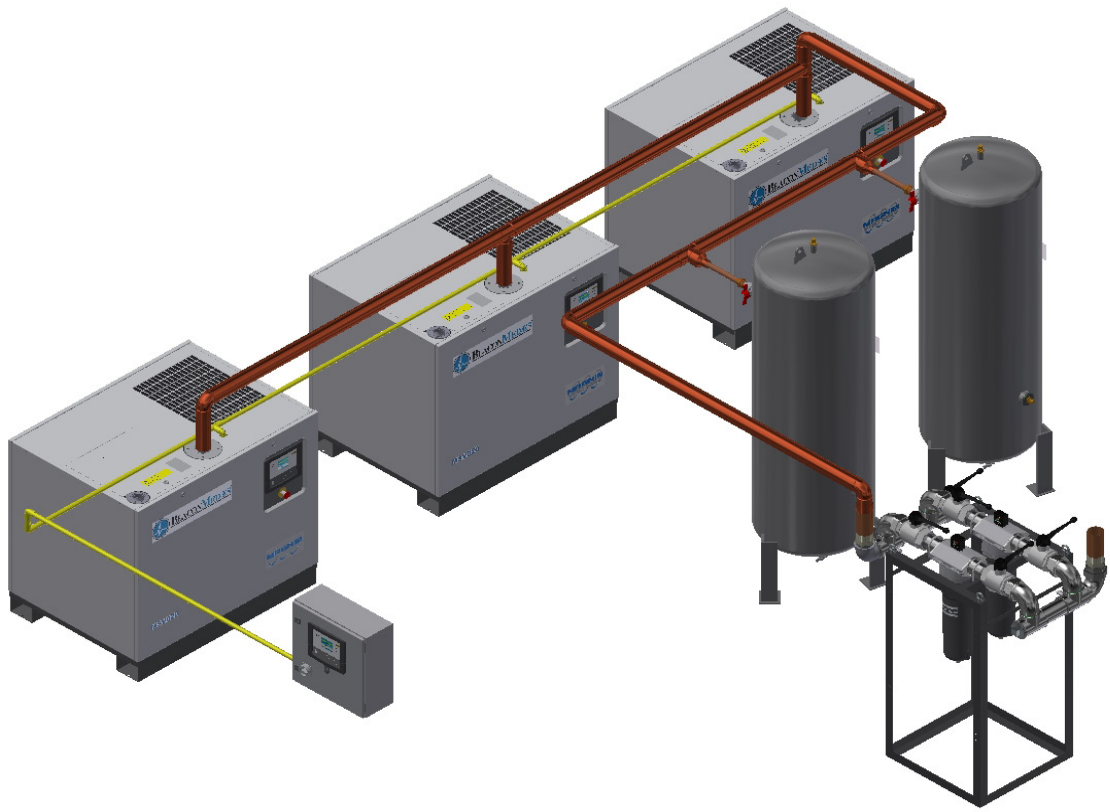
Operation and Maintenance Instructions



ISO / HTM Plant shown

Magnis Medical Vacuum Plant

Part number 2212020371
Revision 02.
February 7, 2018

BeaconMedæs®

Operation and Maintenance Manual

Magnis Medical Vacuum Plant

This unit is purchased from:

Date purchased:

Model number:

Serial number:

Option(s) included:

Any information, service or spare parts requests should include the serial number and be directed to:

UK
BeaconMedæs
Telford Crescent, Staveley
Derbyshire S43 3PF

Telephone: +44 (0) 1246 474242

Email: gbn.info@beaconmedaes.com

USA
BeaconMedæs
1059 Paragon Way
Rock Hill, SC 29730

Telephone: +1 803 817 5600 (USA)
1 888 463 3427 (TOLL-FREE USA)
General Email Inquiries: medgas.comm@beaconmedaes.com
Repair Parts Inquires: medgasparts@beaconmedaes.com

Website Contacts: www.beaconmedaes.com

Atlas Copco Ltd. trading as Atlas Copco Medical
Unit 18 Nuffield Way, Abingdon, Oxfordshire, UK OX14 1RL

Personnel must make themselves familiar with the contents of this manual and the function of the unit before installing, operating or maintaining.

Abbreviations			
Abbreviation	**Full Description**	**Abbreviation**	**Full Description**
BS	British Standard	**m**	Meter
BSP	British Standard Pipe	**mm**	Millimetres
°C	Degree Celsius	**Min**	Minimum
ø	Diameter	**NRV**	Non-return valve
EN	European Standards	**OD**	Outside Diameter
HTM	Health Technical Memorandum	**%**	Percentage
ID	Identification		
“	Inch		
ISO	International Standard Organisation		
Kg	Kilograms		
kPa	Kilo pascals		
Max	Maximum		
Med	Medical		

Table of Contents

1. Safety precautions

1.1. Safety icons

Explanation

	Danger for life
	Warning
	Important note

1.2. Safety precautions, general

General precautions

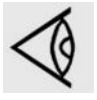
	All responsibility for any damage or injury resulting from neglecting these precautions, or non-observance of the normal caution and care required for installation, operation, maintenance and repair, even if not expressly stated, will be disclaimed by the manufacturer.

1. The operator must employ safe working practices and observe all related work safety requirements and regulations.
2. If any of the following statements does not comply with the applicable legislation, the stricter of the two shall apply.
3. Installation, operation, maintenance and repair work must only be performed by authorized, trained, specialized personnel.

1.3. Safety precautions during installation

Precautions during installation

1. Place the device where the ambient air is as cool and clean as possible, within the limitations for operation (see section Reference conditions and Limitations).
2. During installation or any other intervention on one of the connected pumps or cubicles, the pump must be stopped, de-energized and the isolating switch opened and locked before any maintenance or repair.
3. As a further safeguard, persons switching on remotely controlled machines shall take adequate precautions to ensure that there is no one checking or working on the machine. To this end, a suitable notice shall be affixed to the start equipment.
4. The electrical connections must correspond to the local codes. The device must be earthed and protected against short circuits by fuses in all phases. A lockable power isolating switch must be installed near the device.
5. Never remove or tamper with the safety devices.

	Also consult following safety precautions: Safety precautions during operation and Safety precautions during maintenance or repair. These precautions apply to the Magnis Medical Vacuum Plant. For precautions applying to the connected equipment consult the relevant instruction book. Some precautions are general and cover several machine types and equipment; hence some statements may not apply to your device.

1.4. Safety precautions during operation

Precautions during operation

1. Persons switching on remotely controlled machines shall take adequate precautions to ensure that there is

no one checking or working on the machine. To this end, a suitable notice shall be affixed to the remote start equipment.

2. Never operate the device in the presence of flammable or toxic fumes, vapours or particles.
3. Never operate the machine below or in excess of its limit ratings.
4. Wear ear protectors if applicable. People staying in environments or rooms where the sound pressure level reaches or exceeds 90 dB(A) shall wear ear protectors.
5. Periodically check that:

- All guards and fasteners are in place and tight
- All hoses and/or pipes are in good condition, secure and not rubbing
- There are no leaks
- All electrical leads are secure and in good order

6. Never remove or tamper with the safety devices.

	Also consult following safety precautions: Safety precautions during installation and Safety precautions during maintenance or repair. These precautions apply to the Magnis Medical Vacuum Plant. For precautions applying to the connected equipment consult the relevant instruction book. Some precautions are general and cover several machine types and equipment; hence some statements may not apply to your device.

1.5. Safety precautions during maintenance or repair

Precautions during maintenance or repair

1. Use only the correct tools for maintenance and repair work.
2. Use only genuine spare parts.
3. A warning sign bearing a legend such as <<Work in progress - do not start>> shall be attached to the starting equipment, including all remote start equipment.
4. Persons switching on remotely controlled machines shall take adequate precautions to ensure that there is no one checking or working on the machine. To this end, a suitable notice shall be affixed to the remote start equipment.
5. Never use flammable solvents or carbon tetrachloride for cleaning parts. Take safety precautions against toxic vapours of cleaning liquids.
6. Scrupulously observe cleanliness during maintenance and repair. Keep dirt away by cleaning the parts and exposed openings with a clean cloth, paper or tape.
7. Never use a light source with open flame for inspecting the interior of the device.
8. All regulating and safety devices shall be maintained with due care to ensure that they function properly. They may not be put out of action.
9. Before clearing the device for use after maintenance or repair, check that operating pressures, temperatures and time settings are correct. Check that all control and shutdown devices are fitted and that they function correctly.

	Also consult following safety precautions: Safety precautions during installation and Safety precautions during maintenance or repair. These precautions apply to the Magnis Medical Vacuum Plant. For precautions applying to the connected equipment consult the relevant instruction book. Some precautions are general and cover several machine types and equipment; hence some statements may not apply to your device.

	Units and/or used parts should be disposed of in an environmentally friendly and safe manner and in line with the local recommendations and legislation.

2. General description

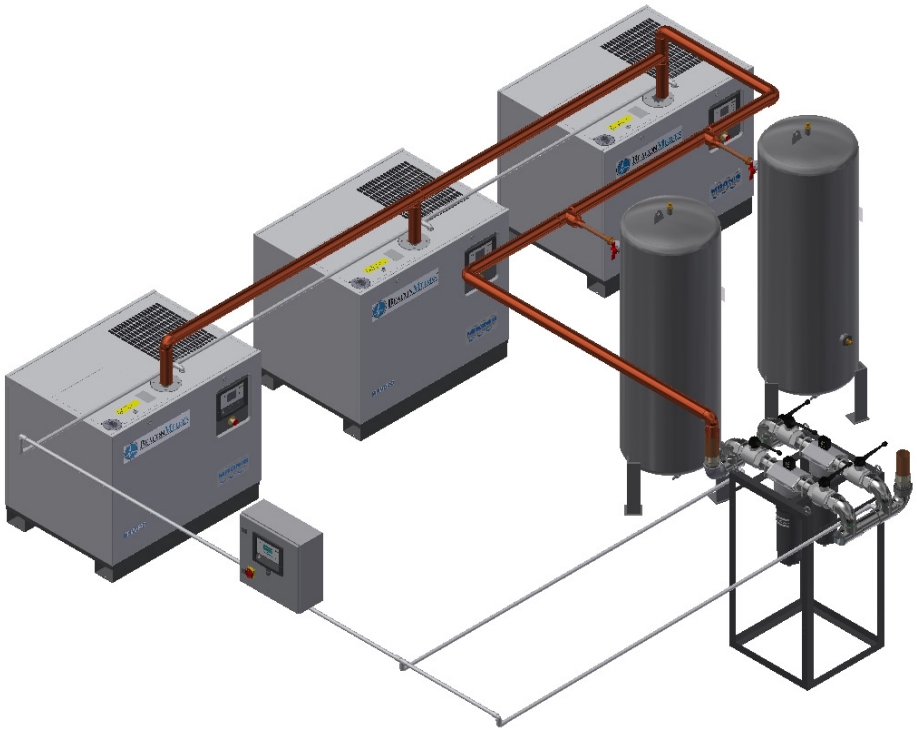
2.1. What is a vacuum

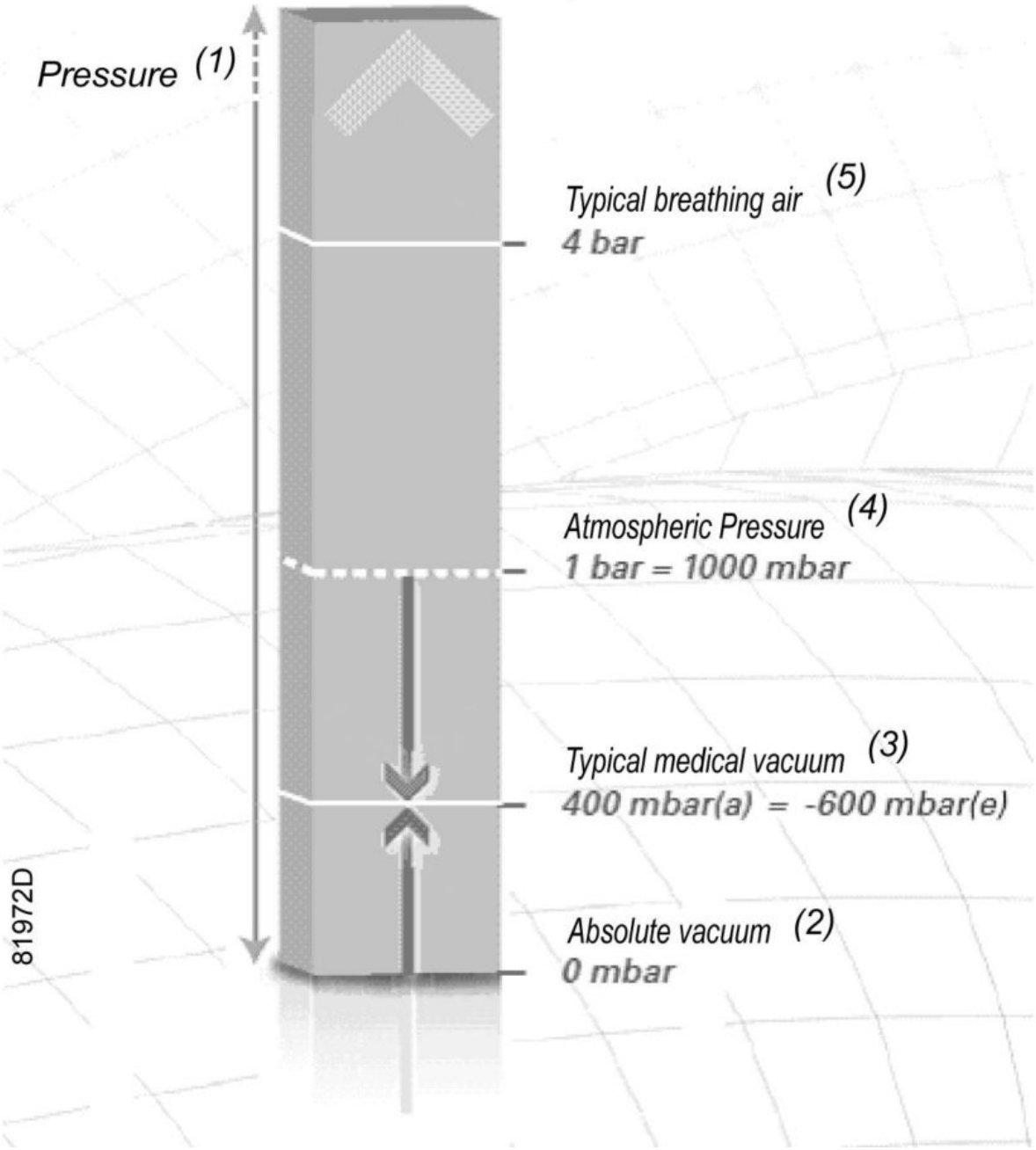
What is a vacuum and how to denote

A vacuum is any pressure in a system that is below the ambient atmospheric pressure. It can be denoted in absolute terms or in effective (gauge) terms:

- mbar(a) – absolute pressure – denotes how much the pressure is above absolute zero vacuum.
- mbar(e) – the effective or gauge pressure – denotes how much the pressure is below local atmospheric pressure.

Since an effective vacuum pressure is always referenced to the absolute atmospheric pressure, effective vacuum pressures are negative values. It denotes the fixed difference between the variable atmospheric pressure (e.g. dependent on altitude and weather) and the vacuum level).





1	Pressure
2	Absolute vacuum
3	Typical medical vacuum
4	Atmospheric pressure
5	Typical breathing air

Atmospheric pressure at sea level is roughly 1 bar or 1000 mbar. For typical medical applications a vacuum of 600mbar below atmospheric pressure is required, which is denoted as -600 mbar(e). From the illustration it can be seen clearly that this value is also equivalent to 400 mbar above absolute zero vacuum and can therefore also be denoted as 400 mbar(a).

It is important to understand which type of reference is required before selecting a pressure instrument for measuring the vacuum. The Magnis Medical Vacuum Plant application uses the absolute pressure system since it corresponds most with performance characteristics.

It must be noted that the distinction doesn't matter for a pressure difference (delta P; e.g. pressure loss), since it is always the result of subtracting 2 pressures (whether stated as absolute or effective pressures).

Flow rate definitions

It should be clearly understood that there is a difference between the volume of 'Free Air Aspired' (FAA) at the terminal units (atmospheric pressure) and the volume of that same quantity of air handled by the pumps at a given vacuum level. For example: 100 litres of free air aspired at atmospheric pressure corresponds to proximately 200 litres of air at a vacuum of -507 mbar(e) (-380 mmHg), and approximately 300 litres at a vacuum of -667 mbar(e) (-500 mmHg).

The volume of rarefied air flowing in a pipeline is consequently around three times the volume of the total design flow which is specified in terms of free-air-aspired. A clear distinction should therefore be made between the free-air-aspired and the capacity (volumetric displacement) of the pumps. In order to avoid confusion, the capacity of the pumps should be given in terms of both free air and volumetric flow rate at the operating vacuum level.

Hence there are 2 common but different ways to denote flow rate in vacuum. The first one is based on the displacement or volumetric flow rate and the second one is based on the throughput or mass flow rate.

Displacement/volumetric flow rate

Over the relevant pressure range, a Magnis pump operates at quasi constant motor speed (rotations per minute) and since the compression chambers have fixed dimensions, the same volume of air is pumped from inlet to outlet with a falling vacuum level. Over the relevant pressure range, this makes the volumetric flow rate quasi independent of the vacuum level. It is the expression of the flow rate inside the piping at the governing vacuum level, and always higher than the free air aspiration flow rate.

Free Air Aspiration or FAA (based on throughput/mass flow rate)

Even if the volumetric flow rate is quasi unchanged with vacuum level, the number of molecules in that pumped volume is not. By definition: the deeper the vacuum, the lower the amount of molecules in the same volume of air. This means that the mass flow will decrease with decreasing (absolute) pressure. It is clear that a flow rate must be stated at a certain vacuum level when using this denotation. For this medical vacuum application, the FAA of the plant is measured at -600 mbar(e) (-450 mmHg) and referred to free air at 1013 mbar(a) and 20 °C. Hence the FAA also expresses a volumetric flow rate which is always lower than the displacement flow rate described above.

2.2. Introduction

The Magnis Medical Vacuum plant (Magnis) is specifically designed and manufactured to fully satisfy the requirements of the European Medical Device Directive and the additional requirements of ISO (International Standard Organisation) version 7396-1:2016(E), NFPA (National Fire Protection Organisation) version 99. To this effect, the Magnis Plant range consists of 2 up to 6 identical pumps which can work independently to satisfy the required vacuum flow. They keep the vacuum level at the point of connection at least as deep as -600 mbar (e) (-450 mmHg) at all times, provided the correct plant type is chosen for the hospital flow demand (see Performance data). In order to achieve this, the pump operates between 30mbar(a) and 240mbar(a) (-770 and-970 mbar(e), -578 and -728 mmHg) to account for any vacuum loss across the filters.

The Magnis Medical Vacuum Plant is set up as a system with (multiple) backup supply and control safety layers in case of single failure of functional components.

Each plant is subject to comprehensive QA controls during manufacturing, incorporates components with proven reliability and each plant is fully tested prior to dispatch.

Description

AR	Vacuum vessel
Bf	Bacterial filter
CCu	Central control unit
PCu	Pump control unit
Vp	Vacuum pump

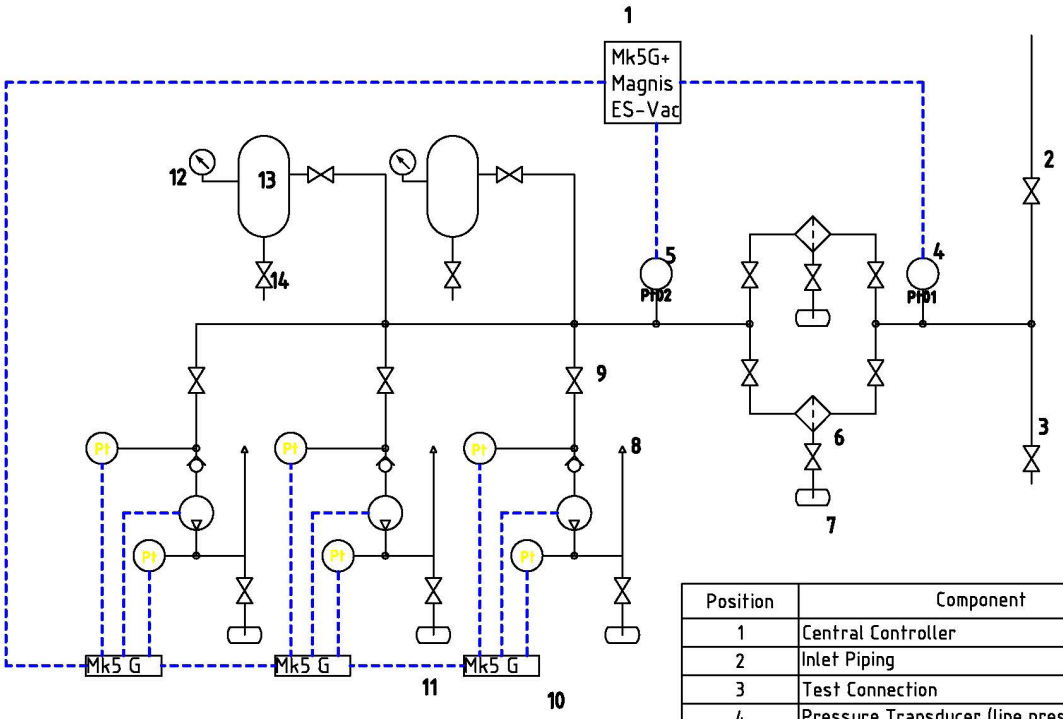
2.3. Plant description

The Magnis rotary screw vacuum pumps are single stage, positive displacement, fluid flooded, rotary screw type units. The individual Magnis vacuum pumps are controlled by a central controller, but can work independently if required.

	Magnis Medical Vacuum Plant complying with ISO7396-1 and are provided with at least 2 standby pumps, e.g. the design flow of a system with 3 pumps is provided by a single pump. Magnis Medical Vacuum Plant systems complying with NFPA-99 are provided with at least 1 stand-by pump, e.g. the design flow of a system with 2 pumps is provided by a single pump.

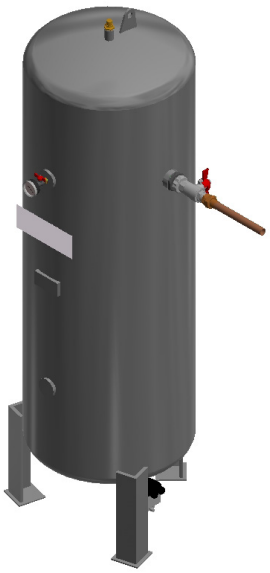
An Magnis Medical Vacuum Plant consists of the following mechanical (full line) and electrical (dotted line) components,

represented here on a typical setup diagram (here with 3 pumps and 2 vessels).



Position	Component
1	Central Controller
2	Inlet Piping
3	Test Connection
4	Pressure Transducer (line pressure)
5	Pressure Transducer (Pump pressure)
6	Bacterial Filter (Duplex Configuration)
7	Drain Flask
8	Exhaust
9	Pump Isolation Valve
10	Magnis Vacuum Pump
11	CAN (controller area network) connection
12	Pressure Gauge
13	Vacuum Vessel
14	Drain Valve

2.4. Vacuum vessel(s)

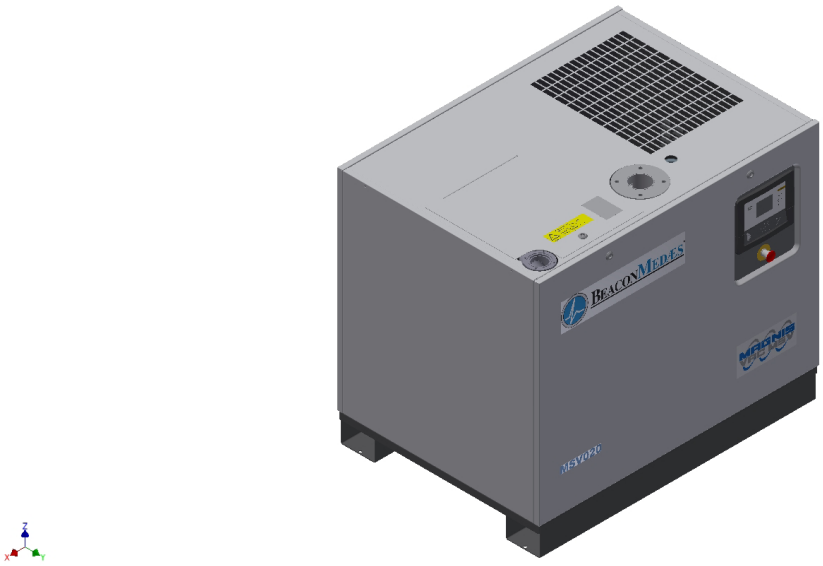


The vacuum reservoir ensures an instantaneous response to demand and prevents continuous operation of the 'Lead' vacuum pump during periods of light demand. It also acts as a buffer to smooth out short peaks in demand. The interior and exterior are protected against corrosion by galvanisation and access covers facilitate future insurance internal inspection. A manual drain valve is fitted to the vessel at the lowest point to enable the removal of any internal moisture which may form with condensation. There is also a tapping for a vacuum gauge. The vessel connects to the vacuum pumps and to the pipeline distribution system by external piping.

The piping arrangement is valved to enable the reservoir to be bypassed if necessary with the plant remaining operational. Although essentially designed as a free standing unit, the vessel feet are rough-drilled to enable the vessel to be bolted down if required. Test details are annotated on a plate permanently fixed to the reservoir.

The reservoir capacity is expressed as the water capacity in litres and the installed capacity is at least equivalent to the design flow rate (free air aspired per minute) of the plant.

2.5. Vacuum pumps



Identical vacuum pumps are used for the Magnis Medical Vacuum Plant range. The vacuum pups are rotary screw vacuum pumps which are single stage, positive displacement, fluid flooded, rotary screw type units. The air discharged from the pump contains fluid which is separated from the air as it passes through a fluid separator located within the air/fluid reservoir. The gas, now at near atmospheric pressure, is exhausted through the discharge port on the reservoir housing. The air/fluid reservoir is equipped with a safety valve to protect the system in the event of excessive restriction to the air flow in the separator element or the discharge system.

The fluid in the system serves three functions: it lubricates the bearings and the rotors, it seals rotor clearances to improve efficiency and it removes heat from the gas as the gas is being compressed, thus lowering the discharge temperature.

The air/fluid reservoir serves as a fluid reservoir and contains the air/fluid separator element. The discharge pipe from the vacuum pump enters the reservoir at a point below the normal fluid level and then turns upwards inside the reservoir. The air fluid mixture is discharged into the reservoir above the fluid level and impinges on the underside of the separator element. The air/fluid reservoir is provided with a fluid filler opening and fluid level gauge. Anti-vibration pads are fitted under the vacuum pump supporting feet to minimize the transmission of vibrations. Each vacuum pump is exhausted separately. It is recommended to install separate exhaust pipes to the outside of the building. If the exhausts are manifolded together during installation, suitably sized non-return valves must be fitted to the discharge of each pump. The discharge pipe work should be of a size so as not to cause back pressure. The overall back pressure, taking into account outlet pipe length, height and other pressure losses may not exceed 60 mbar (45 mmHg) for a running pump. If it does, the exhausts shall not be manifolded with non-return valves and shall be led outside separately.

A drainage trap is also fitted to collect any liquids formed by condensation. During use the in-line bacterial filter prevents contamination within the exhaust discharge system but does not remove offensive odours. Therefore the Vacuum Plant exhaust discharge should terminate outside the building at high level, preferably above the plant room roof and above other buildings in the immediate area. The discharge should be provided with a cowl or other means of protection against ingress of rain, snow, ice, and wind pressure. A weather proof notice must be fixed at the discharge point, which states: <<Medical vacuum discharge – do not obstruct>>.

2.6. Bacterial vacuum filters

Duplex bacterial filters complete with drain flasks are arranged in parallel within the system piping immediately prior to the vacuum reservoir and pumps. A manual isolating valve fitted to both inlet and outlet lines to each filter enable one filter to be selected on-line and the other off-line during normal plant operation.

This arrangement enables maintenance of either filter without interrupting the vacuum plant operation. Each clean filter is designed and sized to carry the full plant design flow rate with a pressure drop not exceeding 33 mbar (25 mmHg). Bacterial vacuum filter elements have penetration levels not exceeding 0.005% when tested by a sodium flame in accordance with BS3928, utilising particles in the 0.02 to 2 micron size range.

	A filter breakdown indicator is fitted across each bacterial filter element to indicate when a filter has reached saturation. This gauge should be checked at weekly intervals and element replacement is required when the gauge indicates 100 mbar (75 mmHg).

Drain flasks are transparent Pyrex with a plastic polymer coating inside and out to prevent damage by accidental knocks and will contain any liquid even if the glass is broken. They are suitable for sterilisation and incorporate manual isolating valves. Bacterial filters lose their effectiveness if allowed to become wet, therefore any liquid within a drain flask necessitates filter element replacement.

2.7. Pressure sensors

Different pressure sensors and switches are installed to measure the vacuum level at different positions in the pipeline system (see the schematic overview in Plant description).

The main pressure feedback is provided by the pressure transmitter PT01 which is installed at the pipeline connection point (upstream of the filters). A backup pressure transducer, marked PT02, is installed directly downstream of the filters. These two sensors also serve to calculate the filter saturation resulting in increased pressure drop.

Each pump inlet is also provided with a pressure transducer upstream of the non-return valve and a pressure transducer downstream of the oil mist separator. The pressure transducer downstream of the oil mist separator ensures feedback about whether a pump is operating satisfactory, while the pressure transducer is used to control

the pump in local mode (see chapter Pump controller operation).

2.8. Magnis Pump Control Cabinets

A controller is installed per pump, ensuring the direct communication with its pump (start / stop commands etcetera). The supply cables, per pump, are to be connected to these cubicles and the necessary transformer and fuses are provided (see service diagram).

VSD (variable speed drive) (U1), which is used to automatically adjust the speed of the motor , depending on the process demand. In the event of a fault the VSD shuts down and a fault signal is sent to the controller, until the fault is cleared the pump will not restart.

On the controller itself, information about the pump is shown (see chapter Interface icons and menu structure). LED's indicate power supply, automatic operation, service warning and fault condition. The software is explained more in detail in chapter Scrolling through all screens.

2.9. Central control unit

A central controller is connected to the pump controllers through a CAN system. A 210-230 V supply needs to be connected to this cubicle, wherein the necessary transformer and fuses are foreseen (see service diagram).

The central controller is based on a master control system referred to as Magnis ES-VAC. The central controller monitors the pressure at the pipeline connection point and sends start / stop commands to the pump controllers based on an even-wear, ΔP/ΔT algorithm. It also tracks the pressure drop over the filters and warns when service is required. It receives information about the pumps, groups it into a clear overview (see chapter Interface icons and menu structure) and transmits the appropriate alarms to the screen and to potential free output contacts. LED's are provided to indicate power supply, automatic operation, service warning and fault condition. The software is explained more in detail in chapter Central controller operation.

3. Operation user guide

3.1. Introduction

As mentioned in chapter Plant description, both a pump controller per pump is foreseen and a central controller which centrally receives information from the pump controllers and sends commands to those pump controllers. The pump controllers are Elektronikon® controllers with text display, while the central controller is an Elektronikon® Graphic+.

Together they form the control system for the medical vacuum plant, performing following functions:

1. Overall plant control and indication
2. Individual pump starting and stopping
3. Plant status monitoring and indication
4. Alarm status signalling

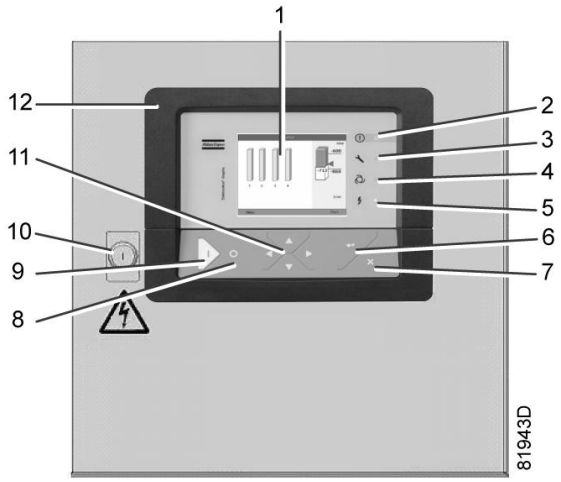
First the individual pump controllers will be explained. In the default situation they are controlled by the central controller, explained in section Central controller - Interface icons and menu structure.

3.2. Pump controller

See Operating manual for Magnis MSV pump.

3.3. Central controller

3.3.1. Interface, icons and menu structure

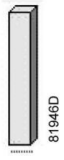
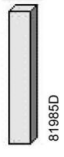


Item	Designation	Function
1	Display	Shows icons and operating conditioning.
2	Warning LED	Is lit when warning is triggered.
3	Service LED	Is lit when a service is needed.
4	Operation LED	Is lit when pump is automatically started and stopped.
5	Voltage LED	Indicates that the voltage is switched on.
6	Enter button	Confirm action.
7	Escape button	Go to previous screen or end current action.
8	Stop button	This button stops the pump when in local mode.
9	Start button	This button puts the pump in automatic operation when in local mode. The operation Led (35) lights up. Elektronikon ® is operative.
10	Cubicle lock	Can be opened with a key to open the cubicle.
11	Scroll buttons	Use these buttons to scroll through the menu.
12	Elektronikon ® Graphic+	Controller.

General icons

Icon	Status	Description
	Stopped/Running	When the controller is stopped, the icon stands still. When the controller is operational, the icon is rotating.
	Control mode	Local start/stop
	Control mode	Remote start/stop
	Control mode	Network control
	Automatic restart after voltage failure	Automatic restart after voltage failure is active
	Week timer	Week timer is active

The symbols used in the pump overview screen are as follows:

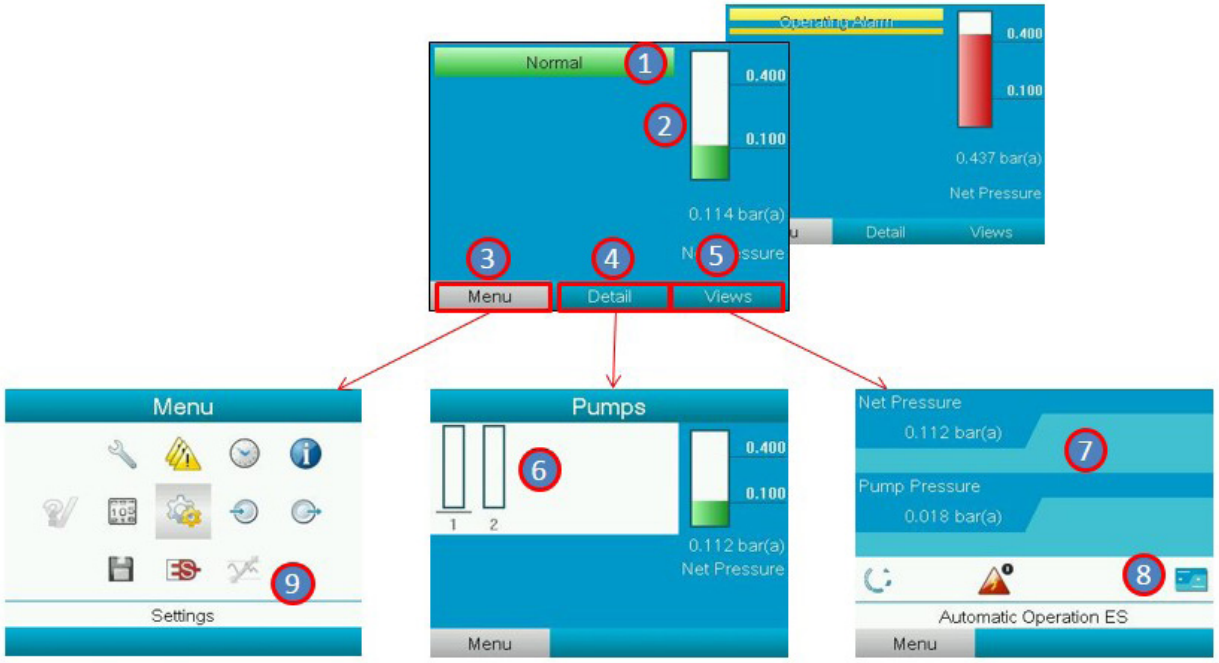
Bar graph	Status	Description
	Idle Pump	The pump is idle and ready to be called.
	Lead pump	The central controller has assigned this pump to be the next one to run.
	Called pump, last one called	This pump has last started to run.
	Called pump	This pump is running.

The table below describes the faults. More details in section Plant fault.

Icon	Status	Description
	No valid pump	A pump controller is expected at this CAN address node but not detected.
	No communication	No reply from the connected pump controller within a predefined time.
 57792F	Blinking network icon	The emergency forced local function is enabled on the pump due to the inlet pressure being too low. It will operate independently until this function is reset.
	No correct answer	Connected pump controller is not responding correctly to the commands (e.g. no reaction on a run command).
	Not Available	The pump is stopped and is counting out the Minimum Stop Time to prevent too many motor starts per hour. During this time the pump is not available to the ES control algorithm.
	Pump Shutdown	Pump is in Shutdown condition.
 81950D	Failed to go on load	The pressure switch at the pump outlet detects a too low pressure when it should not.
 81951D	Overload	The motor draws too much current and the overload has isolated the pump
 82765D	Element temperature warning	The pump element outlet temperature is too high
 57812F	Sensor error	The pump has a sensor error.
	Local mode	The pump has either been manually set to local, was forced locally from an ES command, or was forced locally by the Emergency Forced Local backup system.

	Service required	The pump's running hours have surpassed the predefined interval and maintenance must be carried out.
	Isolated	User has isolated this pump controller. It will not transmit faults or alarms.

3.4. Menu Structure



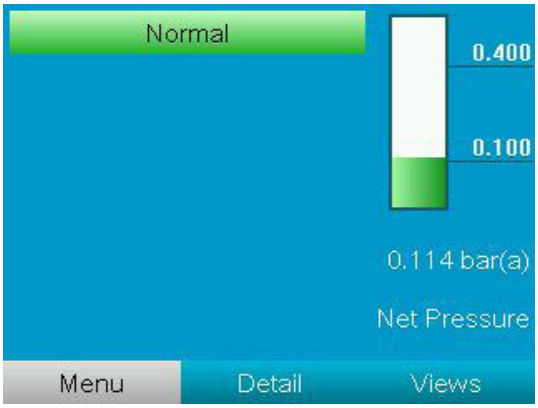
1	Norma / Alarm screen	6	Quantity and status of connected pumps
2	Vacuum level bar	7	Vacuum level on inlet of the system
3	Menu (navigation button to go to Menu screen)	8	Shortcut menu bar and status overview
4	Details (navigation button to go to Details screen)	9	Menu screen (configuration)
5	Views (navigation button to go to Views screen)		

Navigation downward through the flowchart is done by pressing the Enter button. Navigation upward through the flowchart is done by pressing the Escape button on the controller. Specific sub-menus and commands will be explained in the following chapter.

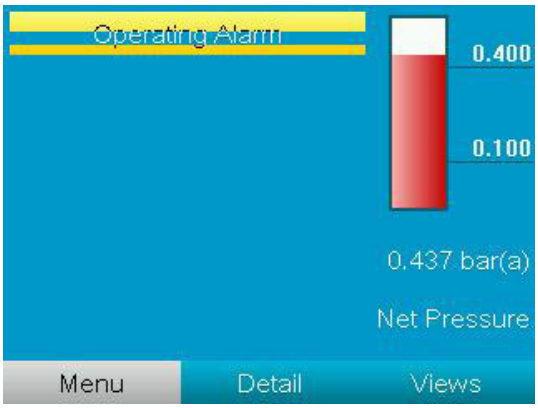
Main screen

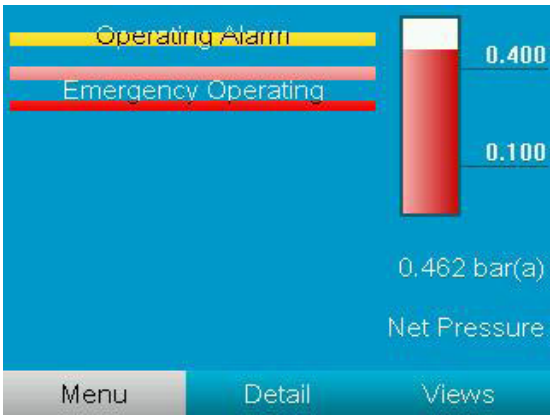
The main screen is the screen that is shown automatically when the voltage is switched on and one of the keys is pushed. It is switched off automatically after a few minutes when no keys are pushed.

The main screen displays the status of the vacuum plant, i.e. the inlet vacuum pressure. Also any possible alarms are shown.



or alarms

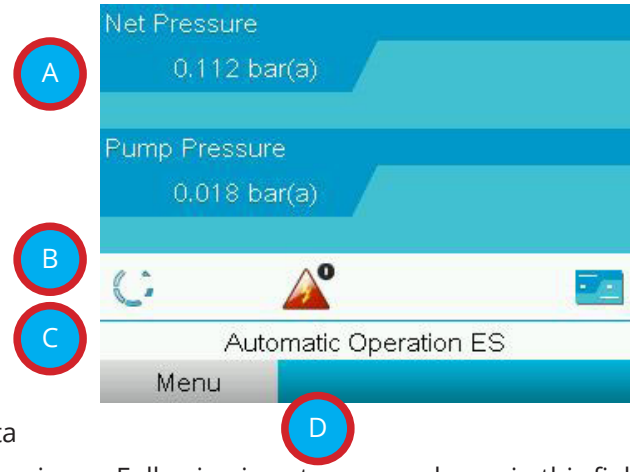




see alarms details in Chapter 3.5

Views screen

The standard Views screen displays the most important inputs of the sensors.



- Section A shows the data
- Section B shows the status icons. Following icon types are shown in this field:
  - Fixed icons. These icons are located utmost left in section B, are always shown in the main screen and cannot be selected by the cursor, e.g. ES-VAC Medical stopped or ES-VAC Medical running
  - Optional icons. These icons are only shown if their corresponding function is activated (e.g. week timer). Also the icon Automatic restart after voltage failure is shown here.
  - Pop up icons. These icons pop up if an abnormal condition occurs (e.g. warnings, shutdowns, service)
- Section C is called the status bar. Here the status or the text that corresponds to the selected icon is shown. If no icon is selected, it relects the status of the ES-VAC Medical.
- Section D shows the action buttons. The function of the buttons depends on the displayed menu. To activate an action button, highlight the button by using the Scroll keys and press the Enter key. To go back to the previous menu, press the Escape key.

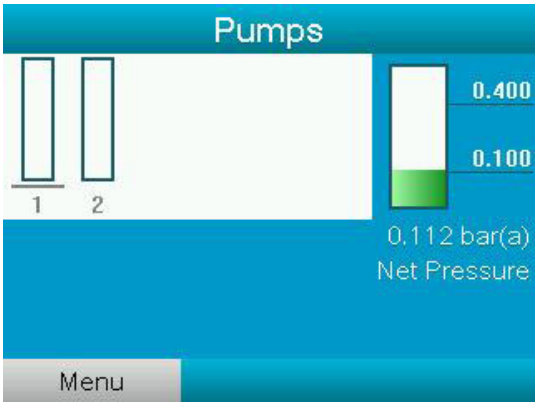
Instead of viewing values, it is also possible to view a graph of one of the input signals in function of time (see section Input and output menu). To modify the display mode, simply select the far right icon in section B of the screen (see above) and select another display mode or modify the mode via the Menu, see section Settings menu, paragraph Main chart.

Pumps detail screen

The pumps detail screen displays the status of the pumps. You can see each pump and whether it is in standby, in load or in unload condition. A pump in load has a full bar, in unload a partially filled bar and when in standby, the bar is empty.

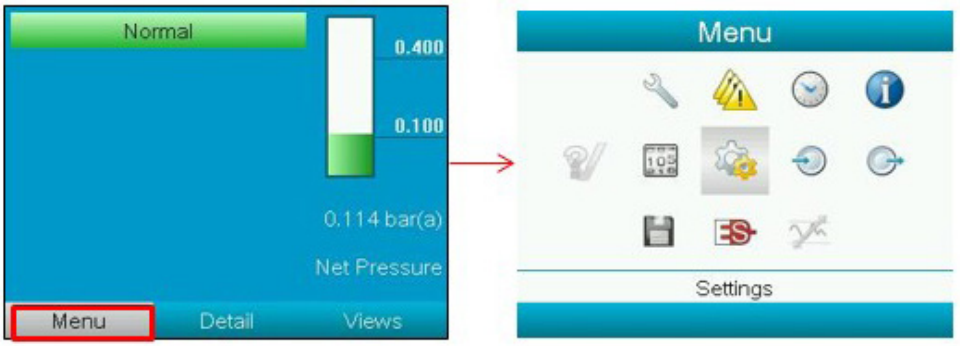
You can also see which pump is the next to be started or stopped by the ES-VAC Medical. This is indicated by a line underneath the bar (see section Interface and icons). Also pumps alarms are shown.

On the example below, 2 pumps are connected to the controller. Both are in standby and the next pump to be started is pump #1.



3.5. General menu

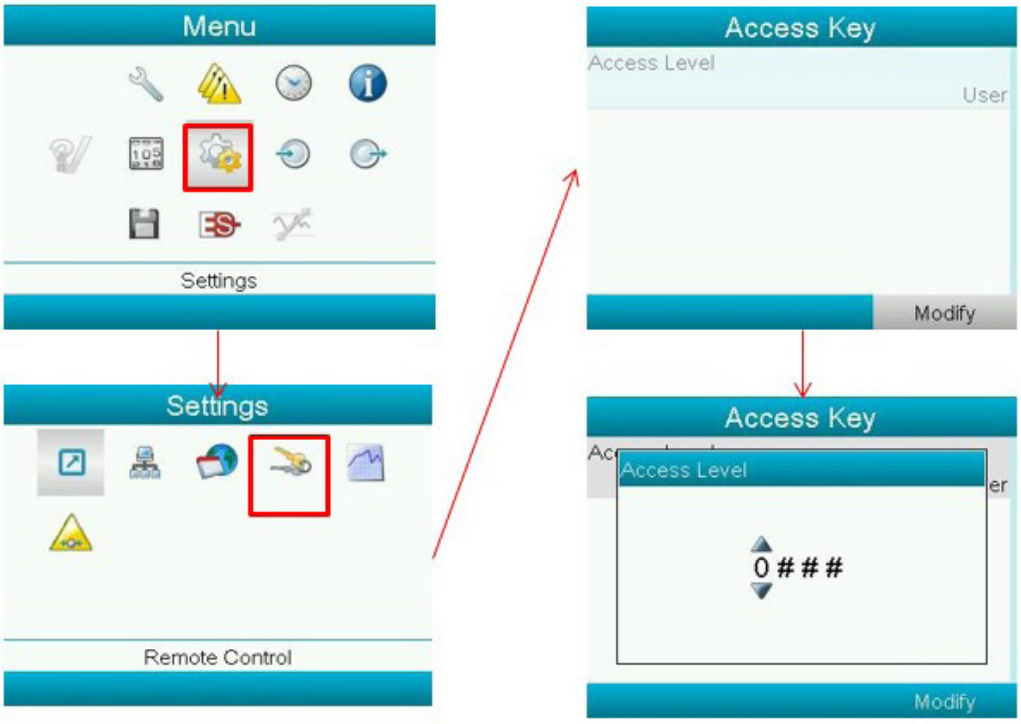
Assess to the menu can be done by pressing action button Menu on a Main screen:



The Settings submenu can be accessed through the main menu by selecting action button Menu and pressing the Enter key. Next, select the Settings icon and press Enter to see a submenu.

3.6. Gaining full access to all menus

To access certain menus like the Settings, ES, Test and Commands menu, the access key needs to be given. In the Menu screen, navigate to the icon indicated below and enter the following sub-menu and insert the code <2801>, using the scroll buttons.



After giving in the access code, the user has full access. When no key is pressed during several minutes, full access disappears and needs to be re-entered if required.

3.7. Service menu

Service Functions menu

Overview

The Overview submenu shows the programmed service intervals and how much time (both in running hours and real time) is left before the next service must be performed for each type of service plan.

Service plan

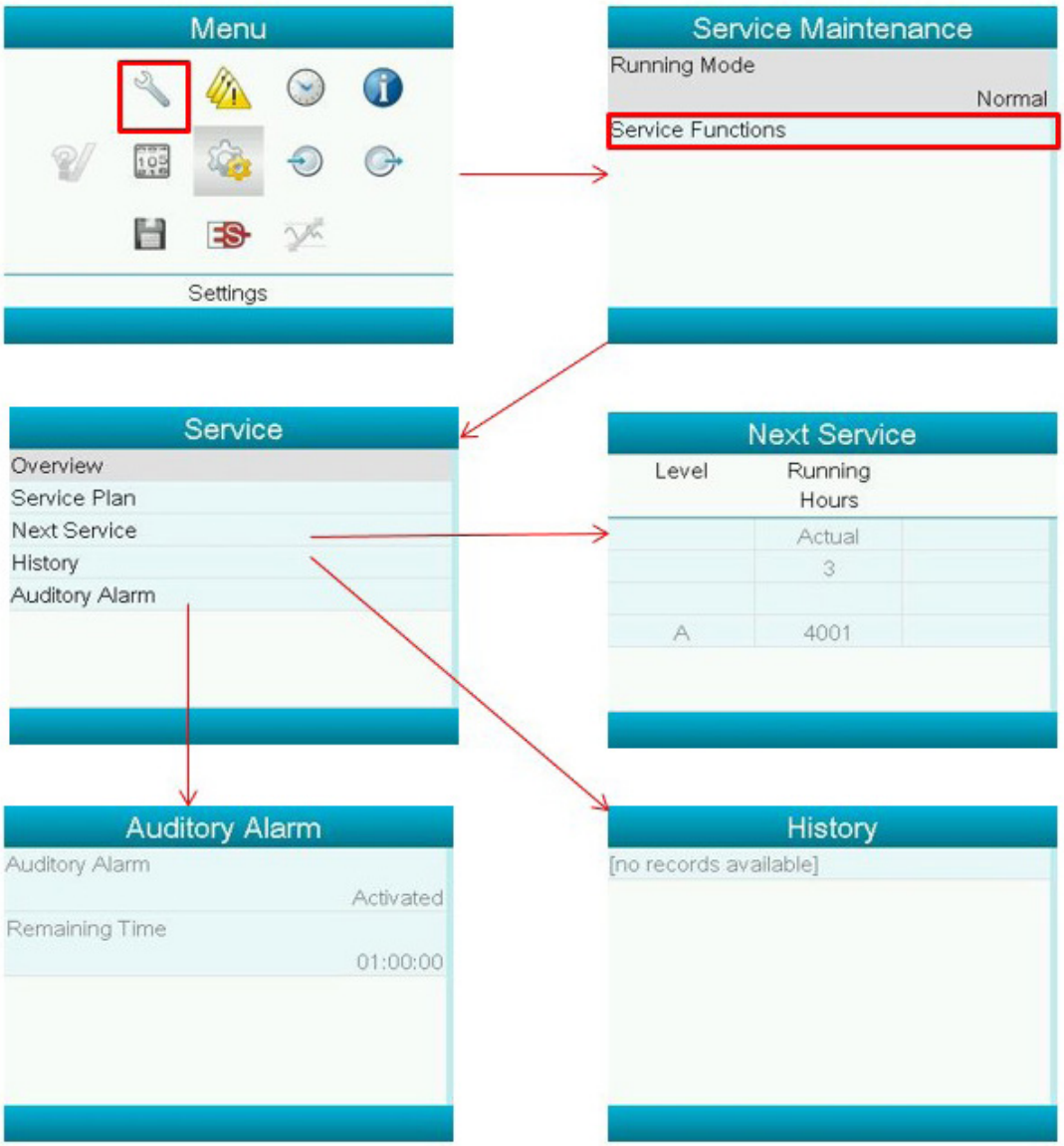
The Service Plan submenu gives an overview of the different types of service that should be performed on the machine (A, B or C) and the time intervals of these. For the ES-VAC Medical there may be no such plans programmed.

Next Service

The Next Service submenu indicates which type of service will have to be performed the next time (A, B or C), how many hours have passed since the last service and how many running hours are in between the last and the next service.

History

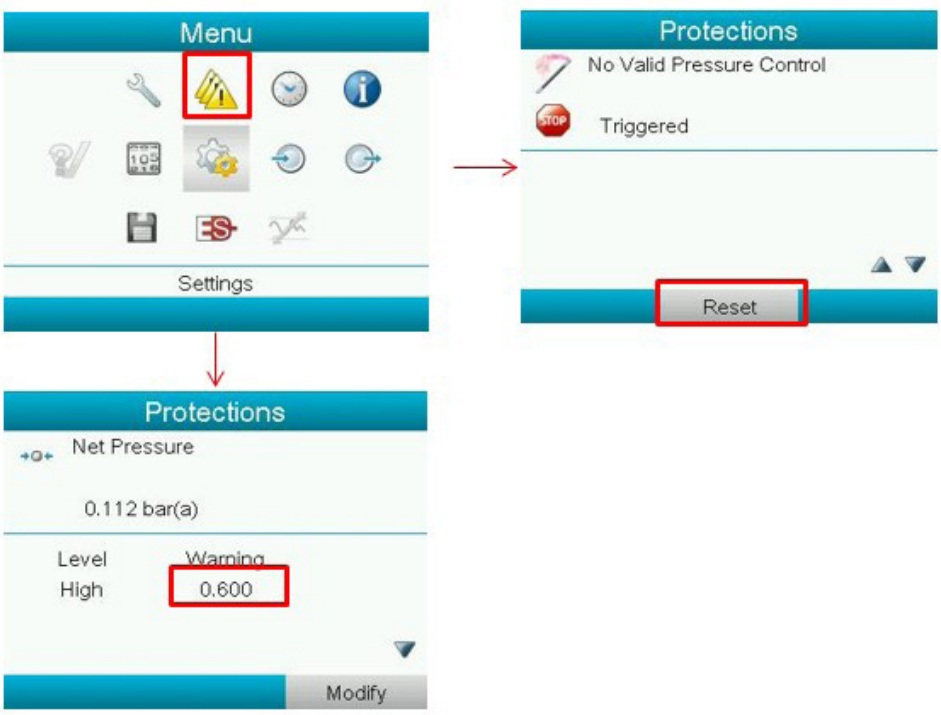
In the History submenu records can be seen when earlier service was performed.



3.8. Protections menu

In general, no alarms on the ES-Medical should be reset. This means that in case the value or the reason for an alarm condition reverts back to the normal state, the alarm will be reset/disabled automatically.

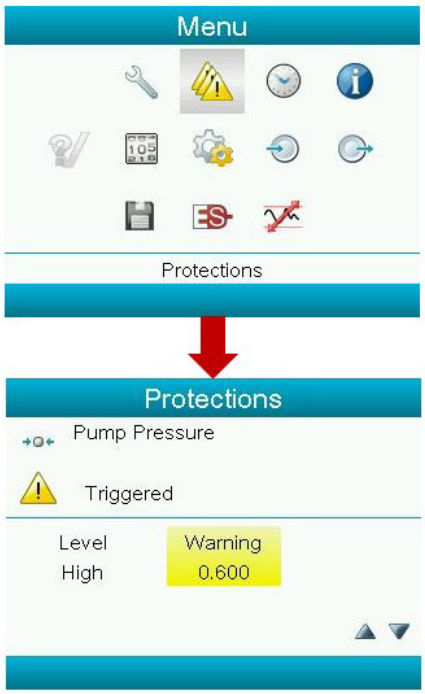
When the plant reverts from an alarm condition to the normal state, this will be written in the log. In case a dryer fails on dew point (regular fault or pre-alarm), this will fail the dryer and cause an operating alarm. When an alarm is triggered on the ES-Medical, the user can go to the Protections menu to see what is causing the alarm (see example on the right in the picture below).



To adapt the limit at which a warning is activated, scroll down to the value that needs adaptation, select Modify and change the value to the desired setting. For the alarm settings on the vacuum Net (Line) pressure this is done in the Protections submenu (see above).

When there is a problem with one of the direct inputs, the red warning LED or blue service LED will be lit. When no problem is visible on the pump overview screen (see Interface icons and menu structure), the Protections sub-menu must be consulted. The reset button is only applicable for the delta P warning. For all other faults, the warning disappears when the problem is remedied. The following four situations are important (the fault is indicated in yellow):

1. Delta P warning: the real pressure drop over the bacterial filters exceeds the predefined limit (limit can be adjusted, please contact BeaconMedæs if needed). After carrying out the filter replacement successfully (see Bacterial filter replacement), press “Reset” in the following screen to clear the warning and turn off the blue service LED:



Pump pressure warning: When the limit is exceeded or no read-out is obtained (indicated by stars ***), a problem with the sensor, cable or connections occurred. As long as this fault is active, delta P can not be calculated. Taking into account the maintenance warnings (see Maintenance warnings), check the sensor, the cable and the connections for proper connection and correct wiring according to the service diagram. The fault should be physically remedied (spare parts can be ordered, consult the spare part list), whereby the yellow warning will automatically reset.

Net pressure warning: When the limit is exceeded or no read-out is obtained (indicated by stars ***), a problem with the sensor, cable or connections occurred. As long as this fault is active, the even-wear algorithm uses the Pump pressure-read-out to control the pumps, if available. Taking into account the maintenance warnings (see Maintenance warnings), check the sensor, the cable and the connections for proper connection and correct wiring according to the service diagram. The fault should be physically remedied (spare parts can be ordered, consult the spare part list), whereby the yellow warning will automatically reset.

No valid pressure control: When both the Pump pressure sensor and the Net pressure sensor are unavailable, the central controller has no pressure feedback and can not control the pumps. Therefore it sends the pump controllers in forced local mode until the problem is remedied.

3.9. Week timer menu

The Week Timer menu can be accessed through the main menu by selecting action button Menu and pressing the Enter key. Next select the Week Timer icon.

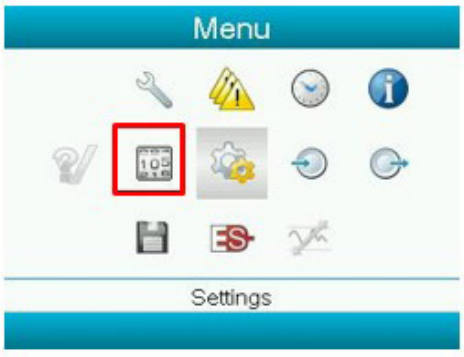
In the Week Timer menu the user can activate a week timer and adapt its settings. For medical applications, this timer is not used, obviously because medical air is to be available at all times.

3.10. Info menu

By selecting the Info icon in the general Menu screen (and pressing More), information regarding MAC address, software, IP settings, etc. can be viewed.

3.11. Counters menu

By selecting the Counters icon in the general Menu screen the amount of hours that the central controller was powered (Module hours) and other counters can be viewed.

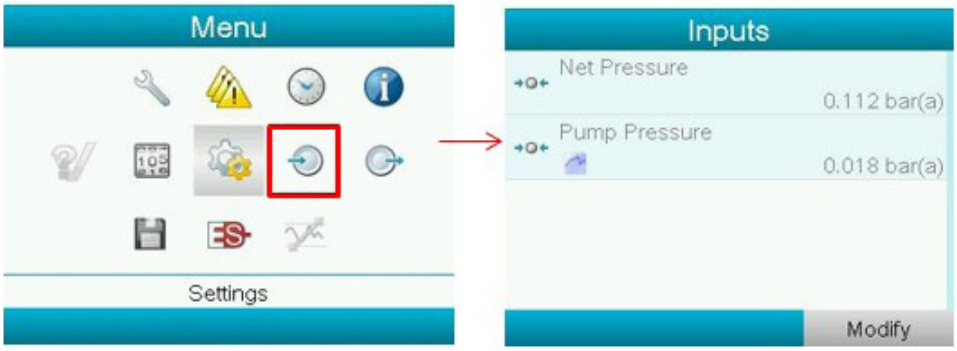


3.12. Input menu

The direct inputs of the ES-Medical controller are visible in the Inputs submenu and are the following:

- Net pressure (pressure on inlet of the vacuum plant)
- Pump pressure (can be different if vacuum filters installed)

To overview status of inputs go to Inputs screen.



3.13. Output menu

The outputs are the alarms that are transmitted potential-free to the hospital control room. “Closed” corresponds to “active”. In the Outputs submenu the outputs can be viewed in real time:

3.14. Event history menu

When an alarm is triggered, the full situation (inputs, outputs, time stamp) is logged into the event history. To take a look, select the Event history icon (see above) in the Menu screen:

The event history keeps track of the last 30 events.

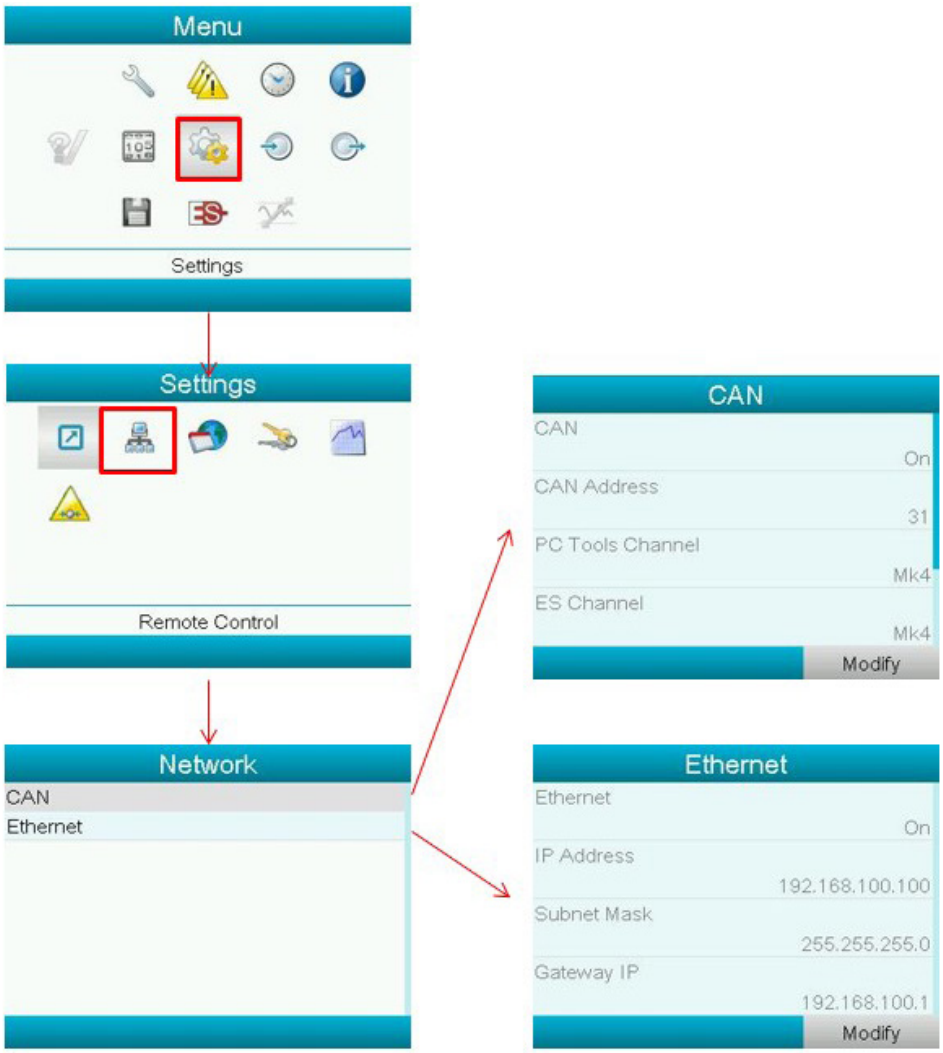
3.15. Settings submenu

Remote control

In the Settings – Remote Control submenu (full access needed, see above), the user can adapt the CAN communication timeout. Normally this setting does not need to be changed. Contact BeaconMedaes if changing is considered.

CAN settings

These settings are set ex factory if the controller is purchased as part of a certified Air plant. For proper operation, the CAN settings need to be defined. To verify, the following steps can be followed after entering the Settings submenu and then selecting the Network icon and CAN:



CAN Address must for Central Controller be set to 30. The CAN settings of the pump are set on their proper controller.

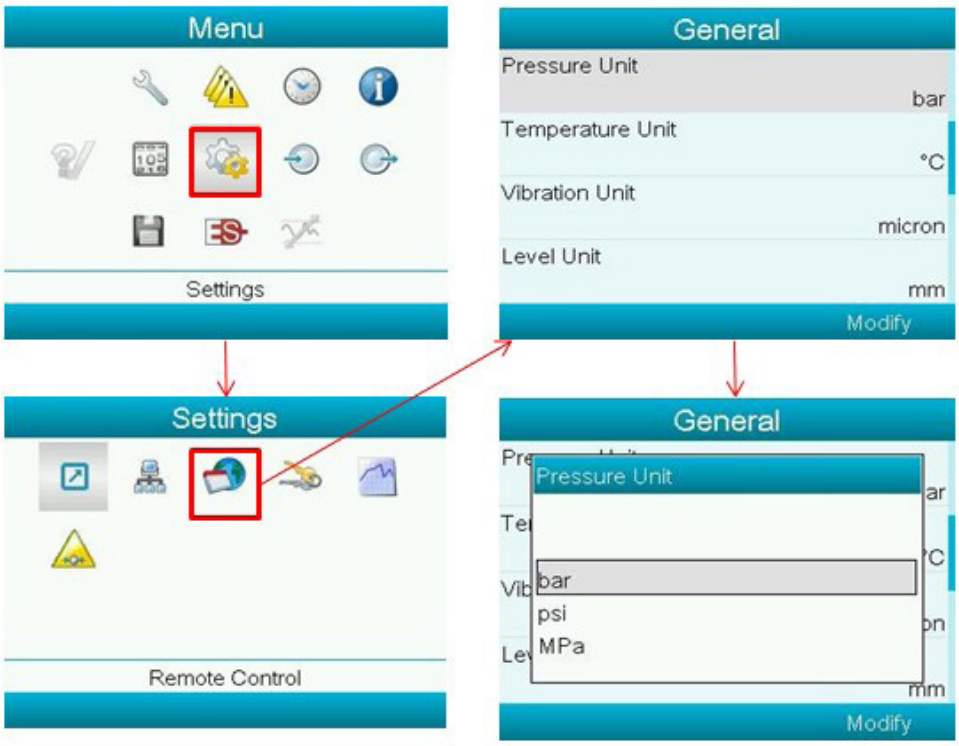
Communication profile must be set to Mk4. When selecting Ethernet in the Network submenu (see the above image), it is possible to set a custom IP address, Gateway IP and Subnet mask.

After connecting an ethernet cable between your network and the controller, the plant can be monitored online when browsing to the set IP address.

General settings

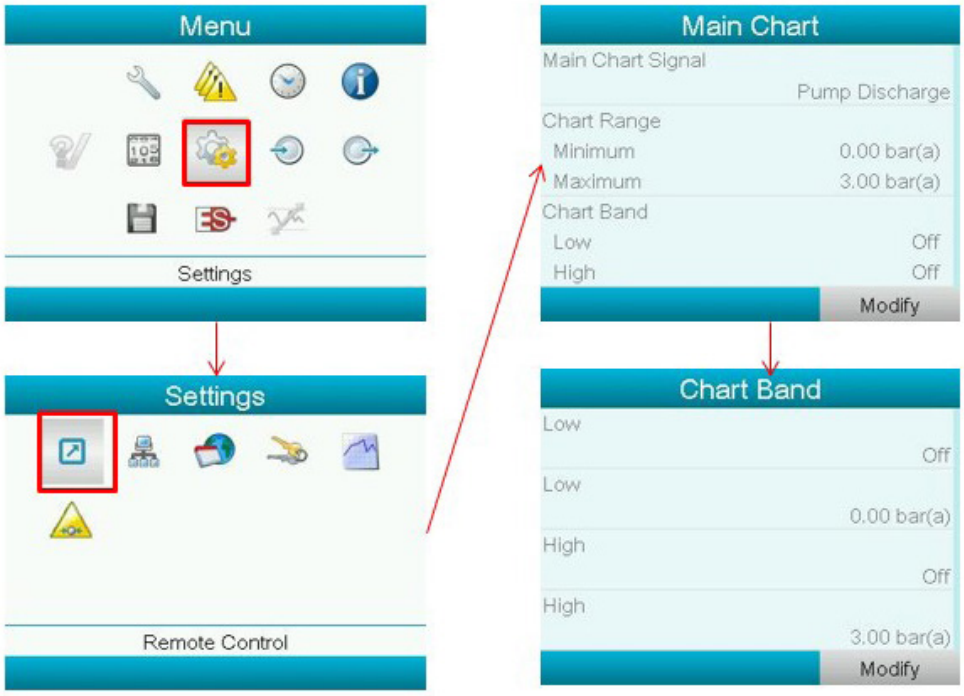
In the Settings- General submenu (full access needed, see above), a number of other settings (Language in Use, Time, Date, Date format, Pressure unit, etc.) can be modified.

Example: to change the pressure unit, navigate to Pressure Unit in the list and press Enter. A pop up screen opens. Select the unit required and press action button Modify to confirm.



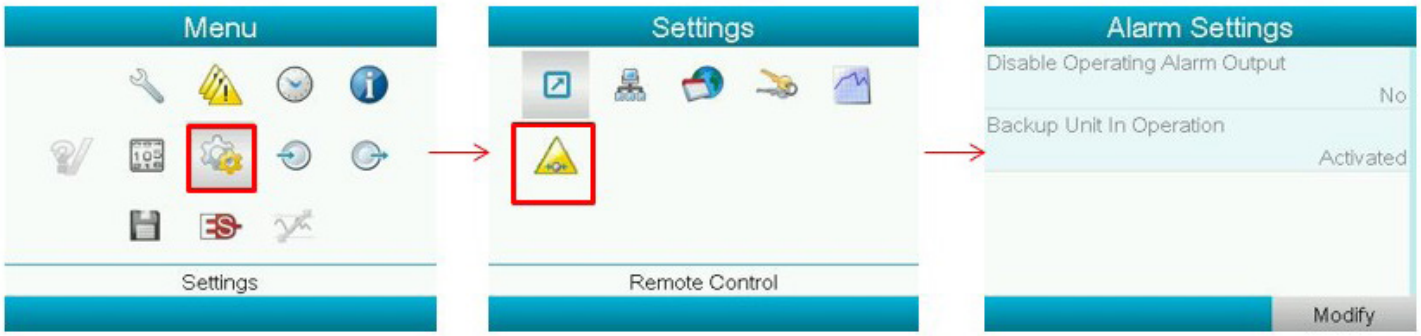
Main chart

To change the settings of the main chart (available as an optional background for the standard display in the Views screen, see section Menu structure, paragraph Views screen), go to the following menu:



Alarm settings

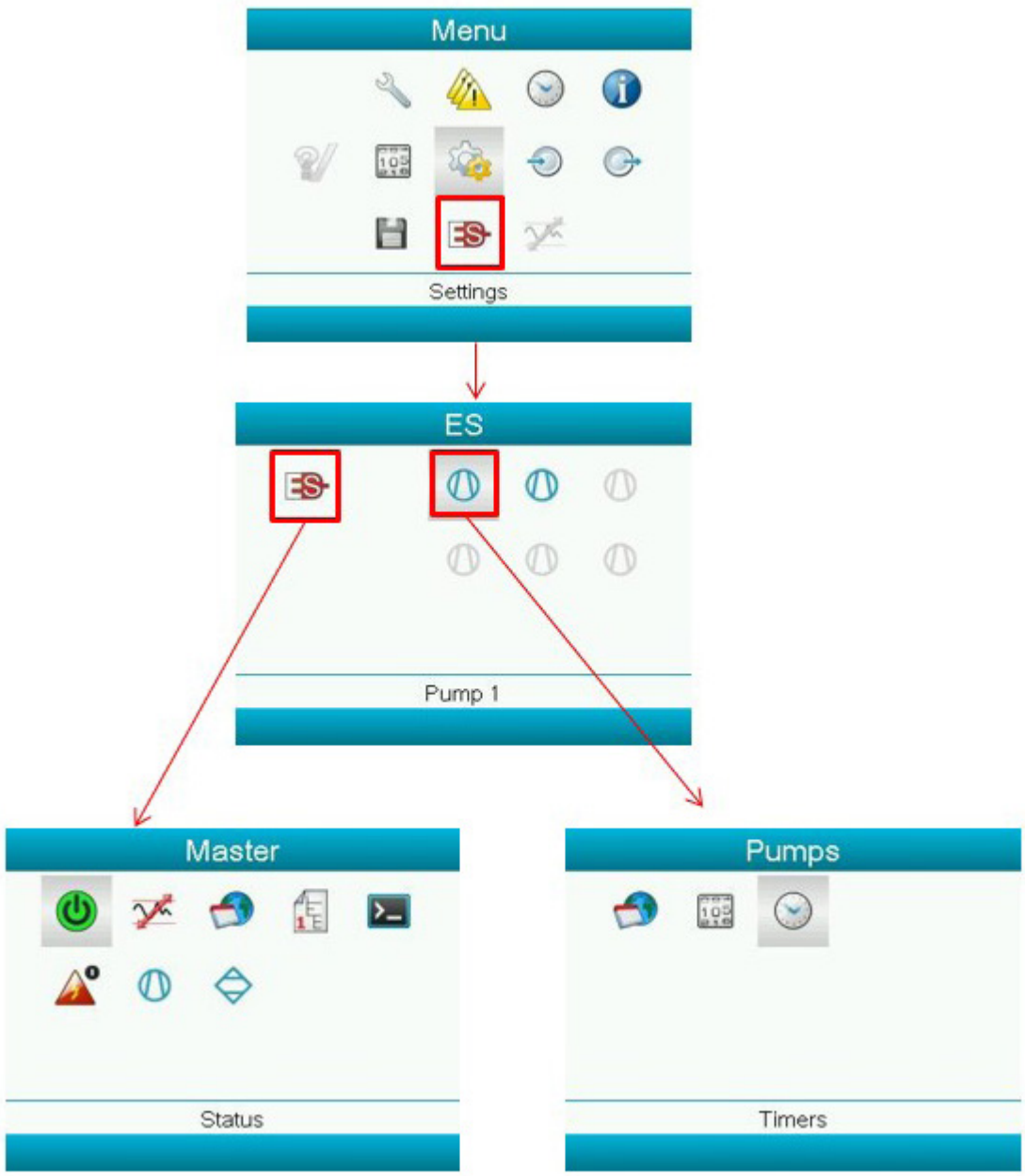
To Activate backup in Operation alarm (LAG alarm) go the Alarm Settings screen (see picture below). Here also has a possibility to disable alarms output, for example during commissioning.



3.16. ES submenu

General

The ES menu is the most important menu in the software, controlling the parameters of the network and the functioning of the entire air plant. Its main structure looks like this:

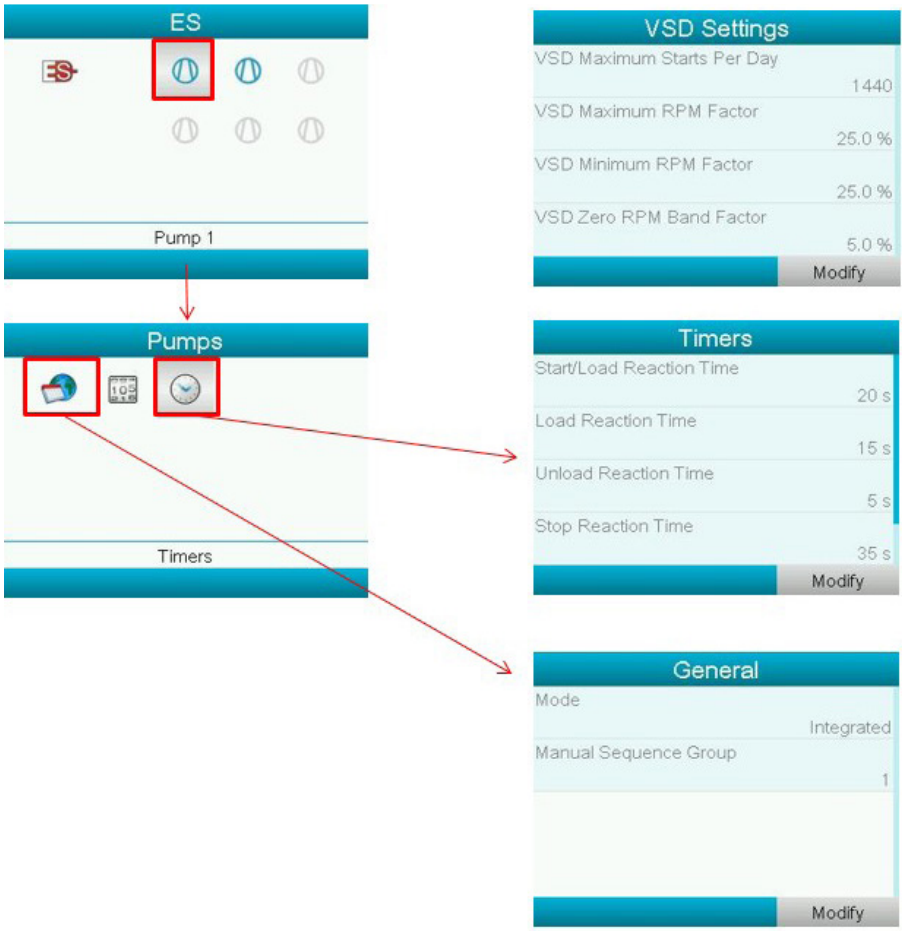


The ES menu is accessed through the main menu. Before the user can access the ES menu, the password for full access has to be entered (see section Settings menu, paragraph Gaining full access).

On the left is a shortcut to the Master screen with the general settings of the ES. On the right, selecting one of the pumps will take you to the pump page, where specific information or settings can be seen or chosen for that component (see further).

The ES - pumps menu

In the Pumps menu, the user can see and adapt a number of compressor settings.



The icons on the Pumps menu lead to the following submenu's (from left to right):

- General: to select whether the pump is integrated or not. For normal ES operation, this should be set to integrated.
- Timers: specific timer settings for the pump. These normally shouldn't be changed.
- VSD settings: specific settings for a VSD pump (pump with a frequency converter).

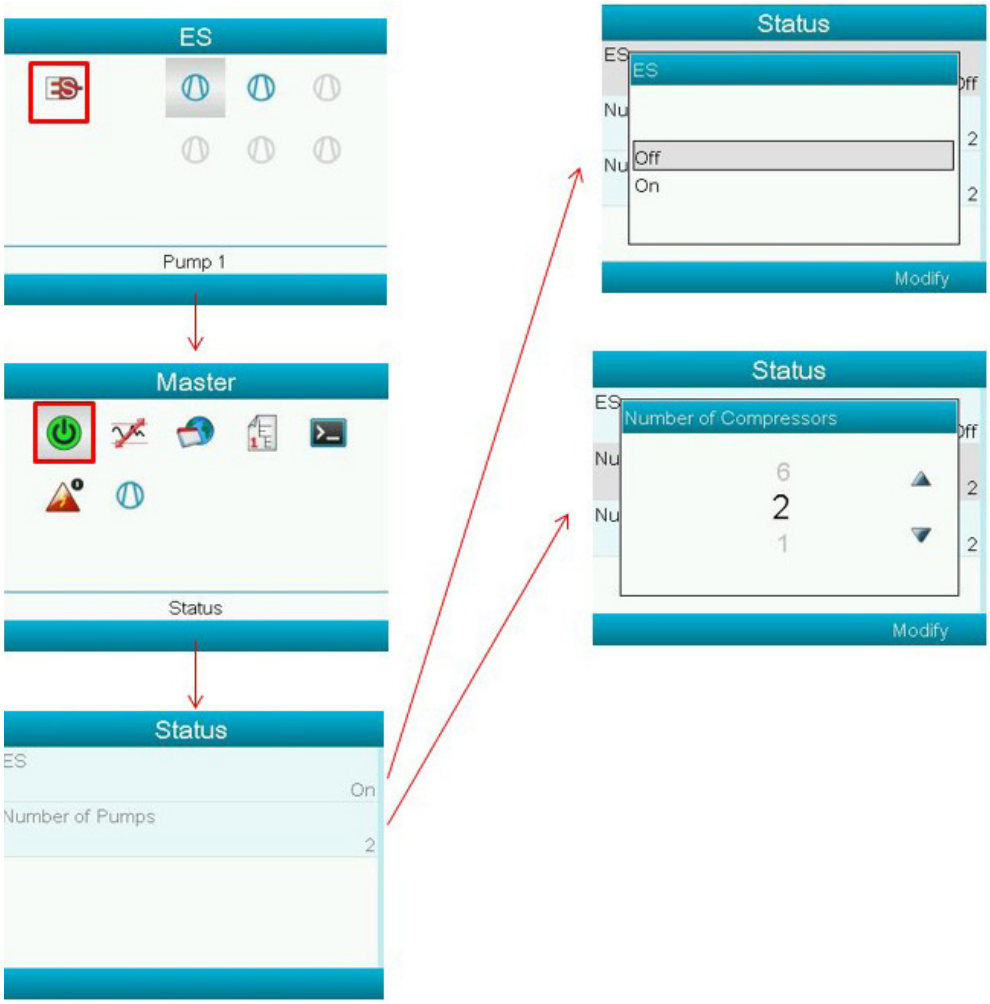
The ES - Master menu

Selecting the number of compressors and dryers

When the ES-VAC Medical is part of a certified vacuum plant, the installed pump will be preset in the controller. However, if the ES-VAC Medical is purchased as a separate product, the number of pumps will have to be set by the user. To do so, refer to the following procedure. Note: this can only be done while the ES is not controlling the vacuum plant (ES is stopped).

Starting and stopping the ES-Medical

To start or stop the ES-Medical, select the Status icon in the ES menu:

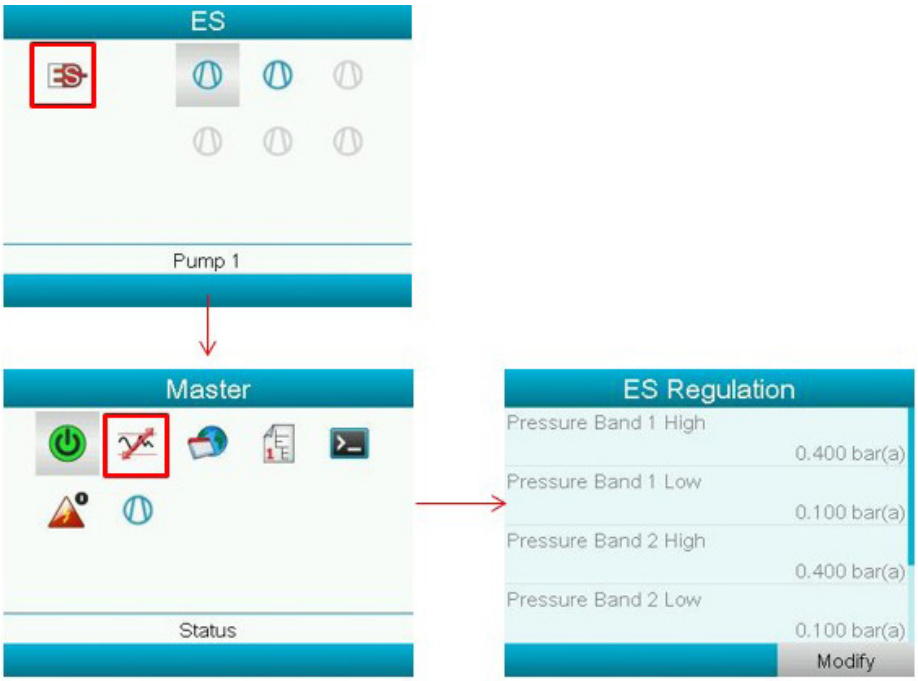


Remarks:

- Make sure all the settings are correct before starting the ES-VAC Medical.
- It is only possible to modify the settings when the ES-VAC Medical is Off.
- Also make sure to already set up the CAN address and that CAN is enabled (see further on how to do
- this).
- **When the ES-VAC Medical is controlling the vacuum plant, first switch to Local mode in order to be able to stop the ES-Medical. Local mode can be switched On and Off in the ES Master - Commands submenu (see further).**

Regulation

In the Regulation submenu the user can adapt the pressure bands (minimum and maximum value) the ES-VAC Medical uses to regulate the pumps.



General

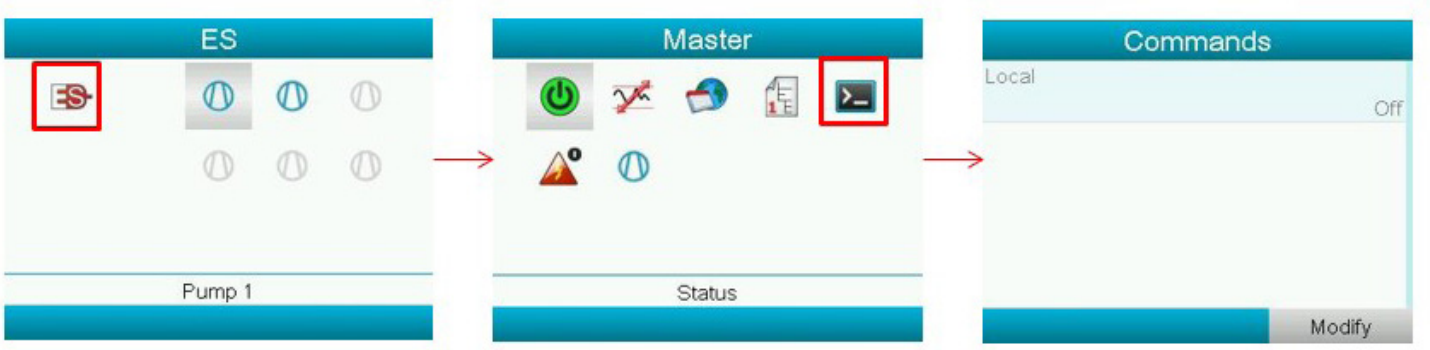
In the General submenu, the user can see if the local mode of the ES-Medical is turned On or Off and if Remote start/stop of the ES-VAC Medical is enabled.

Action scheme

Here the user can select an Action scheme to be used (action scheme 1 or 2). This is normally not used.

Commands

In the Commands submenu the user can put the Local mode of the ES-Medical On or Off. When the ES-VAC Medical is operational, Local mode has to be On in order to be able to put the ES-Medical Off.

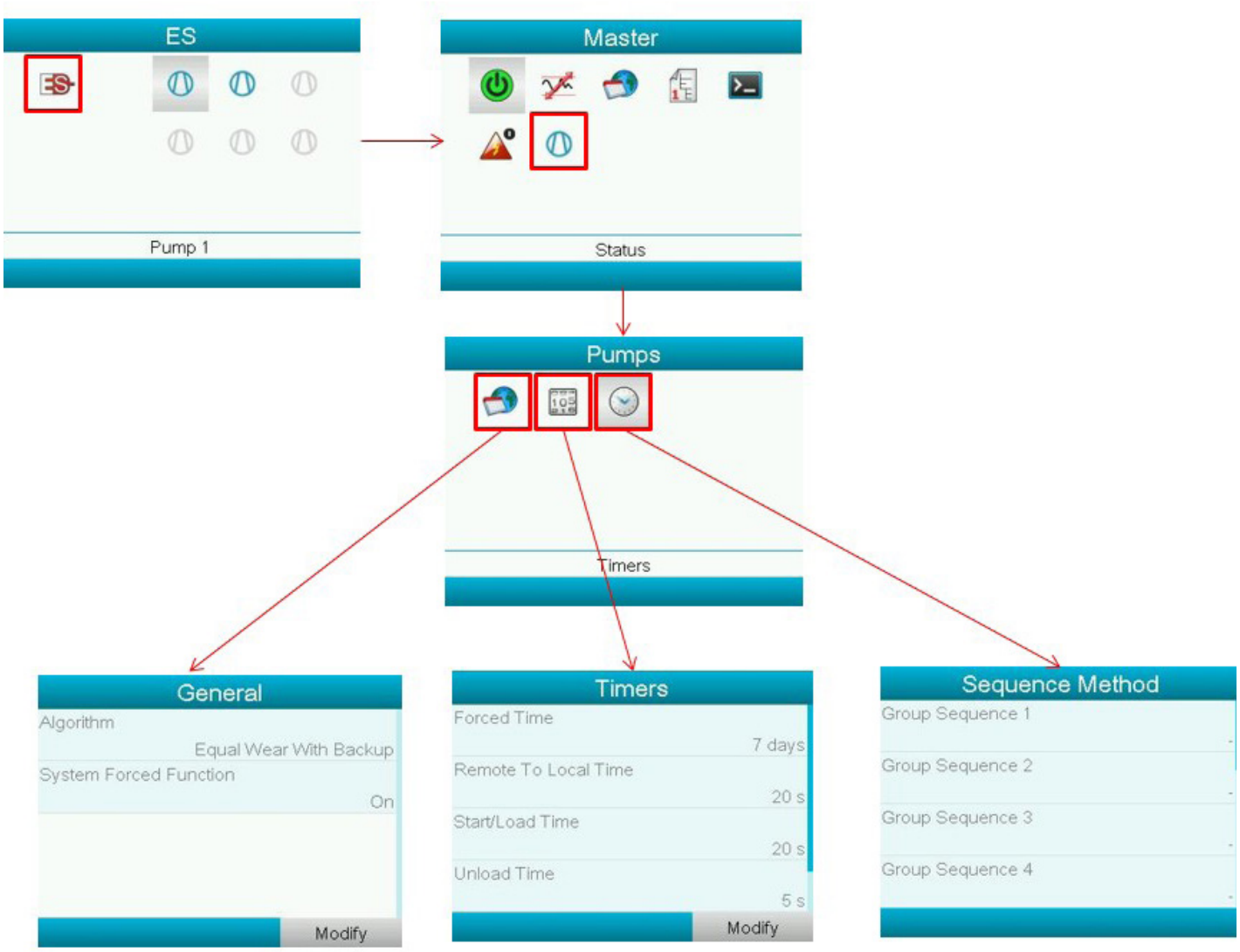


Automatic restart

In the Automatic Restart submenu the settings for the ARAF (automatic restart after power failure) can be adapted. Normally these settings should not be changed.

Pumps

In the Compressors submenu some general settings for the connected compressors can be seen (see image below). Normally these settings should not be changed. Please contact BeaconMedæs.



3.17. Starting ES

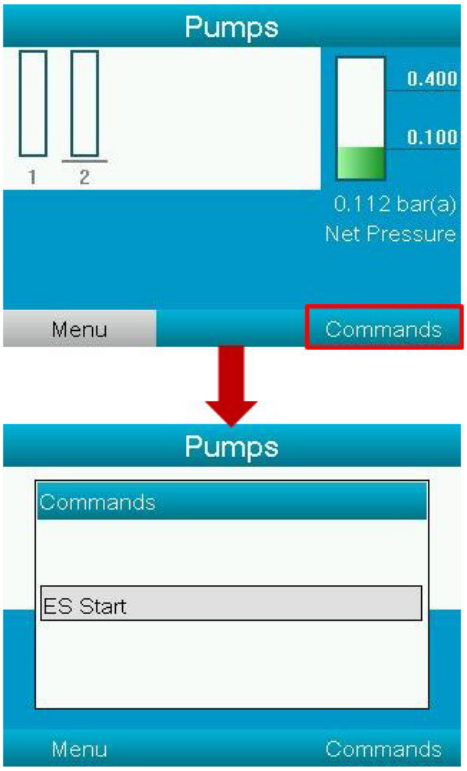
During commissioning the plant (see Starting the plant), the ES control system must be started. During production, the system should have been set correctly in the software. To verify, the following procedure can be followed (full access needs to be obtained, see above):

The number of pumps (compressors) should be set to the actual number of pumps present on your plant and ES should be set On.

To start the system, after having completed the CAN and ES setup described above, carry out the following steps:

- pumps : turn the pumps' main switch to on and the local-lan settings to LAN.
- The emergency forced local warning (see Interface icons and menu structure) and red led is present on the display since the pressure is less deep than -590 mbar(e).
- Once the pressure is deeper than -590 mbar (on the display of the pump controller), the escape button must be pressed on the pump controller (see Interface icons and menu structure) which will make the warning and red led disappear.

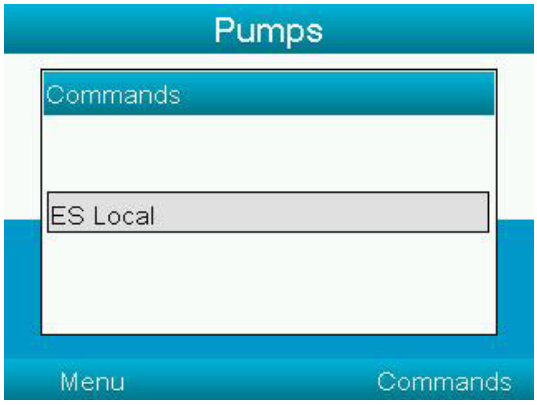
Then carry on to start the ES system (full access needs to be obtained, see above).



Navigate to the Start button and press enter. A spinning circle should appear to indicate that the ES is running.

Stopping & resetting

To stop a certain pump, see section Pump controller operation. To force all pumps local, go to the commands screen and select the “Local” button.



The spinning circle symbol will disappear, indicating that the ES is not active (controlling the pumps) any more. The pumps are now in “Forced Local Mode” even though their local/LAN switch may be in LAN selection. This allows the operator to do maintenance or troubleshooting on the central controller while vacuum is guaranteed by the local pumps.

To reset, after having pressed ‘Local’, turn off the ES (see above), then select ‘On’ again. Then proceed to paragraph ‘Starting’ to start the central controller, putting it in charge of the pumps again. Alternatively, switch CAN off and on.

Isolating a pump controller

To carry out maintenance on a pump without transmitting alarms, select the ES sub-menu from the main menu (requires full access, see above). Browse to the pump that needs to be isolated and press enter. In the following selection menu, navigate to “Mode” and select “Isolated”.

Important: After maintenance, this process shall be followed to select the mode to “Integrated” again.

Other settings

The following settings can be found under the ES > Master sub-menu.

In normal circumstances they should not be changed, please contact BeaconMedaes.

Parameter	Function	Min. setting	Factory setting	Max. setting	Unit
Pressure band x High	To program the maximum setting for pressure band x	0	400	1000	bar(a)
Pressure band x Low	To program the minimum setting for pressure band x	0	100	1000	bar(a)
Pressure band in use	To select between pressure band 1 and 2	-	1	-	-
Scheme in use	To define which scheme is in use (see slave parameter scheme x priority)	-	1	-	-
Forced time	To program the interval at which, if activated by “System Forced”, the central controller starts a new pump in case no sequence change has occurred during the interval	1	2	60	hours
Start Zone 3		0	20	60	sec
Start Zone 4		0	10	60	sec
Stop Zone 1		0	20	60	sec
Stop Zone 0		0	10	60	sec
System Forced function	To allow the central controller to force another sequencing by starting a new pump at the interval programmed in “Forced Time”	1	2	60	hours
Maximum power down time	If ARAF is set to “Active” (e.g. instead of “Infinite”), then the system will only restart automatically within this power down time	15	20	3600	sec

The following settings can be found under the ES > Slave x sub-menu.

In normal circumstances they should not be changed, please contact BeaconMedaes.

Parameter	Function	Min. setting	Factory setting	Max. setting	Unit
Scheme x priority	To put this pump in a certain priority queue, based on the scheme selected (see master parameter “Scheme In Use”)	1	1	6	-
Start/load reaction time	To program the time interval in which the start command from the central controller should result in the pump running	1	50	600	sec
Stop reaction time	To program the time interval in which the stop command from the central controller should result in the pump stopping	1	50	600	sec
Running hours	To adjust running hours for pump x to influence the even wear control algorithm	0	x	500000	h
Mode	See below	-	integrated	-	

4. Controller alarms and faults

4.1. Controller alarms and faults

When an alarm is transmitted to the hospital control room and shown on the central controller (accompanied by the red warning LED on the central controller and, when applicable, also on a pump controller), a problem needs to be remedied. Three alarms can occur, alone or simultaneously.

Per alarm, the possible originating faults are described along with their remedies. When trying to remedy problems, always take into account the maintenance warnings (see Maintenance warnings).

When no alarm is active, the normal status is shown and transmitted to the hospital control room.

4.2. Emergency operating

Description

The net pressure that is measured upstream of the bacterial filters exceeds -600 mbar(e) (-450 mmHg). Evidently, this situation must be attended to as soon as possible.

Causes and remedies

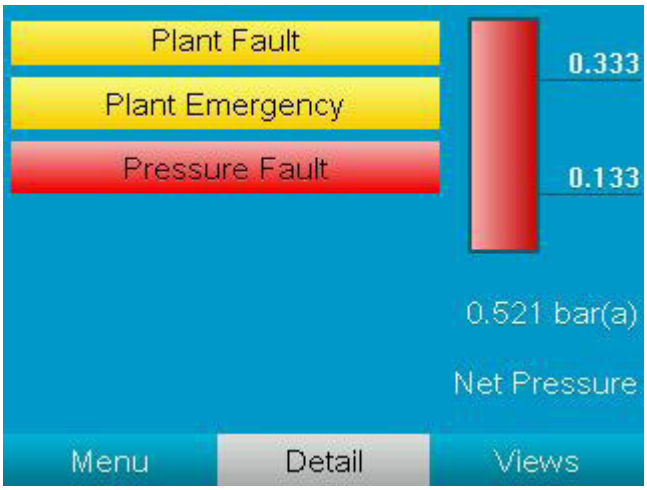
The flow demand in vacuum can not be sustained. One of the following causes could lead to this alarm:

1. The plant is not properly sized to meet the flow demand. Conduct a flow test and consult BeaconMedaes.
2. A ball valve is not in the correct position. Check all valve positions (see section Setting the pneumatic system).
3. One or more pumps are not performing to their full capacity. Check that maintenance is carried out as required according to section Checks and intervals and that the drawn current on the amp meter (see section Interface icons and menu structure) corresponds to the values found in section Fuse values and as written in the logbook during commissioning.
4. The pressure drop over the bacterial filters exceeds 100 mbar. Carry out maintenance (see section Bacterial filter replacement).
5. A leak or rupture is present in the piping, hoses, vessels, filters or pumps. Investigate the plant for leaks. When a leak or rupture is found in a section which can be isolated from the main flow, remedy the problem after isolating the section (for spare parts, consult the spare part list). When the leak or rupture is situated in the main flow pipeline of the plant and cannot be isolated, please contact BeaconMedæs.
6. The piping, hoses or inlets of the pumps are blocked. When a blockage is found in a section which can be isolated from the main flow, remedy the problem after isolating the section (for spare parts, consult the spare part list). When the blockage is situated in the main flow pipeline of the plant and cannot be isolated, please contact BeaconMedæs.

A non-return valve of a pump is locked in the closed position. Pump by pump, verify if there is an impact on the pressure between the pump running and not running (Contact BeaconMedæs). If there is no impact, order a non-return valve service kit (consult the spare parts list) and procweed to replacing the non-return valve according to

section Non-return valve and inlet screen replacement.

4.3. Pressure fault



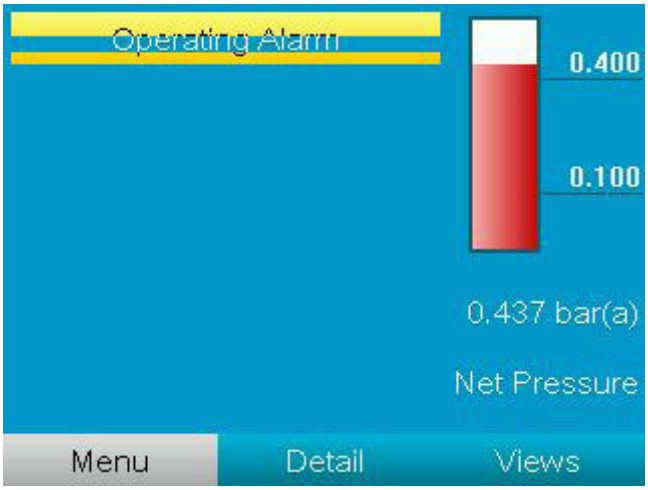
Description

The net pressure that is measured upstream of the bacterial filters exceeds -480 mbar(e) (-360 mmHg). Evidently, this situation requires immediate attention.

Causes and remedies

This situation is the escalation of the Plant emergency alarm above, and the same causes and remedies apply.

4.4. Operating Alarm



Description

A fault has occurred which potentially leads to the system performing sub-optimal, and if left unattended could result in the loss of vacuum.

Causes and remedies

First, all controllers must be checked for the presence of red LED's being lit (unless if causes 1 or 2 apply, see below). Navigate to the pump overview screen to ensure no warning icons (see Interface icons and menu structure) are present on any of the pump bars.

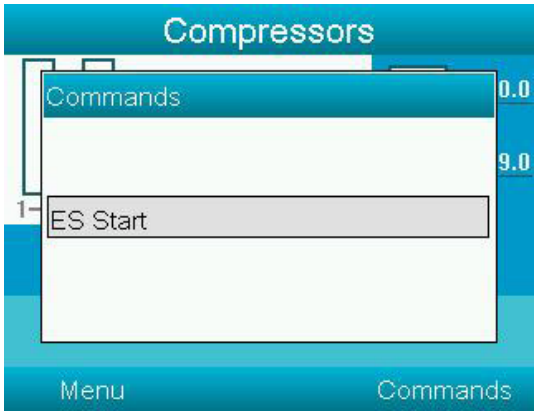
If a red LED is lit on a pump controller, the corresponding problem should occur both on the pump overview screen and on the main display of the pump controller, where it should appear as a blinking icon (see Interface icons and menu structure):

1. Slave switched to local:

Check if the Emergency Forced Local symbol and red led are present on the pump controller (see Interface icons and menu structure). If so, a fault may have occurred whereby the system itself did not sustain the vacuum at the required minimum. Emergency forced local will start every pump (that is not in local stopped state) automatically based on only one input: the pump's local pressure transducer sensing a pressure less deep than -590 mbar(e). Please contact your customer contact. Once the cause is fixed, and pressure is deeper than -590 mbar(e), the user can only reset the warning by pressing the escape button, otherwise the pump will run infinitely in this safety mode. If the local/LAN switch is set to local and there is no reason for it, please switch it back to LAN control. This is not a fault as such but constitutes a situation which is sub-optimal (the central controller can't control the pump to ensure even wear or respond to the demand based on pressure difference per unit of time).

2. No answer:

Interrelated with the previous fault, sometimes the Emergency Forced Local fault can cause the central controller (Magnis ES-VAC) not to find the pump controller. After resetting the Emergency Forced Local as described above, also the following procedure must be carried out (full access needs to be obtained, see Central controller operation) : go to submenu Commands and press Reset.



No Communication: Either the controller has no electrical supply or there is a CAN network error. Taking into account the precautions of chapter Maintenance warnings, check that the controller is adequately electrically supplied and fix if necessary. If supply is adequate, check the software CAN settings in both the pump controllers and the central controller (see previous chapters). Verify that the CAN cables at the backside of the cubicles are correctly connected to the other cubicles. If so, open the cubicle and verify that the CAN cable is correctly connected between the cubicle back plate and the controller. If that is the case, open the CAN connectors and verify that the wires are correctly connected. Contact BeaconMedæs for further investigation.

After fixing the problem, the status should automatically reset. If it doesn't, press "Local" in the commands screen of the central controller and select ES "Off" in the ES menu (see Central controller operation). Then select on again and press start in the commands menu. Alternatively, in the CAN menu, press CAN off and on.

3. Sensor error: A problem with the pump's local pressure sensor, cable or connections has occurred or the pressure is out of range (e.g. -1,1 bar). Unless if the pump is in local off mode, this error will always start the pump (Emergency Forced Local mode). Taking into account the precautions of chapter Maintenance warnings, check the sensor, the cable and the connections for proper connection and correct wiring according to the service diagram. The fault should be physically remedied (spare parts can be ordered, consult the spare parts list), whereby the alarm will automatically reset. If however the pressure is believed to be out of range (pump runs in Emergency Forced Local mode and plant inlet is closed or no vacuum demand), this error will reset automatically once the pressure is in range again.
4. Failed to go on load: Two situations can be discerned:

a. When the fault appears when the pump is running, two causes can lead to this fault:

- The switch, cable or connections lead to a short circuit. Taking into account the precautions of chapter Maintenance warnings, check the sensor, the cable and the connections for proper connection and correct wiring according to the service diagram. The fault should be physically remedied (spare parts can be ordered, consult the spare parts list), whereby the alarm will automatically reset.
- The pump does not succeed in producing a vacuum deeper than -200 mbar(e) (-150 mmHg) within 10 seconds after the pump has been called (asked to run by the controller). This means that the pump is most likely defect. Check that the pump is rotating when called. If not, verify the electrical connections to the pump. If the pump does rotate, flow demand may exceed the plant flow capacity, there may be a leak or a blockage.
- When the fault appears when the pump isn't running, two causes can lead to this fault:
  - The switch, cable or connections are broken or loose. Check the sensor, the cable and the connections for

proper connection and correct wiring according to the service diagram. The fault should be physically remedied (spare parts can be ordered, consult the spare parts list), whereby the alarm will automatically reset.

- The non-return valve, installed upstream of the pump inlet, is locked in open position. This could lead to oil being sucked out from the pump into the piping and must be attended to as soon as possible. Order a non-return valve service kit (consult the spare parts list) and proceed to replacing the non-return valve according to chapter Non-return valve and inlet screen replacement.

5. Motor tripped: The motor draws more current (for several seconds) than the value set in the overload protection. This fault will always stop the pump and hence requires immediate attention. Taking into account the precautions of chapter Maintenance warnings, open the corresponding cubicle and verify if the overload setting is according to the recommendation of chapter Fuse values. If so, verify that the supply matches the required voltage +/- 10%. A voltage dip or current surge may have occurred. If the supply is adequate, verify that all connections between cubicle and motor are in order and attached correctly (see service diagram). If so, verify that the pump is maintained as required by chapter Checks and intervals in terms of e.g. oil and filter replacements and inspect the pump for any defaults or blockages. If no cause can be established, please contact BeaconMedaes. After fixing the problem, press the reset button on the overload protection inside the cubicle (see picture), close the cubicle and switch on the isolating switch. Press the escape button (see Interface icons and menu structure to clear the display. Verify that the pump runs without problems for 10 minutes at least (e.g. by testing with JOG function, see Pump controller operation).
6. Oil level low (when an oil level switch option is installed): In this case, the red warning LED (and no other symbols) is lit on the pump controller, additional to the warning sign on the corresponding pump bar graph shown on the central controller. Verify the oil level and replenish if needed (see Oil, oil filter and oil separator change).

5. Installation

5.1. Introduction

	Installation of a medical vacuum plant must be carried out by suitably qualified and competent personnel who fully understand the standards required when working on a piped medical gas distribution system and are conversant with the information contained in this Instruction book. Installation must be carried out strictly in accordance with the specific installation proposal (see chapter Installation proposal) and service diagram issued with the plant.

The Magnis Medical Vacuum Plant must be installed within a plant room which provides adequate ventilation for the cooling of electric motors, bearing in mind that approximately 75% of all energy consumed is dissipated into the plant room as heat. At least 500 mm must be allowed between the plant and any walls or other obstructions and additional headroom is required to enable installation. Specific plant dimensions must be taken in to account especially where access is limited. Install the unit in an area where the noise levels do not cause an inconvenience. When bolting the unit to the floor, take into account that the hole diameters in the frame are between 10 mm and 13 mm.

	Upon installation, take into account the warnings provided in chapter Installation warnings.

5.2. Installation warnings

Portable and mobile RF communications equipment can affect the Magnis Medical Vacuum Plant. They should be used no closer to any part of the Magnis Medical Vacuum Plant, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter (See EN 60601): The following minimum distances are recommended:

Rated maximum output power of transmitter (W)	Minimum separation distance between portable/mobile RF communications equipment and the Magnis Medical Vacuum Plant (m)		
	150 kHz to 80 MHz	80 MHz to 800 MHz	800 MHz to 2,5 GHz
0.01	0.035	0.035	0.23
0.1	0.11	0.11	0.73
1	0.35	0.35	2.3
10	1.1	1.1	7.3
100	3.5	3.5	23

Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey, should be less than the compliance level in each frequency range (performance criteria A, level 3 limit).

1. The Magnis Medical Vacuum Plant is intended for use in the electromagnetic environment specified below. The customer or user should assure that it is used in such an environment.

Emissions test	Compliance	Electromagnetic environment
RF emissions CISPR 11	Group 1	The Magnis Medical Vacuum Plant uses RF energy only for its internal function. Therefore, its RF emissions are very low and not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	The Magnis Medical Vacuum Plant is suitable for use in all establishments including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.

Immunity test	IEC 60601 test level	Electromagnetic environment
Electrostatic discharge (ESD) IEC 61000-4-2	+/- 6 kV contact +/- 8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast ransient/ burst IEC 61000-4-4	+/- 2 kV for power supply lines +/- 1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.

Surge IEC 61000-4-5	+/- 1 kV line(s) to line(s) +/- 2 kV line(s) to earth	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	< 5% mains voltage (< 95% dip in mains voltage) for 0,5 cycle 40% mains voltage (60% dip in mains voltage) for 5 cycles 70% mains voltage (30% dip in mains voltage) for 25 cycles < 5% mains voltage (> 95%	Mains power quality should be that of a typical commercial or hospital environment. If the user requires continued operation during power mains interruptions, it is recommended that the Magnis Medical Vacuum Plant be powered from an uninterruptible power supply (UPS) or institutional stand-by generator.
Power frequency (50/60 Hz) magnetic field IEC61000-4-8	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.

The Magnis Medical Vacuum Plant shall be installed in an environment where the conditions specified in chapter Reference conditions and limitations are not exceeded. It shall be protected from rain, snow or other precipitation and the distances to walls as specified shall be respected.

2. Make sure that the environment is not potentially explosive.
3. Make sure that the ambient condition limits specified in chapter Reference conditions and limitations are not exceeded during the course of the plant lifetime and that they comply with the protection class of the drive motor.
4. Make sure that the vacuum pumps, pipes, filters, and cubicles can neither inadvertently or intentionally be stepped on and cannot be used as support for heavy objects, and cannot be hit by falling objects.
5. Make sure that no temperature sensitive parts (plastic, wood, cardboard, paper, electronics) will touch the surface of the vacuum pumps.
6. Make sure the installation location is vented such that a sufficient cooling of the vacuum pumps is warranted (see chapter Design data).
7. Make sure that the vacuum pumps will not be touched inadvertently during operation.

	During operation the surface of the pump may reach temperatures of more than 70 °C, risk of burns.

8. Make sure that the oil sight glass will remain easily accessible.
9. Make sure that the oil drain port, oil filter and oil fill port will remain easily accessible.
10. Make sure that the power supply is compatible with the data on the nameplate of the drive motor.
11. Electrical installation work must only be executed by qualified personnel that knows and observes the following regulations:

For HTM/ISO:

- BS 7671
- IEC 60364-7-710 or CENELEC HD 384
- IEC 60664
- national accident prevention regulation

For NFPA:

- Refer to the electrical diagram provided with the unit before starting any installation work.
- Do not operate the vacuum pump or central controller on a voltage other than that specified on the dataplates
- All customer wiring should be in compliance with the National Electrical Code and any other applicable state or local codes. Refer to the wiring diagram(s) that come with the vacuum system for pertinent wiring connections.

- Electrical power for the medical system must be supplied from the emergency life support circuit.
- Check the control voltage, phase and amp ratings before starting the electrical installation and make sure the voltage supplied by the hospital is the same.
- The cable size should be able to handle peak motor amp load of all operating units. Refer to the vacuum pump system full load amperes on the wiring diagram.

12. Before disconnecting any piping, pneumatically isolate the section and slowly in-bleed air to raise the pressure to atmospheric pressure. Do not suddenly open any isolating valve that may cause rapid pressure release (increase). Open valves slowly and allow sufficient time for pressure to stabilise.
13. A checklist / logbook will be made wherein the installer will mark the adherence of the installation to the following paragraphs:

- Mechanical positioning (see Installation proposal).
- Piping connections (see Installation proposal).
- Electrical connections (see Electrical connections).
- Pre-start inspection (see Pre-start inspection).
- Electrical functional check (see Electrical functional check).
- Pneumatic settings (see Setting the pneumatic system).
- Automatic operation and leak check (see Automatic operation & leak check).

14. Transportation should be carried out according to section Transporting.

5.3. Mechanical installation

3.3.1 Transporting

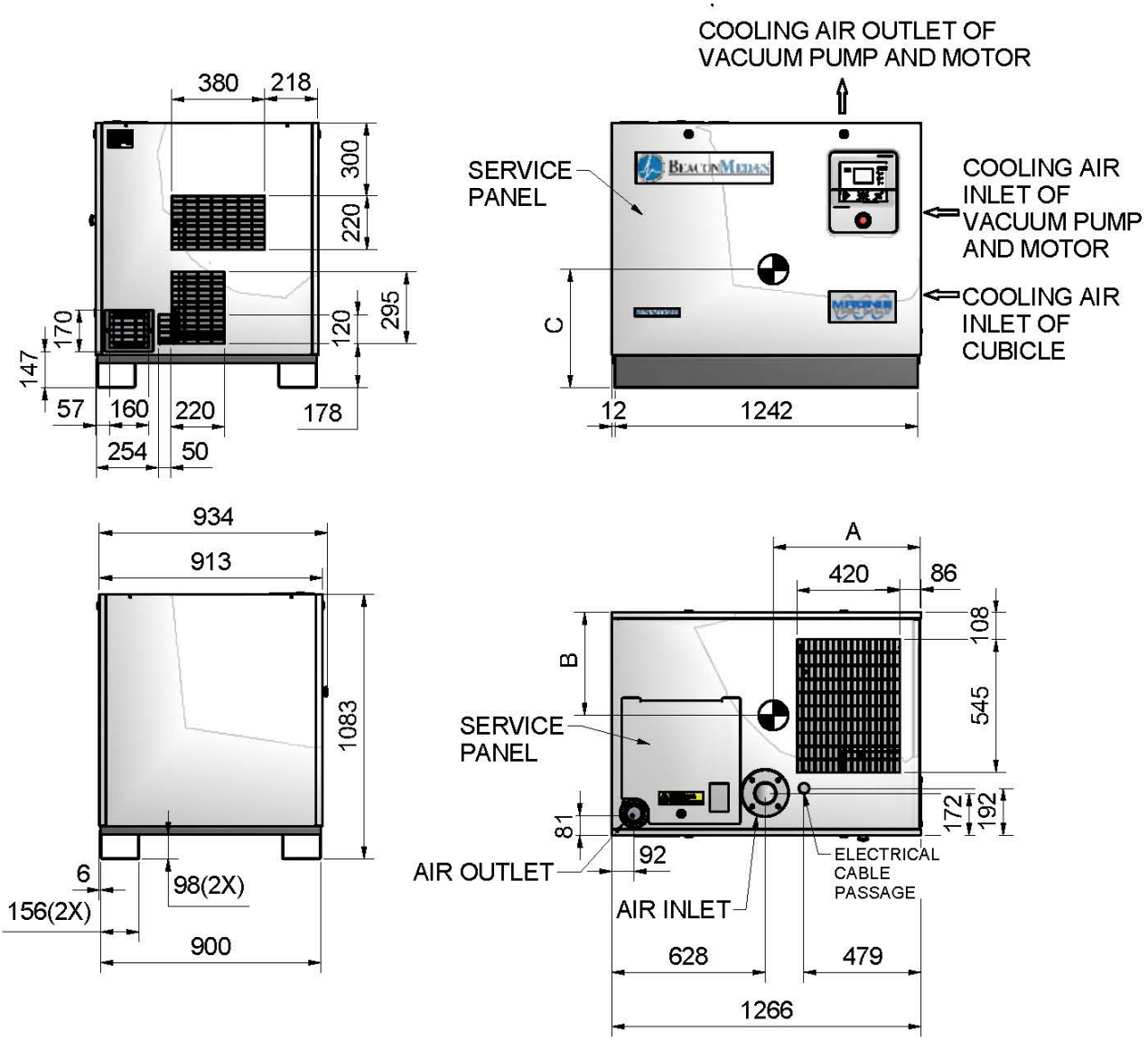
Once the unit is unpacked from the crate it can be transported by forklift or by crane.

- Forklift: the forklift arms should be placed underneath the lowest plates on which the pumps are mounted. Pay attention to position the forklift arms for optimal weight distribution.
- Crane: use all lifting eyes provided and pay attention to put equal tension on all lifting chains (if applicable).

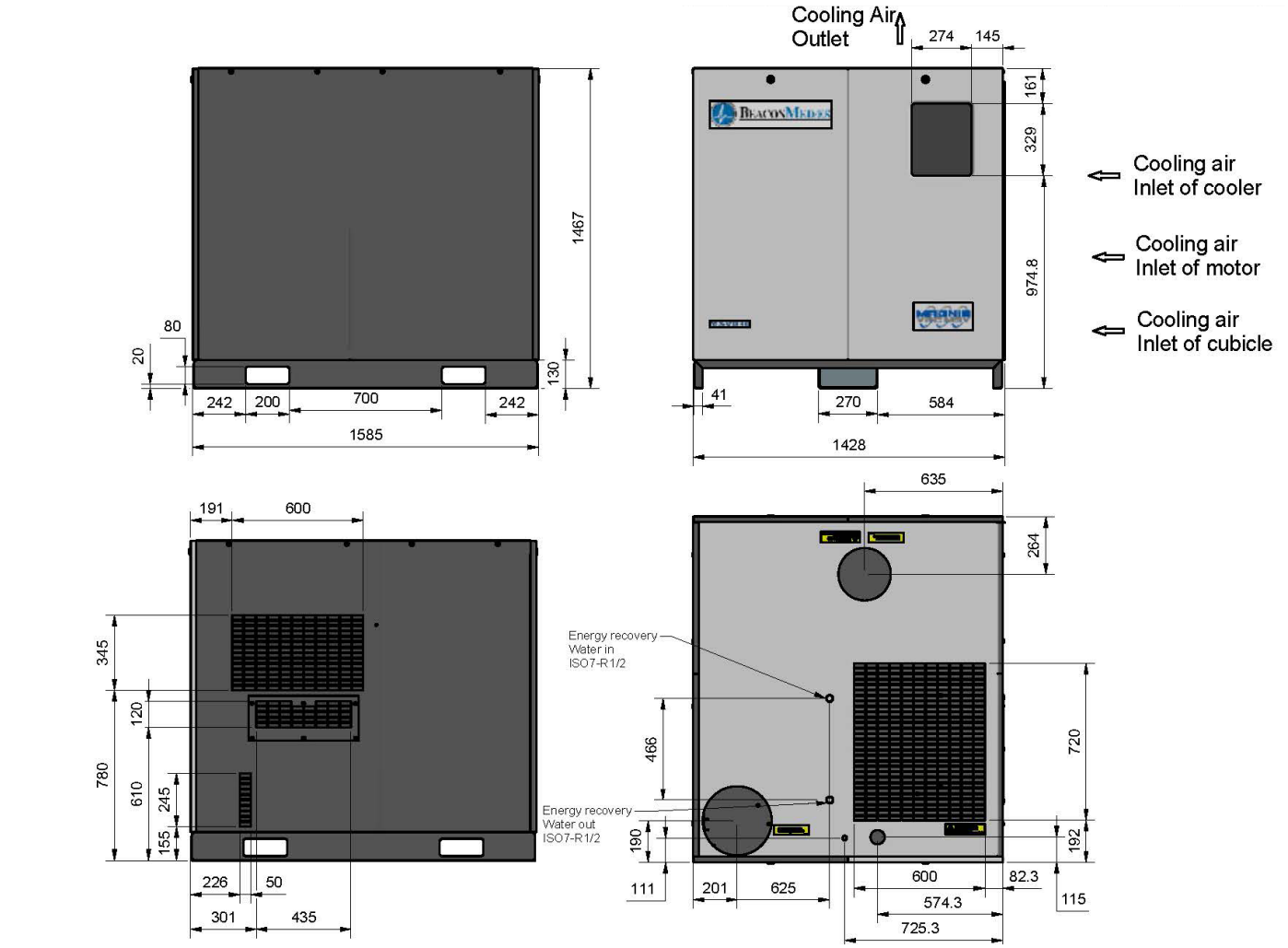
5.4. Dimension drawings

5.4.1. Pump

Magnis MSV007 -MSV020

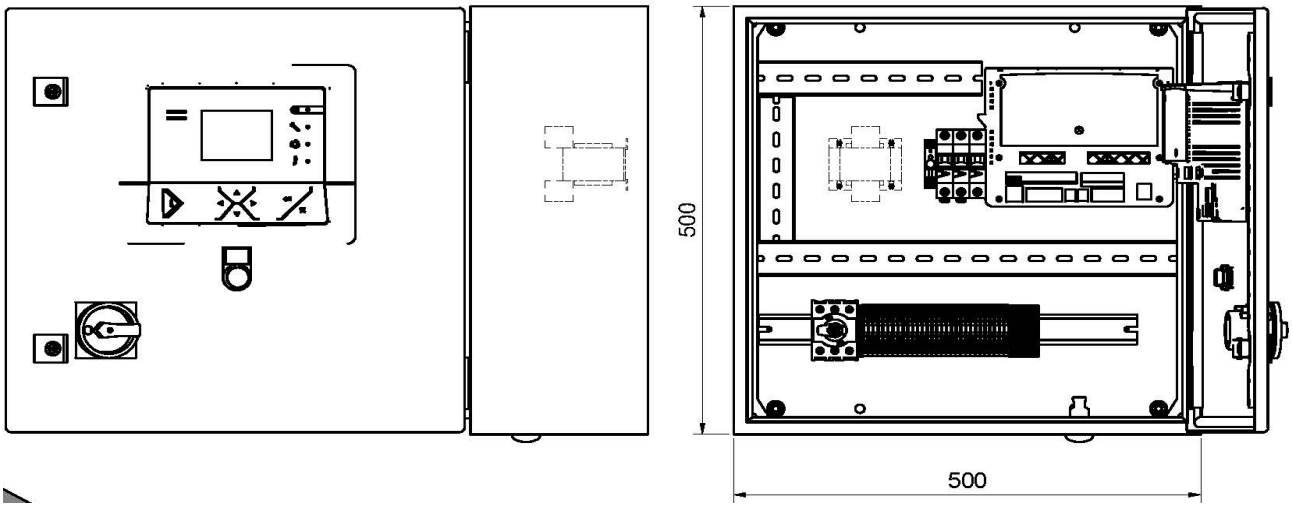


Magnis MSV030 - MSV050



5.4.2. Central Controller

ES-VAC Medical



5.5. Storage

	If the medical vacuum plant installation is going to be stored, protective measures must be taken.

Protect the medical vacuum plant installation against dust and moisture. Store in a clean, cool, dry and well ventilated area.

- Make sure that the medical vacuum plant installation is not subject to vibration.
- If the vacuum plant installation is stored in packing, put some vapour corrosion inhibitor (VCI) paper into the packing.
- If the vacuum plant installation is stored for one year or more, consult BeaconMedaes.

5.6. Electrical connections

The central controller is a stand-alone unit so the sensors Pt01 and Pt02 need a cable installing between the controller and the sensors, consult the service diagram located inside the cabinet for the correct wiring, connect Pt02 to the pressure sensor downstream of the bacterial filters (backup sensor) and Pt01 to the pressure sensor upstream of the bacterial filter measuring the net pressure.

Consult the service diagram (it can be found inside the cubicles) and verify the motor data plates. Ensure that the power supply is off and correctly isolated before connecting to the cubicles. All wiring must be in accordance with IEE regulations. Cable sizes and fuses given in chapter Electrical cable size are recommendations. All cable sizes and protective devices must be sized by a qualified electrician.

The Magnis Medical Vacuum Plant requires a separate power supply for each vacuum pump, preferably from an essential circuit, and requires a 210-230 V AC supply to the central controller cubicle.

Check that the central controller power LED is lit and the controller screen is operational when the 115-230V essential electrical supply is connected.

Earth the vessels and other piping as required.

Usually it is required to have a central alarm panel (in the engineering control room or telephone exchange etc.) Therefore potential free contacts (with the alarm signals) are foreseen in the central controller cubicle.

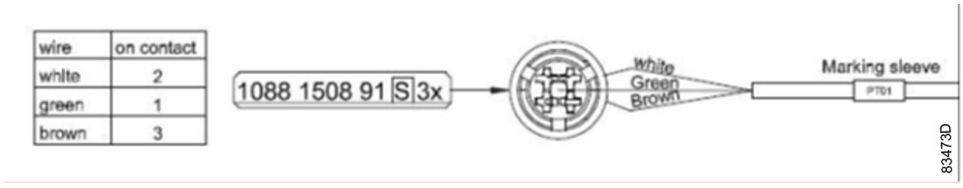
Set up the alarm panel and carry out the alarm test according to Central controller operation.

When in normal status, the alarm signals to the alarm panel are forced closed and when an alarm is triggered, they open. This also means that all alarms will trigger at the central alarm panel when power supply to the central controller is lost.

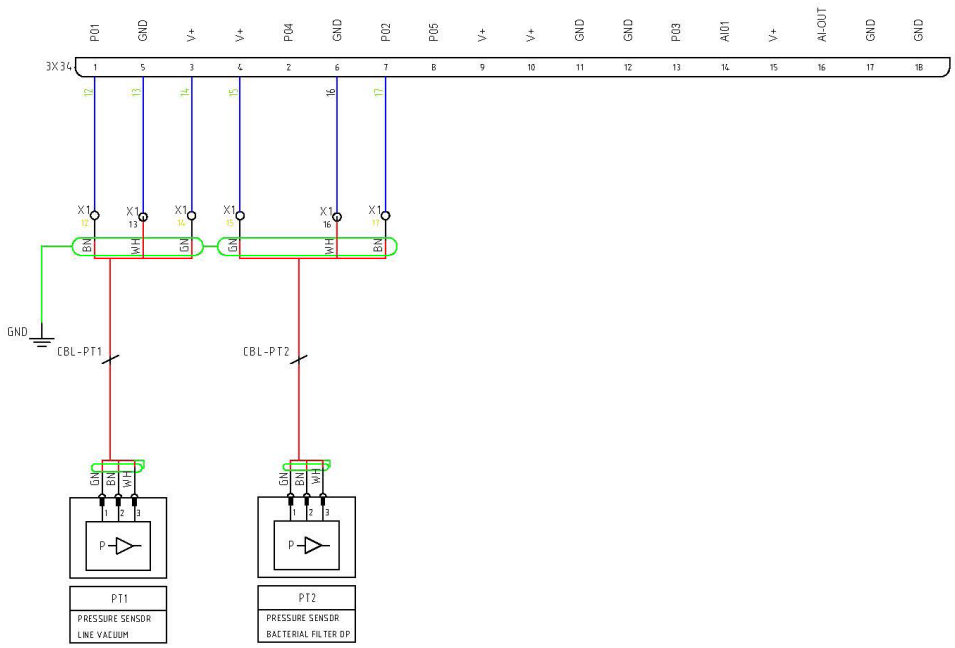
5.7. Pressure sensors

Pressure sensors Pt01 and Pt02 should be installed on-site. Sensors supplied lose together with ES-VAC Central controller. Cable already connected inside of the central controller. A 10 m screened cable to connect the 2 pressure transmitters to the ES-Medical is supplied with the ES-Medical and upon delivery can be found in a cubicle of ES-VAC. If cable length is not sufficient, a longer cable can be made as follows:

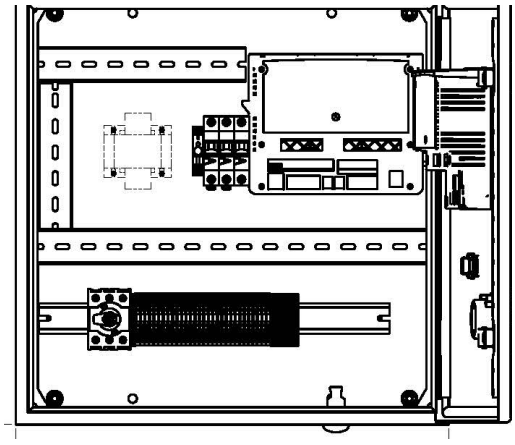
Use a 3 x 0.5 mm² screened cable to connect the pressure transducers. For the pressure transducers, the cable must be connected to the connector according below diagram:



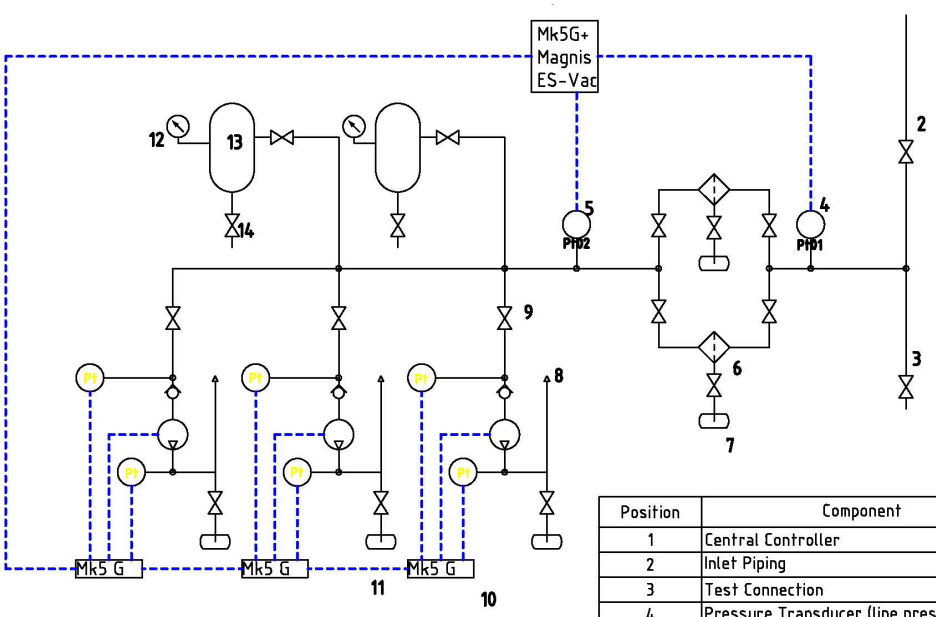
The sensors need to be connected in the following way inside the cubicle (see also the service diagram):



This means that the following connections should be made on the X1 connections in the bottom of the cubicle (see image below):



The sensors need to be physically installed on a vacuum pipeline. See flow diagram below to find correct location of the sensors:



Position	Component
1	Central Controller
2	Inlet Piping
3	Test Connection
4	Pressure Transducer (line pressure)
5	Pressure Transducer (Pump pressure)
6	Bacterial Filter (Duplex Configuration)
7	Drain Flask
8	Exhaust
9	Pump Isolation Valve
10	Magnis Vacuum Pump
11	CAN (controller area network) connection
12	Pressure Gauge
13	Vacuum Vessel
14	Drain Valve

5.8. CAN Network

Each Magnis vacuum pump should be connected using CAN network in order communicate with a Magnis ES-VAC Central controller. A CAN communication lead between the central controller and each vacuum pump is required and needs to be connected as shown in the Compressor Area Network (CAN) cabling instruction.

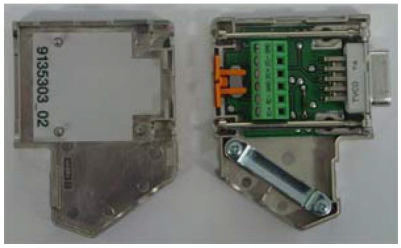
The CAN network is composed of Maximum 6 Magnis pumps and ES-VAC Central controller. Each device is connected to the Compressor Network through its CAN connector, in a 'bus' topology, i.e. starting from Device 1 to 2, from 2 to 3...6.

Each device in Magnis Medical Vacuum System received from a factory has already CAN address assigned. Each pumps will have addresses from #1 to #6. Magnis ES-VAC Central controller will have address #30 and those settings should not be changed without reasons.

Only CAN cabling needs to be done on-site during installation. This topology requires 2 cables to be connected to each device (except first and last), though there is only 1 connector foreseen on the pumps. Therefore special connectors, as described below, are used, allowing the incoming and outgoing cables to be attached to the device using 1 single connection point. Another advantage is that the devices can be disconnected, without destroying the network.

5.8.1. CAN Connection

The connectors exist in two variants: normal node and service node. A service node can be used on the device where the service computer will be connected. It allows the connection of another device without disconnecting any other device. There can be as many service points a needed, but only one can be connected to a PC at any one time.



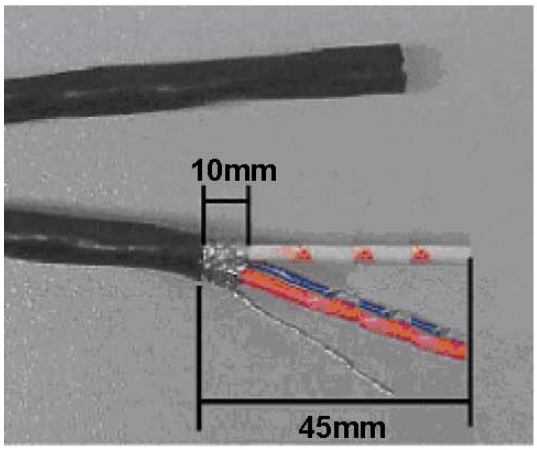
5.8.2. Cable

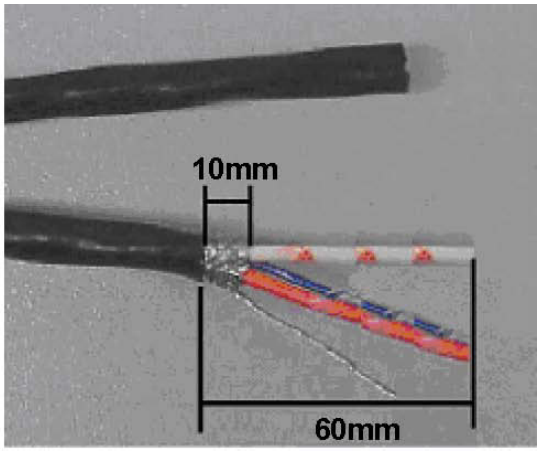
The BUS-CAN cable (1 pair + ground) should be used to connect the machines and controllers together. This cable has been fully tested and qualified for use with BeaconMedaes equipment and as such is the only CAN cable BeaconMedaes recommends.

This cable is in accordance with ISO 11898 and allows network segments of maximum 250m. A total network length of 500m is possible, but then a repeater has to be used as described in paragraph 4.5.

5.8.3. Connector cabling procedure

- Prepare the end of each cable for the CAN connector by removing either 45mm or 60mm of the cable insulation, depending on whether the cable is incoming or outgoing.
- Next, remove the plastic foil, leaving 10mm of cable shielding.
- Then remove the fill-up material and the white/blue conductor.
- Finally, remove 5mm of insulation from the blue, orange and white/orange conductors.





5.8.4. Terminal connector cabling

For the connector at the beginning and end of the network, the cable should be connected to the terminals designated 1C-, 1C+, and GND, as shown below.

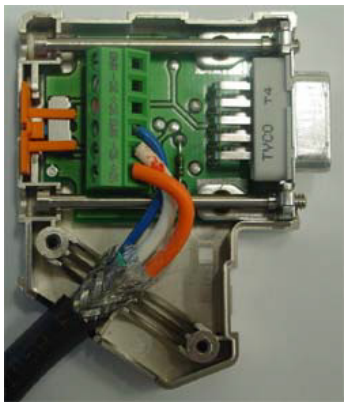
Make sure that the wire shielding touches the shielding plate of the connector.

Close the connector and set the terminating switch to ON.

Plug the connector into the LAN port of the device, which can be found on the back of machine regulators and on the front of the AIRmonitor box.

The CAN wires should be connected inside the CAN connector as follows:

- Blue wire to terminal GND
- White/orange wire to terminal 1C-
- Orange wire to terminal 1C+



Connector wiring for the beginning or end of the network

The switch on the back of the connector should be in the “ON” position for connectors at the beginning and end of the network. Be absolutely sure that the cable is connected to the correct terminals inside the start and end connectors. Failure to do this will prevent the network from functioning properly and will certainly mean that the start and/or end machines do not become connected to the network at all.

5.8.5. Node connector cabling

For the connectors in the middle of the network, connect the wires as follows:

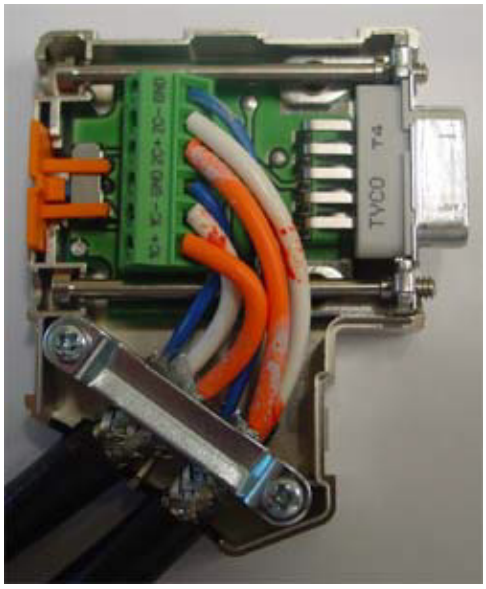
Incoming Wire

- Blue wires to terminal GND
- White/orange wires to terminal 1C-
- Orange wires to terminal 1C+

Outgoing Wire

- Blue wires to terminal GND
- White/orange wires to terminal 2C-
- Orange wires to terminal 2C+

Make sure that the wire shielding touches the shielding plate of the connector. Close the connectors and set the terminating switches OFF. Plug the connector into the LAN port of the device, which can be found on the back of machine regulators and on the front of the AIRmonitor box.

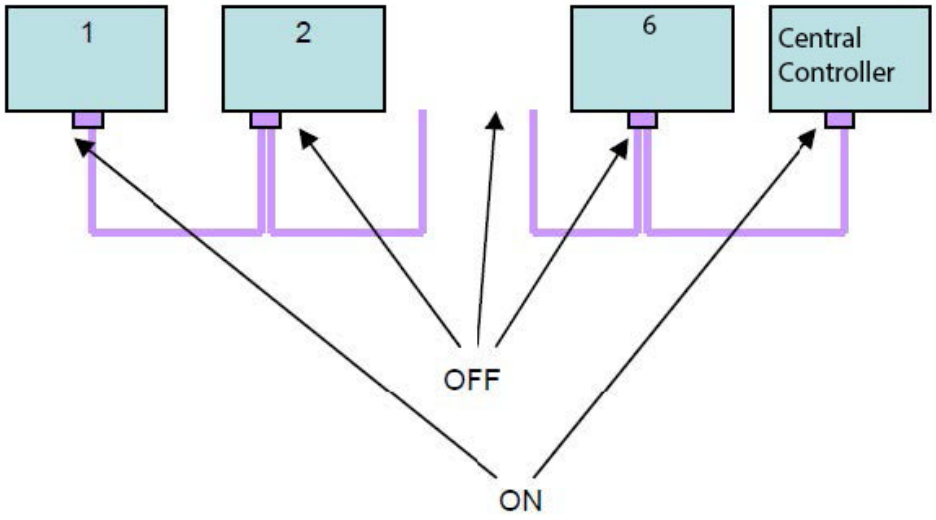


Wiring for connectors in the middle of the network

The switch on the back of the connector should be in the “OFF” position for connectors in the middle of the network

5.8.6. Line termination

Correctly “terminating” the CAN network is important for a properly functioning network. This is done by inserting so-called line termination resistors at the beginning and at the end of the network cable.



In the connectors as specified above, this termination function is included and can be set by means of a small terminator switch. Make sure this switch is in the ON position for both the first and last device, and in the OFF position for all other devices. Both connector types are equipped with this switch.

5.8.7. The logical network

The CAN network (as any network) requires that each device connected to it has its own address, also referred to as Node ID. The CAN net allows for 31 different addresses: 1 to 31. On each CAN device it will be possible to change this value, either from the display, or by means of special switches on the apparatus itself. As standard each device has node ID 31 as factory setting. This value should not be used in a real network, to allow the fast and easy integration of new devices on a running network. If none of the devices in a net has ID 31, a new pump can safely be connected to the net with default values. (However change the ID asap to another valid value)

Following rules should be followed:

- Each device on the same net should have a different node ID
- Node ID 31 is for default purpose only, always change this ID once the device is installed
- Some applications require fixed node ID’s for some device, please check in the application manuals e.g. the Energon 1 sequencer only operates on devices 1,2, 3 and 4 !!!

6. Web server

All Elektronikon controllers have a built-in web server that allows direct connection to the company network or to a dedicated PC via a local area network (LAN). This allows to consult certain data and settings via a PC instead of via the display of the controller.

Getting started

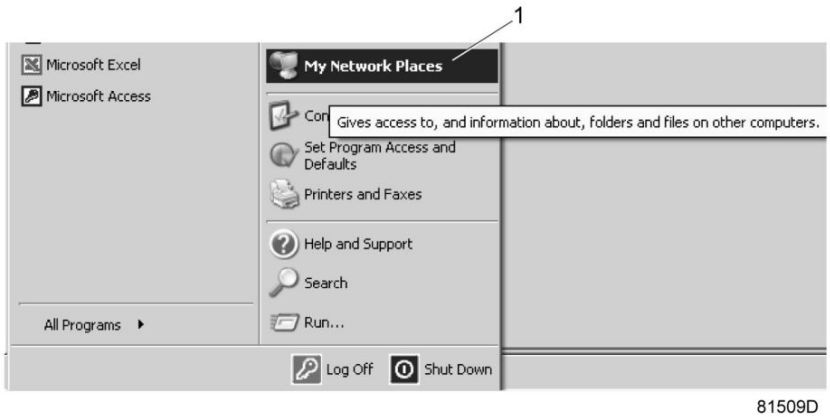
Make sure you are logged in as administrator.

- Use the internal network card from your computer or a USB to LAN adapter (see picture below).

Use a UTP cable (CAT 5e) to connect to the controller (see picture below).

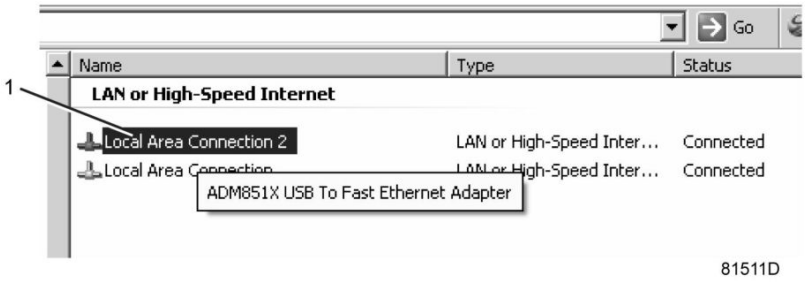
Configuration of the network card

- Go to My Network places (1).

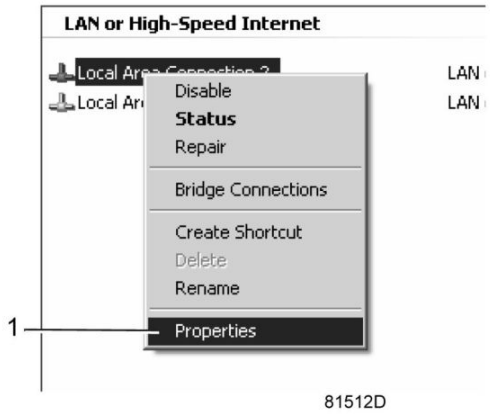


- Click on View Network connections (1).

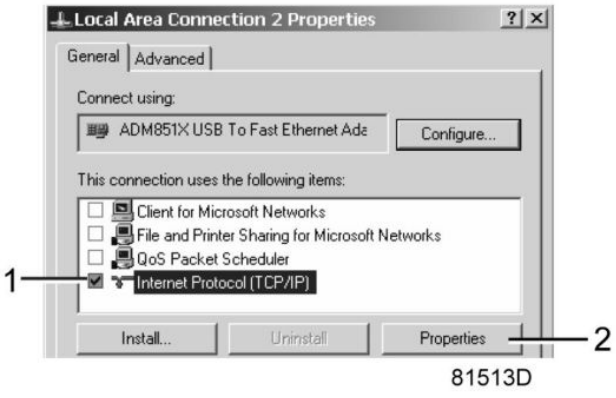
- Select the Local Area connection (1), which is connected to the controller.



- Click with the right button and select properties (1).



- Use the check box Internet Protocol (TCP/IP) (1) (see picture). To avoid conflicts, de-select other properties if they are selected. After selecting TCP/IP, click on the Properties button (2) to change the settings.



- Use the following settings:

IP Address 192.168.100.200

Subnetmask 255.255.255.0

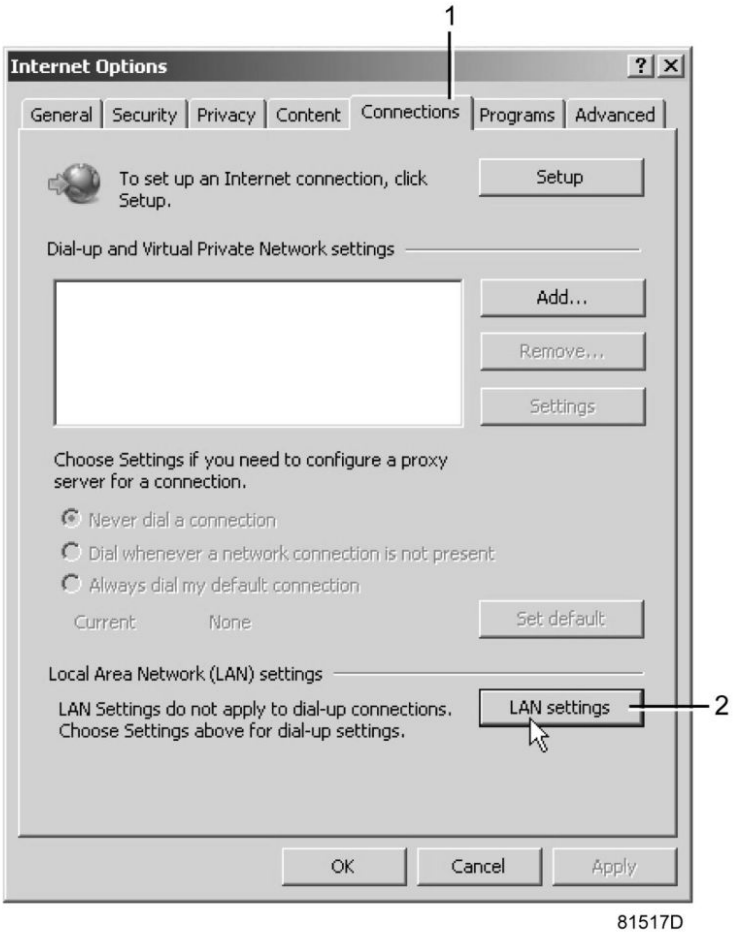
Click OK and close network connections.

Configuration of the web server

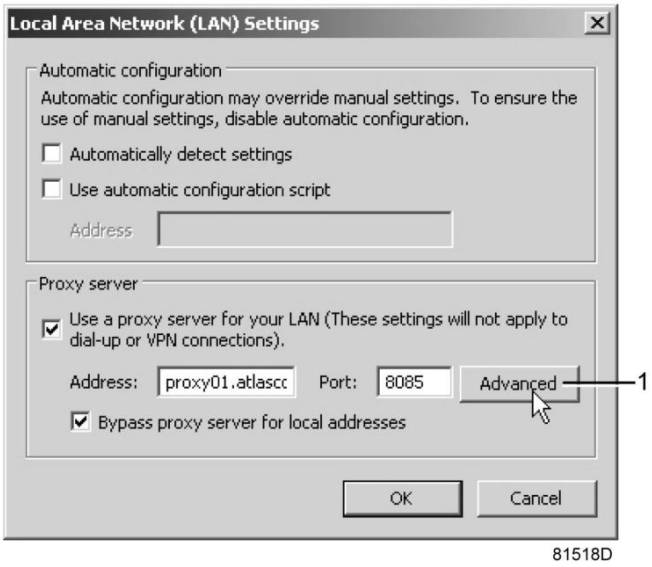
Configure the web interface

- When using Internet Explorer: Open Internet Explorer and click on Tools - Internet options (2).

Click on the Connections tab (1) and then click on the LAN settings button (2).



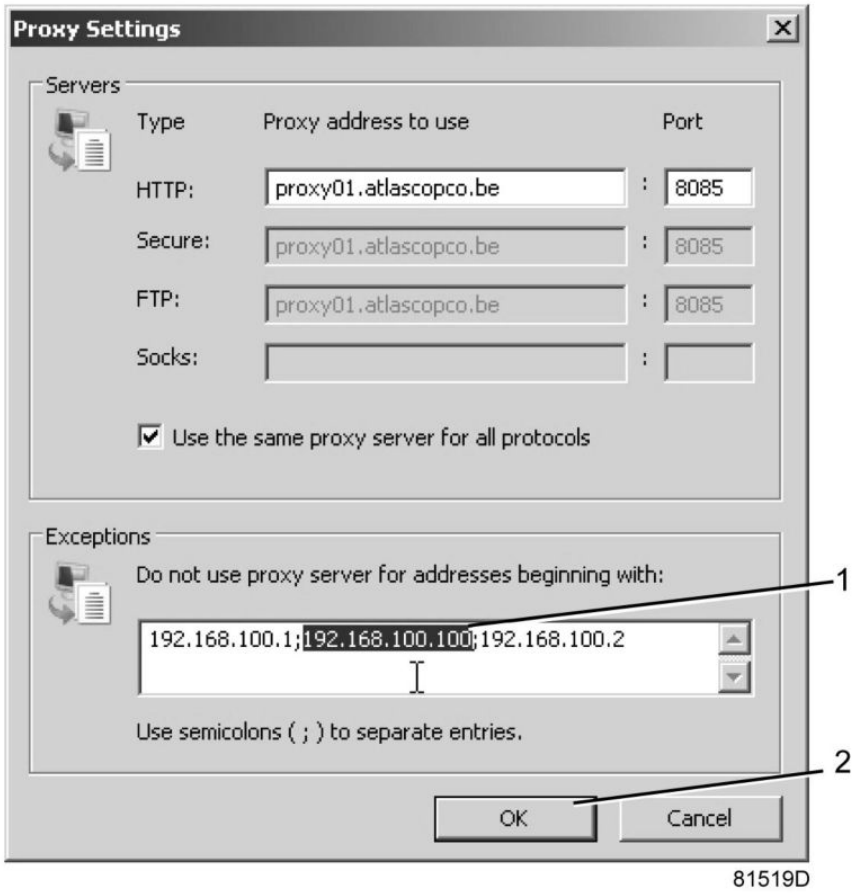
- In the Proxy server Group box, click on the Advanced button (1).



In the Exceptions Group box, enter the IP address of your controller. Multiple IP addresses can be given but they must be separated with semicolons (;).

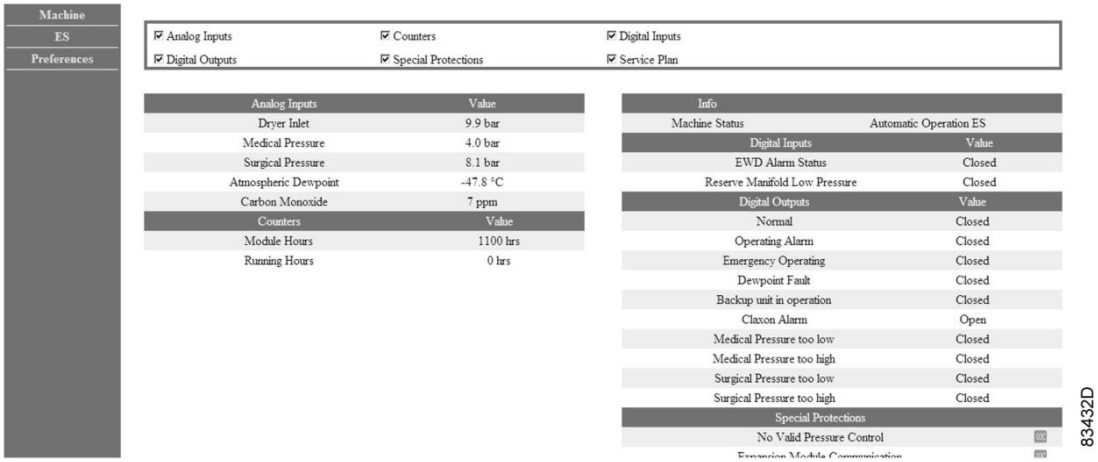
Example: Suppose that you already added two IP addresses (192.168.100.1 and 192.168.100.2). Now you add 192.168.100.100 and separate the 3 IP addresses by putting semicolons between them (1) (see picture).

Click OK (2) to close the window.



Viewing the controller data

- Open your browser and type the IP address of the controller you want to view in your browser (in this example http://192.168.100.100). The interface opens:



Navigation and options

- The banner shows the machine type and the language selector. In the below example, three languages are installed on the controller.

The menu shows 3 buttons.

- Machine: shows the status of the air plant.
- ES: shows the ES status.
- Preferences: allows to change temperature and pressure unit.

7. Commisioning

7.1. Introduction

Commissioning of a medical vacuum plant must be carried out strictly in accordance with the following procedures, which are designed to ensure that the installation is correct and ensure that the Magnis Medical Vacuum Plant operates correctly. The full commissioning procedure must be carried out after the installation before the system is brought into use. The relevant sections of the commissioning procedure must be repeated following major component replacement or whenever the plant operation or performance is suspect. Commissioning must only be undertaken by suitably qualified and competent personnel who are fully conversant with the information contained in this manual. It is recommended that for a full commissioning procedure, the following paragraphs are carried out in strict sequence. This ensures that at each step the plant is correctly set for the next procedure.

Where applicable, a work permit must be obtained before commencing any work on the medical vacuum system. These procedures are designed in accordance with EN 7396-1 (e.g. integrity of the pipeline installation, check system design performance and functionally test all components).

7.2. Setting the pneumatic system

Prior to checking the automatic operation, the pneumatic system must be selected as follows:

1. Fully open the drain valves at the exhausts of each pump.
2. Fully open the valves at the inlets of each pumps.
3. Fully open the valves at each vessel connection.
4. Fully open the valves before and after the lead bacterial filter(s).
5. Fully close the valves before and after the stand-by bacterial filter(s).
6. Fully open the drain valves at the bottom of the bacterial filter(s).
7. Fully close the (full flow) test connection ball valve.
8. Fully close the vessel drain valves.
9. Fully close the inlet connection valve which connects the plant to the distribution piping while proving the plant operation (see: Automatic operation & leak check).
10. After proving the plant operation, making sure that all terminal units are correctly fitted, and after successfully completing the pipeline carcass pressure test, the inlet connection ball valve can be opened.

7.3. Pre-start inspection

The pre-start inspection is essential to ensure that all components are secure, correctly assembled and that no damage occurs to the plant during initial start-up. The procedure to carry out the pre-start inspection is as follows:

1. Ensure that all electrical power supplies to the plant are off and isolated at the controllers (isolator switches turned OFF).
2. Check the rating of the power supply fuses and fuses in the controller cubicles.
3. Check the security of all components inside the cubicles and examine all connections. Inspect for any obvious damage and rectify if necessary.
4. Check all external piping connections for security and damage with special attention to flexible hoses.
5. Verify on the sight glass of all pumps that the oil reaches the upper half of the glass, if necessary add oil.
6. Fully close all ball valves.
7. Ensure that the vacuum plant inlet is correctly connected to the distribution system. Ensure that the distribution system is isolated from the plant by closing the distribution system ball valve at the inlet connection point.
8. Ensure that each vacuum pump is connected to the exhaust system and that there are no closed ball valves present or other elements blocking the exhaust.
9. Ensure that all loose articles are removed from the vicinity of the plant.
10. Check the drain flasks for damage to the bowl or connection, order spare parts if needed.
11. Where applicable, check that the pipeline installation is correctly identified and labelled with identification tape

at 10 metre intervals and on both sides of any dividing wall.

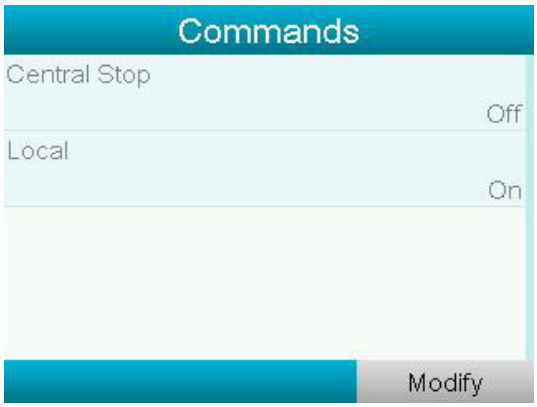
7.4. Electrical functional check

Following the initial electrical power connection and every time the electrical power supply connections have been disturbed for any reason, all electrical connections must be checked for security and the electrical functional check must be carried out.

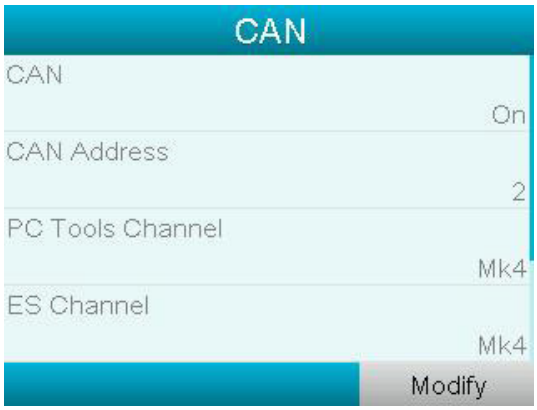
All software settings set at a factory. Corrections should be done in case of changing of configuration of the system, e.g. adding more pumps or service interventions. Check more details with BeaconMedæs service representative.

7.4.1. Pumps check

2. Switch the isolator on pumps to ON.
3. Check that the pump controllers powered LED's are lit and the screens are operational when the isolator switches are ON.
4. Ensure the controllers are set to Local control.



5. Ensure the CAN address for each pump set correctly (#1 for the first pump , #2 for second...) in a settings menu and CAN communication is ON. Communication protocol is set to Mk4.

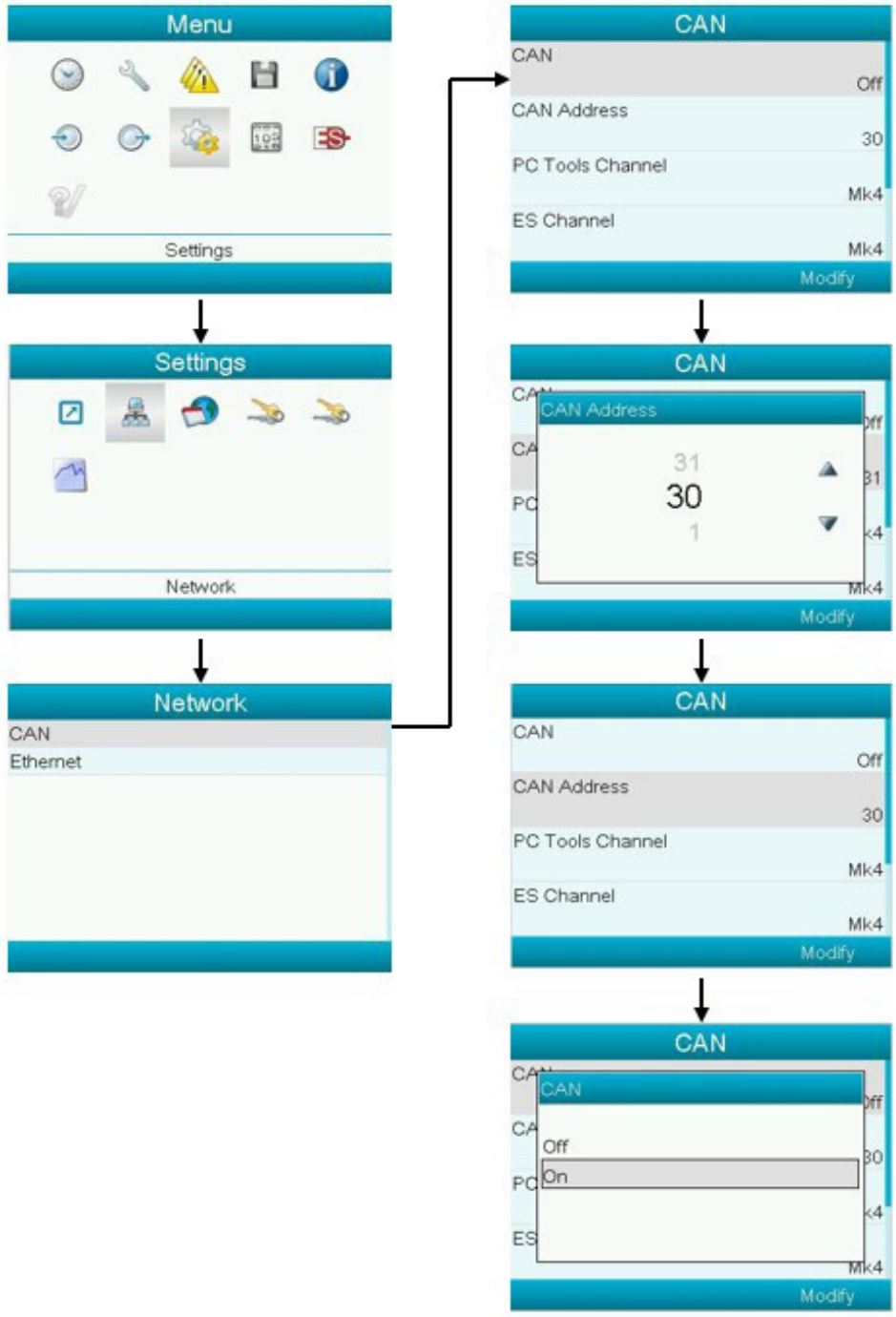


6. Test motor rotation by pressing Start and Stop buttons(see Chapter 5.3.1). If a motor doesn't rotate during this check, check the connections in the connection box on the motor and check the connections inside the cubicle. Check the overload settings and the fuses (section Fuse values). When the problem is corrected, carry out the rotational check again.

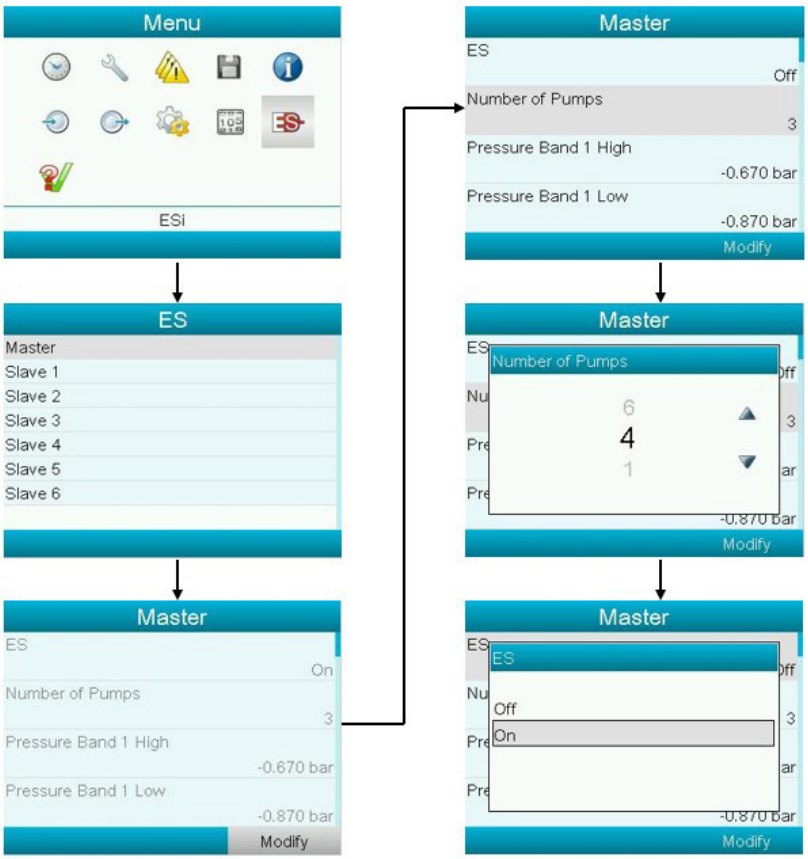
7.4.7. Central Controller check

1. Switch the isolator switches on the Central Controller to ON.
2. Check that the central controller power LED is lit and the controller screen is operational when the 210-230 V supply is connected.
3. Ensure the controllers are set properly.
4. Ensure the CAN address for the Central Controller is set to **#30** in a settings of the menu. CAN communication

is ON. Communication protocol is set to **Mk4**:



5. Ensure quantity of pumps set correctly in a menu of the Central Controller



7.5. Filters check (if installed)

Call on the ES-VAC controller the “Inputs” screen and observe pressure readings.

7.6. Automatic operation & leak check

The following initial start-up procedure ensures that the plant is set to operate normally and the vessel is evacuated

to a vacuum level of at least -870 mbar(e) (-653 mmHg).

1. Set all isolators to ON, powering the complete system.
2. Power the central controller and proceed to chapter Central controller operation to start the software.
3. Set the Local/LAN setting to LAN on all pump controllers.
4. Observe that the plant emergency and pressure fault alarms are active.
5. Observe that the pumps are being called and the pressure on the controllers approaches vacuum. Open the test connection (unplug the plug) slightly to simulate a vacuum flow demand, observe that the pumps respond to maintain vacuum.
6. Ensure that each vacuum pump operates normally without any unusual noise or vibration. Should any fault occur, the respective vacuum pump must be switched off immediately. Refer to Faults and remedies and restart the commissioning.
7. After at least 1 hour, fully close the test connection and refit the plug. Observe the gauge(s) on the vessel(s) until a vacuum is reached, at this point all pumps should stop.
8. Observe that the alarms are now extinguished.
9. With the complete system at nominal distribution pressure, with the source of supply isolated and with all other valves open, the pressure increase in the pipeline shall not exceed 200 mbar (150 mmHg) after 1 hour. The pressure drop shall be corrected for variations due to temperature according to the ideal gas laws (see EN 7396-1 annex E). In case the pressure increase in 1 hour is greater, close off sections of the pipeline, track leaks (audibly or through other means), and fix them. Then redo the test.
10. Ensure that the system continues to operate within the design flow rate and that the pumps operate normally with no signs of problems for at least one hour.
11. Per pumps' cubicle, read out the value of the drawn nominal current on the amp meter and note down the value. (HTM Only)

7.7. Starting the plant

After going through the procedures explained in the previous paragraphs (make sure that the valves are set according to paragraph Setting the pneumatic system), the plant can be left to run automatically. Ensure that all local/LAN settings are set to LAN and that the automatic operation LED's are lit on every controller. See picture at Pump controller overview. Ensure that paragraph Central controller operation is followed to start the software. Follow the guidelines explained in chapter Checks and intervals to ensure trouble free and reliable operation throughout the life of the plant.

8. Maintenance

8.1. Introduction

Medical vacuum plant installations require periodic routine maintenance to ensure trouble free and reliable operation throughout the life of the plant. BeaconMedaes offers several types of service contracts, relieving you of all preventive maintenance work. Consult your BeaconMedaes Customer Centre.

8.2. Maintenance warnings

	Additional to the safety precautions mentioned in section Safety precautions during maintenance or repair, special care must be taken when servicing the bacterial filters, pumps, non-return valves, inlet screens, piping, vessels or other components of the Magnis Medical Vacuum Plant.

1. Proper protective clothing (face mask, eye protection, overall, disposable gloves and apron) must be worn when installing, servicing or handling this equipment. A service kit with face masks, gloves and overall is available. Consult the Spare Part List for the part number.
2. Danger to health during inspection, cleaning or replacement and danger to the environment: Contaminated filters elements, inlet screens, non-return valves or other components must be disposed of using the hospital procedure for contaminated waste, and drain flasks must be sterilised using hospital equipment and procedures. Any type of particular matter or liquid within a drain flask or inlet screen must be treated as potentially biologically contaminated. Any moisture drained from vessels or other drain points must be treated as biologically contaminated. Prior to transportation, items will be decontaminated as well as possible and the contamination status shall be stated in a Declaration of contamination form.
3. Prior to vacuum pump maintenance, stop the pump and let it cool down for no more than 20 minutes (in case of oil replacement). Make sure the pump is shut down and locked against inadvertent start up. Prior to opening cubicles, isolate the cubicle from supply by either switching off the isolating switch (pump controllers) or by shutting off the supply at the plant room (central controller).
4. During operation, the surface of the pump may reach temperatures of more than 70° C, risk of burns.
5. Filling oil through the suction (inlet) connection will result in breakage of the vanes and destruction of the vacuum pump. Oil must be filled through the oil fill port only. Risk of injury from hot oil mist with open oil inlet plug, remove only when vacuum pump is stopped. The pump must only be operated with the oil plugs firmly inserted.
6. Degraded oil can choke pipes and coolers. Risk of damage to the vacuum pump due to insufficient lubrication. Risk of explosion due to overheating. If there is suspicion that deposits have gathered inside the vacuum pump, oil must be flushed (contact BeaconMedæs). Therefore strictly adhere to the maintenance intervals, checks and procedures as described in this chapter, and strictly adhere to the limitations as described in chapter Reference conditions and limitations. If a maintenance interval has not been adhered to these and potentially resulting in sludge formation, proceed to procedure Change from mineral oil to synthetic oil.
7. Improper work on the vacuum pump puts the operating safety at risk, approval for operation and warranty will be void. Any dismantling that is beyond of what is described in this manual must be done by specially trained personnel (contact BeaconMedæs).
8. All maintenance work must be carried out by a competent person who must be fully conversant with the procedures and standards required when working on medical vacuum systems. Maintenance personnel must follow the information contained in this manual and must fully appreciate the safety precautions required. Electrical work must only be executed by qualified personnel that knows and observes the following regulations:

For ISO/HTM:

- BS 7671
- IEC 60364 or CENELEC HD 384
- IEC 60664
- National accident prevention regulation.

For NFPA

- All customer wiring should be in compliance with the National Electrical Code and any other applicable state or local codes.
- Refer to the wiring diagram(s) that came with the vacuum system for pertinent wiring connections.

9. The vacuum pumps emit noise of high intensity. Risk of damage to the hearing. Persons staying in the vicinity of a non noise insulated vacuum pump over extended periods shall wear ear protection.
10. Before disconnecting any piping or opening bypass valves (e.g. over filters), pneumatically isolate the section

and slowly in-bleed air to raise the pressure to atmospheric pressure. Do not suddenly open any isolating valve that may cause rapid evacuation of any section that may be at atmospheric pressure. Open valves slowly and allow sufficient time for pressure to stabilise.

11. Check with the hospital if a work permit is required, obtain if necessary.
12. It is essential that only genuine spare parts are used during maintenance. Any damage or malfunction caused by the use of unauthorised parts is not covered by warranty or product liability.
13. The electrical power supply to the central controller must be switched off and isolated prior to carrying out any electrical maintenance work to the central controllers' cubicle.
14. Foresee the correct tools before beginning any maintenance work. During use, it is possible that tools will become contaminated with oil or grease, it is therefore important that tools are cleaned and degreased following any maintenance operation, especially if the same tools are subsequently used with an Oxygen System. When the tools come into contact with possible bacteria contaminated parts (e.g. if the bacterial filters were ruptured), they must be sterilised after completion.
15. Should maintenance personnel come across a doubtful situation such as contamination by mucus or blood, they must stop work and report the situation to the hospitals authorised person. If asked to proceed with maintenance, personnel must follow the guidance of the hospital, and regardless, the following rules must always be observed:
    - Biological contamination may appear crystalline or organic.
    - Do not be deceived by appearance and treat any foreign material as a possible hazard.
    - Do not commence any work on a vacuum system suspected of contamination without authorisation and guidance of the authorised person.
    - Do not eat or smoke when working on vacuum systems or components suspected as being contaminated.
    - Do not dispose potentially contaminated material and oil in ordinary waste bins, but according to hospital procedures (e.g. sealed in marked bag and entrusted to hospital authorities for safe disposal).
    - Contact the authorised person if in doubt.
    - Do not place contaminated tools or equipment into your tool box.
    - Inspect for cuts or abrasions before applying waterproof dressing as necessary to effectively cover all lesions.
    - Wear all protective clothing throughout all work stages. Wear the waterproof gloves provided and ensure that they remain intact throughout all work stages. Wear an overall and ensure that it remains fully buttoned.
    - Take care not to cut yourself. If a glove is punctured, remove glove and allow wound to bleed freely. The contaminated area should be washed gently under running water and not scrubbed. Inform the authorised person of the incident immediately, and seek medical advice on appropriate action. Report the incident in accordance with company rules.
16. Immediately upon completion of work, remove any contaminated clothing and wash hands (and, if necessary, contaminated tools) in a 2% glutaraldehyde solution (or similar) and rinse under running water.
17. Any leakage should be attended to immediately. Damaged hoses or flexible joints must be replaced.
18. Always consult BeaconMedæs if a timer setting has to be changed.
19. Do not overfill with oil as this may lead to oil loss at high intake pressures.
20. If the bacterial filter drain is often filled with fluid, it could indicate contamination of the pipeline and must be investigated. The bacterial filter must be replaced after the source of contamination has been identified and removed, and after the filter pipeline has been dried out.
21. A logbook will be kept with all maintenance activities and their date and running hours.

8.3. Checks and intervals

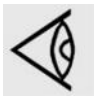
Regular checks

When no alarm system is in place that warns personnel directly, check the controller displays daily for readings and messages. When problems with the power supply have occurred, it is advised to check the displays immediately. Normally, the display shows the plant / pumps inlet pressure and the status of the plant / pumps.

Remedy the problem if alarm LED's are lit or alarms are present on the displays, see section Interface, icons and menu structure.

The service (blue) LED's will be lit or the display will show a service message if a service level for a monitored component has been exceeded. Carry out the service actions of the indicated plans or replace the component and reset the relevant item, see following sections.

Intervals (see also the service plan on the controller)

	The following intervals are a guideline for nominal working conditions. The local Customer Centre may overrule the maintenance schedule, especially the service intervals, depending on the environmental and working conditions of the plant.

Maintenance of complete Magnis Medical vacuum concist of maintenance of individual components:

	Magnis Pumps	Vacuum filters	Vacuum vessels
Weekly	See Operation manual for Magnis pump.	See operation manual for vacuum filters	
Monthly			
6 - monthly or every 1000 running hours(*)			
Yearly or every 2000 running hours			
2- yearly or every 4000 running hours			
5- yearly or every 10000 running hours			

(*): whichever comes first.

8.4. Dismantling and disposal

	Please respect the maintenance warnings. See Maintenance warnings.

The procedure to dismantle and dispose of the vacuum plant is as follows:

1. Switch off all isolating switches and the main power supply switches.
2. Clean drains and filters as described in paragraphs Bacterial vacuum filters and Drain flask change.
3. Close the inlet connection point valve and open one of the drain valves without drain flask slowly to bring the pressure inside the pipes to atmospheric pressure.
4. Disconnect all electric cables and dismount the cubicles.
5. Drain all oil from the vacuum pumps and remove the oil filters.
6. Separate all materials and components to be treated as special waste from the pump.
7. Dispose of the oil and contaminated items (piping, filters, ...) in compliance with the applicable regulations.
8. Dispose of electric components according to the applicable regulations.
9. Dispose of any other uncontaminated material as scrap metal.

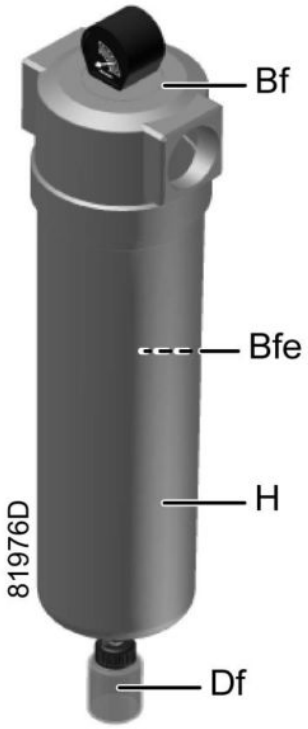
8.5. Bacterial filter replacement (for plant with bacterial filter)

	Always respect the maintenance warnings. See Maintenance warnings. Filter elements cannot be cleaned or re-used. Dispose of in accordance with hospital procedures for contaminated waste. Do not over-tighten the filter element as distortion of the O-ring seals may occur and prevent an effective seal.

The procedure to replace the bacterial filter is as follows:

1. For Magnis vacuum plant, it is allowed to dismount the support of filter frame beams at the side to allow easier access to the filters.
2. Set the filter(s) that is (are) not going to be changed on-line by slowly, fully opening the valves before and after the filter(s).
3. Isolate the filter(s) that is (are) going to be changed by fully closing the valves before and after the filter(s).
4. Isolate the drain flask (Df) in use by closing the isolating valve. If any liquid is present, follow the instructions as given in Maintenance warnings and notify the Authorised Person (MGPS) immediately. Otherwise, remove the drain flask.
5. Remove the filter housing. Unscrew/unclamp the filter housing and remove. To unscrew the filter housing, it may be convenient to use a special strap tool.

6. Remove the filter element (Bfe) and dispose it according to hospital procedures for contaminated waste.
7. Fit the new filter element and secure it with the retaining nut (if applicable). Tighten by hand.
8. Refit the filter bowl housing, screw the drain flask back on and open the drain valve.
9. Reset delta P in the Elektronikon if necessary. (see Central controller operation, Protections and service menu).

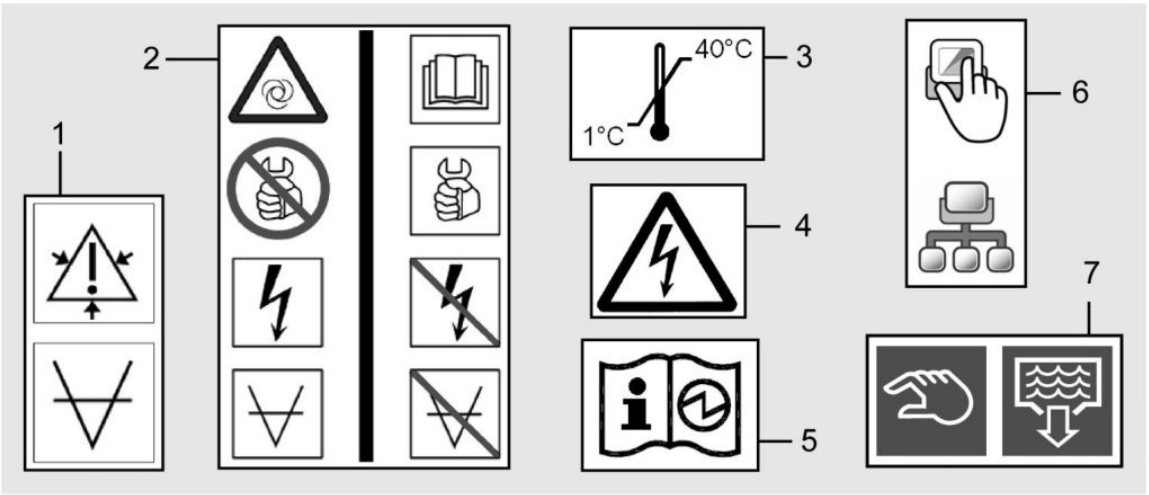


	Description
Bf	Filter head
Bfe	Bacterial filter element
Df	Drain flask
H	Filter housing

8.6. Service kits

A wide range of service kits are available. Service kits comprise of all parts required for servicing the components and offer the benefits of genuine parts while keeping the maintenance budget low. Consult the spare parts list for part numbers. For parts which are not listed (e.g. pump parts not included in the service kits), please contact your supplier.

9. Pictographs



Reference	Description
1	Pressurized (vacuum), open slowly.
2	Warning automatic operation. Read the manual. Service only allowed on components not under voltage or vacuum.
3	Ambient temperature limits.
4	Warning electricity (isolate before opening).
5	Read the manual, manual provided electronic.
6	Local control / LAN control (see chapter Pump controller operation).
7	Manual drain.

10. Problem solving

10.1. Introduction and warnings

For location and names of components, refer to the previous chapters. Item numbers of spare parts needed to remedy problems can be found in the spare part list. If not, please contact your BeaconMedaes Customer Centre.
When a remedy corresponds to a procedure specifically explained in chapter Maintenance, consult the relevant paragraph and follow the procedure.

All precautions of chapter Safety precautions during maintenance or repair and Maintenance warnings apply when attempting to remedy faults.

10.2. Faults and remedies

Control and Regulation System

Component	Condition	Potential cause of the fault	Remedy
Line pressure sensor	Line pressure sensor: malfunctioning	Mechanical defect	Replace defective components (contact BeaconMedaes)
	Line pressure sensor: no measurement (error signal)	• Electrical connection of sensor (internal or external) interrupted • Mechanical damage (too high mounting torque) • Connection plugs not connected • Crack because of vibration or incorrect mounting • Sensor internally defect • No supply voltage	• Check electrical connections • Check sensor
	Line pressure sensor: measurement too low (e.g. measures -620 instead of true -600 mbar)	• Condense on connection plugs • Faulty supply signal • Clogging or contamination • Sensor internally defect • Deviation due to ageing • Deviation due to incorrect production	• Check sensor • Replace defective components (contact BeaconMedaes)
	Line pressure sensor: measurement too high (e.g. measures -580 instead of true -600 mbar)	• Condense on connection plugs • Faulty supply signal • Clogging or contamination • Sensor internally defect • Deviation due to ageing • Deviation due to incorrect production	If difference with true pressure surpasses 40 mbar: • Check sensor • Replace defective components (contact BeaconMedaes)

Central control module (Magnis ES-VAC)	Central controller: doesn't read in pressures	Software fault	Re-download software
	Central controller: doesn't read in (correct) Slave states	Software fault	Re-download software
	Central controller: software too slow	Software fault	Re-download software
	Central controller: doesn't produce run queue	Software fault	Re-download software
	Central controller: gives out "Run" command too slowly	Software fault	Re-download software
	Central controller: gives out "Not Run" command too slowly	• Software fault • Connection fault between ESVAC and hospital control room display	• Re-download software • Check connection between Magnis ES-VAC and hospital control room display
	Central controller: doesn't issue alarm(s)	Software fault	Re-download software
	Central controller: doesn't issue service warning(s)	Software fault	Re-download software
Cubicle	Cubicle: does not comply with IP54	• Insufficient sealing • Holes in cubicle • Cable glands not closed • Locks defect • Cubicle ruptured mechanically	• After handling, check sealing/ cracks/holes • Replace defective components
	Cubicle: insufficient protection	• Door open • Locks defect • Cubicle under voltage • <<Finger proof>> protections removed	• After handling, check sealing/ cracks/holes • Replace defective components (contact BeaconMedaes)
Power supply cable	• No voltage to • Inadequate current allowed through	• Supply problem • Broken cables • High contact resistance • Power cable mechanically damaged	• Check Elektronikon module (LED) • Check cables/connections • Replace defective components (contact BeaconMedaes) • Restore power
	Insufficient or no insulation	Insulation is damaged	• Check cables/connections • Replace defective components (contact BeaconMedaes)

11. Technical data

11.1. Electric cable size

Important warning

	To preserve the protection degree of the electric cubicle and to protect its components from dust from the environment, it is mandatory to use a proper cable gland when connecting the supply cable to the cubicle.

	• The voltage on the compressor terminals must not deviate more than 10% of the nominal voltage. It is however highly recommended to keep the voltage drop over the supply cables at nominal current below 5% of the nominal voltage (IEC 60204-1). If cables are grouped together with other power cables, it may be necessary to use cables of a larger size than those calculated for the standard operating conditions. • Use the original cable entry. See section Dimension drawings. • Local regulations remain applicable if they are stricter than the values proposed below.

11.2. Reference conditions and limitations

Reference conditions

Condition	Unit	Value
Inlet pressure	mbar(e)	-600
Atmospheric pressure	mbar(a)	1013
Pressure drop bacteria filter	mbar	30
Exhaust back pressure	mbar	0
Air inlet temperature	°C	20
Ambient temperature	°C	20
Oil type (standard)		PAO (Syntectic)

Limitations for operation

Condition	Unit	Value
Maximum atmospheric pressure	mbar(a)	1040
Minimum atmospheric pressure	mbar(a)	700
Maximum ambient temperature *	°C	40
Minimum ambient temperature	°C	1
Maximum inlet temperature	°C	40
Minimum inlet temperature	°C	1
Minimum pump inlet pressure	mbar(e)	980
Maximum exhaust back pressure	mbar	60
Minimum exhaust back pressure	mbar	0
Maximum pressure drop bacteria filter	mbar	100

Remark: To obtain pressure values in mmHg instead of mbar, multiply by 0.75.

* To guarantee service intervals as stated in chapter Checks and intervals, it is recommended to use PAO oil if the average ambient temperature exceeds 30 °C.

11.3. Performance data

At the reference conditions described in the previous paragraph, the following performance data are given with a tolerance of 10%. FAA stands for the Free Air Aspiration in terms of mass through-put. FAA and volumetric flow rate are measured according to ISO 5167 / ISO 21360 / ISO 1607-1. The sound pressure level is measured as the maximum free field noise level at 1 m distance from the pump according to ISO 2151 / DIN 45635.

11.4. Altitude corrections

These performance data apply for the reference condition of 1013 mbar atmospheric pressure. When the Magnis Medical Vacuum Plant is installed at an altitude where the average atmospheric pressure is lower (e.g. more than 50 m above sea level), the following derating table must be used. Multiply the required hospital flow rate by the altitude derating factor to obtain the flow rate which will be used to size the plant. Interpolate as required, or use the calculation tool. Contact BeaconMedæs.

Altitude (m)	Atmospheric pressure (mbar)	Flow rate derating factor (-)
50	1007	1
500	955	1,09
1000	900	1,19
1500	846	1,3
2000	795	1,42

Also the cut-in and cut-out settings need to be adjusted in the central controller software (see: Central controller operation) according to the following table.

Altitude (m)	Atmospheric pressure (mbar)	Cut-in (mbar)	Cut-out (mbar)
50	1007	-670	-870
500	955	-670	-850
1000	900	-670	-800
1500	846	-670	-740
2000	795	-630	-690

11.5. Design data

HTM/ISO

Plant Type	System Flow l/m	Pump Type	Pump Flow l/m	Quantity of active pumps	Quantity of backup pumps	Vessel Size l	Quantity of Vessels	Quantity of Filters
mVAC-007DS-MSV	1370	MSV 007 MED IEC-UL/CUL	1520	1	1	2000	2	1
mVAC-010DS-MSV	1810	MSV 010 MED IEC-UL/CUL	2010	1	1	2000	2	1
mVAC-015DS-MSV	2430	MSV 015 MED IEC-UL/CUL	2700	1	1	2000	2	1
mVAC-020DS-MSV	2950	MSV 020 MED IEC-UL/CUL	3280	1	1	2000	2	1
mVAC-030DS-MSV	5000	MSV 030 MED IEC-UL/CUL	5550	1	1	2000	2	1
mVAC-040DS-MSV	5920	MSV 040 MED IEC-UL/CUL	6580	1	1	2000	2	1
mVAC-050DS-MSV	6710	MSV 050 MED IEC-UL/CUL	7450	1	1	2000	2	1
mVAC-030TS-MSV	9990	MSV 030 MED IEC-UL/CUL	5550	2	1	2000	2	1
mVAC-050TS-MSV	13410	MSV 050 MED IEC-UL/CUL	7450	2	1	2000	2	1
mVAC-007TD-MSV	1370	MSV 007 MED IEC-UL/CUL	1520	1	2	2000	2	1
mVAC-010TD-MSV	1810	MSV 010 MED IEC-UL/CUL	2010	1	2	2000	2	1
mVAC-015TD-MSV	2430	MSV 015 MED IEC-UL/CUL	2700	1	2	2000	2	1
mVAC-020TD-MSV	2950	MSV 020 MED IEC-UL/CUL	3280	1	2	2000	2	1
mVAC-030TD-MSV	5000	MSV 030 MED IEC-UL/CUL	5550	1	2	2000	2	1
mVAC-040TD-MSV	5920	MSV 040 MED IEC-UL/CUL	6580	1	2	2000	2	1
mVAC-050TD-MSV	6710	MSV 050 MED IEC-UL/CUL	7450	1	2	2000	2	1
mVAC-030QD-MSV	9990	MSV 030 MED IEC-UL/CUL	5550	2	2	2000	3	1
mVAC-050QD-MSV	13410	MSV 050 MED IEC-UL/CUL	7450	2	2	2000	3	1
mVAC-007DS-MSV-NVNF	1370	MSV 007 MED IEC-UL/CUL	1520	1	1			
mVAC-010DS-MSV-NVNF	1810	MSV 010 MED IEC-UL/CUL	2010	1	1			
mVAC-015DS-MSV-NVNF	2430	MSV 015 MED IEC-UL/CUL	2700	1	1			
mVAC-020DS-MSV-NVNF	2950	MSV 020 MED IEC-UL/CUL	3280	1	1			
mVAC-030DS-MSV-NVNF	5000	MSV 030 MED IEC-UL/CUL	5550	1	1			
mVAC-040DS-MSV-NVNF	5920	MSV 040 MED IEC-UL/CUL	6580	1	1			

Magnis Medical Vacuum Plant

Plant Type	System Flow l/m	Pump Type	Pump Flow l/m	Quantity of active pumps	Quantity of backup pumps	Vessel Size l	Quantity of Vessels	Quantity of Filters
mVAC-050DS-MSV-NVNF	6710	MSV 050 MED IEC-UL/CUL	7450	1	1			
mVAC-020TS-MSV-NVNF	5900	MSV 020 MED IEC-UL/CUL	3280	2	1			
mVAC-030TS-MSV-NVNF	9990	MSV 030 MED IEC-UL/CUL	5550	2	1			
mVAC-040TS-MSV-NVNF	11840	MSV 040 MED IEC-UL/CUL	6580	2	1			
mVAC-050TS-MSV-NVNF	13410	MSV 050 MED IEC-UL/CUL	7450	2	1			
mVAC-020QS-MSV-NVNF	8860	MSV 020 MED IEC-UL/CUL	3280	3	1			
mVAC-030QS-MSV-NVNF	14990	MSV 030 MED IEC-UL/CUL	5550	3	1			
mVAC-040QS-MSV-NVNF	17770	MSV 040 MED IEC-UL/CUL	6580	3	1			
mVAC-050QS-MSV-NVNF	20120	MSV 050 MED IEC-UL/CUL	7450	3	1			

NFPA

Plant Type	Plant Output @19°Hg SCFM	Pump Type	Pump Flow SCFM	Total Quantity of Pumps	Quantity of Standby pumps	Total Receiver Volume Gal.	Quantity of Receivers	Quantity of Filters	Receiver Connections
MSV007D-240V-HCV	56	MSV 007	56	2	1	240	1	Vacuum Filter Set, MV Based, Frame Mounted	4
MSV007T-240V-HCV	112	MSV 007	56	3	1	240	1		4
MSV007Q-240V-HCV	168	MSV 007	56	4	1	240	1		4
MSV010D-240V-HCV	72	MSV 010	72	2	1	240	1		4
MSV010T-240V-HCV	144	MSV 010	72	3	1	240	1		4
MSV010Q-240V-HCV	216	MSV 010	72	4	1	240	1		4
MSV015D-240V-HCV	89	MSV 015	89	2	1	240	1		4
MSV015T-240V-HCV	178	MSV 015	89	3	1	240	1		4
MSV015Q-240V-HCV	267	MSV 015	89	4	1	240	1		4
MSV020D-240V-HCV	124	MSV 020	124	2	1	240	1		4
MSV020T-240V-HCV	248	MSV 020	124	3	1	240	1		4
MSV020Q-240V-HCV	372	MSV 020	124	4	1	240	1		4

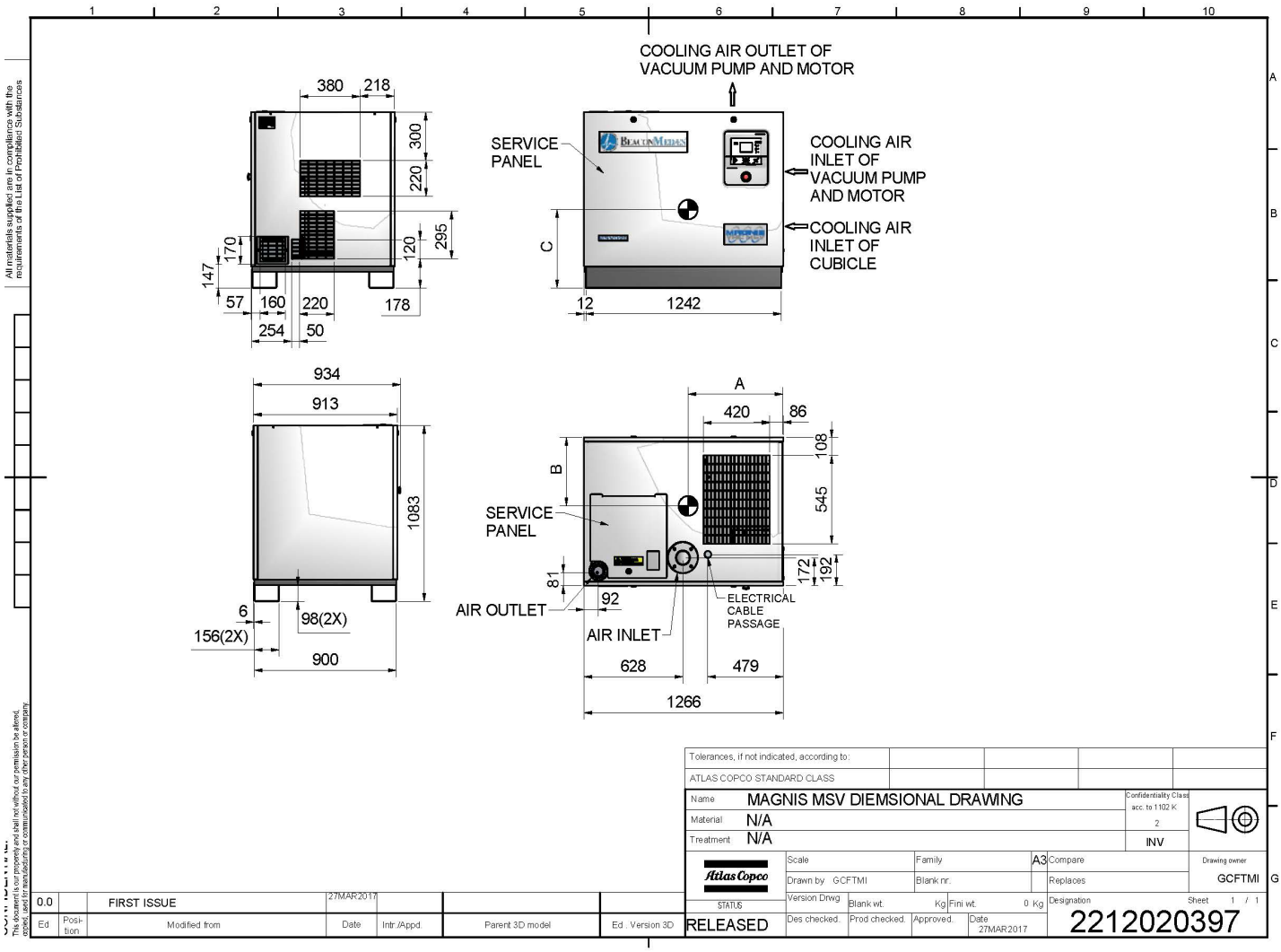
Magnis Medical Vacuum Plant

Plant Type	Plant Output @19°Hg SCFM	Pump Type	Pump Flow SCFM	Total Quantity of Pumps	Quantity of Standby pumps	Total Receiver Volume Gal.	Quantity of Receivers	Quantity of Filters	Receiver Connections
MSV030D-400V-HCV	231	MSV 030	231	2	1	400	1	Vacuum Filter Set, MV Based, Frame Mounted	6
MSV030T-400V-HCV	462	MSV 030	231	3	1	400	1		6
MSV030Q-400V-HCV	693	MSV 030	231	4	1	400	1		6
MSV040D-400V-HCV	273	MSV 030	273	2	1	400	1		6
MSV040T-400V-HCV	546	MSV 030	273	3	1	400	1		6
MSV040Q-400V-HCV	819	MSV 030	273	4	1	400	1		6
MSV050D-400V-HCV	309	MSV 030	309	2	1	400	1		6
MSV050T-400V-HCV	618	MSV 030	309	3	1	400	1		6
MSV050Q-400V-HCV	927	MSV 030	309	4	1	400	1		6

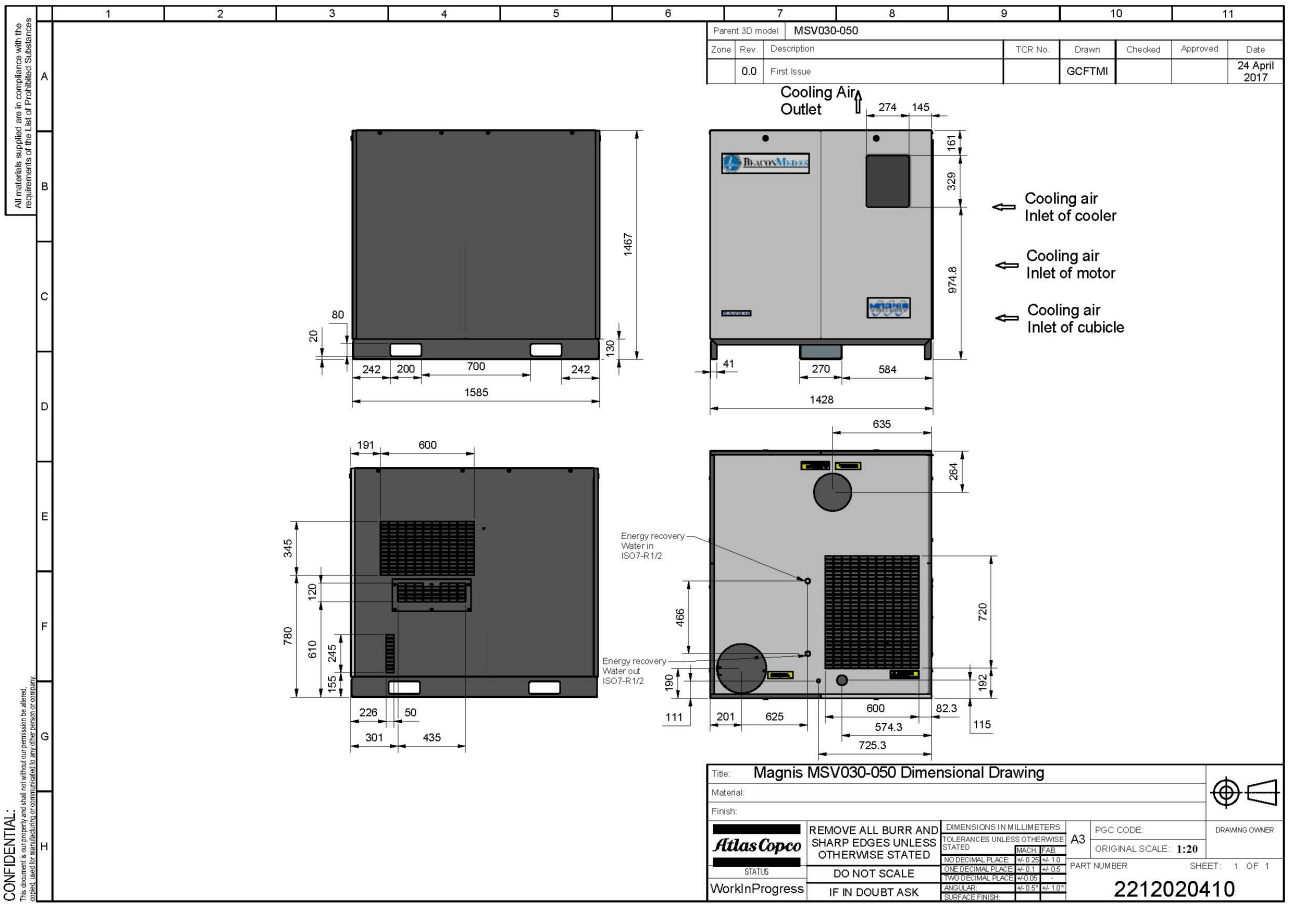
Dimension drawings

11.5.1. Pump

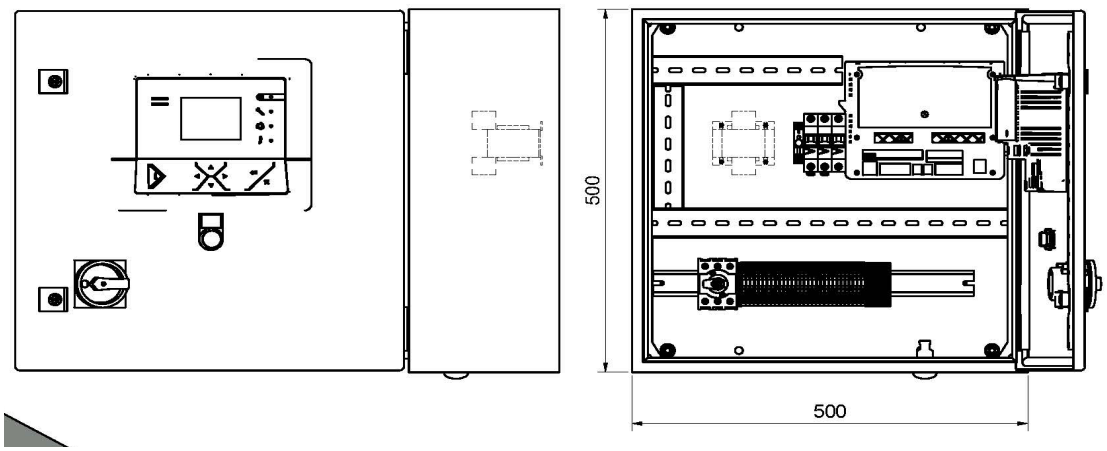
Magnis MVS007 -MVS020



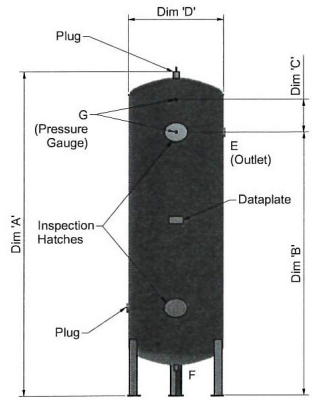
Magnis MVS030 -MVS050



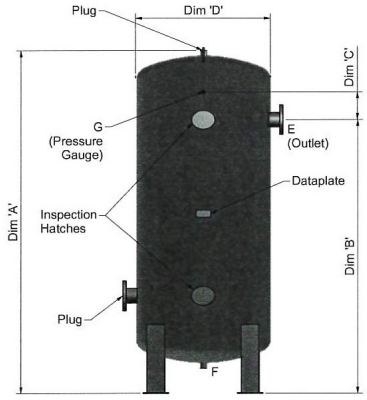
11.5.2. ES-VAC Medical



11.5.3. Vessels



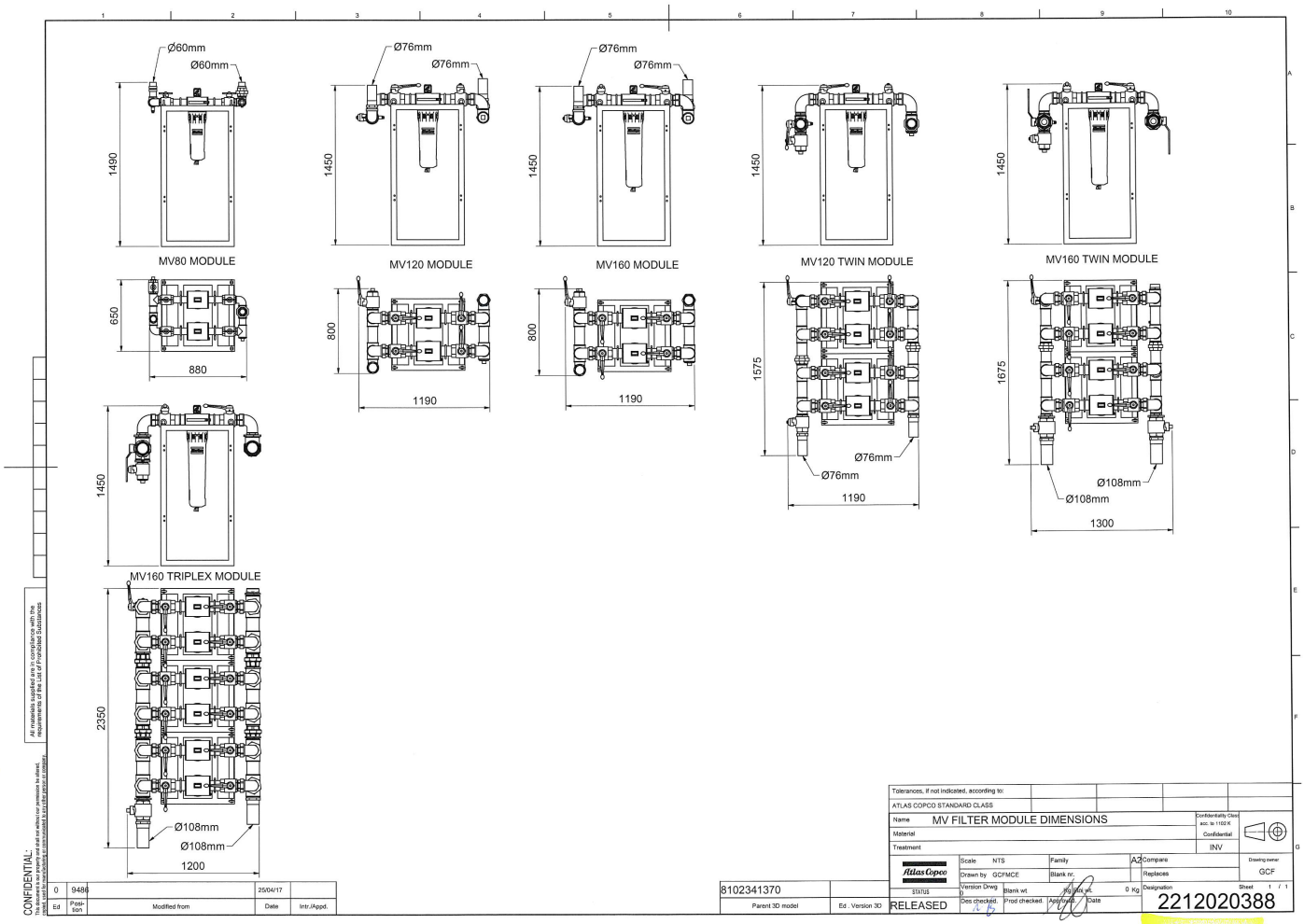
500 & 1000L



1500, 2000 & 3000L

Standard Range - Vacuum Vessels										
Part No.	Vol/Ltrs	Pressure/	Weight Kg	Dim 'A'	Dim 'B'	Dim 'C"	Dim 'D'	'E'	'F'	'G'
8102341000	500	-0.9	195	2105	1575	-	610	2" BSPT	1/2" BSPT	3/8" BSPT
8102341001	1000	-0.9	380	2630	2100	220	762	2" BSPT	1/2" BSPT	3/8" BSPT
8102341002	1500	-0.9	520	2670	2100	220	900	65 NB	3/4" BSPT	3/8" BSPT
8102341003	2000	-0.9	800	2775	2175	220	1067	100 NB	3/4" BSPT	3/8" BSPT
8102341004	3000	-0.9	1000	3050	2425	220	1220	100 NB	3/4" BSPT	3/8" BSPT

11.5.4. Vacuum Filters



12. Usability

Intended use

12.1. Description

The Magnis Medical Vacuum Plant provides a source for vacuum (suction) for a variety of applications in the hospital, mainly in operating theatres, intensive care, emergency and respirology units. Specific applications include:

- Wound drainage
- Assisted wound closure
- Chest and lung drainage
- Removal of excess blood during surgery
- Collection of other bodily fluids
- Gastric emptying
- Cleaning endotracheal tubes
- Liposuction (lipoplasty)

12.2. Plant application specification

Medical purpose

- To provide vacuum (suction) for a variety of applications in the hospital, mainly in operating theatres, intensive care, emergency and respirology units
- Condition(s) or disease(s) to be screened, monitored, treated or diagnosed: none

Patient population

- Age: newborn to geriatric
- Weight: not relevant
- Health: not relevant
- Nationality: multiple
- Patient state:
  - Patient is operator: patient is never intended to be the operator
  - Patient is not operator: default case

Part of the body or type of tissue applied or interacted with:

- Direct contact is not foreseen, the device connects to the patient via a transport piping system.

Intended operator

1. Education:
   - minimum: At least 21 years old, high school or equivalent.
   - maximum: none
2. Knowledge:
   - minimum: Can read and understand westernized Arabic numerals. Basic technical knowledge and software understanding required.
   - maximum: none
3. Language understanding: Language of the instruction book and preferably also English
4. Experience:
   - minimum: no special experience necessary
   - maximum: none
5. Permissible impairments: Mild reading vision impairment or vision corrected to log MAR 0,2 (6/10 or 20/32), at

least one arm/hand capable of guiding device, average degree of ageing-related short term memory impairment.

12.2.6. Applications

1. Environment:
- general: plant room in a hospital
- conditions of visibility: well lit room
- physical: 1 to 40 °C
2. Frequency of use: every day intermittently or continuously mobility: stationary device

12.3. Primary operating functions

1. Critical functions :
- Switching on.
- Maintenance.
2. Frequent functions :
- None.

12.4. Risk analysis

Intended use :

- see above

Operator Profile :

- see above : Intended operator

Things that could go wrong :

Sources: literature, complaint file, sales force, nursing experts, risk analysis.

a. during normal use: See: Faults and remedies e.g. loss of vacuum

b. use errors: Misuse / no or wrong maintenance

c. environment:
- above 40 °C
- below 1 °C

d. patient: not applicable

e. reading: not applicable

f. hygiene: not applicable

g. application: outside of operating room

Task requirements:

Maintenance

The context of use:

See above: Applications

Information on Hazards known for existing similar device:

Included in Things that could go wrong.

Resulting Hazards :

See Installation warnings and Maintenance warnings.

Preliminary review of the Operator-Equipment interface concept:

According to design process.

Conclusion: no issue.

12.5. Use scenarios

Worst case scenarios to provide a basis for validation with Patient = Operator is not applicable.

- Patient is never intended to be the operator.

1. Operator actions related to primary operating functions :
   - See operation user guide
2. Operator-equipment interface requirements for the primary operating functions :
   - According to design process.
3. Operator-equipment interface requirements for those use scenarios that are frequent or related to basic safety or essential performance :
   - According to design process.

13. Declaration of conformity

Declaration of Conformity

Manufacturer	Atlas Copco Ltd. trading as Atlas Copco Medical 18 Nuffield Centrum, Nuffield Way, Abingdon, OX14 1RL, UK
Product	
Classification	IIb
Conformity Route	Annex II
Quality Management System	EN ISO 13485:2012
GMDN Code	36271
GMDN Term	Medical gas and vacuum supply systems
Standards Applied	EN 980, EN ISO 7396-1, EN ISO 14971, EN 5169, EN 13348, EN 837-1, EN 1041, EN ISO 10993-1, EN 61000-6-4, EN 61000-6-2
Notified Body	Lloyd's Register Quality Assurance Limited, 71 Fenchurch Street, London EC3M 4BS United Kingdom (LRQA Notified Body Number 0088)
MOD Certificate(s)	LRQ 4007749/C
Start of CE Marking	3rd April 2013
Place and Date of Issue	Abingdon, 25th May 2016

We hereby declare that the above mentioned products meet the provisions of the Council Directive 93/42/EEC concerning Medical Devices, as amended by Directive 2007/47/EC. All supporting documentation is retained under the premises of the manufacturer.

Endorsing Signature
Sanjay Safaya (General Manager)

Document ref.: RD0 C0009v6.docx

BEACONMEDÆS®

HTM/ISO Markets (Use UK address)
Tel: +44 (0) 1246 474242

NFPA Markets (Use USA address)
Tel: +1 803 817 5600 (USA)
Tel: 1 888 817 5600 (TOLL-FREE USA)

www.beaconmedaes.com

Atlas Copco Ltd. trading as Atlas Copco Medical
Unit 18 Nuffield Way, Abingdon, Oxfordshire, UK OX14 1RL

CE
0088