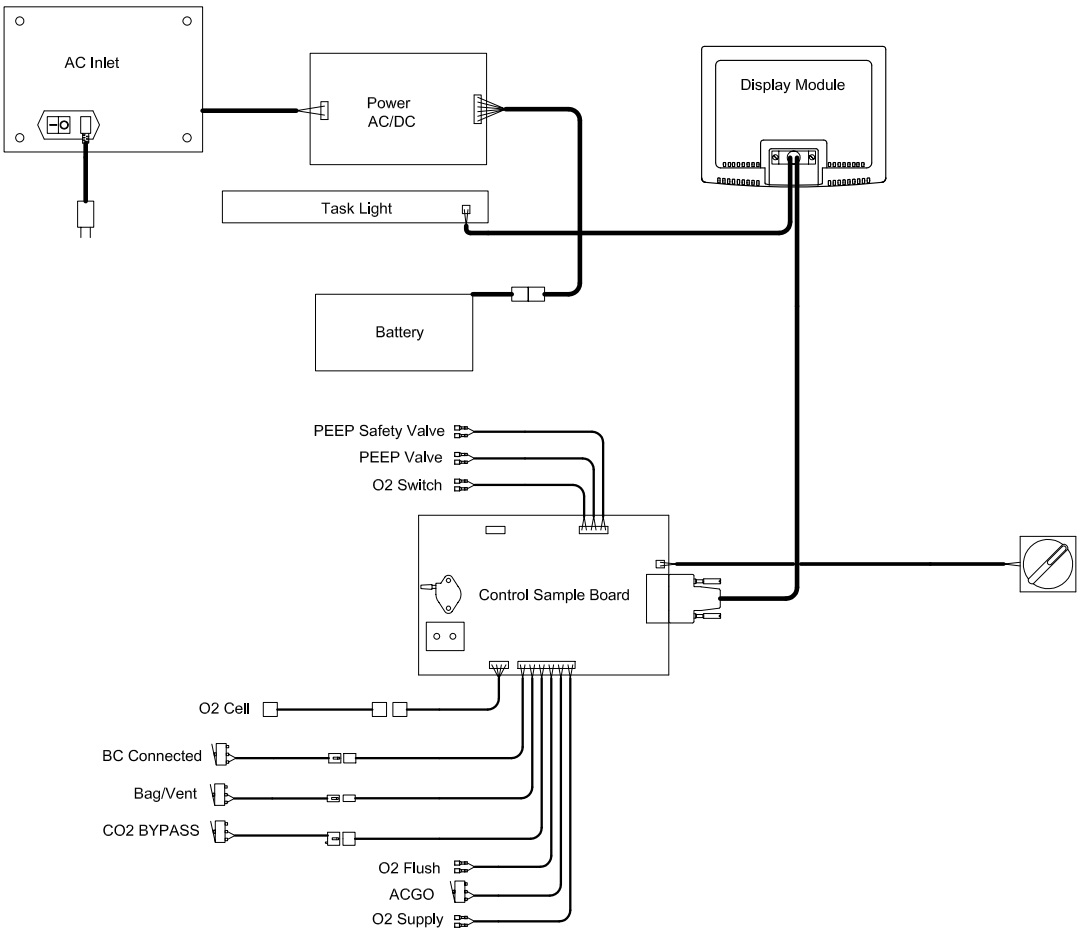


Figure 11-4 • Wiring harnesses

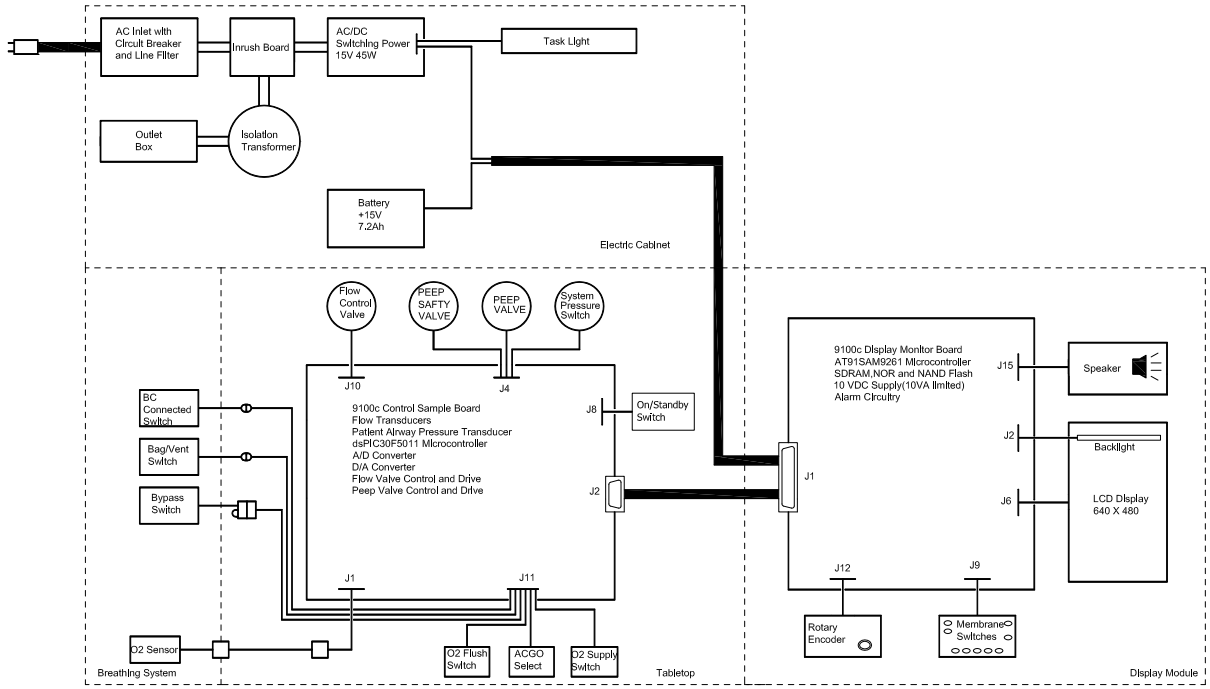


Figure 11-5 • Ventilator functional block diagram

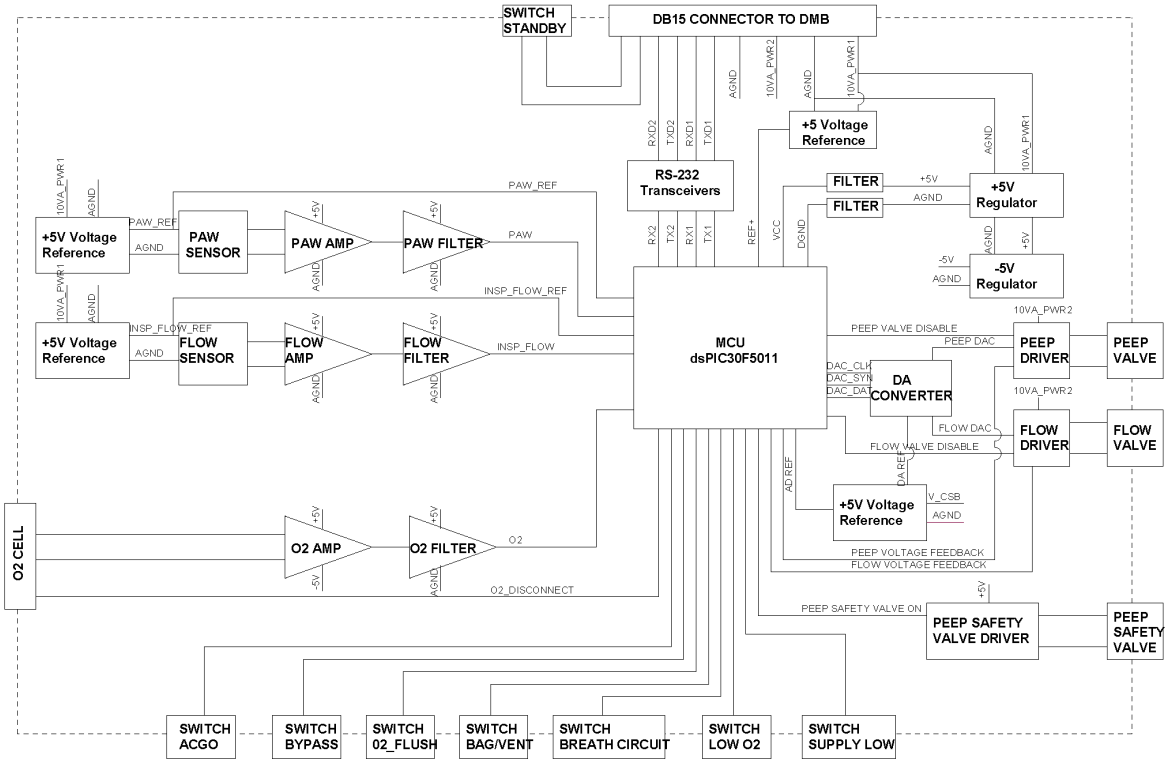


Figure 11-6 • Control sample board block diagram

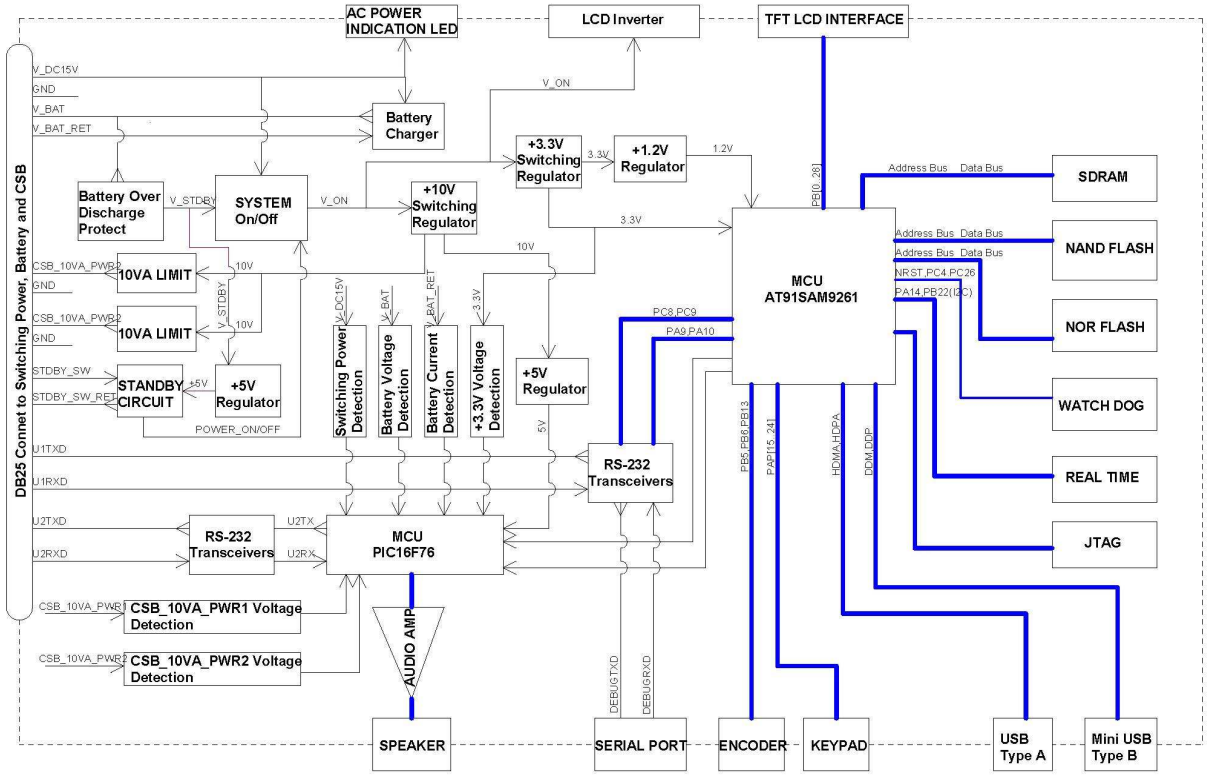


Figure 11-7 • Display monitor board block diagram

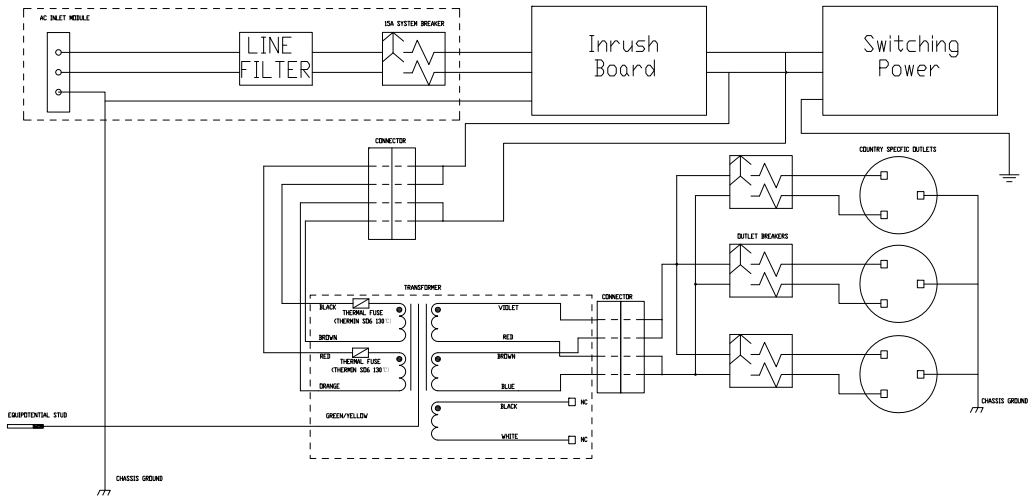


Figure 11-8 • Schematic, AC inlet module; 100 - 120 V

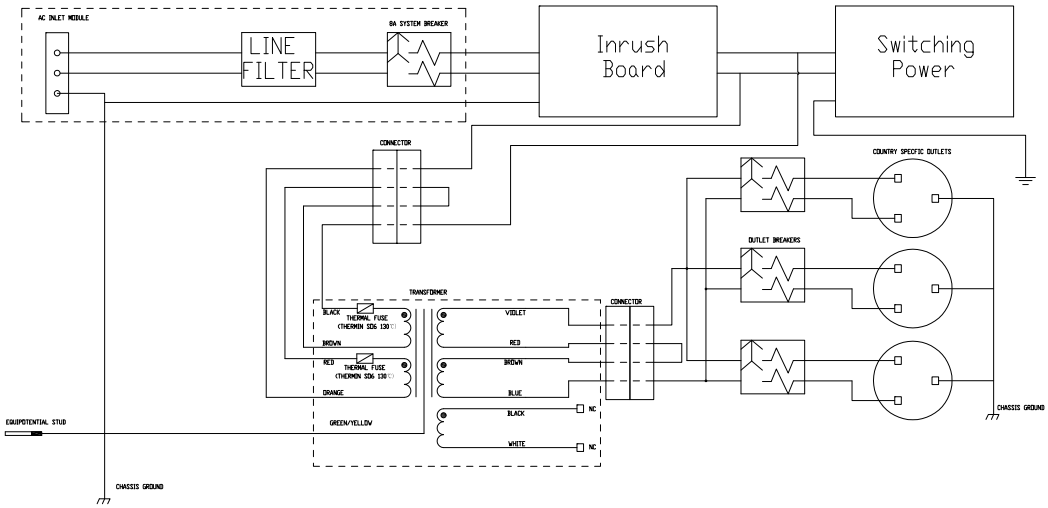


Figure 11-9 • Schematic, AC inlet module; 220 - 240 V

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