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1 Introduction

1.1 About this manual

This manual provides information for the preparation, use and care of the EV500 anaesthetic ventilator, together with suitable equipment from the Ulco range. Although this equipment has been carefully designed for simplicity of assembly and use, it is recommended that the contents of this manual be studied before attempting preparation or care of the equipment. Explanatory diagrams are provided in order to help the reader understand the concepts described.

This user manual should be read in conjunction with the user manual(s) for the vaporisers, anaesthesia gas delivery system, absorbers and monitoring equipment.

1.2 Intended Use

The EV500 Anaesthetic Ventilator is a medical device for providing Intermittent Positive Pressure Ventilation during procedures requiring inhalation anaesthesia for human adults and children above 5kg body weight.

The apparatus is intended for use solely in an operating or induction room.

The apparatus is intended to be used with hospital gas supply pressures within the range 280 - 500 kPa.

The apparatus is intended to be used under the continuous control of a person suitably trained and clinically qualified in its use.

To comply with the Anaesthetic Workstation standard IEC 60601-2-13, the EV500 shall be used with monitoring and alarms as described in Section 1.5.

In addition, the EV500 ventilator shall be used in conjunction with an automatic gas scavenging system (AGSS).

1.3 Device Classification

The EV500 was assessed for safety to the international standard IEC 601-1:1988 + A1 + A2.

The EV500 Anaesthetic Ventilator is classified as follows:

- Class I equipment for the purposes of electrical safety
- Type CF applied part
- Continuous Operation
1.4 Warnings and Cautions

- NOT FOR USE IN THE PRESENCE OF FLAMMABLE ANAESTHETIC AGENTS

- The ‘BOTTOM’ pressure alarm setting must be adjusted such that the green pressure bar display brightens on the peak of every breath but the lower set limit bar display is not flashing. If it is flashing then it indicates that it is set too low and may not be sensitive to drop in cycling pressure. I.e. from a disconnection.

- If the unit alarms, check the patient. Establish that the patient is being ventilated correctly.

- This equipment is an adjunct to patient safety and it must in no way replace the normal monitoring by skilled personnel. The manufacturer accepts no responsibility for incidents arising from either incorrect use or malfunction of this equipment.

- Power line voltage is present on the main PCB. Mains voltage can be encountered at the fuses, mains inlet and PCB. Ensure the unit is unplugged whenever you are disassembling it.

- It is strongly recommended that pulse oximeters, Oxygen analysers and end tidal CO2 monitors be used. These will help to ensure patient safety, make precise ventilation possible and so achieve the best possible ventilator parameters for the patient.

- The unit will automatically switch off if the standby battery is too low to ensure reliable operation.

- An authorised Ulco Technical Service Representative must perform maintenance on this equipment. Ulco products in need of factory repairs must be sent to the nearest local agent or directly to Ulco.

WARNING
DO NOT USE IN THE PRESENCE OF FLAMMABLE ANAESTHETICS
PLEASE NOTE OVERPRESSURE CYCLING (PAGE 5)

1.5 Monitoring and alarms

This unit must be used in conjunction with equipment providing the following alarms and monitoring capabilities:

- Inspiratory oxygen concentration
- Anaesthetic agent concentration
- CO₂ concentration

In addition, monitoring of exhaled volume is strongly recommended.
2 Operating Instructions

This all-purpose anaesthesia ventilator is **TIME CYCLED** and gas driven. It should be connected to a supply line of 350-450 kPa (50-70 lb/sq inch), this being the standard operating theatre supply line pressure for inhalation gases. Reduced cylinder pressure is also within this range.

Medical grade oxygen or air can be used but oxygen is preferable as it is free from impurities such as oil and moisture.

An operator unfamiliar with the ventilator should note the various controls and be sure to understand how variations of each control affect patient ventilation. If uncertain, operators should practice running the ventilator prior to connection to the patient and become familiar in setting the volume, timing and the inspiratory pressure.

Inspiratory pressure adjustments can be done by occluding the ventilator’s patient outlet during the inspiratory phase and adjusting the Insp. Pressure control whilst watching the pressure gauge. Make sure the bellows are expanded and not fully compressed during this adjustment as the gauge measures the circuit and not the driving pressure.

2.1 Connect the Ventilator

Connect ventilator to anaesthetic machine as shown in the diagram and set the required gas flow on the flowmeter, then press the oxygen flush to fill the bellows. Connect power to the ventilator and ensure that the green MAINS LED is on.

2.2 Check for Leaks

This is done to confirm the satisfactory function of the one way valve at the base of the bellows and to ensure the absence of leaks in and around the bellows.

With the ventilator turned off and the bellows fully expanded (gas flow approximately 1 L/min), occlude the patient connection. Loosen the lock nut of the volume control, and slide the volume-adjusting spindle up and down. It should move freely, and the bellows should return to its fully expanded position after a short duration (depending in the gas flow). Set inspiration pressure to the maximum and turn the MODE selector to POS. The ventilator should switch on and the audible alarm, the HIGH and LOW LEDs and the red flashing MAINS LED should come on for approximately 1 second. The green pressure bar graph and the red timing displays all come on. Take note if any segment or alarm is not working.

On inspiration (with the outlet of the Y-piece occluded and the bellows fully expanded) the ventilator gauge should register the maximum pressure without the bellows compressing no more than a small amount and return to full expansion on expiration. If the bellows do not return to their original volume and continue to lose further volume, a leak exists either in the bellows, the one way valve or the breathing circuit.
2.3 Check Alarm Functions

Set the TOP SET LIMIT control such that the inspiratory pressure exceeds it. Check that the HIGH LED is on, the alarm sounds and switches to Expiration (There is no audible alarm if the alarm is muted by the OFF/RESET switch or if the unit is still in the 1 minute mute period after being turned on).

Set the BOTTOM SET LIMIT control such that inspiratory pressure is less than it. Check that after approximately 20 seconds, the LOW LED is on and that the alarm sounds (if it is not muted).

2.4 Settings

2.4.1 Timing

The timing is set by the INSPIRATORY TIME and RATE control knobs. The settings are displayed by the LEDs under their corresponding inscriptions. Setting the RATE (breaths per minute) will not alter the inspiratory time, but the resultant I:E ratio which is also displayed will alter. Parameters will stay within the range set in the ‘Specifications’ section.

2.4.2 Volume

The tidal volume is set by adjusting the bellows limit rod (loosen the lock nut to adjust and tighten after adjustment has been made) to the desired inscribed level. Note that the markings are approximate and expired volume monitoring may be necessary for exact volume determination.

2.4.3 PEEP

Should PEEP be necessary, turn the mode selector to PEEP and adjust the expiratory pressure control to the required level during expiration. The maximum PEEP is limited to 20 cmH₂O pressure.

2.4.4 Pressure

The inspiratory pressure control is adjusted so that when the patient is ventilated the required volume is delivered within the previously set inspiratory time.

2.4.5 Flow

This control changes the Inspiratory characteristics of the ventilator from a flow generator (nil entrainment) in the closed position, to a pressure generator (full entrainment) in the open position. Positions between these two extremes offer a unique ability to combine flow and pressure generation.

2.4.6 CPAP

If CPAP is inadvertently selected the ventilator will stop cycling.
Reset the mode selector to the POS or PEEP position to restart cycling.

### 2.5 Pressure Cycling Option (NOT FITTED AS STANDARD)

**WARNING**

To pressure cycle the ventilator, set Inspiratory time and inspiratory pressure to maximum then set the upper limit LED to the required switching pressure. When the two LED’s meets, the ventilator will switch to expiration. An audible BEEP will sound every time the pressure limit is reached (over pressure limit).

NB. The rate display does not show the pressure cycling rate but the set rate that was selected for time cycling. (This mode is intended as a safety system for overpressure).

### 2.6 In Use with a Patient

Ensure that the proposed breathing circuit is compatible with the ventilator used. Turn on the ventilator and adjust the timing, volume and pressure to approximate requirements. Connect the patient and then make the final fine adjustments to suit the characteristics of the lungs (i.e. individual variation in compliance, airways resistance and required minute volume). Check that the expiratory pressure falls to zero at each cycle (i.e. no obstruction in the expiratory pathway).

Pollution control systems may be attached to the exhaust of the ventilator. It is important to guard against possible obstruction and excess suction. Both will be indicated on the ventilator gauge (not returning to zero if obstructed or the bellows being sucked up during the expiratory period if the suction is too high and a negative pressure is being generated).

Confirm adequate ventilation of the patient by observing good chest movement with each inspiration. Make sure all connections are leak free and firmly connected. Unnecessary high inspiration pressures should be avoided. Set the inspiratory pressure and time so that the selected volume is delivered just before the inspiration ends to obtain a plateau. With the circle system ensure that all dump (APL) valves are closed off as venting is through the rear of the ventilator.

A suggested method of setting the inspiratory parameters is to first place the flow control in the mid position. The required tidal volume is selected and the required inspiratory time is set. The inspiratory pressure is then adjusted so that the tidal volume is delivered just before the end of the inspiratory period. The suggested expiratory time is 3 times the inspiratory time. For adults, for example, an inspiration time of 1 second (rate 15 BPM ratio 1:3). When set as described the following features will be seen:

1. A short period of ‘inspiratory hold’ when the tidal volume has been delivered and the expiratory time has not yet begun. This is seen on the pressure gauge as a pressure drop and a momentary hold at this lower pressure. This is an indication of compliance (lung and chest wall) and compliance changes occurring during the anaesthetic can be monitored.

2. The inspiratory ‘hold’ is a good indication that the circuit is leak free. A continually falling pressure at this point (with healthy lungs) indicates a leak in the circuit (e.g. deflated endotracheal tube cuff).
3. Ventilation volume, once set, will remain constant throughout the anaesthetic in spite of minor changes in compliance eg tilting the patient or a relaxant partially wearing off.

4. If varying times constants exist within the lungs (eg severe COAD) better ventilation of the slow fillers is achieved with an inspiratory hold phase and atelectasis is prevented.

2.6.1 Setting the alarm

1. Switch the ‘0-30/0-60’ switch to 0-30 unless you are using pressure in excess of 30 cmH2O.

2. Adjust the BOTTOM SET LIMIT such that it is lower than the peak inspiratory pressure. The display should brighten on every breath without the lower bar flashing. If it is flashing then it indicates that it is set too low and may not be sensitive to drops in cycling pressure (eg from a disconnection).

3. Adjust the TOP SET LIMIT such that it is just higher than the peak inspiratory pressure.

4. Check, after 1 minute, that the alarms are off. If the MAINS red LED is flashing and the alarm is sounding intermittently, then either the alarms battery may need to be renewed or the internal battery recharged.

5. If the numerical displays are flashing, then the parameter has changed significantly from the previous breath.

6. If CPAP is being used, adjust the BOTTOM set limit counter clockwise until the LOW alarm just extinguishes.

7. Pressing the PRESS FOR OFF button will mute the alarm for 1 minute.

2.6.2 To switch off

To switch the unit off, switch off the ventilator and press the PRESS FOR OFF button until the displays are off. ‘1’ will be displayed for approximately 20 seconds and turn off and then only the green ‘MAINS’ LED should be on.
3 Care and Maintenance

3.1 Cleaning intervals

The ventilator is an automatic bag squeezer, and the bellows within the ventilator takes the place of a normal rebreathing bag. Therefore, the bellows should be cleaned as often as a rebreathing bag, usually after any infected case or at the end of the day. If an inline bacterial filter is fitted on the breathing hose to the ventilator, cleaning will only be needed once every one or two months.

**Note:** The filter should be replaced in accordance with the manufacturer’s recommendations.

3.2 Method for cleaning ventilator

The machine must be disconnected from the mains before cleaning or disinfecting. The ventilator’s outer surfaces can be cleaned using a soft cloth and mild soap solution. After washing, wipe with clean water and allow to dry. Do not allow fluids to penetrate the housing or any of the external connectors.

In all cases, care must be taken in order to prevent liquids from entering the electronics situated in the base of the ventilator.

**Dismantle the ventilator**

1. Loosen the four knurled screws (labelled (1) in Figure 1) and remove the bellows canister

![Figure 1: Location of knurled screws](image)
2. Remove the ventilator head assembly from the ventilator by pulling upward on the delrin block.

![Diagram showing removal of bellows canister and bellows bag assembly](image)

**Figure 2: Removal of bellows canister and bellows bag assembly**

3. Remove the bellows assembly by rotating in counter-clockwise as shown in Figure 2.
Figure 3: Disassembly of Volume control assembly
4. The ventilator head can be put through a washer at 80°C.

5. The bellows canister may be washed or autoclaved (volume control must be removed as shown in Figure 3).

6. The base disk (mushroom) should be removed from the bellows assembly before washing. Pull the rubber bag from the delrin base disk as shown in Figure 5. The bellows may be washed or autoclaved. The base component (mushroom) should not be autoclaved but can be put through a washer at 80°C.
7. Dry all components thoroughly before re-assembly. Low pressure warm air should be passed through the ventilator head by attaching a hose to the scavenge port.

### 3.3 Disinfection

If the unit has been contaminated, the whole ventilator may be gas sterilised. Do not sterilise the ventilator using radiation sterilisation techniques.

A disinfectant may also be used when cleaning the ventilator, if diluted with water. First wipe the whole ventilator with a damp sponge containing disinfectant, then remove the canister, bellows and head assembly as described above and wipe the inside of the ventilator (chamber).

Individual components may be cleaned using a washer (Meile or similar). Breathing circuits and components such as ventilator bellows, canisters and head should be washed at approximately 80°C with a slightly alkaline detergent solution (pH 10-11).

#### 3.3.1 Chemical disinfecting

- Wash in soap solution and then dry
- Soak in 2% glutaraldehyde (pH 6.5) for 19-20 minutes. Rinse and dry thoroughly.

#### 3.3.2 Steam Autoclaving components

Normally this is not required for anaesthesia equipment and accessories. If autoclaving is needed, use the glove cycle. Do not autoclave the head assembly or the base disk of the bellows bag assembly.
3.3.3 Gas sterilising

ETO gas sterilising can be carried out on all removable components after washing or on the entire ventilator. Aerate thoroughly after gassing.

3.4 Care and Maintenance of Bellows

Reversion and loss of strength is usually the result of exposure to high temperatures or excessive age. Some other factors, which cause degradation of natural rubber, are copper and manganese containing materials, which can include some water supply systems. The copper acts as a catalyst to degrade the rubber and surprisingly small amounts can lead to very rapid aging of the rubber, causing loss of strength.

Contact with solvents or oils can also damage rubber and can lead to tackiness and loss of strength, but will usually swell the rubber while it is still present. The rubber is compounded with antioxidants which are intended to preserve it against oxidation and aging, but if very powerful detergents or soaps are used to clean the bellows, these may leak out leaving the rubber largely unprotected.

Other agents, which will attack rubber, are SUNLIGHT, ULTRA VIOLET light and OZONE. Temperatures in excess of 80°C will cause reversion and at 100°C this occurs quite rapidly.

SUGGESTED PROTECTIVE METHODS

- Keep spare bellows in boxes and away from fluorescent (in the dark)
- Use only mild soaps and warm water to clean the bellows.
- The bellows should be dried while fully expanded.
4 Principles of Operation

The ventilator is divided into 2 main systems, electronic and pneumatic.

4.1 The electronic system

The electronic system is a micro-controller based system generating timing signals from a quartz crystal oscillator. The timing signals are used to control pneumatic valves in the system. The micro-controller uses internal feedback, COP (computer operating properly) and watchdog pulses to monitor its performance and check for abnormalities. The micro-controller generates the LED display and the alarms. The main PCB module, the EV200, has the power supply, battery charger, pressure transducer and peripheral drivers on board. It incorporates a ventilation disconnection alarm system which monitors the patient airway pressure. It is designed to indicate an alarm condition if:

- the patient airway pressure has not cycled above and below a manually set pressure level within 16 seconds
- the patient airway pressure has exceeded the overpressure set point
- in CPAP mode the pressure drops below the BOTTOM SET LIMIT for more than 1 second
- the unit detects an internal system fault:
  - the standby battery is too low (battery low LED flashes and the alarm sounds intermittently)
  - the alarm’s battery is too low (battery low LED flashes and the alarm sounds intermittently)
  - the standby battery has failed (battery low LED flashes and the alarm, unless muted, sounds)
  - the micro-controller has failed, i.e. watchdog alarm (continuous sounding alarm)

The audible alarm is muted for one minute when the unit is turned on and when off/reset is pressed. This allows for the patient and ventilator to be adjusted to establish correct functional conditions.

To switch the unit off, the ventilator must be first turned off and the OFF/RESET button held for approximately 2 seconds. An alarm will sound after approximately 1.5 seconds until the unit is off to signal the OFF condition. The green pressure bar graph and the red timing display will go blank except for ‘1:’ in the ratio display. This will stay on for approximately 20 seconds and then blank as well.

Note that if the OFF/RESET button is held for approximately 15 seconds the unit will turn off, even if the micro-controller has failed (watchdog alarm). If the ventilator is still on, the unit will then turn back on (reset).
The unit will turn off if the standby battery is too low to ensure reliable operation. This is also to protect it from excessive discharge.

### 4.2 The Pneumatic System

The pneumatic system is used to compress the bellows via needle valves, jets, and a venturi. The motive force is derived from the driving gas.

With the ventilator connected to drive gas supply, switching the ventilator mode selector to ON will cause a pressure switch to operate, causing power to be applied to the EV200 assembly. This will start the timing sequence. On inspiration, the EV200 turns on the high pressure supply to the main (positive) jet. The flow to this jet is regulated by the inspiration pressure control needle valve such that the venturi pressure ranges from 0 cmH\(_2\)O to 60 cmH\(_2\)O. The inspiratory time display will brighten slightly. At the end of the inspiration time, the EV200 deactivates the cycle valve, the inspiratory time display dims, and the expiratory time display brightens.

If the MODE selector is in the PEEP position, then the EXP pressure control needle valve regulates the flow (from the cycle valve in the resting state) such that the venturi pressure ranges from 0 cmH\(_2\)O to 20 cmH\(_2\)O.

The patented venturi system prevents excessive pressure in the patient circuit, without the need for spring operated relief valves that can stick. The venturi is directly connected to the breathing circuit via the bellows and to atmosphere via a flap valve to prevent air entrainment. Should air entrainment be required to increase flow, then the flow control may be used. Flow can be increased to over 100 L/min.

When the pressure set by the control valve is reached, then the venturi stalls and the excess pressure flows to atmosphere via the flap valve.

### 4.3 Ventilation Circuits

#### 4.3.1 Circle system

The EV500 can be used with any standard anaesthesia machine with a circle system. The ventilator replaces the rebreathing bag and the circle absorber dump valve is closed off. Venting is through the ventilator.

#### 4.3.2 Tee piece

The tee piece is well suited for use with babies, although it can also be used with adults. The Bain is a tee piece circuit. The ventilator is attached to the expiratory limb of the tee piece. For babies and small children, a one way valve on the expiratory limb can also be used and results in only fresh gas flow ventilating the patient.

It is sometimes used to avoid the possibility of a large volume of gas distending the lungs of a neonate, but mostly ventilation is done without the one way valve and inspiration pressure kept low. With adults (e.g., the Bain circuit), fresh gas flows must be kept high enough to prevent excessive rebreathing.
4.3.3 Non-rebreathing one way systems

These are for adult use and can be used for air or anaesthetic gases. The ventilator can function as a minute volume divider by adjusting the volume setting to maximum. Each filling volume of the bellows is then determined by the fresh gas flow during the expiration period, and the inspiratory pressure is adjusted so that whatever volume is in the bellows is delivered to the patient.
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5 Technical description

5.1 Power supply

AC power is fused and is transformed to 12V AC by TR1 and rectified by BR1. External DC, or the rectified AC, is filtered by C1 (1000µF) and appears at PIN 1 of U3 (LM2575T5.0). This is a step down switching regulator of nominal 5V output. R2 (1k8) is used to boost the output to 7V2 to charge the 6V battery through D2. Q1 and R1 (1R0) are configured as a current limiter, which in the limit condition will drop the charging voltage to 5V in series with a 1R resistor. The current will be limited to approximately 500mA. The main 6V battery, and the 9V alarms battery are isolated through diodes D4 and D5 and when pressure is applied to SW1 (when the ventilator is switched on) this voltage is applied to the alarms circuit and U4 (LM324).

When this voltage is applied to U4 and ZD1 (5V reference) through R4, the output pin (PIN 8) will drive Q2 (BD135) to supply 5V at its emitter. The feedback around U4 will regulate this voltage. C3 (680µF) improves the transient response and reduces noise on this 5V supply.

This 5V is supplied to U5 (LM3578A) which is a step-up switching regulator that supplies a regulated 10V. This 10V supplies the alarms and transducers. The 5V supply is monitored by a reset generator comprising R31, 32, 33 ZD2 and Q5. This circuit applies 0 (zero) volts to PIN1 of U1 (reset) until the supply exceeds approximately 4V, at which point it switches to HIGH.

5.2 Micro-controller

The micro-controller U1 (MC68HC705C8FN) inputs information from the switches and the analogue to digital converter, and outputs information to the front panel displays, alarms, watchdog and RS232 terminal (if fitted). It utilises a COP (Computer Operating Properly) timer which will reset the system if specific internal functions are not performed at set intervals, indicating that the controller is in a loop, or normal processing has been disrupted.

5.3 Alarms

U6 (XR2203) drives the front panel LEDs, audio sounder and low battery LED driver. The sounder is driven by either a high on the audio input (PIN3) or a high from the watchdog detector (PIN4). The watchdog circuit comprises C12, D8 and R28.

An alternating waveform is fed to PIN7 through C12 and rectified by D8. This input causes the output pin (PIN7) to pull down the voltage through R28 and C11. A constant high or low of greater than approximately 150ms will allow C11 to charge via R28, switching the output on PIN13 low and turning on the sounder.
The low battery indicator is configured such that it is normally turned on via R27 and Q4. The low battery input (PIN5) is held high to turn this LED (flashing red) off. If the unit is switched on in the absence of mains power or standby battery power, then the sounder and the low battery indicator should both be active.

5.4 Pressure transducer amplifier

The signal from the pressure transducer (MDX 10DP) is approximately 35mV for full-scale output - 60 cmH₂O. R15 is selected to allow for temperature compensation. The signal at U11A PIN1 should be 1V for 0 cmH₂O pressure and 6V for 60 cmH₂O.
## 6 Troubleshooting

<table>
<thead>
<tr>
<th>Ventilator on, mains off</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No alarms</td>
<td>Check pressure into ventilator</td>
</tr>
<tr>
<td></td>
<td>Adjust pressure switch</td>
</tr>
<tr>
<td></td>
<td>Check 9V and 6V battery</td>
</tr>
<tr>
<td>Continuous alarms</td>
<td>Check reset circuit Q5, ZD2*</td>
</tr>
<tr>
<td></td>
<td>Check 5V and 10V*</td>
</tr>
<tr>
<td></td>
<td>Check 4MHz oscillation*</td>
</tr>
<tr>
<td></td>
<td>Watchdog pulses U1 P27*</td>
</tr>
<tr>
<td>Continuous low battery</td>
<td>Check 6V battery (charge or replace)</td>
</tr>
<tr>
<td></td>
<td>Check 9V battery (charge or replace)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mains on</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No green MAINS LED</td>
<td>Check power at outlet</td>
</tr>
<tr>
<td></td>
<td>Check fuses</td>
</tr>
<tr>
<td></td>
<td>Replace IEC mains lead</td>
</tr>
<tr>
<td></td>
<td>Check display board connection*</td>
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<td></td>
<td>Check AC at transformer secondary*</td>
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<td></td>
<td>Check DC at U5 P1*</td>
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<tr>
<td></td>
<td>Check 7V2 at Q1 emitter*</td>
</tr>
<tr>
<td>CPAP on, MODE not indicating</td>
<td>Check adjustment of CPAP pressure</td>
</tr>
<tr>
<td></td>
<td>Check switch (in top assembly)*</td>
</tr>
<tr>
<td></td>
<td>Check pressure to switch from MODE selector*</td>
</tr>
<tr>
<td>Can’t adjust range or offset of transducer</td>
<td>Check 10V supply*</td>
</tr>
<tr>
<td></td>
<td>Transducer may be faulty*</td>
</tr>
</tbody>
</table>

*Only to be attempted by suitably qualified technical staff.

### 6.1 To access internal electronics

- Remove the lid and bellows assembly (be sure to remove the valve etc that may still be in the top assembly).
- Remove the screws at the rear and slide the top cover backwards and off
- Remove the large screws which hold the connection block (mid right hand side, next to a pressure line and the patient pressure monitor line).
• Slide the unit forward so that the bottom plate with the feet becomes exposed at the rear. Do not slide out all the way, as there are connections to the top assembly (Insp. & Exp. Time controls, CPAP pressure switch, cycle valve and the battery). Slide out far enough so that you are able to disconnect these connections.

• Battery must be disconnected at the battery and the wires pulled down

• Disconnect the front panel 6W connector.

• The bottom plate and EV200 PCB can now be removed

• To remove the micro-controller insert a PLCC extractor diagonally across the IC and remove.

Note Be very careful to insert the micro-controller with the correct orientation (flat to flat) as the sockets are delicate. Line up the IC correctly before attempting to push it home.

**IMPORTANT**

Always perform PERFORMANCE CHECK whenever the unit has been opened for service.
### 6.2 Main PCB Assembly Parts List

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<td>4</td>
<td>Diode</td>
<td>1N4148</td>
</tr>
<tr>
<td>CON101</td>
<td>1</td>
<td>Ribbon Cable Assembly</td>
<td>MF200SA ASSY</td>
</tr>
<tr>
<td>CON102</td>
<td>1</td>
<td>Header 8 way</td>
<td>1100-8-108-01</td>
</tr>
<tr>
<td>CON103</td>
<td>1</td>
<td>Header 4 way</td>
<td>1100-8-106-01</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Switch + Alarm pot Assy</td>
<td>MF200SA ASSY</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Timing Pot Assy</td>
<td>MF200TP ASSY</td>
</tr>
</tbody>
</table>
7 Service and Calibration

7.1 Service intervals and components

The performance check specified in Section 7.7 should be performed every 12 months. The following kits should be applied at the indicated intervals.

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Product. Description</th>
<th>Interval in Months</th>
<th>Qty</th>
<th>Part. No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EV500 Service Kit</td>
<td>12</td>
<td>1</td>
<td>EV500-99</td>
</tr>
</tbody>
</table>

7.2 VE500-99 Service kit

- 3 off OR-5001O-ring
- 2 off OR-5006O-ring
- 2 off OR-5010O-ring
- 2 off OR-5011O-ring
- 2 off OR-5108SO-ring
- 1 off OR-5113SO-ring
- 2 off OR-5115O-ring
- 2 off OR-5212SO-ring
- 2 off OR-5214O-ring
- 1 off OR-5218SO-ring
- 1 off OR-5259SO-ring
- 4 off OR-0401O-ring
- 1 off VE11612Spring
- 1 off VE50432Weight Assy.
- 4 off WAM6PWasher
- 4 off WA-DZUSWasher
7.3 Tools to be used

- 1.5mm, 2.5 mm and 4 mm Allen keys
- Philips screwdriver
- Flat screwdriver
- 1” spanner
- Silicone grease Molykote 111.

7.4 Preparation to service EV500 Electronic Ventilator

- Make sure that the anaesthetic machine is OFF.
- Disconnect EV500 ventilator from anaesthetic machine. This is remove oxygen driving gas for ventilator, ventilator to absorber hose, scavenger hose and coiled hose between absorber and ventilator.
7.5 Service Procedure

1. We must first separate the top sub assembly from the bottom sub assembly; to do this we must remove the 4 screws SM0410B with a 2.5mm Allen key and then pull up the top sub assembly as per Figure 7.

![Image of removal of top sub assembly](image)

**Figure 7: Removal of Top Sub assembly**

2. Replacement of o-rings OR-5212S from Bellows assembly. Refer to Figure 8.
   a. Turn anticlockwise the four AB20102 knobs and proceed to remove canister assembly from top sub assembly.
   b. Turn anti clockwise the bellows assembly EV506 and remove it from ventilator head.
   c. Replace o-ring OR-5212S and smear it with silicone grease Molykote 111.
3. Replacement of o-rings OR-5259S and weight assembly VE50432 from the Ventilator head sub assembly. See Figure 9.
   a. Replace the o-ring OR-5259S and smear it with molykote 11 grease.

Figure 8: Removing Canister and Bellows Assembly
b. Remove the cage VE50433 by using a flat screwdriver and then the VE50432 weight assembly.

c. Check that the valve seat VE50431 is not damaged, otherwise it needs to be replaced.

d. If the valve seat doesn’t need to be replaced, then replace the new VE50432 weight assembly taking care not to grease this component.

e. If the valve seat VE50431 needs replacement, use a tool (object) of about 17.2mm diameter, which will fit tight into this component and turn it anticlockwise. Only then we can remove it from the ventilator head assembly.

---

4. Service of o-rings OR-5214 and OR-5218S from VE511 Silencer Assembly. Refer to Figure 10.
   
   a. Pull out the VE511 Silencer Assembly from the Bottom part of EV500 Ventilator.
   
   b. Pull out the VE11122 Exhaust Connector and the VE11121 Connector Carrier Plug from the VE511 Silencer Assembly
   
   c. Replace the o-rings OR-5218S and OR-5214 and smear them with Molykote 111 grease.
   
   d. Reassemble the components in the reverse way they were disassembled.
5. Service of o-rings OR-5115, OR-5212, OR-5113S and OR-5108 from the connectors between Venturi Block Assembly EV508 and Ventilator Head Assembly EV504. Refer to Figure 11.
   a. Pull out connectors from EV508 Venturi Block Assembly.
   b. Replace the o-rings attached to those connectors and smear them with molykote grease when assembled.
   c. Reinsert the connectors back into the VE508 Venturi Block Assembly.

6. Service of o-rings OR-5006, OR-5010, OR-5011 and OR-0401S from expiratory valve EV519-EP. Refer to Figure 12 and Figure 13.
   a. Remove the knob KN-14B by using a flat screwdriver. It must be unscrew clockwise.
b. Once the knob is out, remove the bush EV5193 with a 9/16” spanner.
c. Remove the Expiratory valve from the ventilator.
d. Replace the o-rings OR-5011 which is located in the EV5193 bush and smear it with Molykote grease.

e. Remove the expiration needle EV5192 from the expiratory valve and replace the o-ring OR-5006. Smear it with Molykote grease when assembled.
f. Unscrew the adjustable seat VE3195 and replace the o-rings OR-5010 and the two OR-0401S smearing them with Molykote grease.
g. Reassemble all components in the reverse way they were disassembled.

![Figure 12: Removal of Expiration Valve EV519-EP from Ventilator](image1)

7. Service of o-rings OR-5006, OR-5010, OR-5011 and OR-0401S from inspiratory valve EV519-IP. Refer to Figure 14 and Figure 15.

a. Remove the knob KN-14B by using a flat screwdriver. It must be unscrew clockwise.
b. Once the knob is out, remove the bush EV5193 with a 9/16” spanner.
c. To remove the inspiratory valve EV519-IP we must first remove the EV-E5 main board and the EV105 pressure gauge.

![Figure 13: Service of o-rings in expiratory valve EV519-EP](image2)
d. Remove the 2 countersunk screws SM0410C that held the Main Board EV-E5 and its plate on the bottom shelf of the EV500 ventilator by using a Philips screwdriver, and then remove aside the main board EV-E5 without disconnecting the cables.

e. Unscrew the VE10511 clamping nuts of the EV105 pressure gauge and remove the gauge from the ventilator.

![Removal of Electronic Main Board and Manometer from EV500](image)

f. Remove the Inspiratory valve from the ventilator.

g. Replace the o-rings OR-5011 which is located in the EV5193 bush and smear it with Molykote grease.

h. Remove the expiration needle EV5192 from the expiratory valve and replace the o-ring OR-5006. Smear it with Molykote grease when assembled.

i. Unscrew the adjustable seat VE3195 and replace the o-rings OR-5010 and the two OR-0401S smearing them with Molykote grease.

j. Reassemble all components in the reverse way they were disassembled.
Figure 15: Service of o-rings in inspiratory valve EV519-IP

8. Service of the o-rings OR-5001 and OR-0201 from the VE116 Selector Valve Assembly. See Figure 17 and Figure 17.
   a. Remove all KN-14B and KN-14R knobs from the front face of the EV500 ventilator as described in 4.6 and 4.7.

Figure 16: Removing EV503 Front Plate from EV500 Ventilator

b. Remove cap KN-21BW Cap from VE116 Selector Valve, then unscrew the nut in the KN-21B knob with a 9mm socket and remove the knob.
c. Remove the pressure gauge VE1051 as per 4.7.
d. Remove the nut that hold the 0-60 / 0-30 cm H2O switch with a 9mm spanner.
e. Remove the nut that hold the OFF/Reset button with a pair of pliers.
f. Now we can remove the EV503 Front Plate.
g. Remove the VE116 Selector valve by unscrewing the 2 SM0310C screws that held the valve in the bottom shelf EV502M.
h. Remove the VE116 from the EV500 ventilator and proceed to disassemble.
i. Remove the 3 screws SI18114R with a screwdriver.
j. Remove the VE1162M Cover Cam and the VE1163M Cam Selector.
k. Remove the 3 fittings CNSVM5 and then the VE11612 springs, VE11611 poppet valves and o-rings OR-0201S.
l. Remove from the other side of the VE1161 body the VE11613 bush and o-rings OR-5001.
m. Replace o-rings and springs and re-assemble the components in the reverse order they were disassembled. Always smear o-rings with Molykote 111 grease.

Figure 17: Removal of Selector Valve VE116

7.6 Post Service Tests

1  Replace the 9V battery

2  Check that all electrical functions are correct
   a)  Check that the computer chip model number appears in the rate window, 2 seconds after the unit has been turned on.
   b)  When the unit is turned off, the following display should appear:
       •  Insp. time window – PR
       •  Exp. time window – ESS
       •  Rate window – OFF
   c)  Check the computer connection (9 pin plug) with an oscilloscope. The reading should be +5V to –5V.

3  When all work and checks have been carried out, the unit is to be connected to a ventilator tester (such as a Biotek VT2 lung analyser) and a performance readout obtained.
4 When service is complete, the unit is to be thoroughly cleaned externally and a “Date of Service” label is to be filled in and attached to the unit.
7.7 Performance check

1. Disconnect mains lead and check fuses are 100mA SLO-BLO, switch ON ventilator (mains power off).

2. Ensure that all the LEDs come on in the normal sequence. After approximately 1 second, the red flashing MAINS light should cease, and the alarm should be silent. Switch on MAINS power.

3. Ensure that the green MAINS LED is on.

4. Check that rotating the SET LIMITS and TIMING controls adjusts the relevant LED displays smoothly through their range.

5. Check that CPAP on the MODE switch enables CPAP.

6. Ensure that the 0-60/0-30 switch switches the appropriate ranges (CCW BOTTOM SET LIMIT = 6cmH₂O) > Adjust ventilator for 6cm H₂O PEEP and Insp = 50cmH₂O.

7. 0cmH₂O = 0 LED
   6cmH₂O = CCW BOTTOM SET
   50cmH₂O = 16 LED (0-60)
   Set POS (Exp = 0cmH₂O). Set TOP SET LIMIT less than Insp. Pressure.

8. Ensure that the HIGH LED and sounder are on (when not muted). Set TOP SET LIMIT and BOTTOM SET LIMIT CW to top of display.

9. Check after 20 seconds that the LOW LED and sounder are on. Set the BOTTOM SET LIMIT such that the display brightens at the peak of inspiration, and is not flashing.

10. Ensure display is showing appropriate values and alarm is off. Press the PRESS FOR OFF switch for approximately 2 seconds.

11. Ensure that the monitor doesn’t switch off and the audible alarm mutes for 1 minute. Press the PRESS FOR OFF switch for approximately 30 seconds.

12. Ensure that the monitor switches off (release switch) then back on. Switch off the ventilator and press the PRESS FOR OFF for 4 seconds.

13. Check the alarm has switched off (‘1:’ blank after 20 seconds).

Tested by: __________________________ Date: __________________________
Signed: ___________________________ Ventilator Model: ________________ S.N: ________________
Display S.N.: __________________________ Mains S.N.: ________________ Location: __________________________

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8 Physical Features

8.1 EV500 Ventilator (front view)
8.2 EV500 Ventilator (rear view)

USE DRY GAS ONLY

MAX. LINE PRESSURE = 500kPa
MIN. LINE PRESSURE = 280kPa

DRIVING INLET GAS

DATA OUTPUT
100 mA T 250VAC
FUSES 20 x 5 mm
240VAC 50Hz 60mA
RATED POWER INPUT
TYPE CF
CLASS I

ULCO MEDICAL
MARRICKVILLE NSW AUSTRALIA

IDENTIFICATION LABEL
AIR/OXYGEN GAS CONNECTOR
SILENCER
SCAVENGER FITTING
DATA OUTPUT CONNECTOR
8.3 Connection Schematic

These are provided to enable user and service personnel to identify parts and assemblies for servicing and maintenance requirements.
8.4 Assembly Drawings

Included are:

- Box Assembly
- Bottom Shelf Assembly
- Manometer Assembly
- Head Assembly
- Weight Assembly
- Connector Assembly/Exhaust
- Fastener Assembly
- Vent Canister Assembly
- Bellows Assembly
- Volume Control Assembly
- Venturi Block Assembly
- Flow Block Assembly
- Silencer Assembly
- Outer Silencer Assembly
- Solenoid Valve Assembly
- Vent Drive Assembly
- Selector Valve Assembly
- Inspiratory Pressure Valve Assembly
- Expiratory Pressure Valve Assembly
- Hose Assembly – Oxygen
8.5 Top Cover Assembly EV501M

This equipment must only be used by qualified persons and in accordance with the manufacturer's instructions.

This equipment must only be serviced and maintained in accordance with the manufacturer's instructions.

This equipment must in no way replace monitoring by qualified personnel and must only be used in conjunction with independent monitoring procedures described in the manufacturer's instructions.

8.6 Bottom Shelf Assembly EV502

MIN. LINE PRESSURE = 280kPa
MAX. LINE PRESSURE = 500kPa
USE DRY GAS ONLY

DRIVING GAS INLET
EXHAUST PORT
DATA OUTPUT

FUSES 20 x 5 mm 100 mA T 250VAC

RATED POWER INPUT 240VAC 50Hz 60mA

TYPE CF
CLASS I
8.7 Manometer Assembly EV105
8.8 Head Assembly EV504

8.9 Weight Assembly VE50432
8.10 Connector Assembly Exhaust EV5043

8.11 Fastener Assembly AB20102
8.12 Vent Canister Assembly VE505

![Diagram of Vent Canister Assembly VE505]

- VE507
- VE5051
- VOLUME = 5
- WA M6.3
- WA D7US
- VE5052
- A820102
8.13 Bellows Assembly EV506
8.15 Venturi Block Assembly EV508

![Diagram of Venturi Block Assembly EV508]

**SECTION A-A**

**SCALE 1:1**

1. Refer to these items on the assembly shown here for connection purposes only.
8.16 Flow Block Assembly EV509
8.17 Silencer Assembly VE511

8.18 Outer Silencer Assembly VE1112
8.20 Solenoid Valve Assembly EV514
8.21 Selector Valve Assembly VE116

8.22 Inspiratory Pressure Valve Assembly EV519-IP
8.23 Expiratory Pressure Valve Assembly EV519-EP

8.24 Hose Assembly – Oxygen HO-20
Used for spontaneous ventilation.
Ventilator in use mounted on anaesthetic machine for controlled spontaneous ventilation.
9.3 Circle System

Using the ventilator for automatic and spontaneous ventilation.
9.4 Disassembly

1. Remove the ventillator.
2. Lift off the former to remove belows assembly.
3. Lift off head of belows assembly.
4. Lift off head of belows assembly.
5. Lift off head of belows assembly.
6. Gently slide box away from front panel.
7. Slight off supply from tail and remove disk.
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10 Specifications

10.1 Physical

Width ........... 186mm
Depth .......... 186mm
Height ........... 400mm
Weight .......... 7.5kg

10.2 Controls

- Inspiratory pressure is adjustable 60cmH₂O. This setting also acts as a pressure limit.
- Inspiratory flow is adjustable to over 100 litres per minute.
- Tidal volume is adjustable to 1300ml. Larger volumes can be achieved with increased fresh gas flow. Indicator marks are approximate.
- Inspiratory time is variable from 0.1 to 4 seconds. Expiratory time is variable from 0.1 to 16 seconds. I/E ratio is limited between 1:0.5 to 1:4.0. Rate is variable from 3 to 300 breaths per minute.
- Expiratory pressure is variable (PEEP & CPAP) to 20cmH₂O.

10.3 Pneumatic Specifications

- Ventilator can be driven from air or oxygen at 350-450kPa. Gas must be dry, filtered and oil free.
- Standard 22mm taper connections.
- Ventilator internal compliance negligible (measured at end inspiratory level).
- Expiratory resistance less than 2.5cm H₂O/LITRE/SECOND.

10.4 Power Supply

- Power Consumption          approx. 2.0W
  240 VAC              approx. 40mA
  24 VDC               approx. 90mA (If ext DC option fitted)
- Battery life 6V 2.4AH    3hrs+
- Battery charges whenever green ‘MAINS’ led on @7v2 constant voltage current limited to 500mA.
- Mains voltage fuses 110-120 VAC 100mA SLO-BLO 20 x 5mm
  220-240 VAC 100mA SLO-BLO 20 x 5mm
10.5 Environmental

- Operating temperature: 10°C to 40°C
- Relative Humidity: 15% to 90% non-condensing

10.6 Electromagnetic Compatibility

10.6.1 Electromagnetic Emissions

The Signet 615 anaesthetic workstation is suitable for use in the electromagnetic environment specified in the table below. The user must ensure that it is used in such an environment.

<table>
<thead>
<tr>
<th>Emissions test</th>
<th>Compliance</th>
<th>Avoiding Electromagnetic Interference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio Frequency (RF) emissions</td>
<td>Group 1</td>
<td>The anaesthetic workstation uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.</td>
</tr>
<tr>
<td>RF emissions CISPR 11</td>
<td>Class A</td>
<td>The anaesthetic workstation is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.</td>
</tr>
<tr>
<td>Harmonic emissions IEC 61000-3-2</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>Voltage fluctuations IEC 61000-3-3</td>
<td>Not applicable</td>
<td></td>
</tr>
</tbody>
</table>

10.6.2 Electromagnetic Immunity

The Signet 615 anaesthetic workstation is suitable for use in the specified electromagnetic environment. The user must ensure that it is used in the appropriate environment as listed below.

<table>
<thead>
<tr>
<th>Immunity test</th>
<th>IEC60601 test level</th>
<th>Compliance level</th>
<th>Electromagnetic environment guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrostatic discharge (ESD) IEC61000-4-2</td>
<td>± 6 kV contact</td>
<td>± 8 kV air</td>
<td>Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.</td>
</tr>
<tr>
<td>Electrical fast transient/burst IEC 61000-4-4</td>
<td>± 2 kV for power supply lines</td>
<td>± 1 kV for input/output lines</td>
<td>Mains power quality should be that of a typical commercial or hospital environment.</td>
</tr>
<tr>
<td>Surge IEC 61000-4-5</td>
<td>± 1 kV differential mode</td>
<td>± 1 kV common mode</td>
<td>Mains power quality should be that of a typical commercial or hospital environment.</td>
</tr>
</tbody>
</table>
### Immunity test

<table>
<thead>
<tr>
<th>Immunity test</th>
<th>IEC60601 test level</th>
<th>Compliance level</th>
<th>Electromagnetic environment guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage dips, short interruptions and voltage variations on power supply input lines</td>
<td>IEC 61000-4-11</td>
<td>&lt;&lt; 5% $U_T$</td>
<td>Mains power quality should be that of a typical commercial or hospital environment. If the user of the anaesthetic workstation requires continued operation during power mains interruptions, it is recommended that the anaesthetic workstation be powered from an uninterruptible power supply or a battery.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(&gt; 95% dip in $U_T$) for 0.5 cycle</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>40% $U_T$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(60% dip in $U_T$) for 5 cycles</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>70% $U_T$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(30% dip in $U_T$) for 25 cycles</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;&lt; 5% $U_T$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(&gt; 95% dip in $U_T$) for 5 sec</td>
<td></td>
</tr>
<tr>
<td>Power frequency (50/60 Hz) magnetic field</td>
<td>IEC 61000-4-8</td>
<td>3 A/m</td>
<td>Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.</td>
</tr>
</tbody>
</table>

Note: In the table above, $U_T$ is the AC mains voltage prior to application of the test level.

### 10.6.3 Recommended Separation Distance

In the following table, $P$ is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and $d$ is the recommended separation distance in metres (m).

Portable and mobile RF communication equipment should be used no closer to any part of the anaesthetic workstation than the recommended separation distance calculated from the equation appropriate for the frequency of the transmitter.

Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey, should be less than the compliance level in each frequency range (over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m).

Interference may occur in the vicinity of equipment marked with this symbol:

![Radio Symbol]

### Conducted RF

<table>
<thead>
<tr>
<th>Immunity test</th>
<th>IEC 60601 test level</th>
<th>Compliance level</th>
<th>Electromagnetic environment guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conducted RF</td>
<td>IEC 61000-4-6</td>
<td>3 Vrms</td>
<td>Recommended separation distance:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150 kHz to 80 MHz</td>
<td>$d = 1.2\sqrt{P}$</td>
</tr>
</tbody>
</table>

### Radiated RF

<table>
<thead>
<tr>
<th>Immunity test</th>
<th>IEC 61000-4-3</th>
<th>Compliance level</th>
<th>Electromagnetic environment guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiated RF</td>
<td>IEC 61000-4-3</td>
<td>3 V/m</td>
<td>Recommended separation distance:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80 MHz to 2.5 GHz</td>
<td>$80 MHz to 800 MHz$ $d = 1.2\sqrt{P}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>800 MHz to 2.5 GHz $d = 2.3\sqrt{P}$</td>
</tr>
</tbody>
</table>

**Notes:**
- At 80 MHz and 800 MHz, the higher frequency range applies.
These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the anaesthetic workstation is used exceeds the applicable RF compliance level above, the anaesthetic workstation should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the anaesthetic workstation.

### 10.6.4 Recommended Separation Distances from Portable and Mobile RF Communication Equipment

The anaesthetic workstation is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The user of the anaesthetic workstation can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the anaesthetic workstation as recommended below, according to the maximum output power of the communications equipment.

<table>
<thead>
<tr>
<th>Rated maximum output power of transmitter W</th>
<th>Separation distance according to frequency of transmitter m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>150 kHz to 80 MHz d = 1.2√P</td>
</tr>
<tr>
<td></td>
<td>80 MHz to 800 MHz d = 1.2√P</td>
</tr>
<tr>
<td></td>
<td>800 MHz to 2.5 GHz d = 2.3√P</td>
</tr>
<tr>
<td>0.01</td>
<td>0.1</td>
</tr>
<tr>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>10</td>
<td>1.3</td>
</tr>
<tr>
<td>100</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>7.3</td>
</tr>
<tr>
<td></td>
<td>23.0</td>
</tr>
</tbody>
</table>

**Notes:**
- At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.
- These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in metres (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.
11 Terms and conditions

All merchandise to be returned must have prior written authorisation by Ulco, and a valid Return Goods Authorisation (RGA) number shall appear on the shipping label, packing slip, purchase order and any other related documents.

When requesting authorisation to return material, the following information should be provided:

1. Customer purchase order and date.
2. Ulco invoice number and date, and method of shipment (available from delivery document).
3. Part number, quantity, and description of goods to be returned.
4. Reason for returning goods.

The following are acceptable reasons for return of goods:

1. Material failure within warranty period.
2. Service or repairs.
3. Ordered in error or duplication of order.

Any shipping errors or shortages of goods must be reported to Ulco within seven (7) days of receipt of such goods.

Goods are subject to any terms of any applicable warranty. Premature failure of products shall be accepted for return at Ulco’s discretion, and only during the warranty period.

Goods to be returned which are not under warranty should have been purchased within thirty days of request for return, and returned within thirty days after request. Goods shall be returned unused, and in Ulco containers. Goods may be subject to a 20% restocking charge, with the exception of goods failure within the warranty period or due to Ulco error.

The following merchandise is not eligible for return, unless proven defective:

1. Sterile material, unless shipped in error by Ulco.
2. Rubber and plastic components that have been used.
3. Specially ordered or produced items.
4. Goods that have been altered or abused.

All items to be returned shall be shipped, including RGA number, to:

**Ulco Medical**
25 Sloane St
Marrickville NSW 2204
Australia

In the European Community, returned goods authorities should be obtained from:

**Advena Ltd.**
PO Box 30, Leominster HR6 0ZQ UK
Telephone +44(0)1568-620080
Fax +44(0)1568-620078
## GOODS RETURN AUTHORISATION

<table>
<thead>
<tr>
<th>RGA Number</th>
<th></th>
</tr>
</thead>
</table>

## Customer Details

<table>
<thead>
<tr>
<th>Name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td></td>
</tr>
<tr>
<td>State/Country</td>
<td>Postcode</td>
</tr>
<tr>
<td>Returned Product</td>
<td></td>
</tr>
<tr>
<td>Date of Purchase</td>
<td>Date of return</td>
</tr>
</tbody>
</table>

Reason for returning goods (please give a short description of the fault):

|  |
|  |
|  |
|  |
|  |
|  |

Signature

_____________________

## Return to

**ULCO Medical**
25 Sloane St
Marrickville NSW 2204
Australia