

Part No	CN1116
Description	Modbus Display & Control (MDC)



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To assure proper usage, we ask you to read these operating instructions carefully before installation and commissioning of the control device.

1.0 Safety Notice

⚠ CAUTION – Safety

- The Modbus Display & Control is only suitable for a safety extra low voltage supply of 9VDC up to 30VDC

⚠ CAUTION – Electro-Static Discharge

- Many modern electronic components are susceptible to damage from Electro-Static Discharge (Static Electricity). During programming and commissioning, avoid unnecessary contact with electronic components on PCB's. PCB's which are sensitive to static discharges and should be stored and transported in anti-static packaging until they are required to be used.

⚠ Warning – Do not operate in an explosive atmosphere

⚠ Warning – The fans may start during connection and programming. If there is a residual risk of contact with a fan, then contact shall be prevented by suitable control methods to prevent accidental contact

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2.0 Introduction

The Modbus Display & Control (MDC) is a device with two RS485 ports, a keypad for setting parameters and a display to view the status of the connected equipment. One port, the master RS485, communicates with ebm-papst Modbus enabled, electronically commutated fans with software version 5.0 or later using a two-wire plus ground RS485 connection. The second port, the slave RS485, communicates with a higher-level third-party system such as a Building Management Systems (BMS), providing real-time monitoring and control data.

The master port can search, address, and talk to up to 100 fans connected to its network.

The MDC provides an auto-addressing facility to ease installation and commissioning, and supports four different operating modes as explained below:

- Monitor operating mode
 - Monitors pre-defined parameters and reports the information via the digital display and the RS485 slave port, see Tables 1 and 2 below
 - A fault condition will be raised by an on-board LED and a volt-free relay
 - An optional 0-10V differential pressure sensor can provide a signal to display either differential pressure or used by the MDC to calculate and display volume flow
- Monitor & Control operating mode
 - As per Monitor operating mode plus the fan speed is controlled by one, or a combination of:
 - 0-10V control signal input to the MDC
 - Third-party Modbus master system connected to the RS485 slave port of the MDC
 - Local control using the MDC keypad
 - An optional 0-10V pressure sensor can provide a signal to display either differential pressure or used by the MDC to calculate and display volume flow
- Constant Volume / Constant Pressure Control operating mode
 - As per Monitor operating mode but requires an external 0-10V differential pressure sensor used by the MDC to maintain a constant volume / constant pressure. The constant volume / constant pressure setpoint can be entered via the keypad or via the RS485 slave port.
- Modbus Relay operating mode
 - The MDC stops monitoring and controlling the fans in order to be entirely dedicated to conveying messages between a RS485 Modbus Master device and the fans. This operating mode allows remote control of the speed of individual fans via Modbus.

The MDC will display the following parameters from each connected fan (except during Modbus Relay operation):

Actual Speed (RPM)	Set Point (%)	Fan Serial Number
Motor Temperature (°C) *1	Electronics Temperature (°C)	Hours Run (h)
Fan Power Consumption (W)	Fan Warnings	

Table 1 - Information shown on the MDC display for a single fan

The MDC will also display the following parameters from the fan array:

Total Power Consumption (kW)	Volume (m ³ /h or CFM) or Pressure (Pa or in.w.g) *2
------------------------------	---

Table 2 - Information shown on the MDC display for the fan array

⚠ Note *1 - The controller is compatible with all firmware versions of ebm-papst enabled Modbus EC fans version 5.0 and later, however, on 'Modbus LITE' reduced functionality fans, the parameter 'Motor Temperature' will be displayed as "N/A".

⚠ Note *2 - Volume and pressure (either metric or imperial) is only available using an external differential pressure sensor with a 0-10V output and a range of 50Pa, 200Pa, 500Pa, 1000Pa or 2000Pa.

3.0 Overview

3.1 Specification

Product	Modbus Display & Control - CN1116
Supply Voltage	Two sets of connections are provided for either: <ul style="list-style-type: none"> 9 VDC to 30VDC from an optional external PSU or 10 VDC sourced from connection to the fan PSU* (note that fan PSU must be the ≥ 10 mA version) Reverse polarity protected
Supply Current	10mA (low LDC backlight) – 40mA (full LCD backlight)
Enclosure	CN1116 – wall mount
Enclosure Dimensions	See Appendix A – Physical Details
Weight	CN1116 – 204 g
Operating Environment	CN1116 is -20°C to +60°C, 90%RH at 40°C max.
EMC Compliance	BS EN61000-6-3 (emissions) BS EN61000-6-2 (immunity)

* Patent GB 2 431 303

Table 3 - Specification

3.2 Installation

Avoid exposure to vibration, high temperatures. Control of exposure to water and dust varies with each design. The unit shall be installed according to relevant safety guidelines and requirements. Attention should be paid to local regulations and guidance.

3.3 Hot plugging

Hot plugging the MDC is permissible, however, if a new or replacement MDC is not at factory default settings, it will need to be reset to such. Please see Section **7.0 Replacing** for more details.

3.4 RS485 wiring installation

It is recommended to use shielded RS485 cable separated from mains supply wiring. For reliable system operation the RS485 wiring should be installed in accordance with standard industry good practice. Use a “Daisy Chain” linear cable layout avoiding “Star” layout or “Stubs”. We recommend the MDC to be at one end of the RS485 network. It has a built-in 560Ω termination resistor on its RS485 Master Port and therefore another 560Ω termination resistor should be added at the other end of the network cable as shown in Figure 1 below:

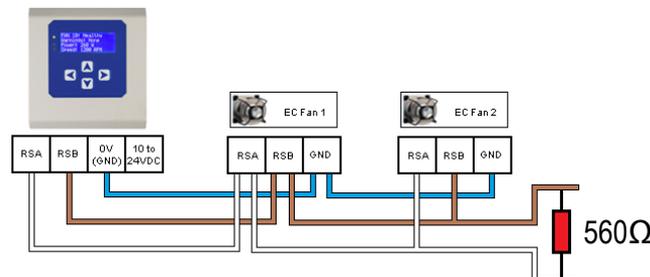


Figure 1 - Schematic of RS485 installation

In case the MDC is in the middle of the network, the built-in termination resistor must be taken out of the circuit by removing the jumper bar located on the PCB. Please note that in this case, two resistors of the same value are required one at each end of the network.

4.0 Configuration and first use of the MDC

4.1 Electrical connection – general information

The electrical connections are shown in **Appendix B – Electrical Connections**. The required connections to the MDC will depend on the intended use, i.e. the intended operating mode, and the desired configuration of fans, sensors, inputs and outputs.

A suggested connection diagram for each operating mode is shown in **Section 5.0 Operating Modes**. For the purpose of explaining the initial configuration and first use of the MDC, the connection diagram for the factory default operating mode of “Monitor” is show in Figure 2 below:

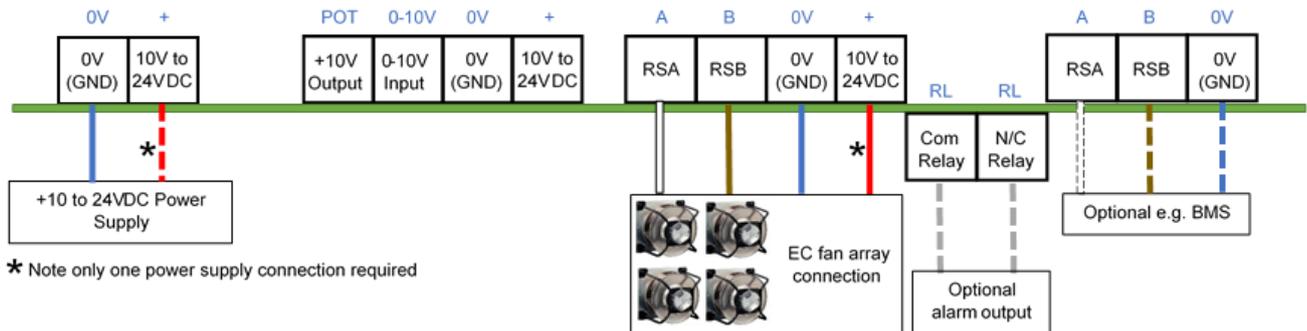


Figure 2 – Typical wiring for default operating mode when used with multiple fans

⚠ CAUTION: Risk of damaging the fan if two power supplies are connected at the same time
Do not connect the fan’s 10Vdc output to the controller if powering the controller from an external supply

4.2 General and Initial Power ON

The MDC is pre-installed with four different operating modes, see **Section 2.0 Introduction**

When power is applied, the MDC undertakes a PCB and software version check and then interrogates the on-board memory for a previously stored fan array and configuration parameters. If there is a previously stored fan array, the MDC will display the status screen of the first fan in the array as shown in Figure 3 below. If there is no previously stored fan array the MDC will display the Main Menu screen where setup is required, see Figure 5.

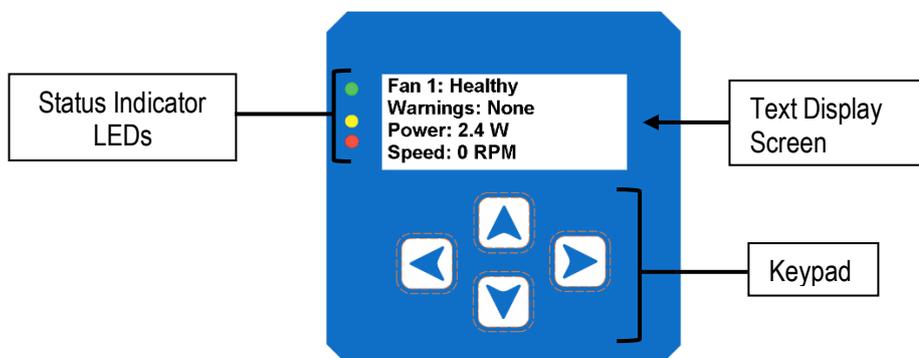


Figure 3 - Fan status screen showing that the MDC had a previously stored fan array

The MDC has three fan status indicator LEDs, a text screen and a keypad interface to navigate around the configuration menus and fan information.

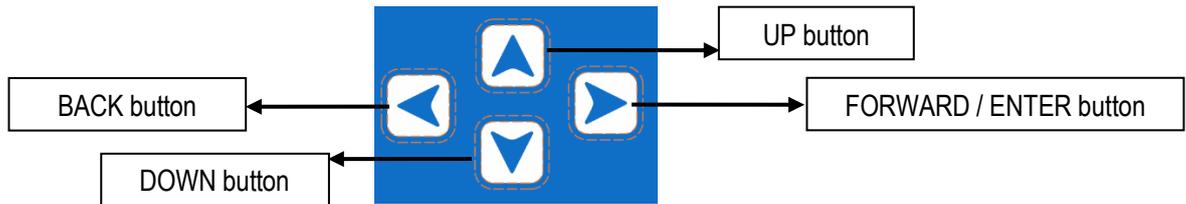


Figure 4 - Keypad buttons

- The FORWARD / ENTER button moves forward to the next fan if monitoring a fan's status screen or confirms the request / change of a set value if configuring parameters
- The UP and DOWN buttons navigate through the screens and change set values
- The BACK button moves back one step in the software structure without saving any changes made

Menu structures are shown with the use of flow charts in **Appendix H – Menu Structure Flow Chart**. There are flow charts for various tasks, set up of each mode, settings, use of the MDC, interrogation of alarms, etc. For example, **H1 – Fan Addressing - New Fan Array -Initial Setup** shows the menu structure for initial set up with new fans, **H2 – Fan Addressing - Existing Fan Array - Initial Setup** shows the menu structure for initial set up where the fans are already addressed and **H20 – Advanced Settings – LCD Brightness** shows how to change illumination of the LCD.

Once configured and when in normal operating mode, the green fan status indicator LED will be on and the MDC will display the operating condition of the fans. Using the keypad interface, the user can scroll through the network of connected fans to check set points, power consumption, alarm conditions and fan warnings from each fan.

When a fan enters an alarm state or has lost communication, the MDC will illuminate the red fan status indicator LED and text on the display screen will show the fan that is experiencing an alarm condition.

If another fan in the array enters an alarm state, the red fan status indicator LED will remain on and controller will then change to display the second fan experiencing an alarm condition. The MDC will automatically change to display a fan that is experiencing an alarm. The same applies if one or more fans lose their communication.

If a warning condition has been detected in any fan, the MDC will illuminate the yellow fan status indicator LED. The display will not automatically show which fan has raised the warning. Fans that have entered a warning condition status can be found by navigating through the array using the keypad buttons or by processing the MDC Modbus registers using an external Modbus Master device connected to the MDC RS485 Slave port.

4.3 Configuring the Fan Array

The MDC can be used on a new installation with fans delivered in their factory default condition or on an existing array of fans which have been networked and pre-addressed.

4.3.1 Configuring the MDC with fans that are in their factory default setting

New fans are typically supplied in the factory default condition with Modbus address 1. New MDC units are supplied without any stored fan array configurations. On first application of power to the MDC, the Main Menu will be displayed as shown in Figure 5 below:



Figure 5 - Main menu display screen on first application of power

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4.3.2 Auto addressing fans using the fan's serial numbers

- To initiate the auto addressing the Main Menu should be displayed (see Figure 5 above). Select 'Fan Addressing' followed by 'New Fan Array' followed by the ENTER button (**See H1 – Fan Addressing - New Fan Array -Initial Setup**)
- Either proceed with "Autodetect" (the MDC will automatically detect the total number of fans) by pressing the ENTER button, or manually enter the total number of fans using the UP and DOWN buttons and then press the ENTER button twice.

For the MDC to locate the fans on the network, all fans must be in the factory default of MODBUS address 1, Baud rate 19200 and parity 8E1. If the fan array has been previously configured for a different address, baud rate or parity setting, they must be returned to the factory set condition before the controller can run the auto address sequence. Changing all fans to Modbus address 1 can be achieved by going to "Advanced Settings" and "Factory Settings" of the fan providing they are all configured to factory default baud rate 19200 and parity 8E1.

In the process of addressing the fans, the MDC uses the fan's manufacturing serial number to identify each individual fan. The addressing is performed in ascending order, where fans with the lowest serial number have the lowest Modbus address and Fan number assigned. The controller starts assigning addresses to the fans from Modbus address 2 up to 102.

An example of a fan array consisting of 3 fans:

Fan Z has Serial Number 1327006PDZ – Controller Assigns MODBUS Address 2 – this is FAN 1.

Fan X has Serial Number 1527006PDS – Controller Assigns MODBUS Address 3 – this is FAN 2.

Fan Y has Serial Number 1527006PDZ – Controller Assigns MODBUS Address 4 – this is FAN 3.

Important

Please ensure that all fans within the array are correctly wired and switched on before trying to address them

Note: After the fans have been automatically addressed it is possible to manually change the FAN number as seen by the controller e.g. FAN 1, FAN 2, etc by going to the "Fan Re-addressing" menu.

See **4.6 Changing the fan addressing order**

Note: The auto addressing option will disappear after all fans have been addressed. This can be reversed by using the "Factory Reset" option inside "Main Menu -> Advanced Settings".

Important

In case of an error during auto addressing, the fans must be physically inspected to ensure they are correctly wired and switched ON before retrying. It is also recommended, in all cases, to reset the MDC and fans to factory settings before retrying.

Important

Before starting the auto addresser, it is recommended to use "Autodetect" instead of manually entering the total number of fans. If "Autodetect" has not been used, please ensure the total number of fans entered truly reflects the total number of fans available in the fan array to avoid leaving a fan unaddressed or to have an extra fan in the system that does not have a physical representation.

4.3.3 Configuring the MDC with fans that have been pre-configured

If the MDC is being retrofitted to an existing array of fans that have been pre-configured with individual Modbus addresses, ensure all fans are connected to the MDC's RS485 Master port and:

- Select “Fan Addressing” followed by “Existing fan array” using the ENTER button (**See H2 – Fan Addressing - Existing Fan Array - Initial Setup**). The MDC will verify and show how many fans it has detected.
- If the number of fans detected is correct, press the ENTER button twice, otherwise add the total number of fans connected to the MDC by using UP and DOWN buttons and then press ENTER button twice.

If not all fans in the array can be found, it is recommended to reset both the fans and controller to factory default using “Advanced Menu” and “Factory Reset” and configure the network from the beginning, see **4.3.1 Configuring fans in the factory default setting**. If that does not solve the problem, it is recommended that communication is checked with each fan to diagnose the fault.

⚠ Note: Only fans pre-configured as defined in **4.3.2 Auto addressing fans using the fan’s serial numbers** can benefit from the “Existing Fan Array” option. If that is not the case, please use “Factory Reset” and then follow the procedure on **4.3.1 Configuring the MDC with fans that are in their factory default setting**

4.4 Fan Status screen

When the MDC has finished addressing all fans in the array, the new Modbus address and serial number of each fan will be saved in non-volatile memory in the MDC. For large groups of fans in an array this may take some time as the MDC must interrogate each individual fan for their serial numbers. Once completed, a “Change Fan Address” prompt screen will appear in case it is desirable to change the fan addressing order.

These procedures will only happen once per array. The MDC will then default to ‘Monitor’ operating mode and the status screen of Fan 1 will be displayed as shown in Figure 6 below:

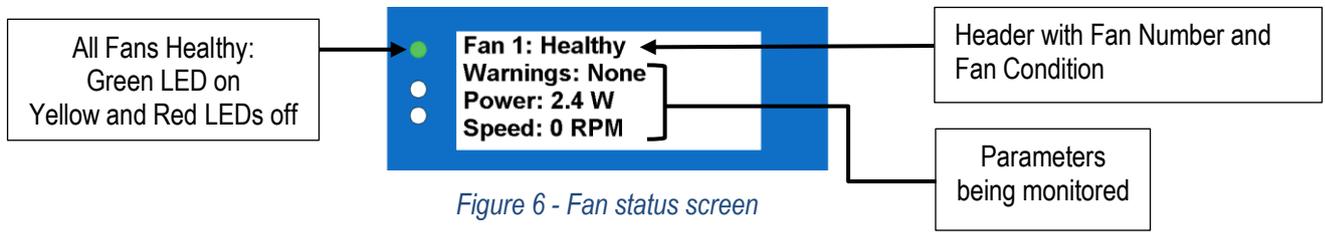


Figure 6 - Fan status screen

From now on, the operating mode can be changed using the Main Menu screen which is accessible by pressing the BACK button twice whilst on Fan 1 status screen. See **Section 5.0 Operating Modes** for more details.

There are several parameters displayed for each fan:

- Fan Condition – Healthy / Alarm / Warning / No Comms
- Warnings – Description of warnings being experienced by the fan
- Power – Power consumption (W)
- Speed – Real-time fan speed (RPM)
- Motor temperature - °C (not available for Modbus Lite reduced electronics fans)
- Electronics Temperature - °C
- Hours Run – Number of fan operational hours
- Fan control - % of maximum input signal
- Serial Number – Manufacturing serial number

There is a maximum of four lines on the display screen. To display a different monitoring parameter, use the ‘UP’ and ‘DOWN’ buttons to scroll through the information for each fan. Three parameters can be displayed at a time

The fan number and condition header are always present when the fan is being monitored. A fan can have one of the following conditions at any given time:

- Healthy - When the fan is fully operational
- Alarm - When the fan has one or more alarms
- Warning - When the fan has one or more warnings
- No Comms - When the fan or the controller has lost communication with the Modbus network

The fan conditions Alarm, Warning and No Comms are discussed in further detail on **Section 6.0 Fault Indication**.

To change to a different fan in the array use the ENTER / BACK buttons to scroll through the fan array.

4.5 Power Meter screen

The power meter screen as shown in Figure 7 below is accessible by pressing the ENTER button when displaying the status screen of the last fan in the array. See **H6 – Status**.

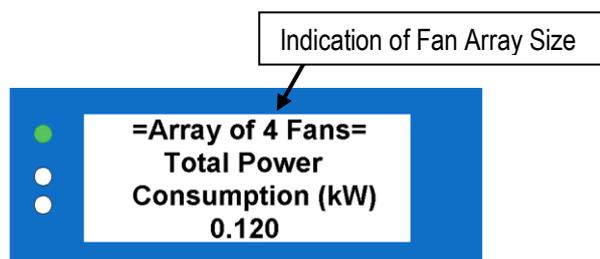


Figure 7 – Power meter screen

The total power consumption consists of the sum of the power consumptions read from each fan (in Watts) converted into Kilowatts. For larger fan arrays it may take some time to read this value the first time as the MDC polls several registers from each fan in order to derive the individual fan power, which will then be converted into total fan array power consumption.

⚠ IMPORTANT

If a fault occurs to one of more fans whilst the Power Meter Screen is being displayed, the MDC will remain on the Power Meter Screen and will switch on the red LED for alarms and/or communication loss or the yellow LED for warnings. After leaving the Power Meter screen, the MDC will automatically display the fan experiencing an alarm or a communication loss.

4.6 Changing the fan addressing order

The fan auto-addressing procedure is described in **4.3.2 Auto addressing fans using the fan’s serial numbers**. The automatic assignment of Modbus addresses to fans can be inconvenient for the user as the preference for the fan addresses may be to follow a logical addressing based on the position of the fans in the array or building. For this reason, it is possible to individually re-address each fan such that their fan numbers match the equipment or building layout.

This option becomes available in the main menu under ‘Fan Re-Addressing’ option once the fans have initially been found and auto-addressed by the MDC. Under this option, a list of fans is displayed where it is possible to see each fan’s Fan number, Modbus address and serial number. See the “Address” part of **H1 – Fan Addressing - New Fan Array -Initial Setup**.

By selecting a fan and pressing ENTER, it is possible to assign a different fan number and corresponding Modbus address to the selected fan using the UP or DOWN buttons and then pressing ENTER.

⚠ Note: As a fan changes its fan number and address, the fan currently at that target fan number and address will be changed to the selected fan's old fan number and address - effectively "swapping" them

⚠ Note: This feature is not available when using the controller with only one fan

⚠ Note: It is not possible to assign a fan number outside the total number of fans e.g. if using the MDC with a 4-fan array, the fan numbers will be restricted to 1-4, with the corresponding Modbus addresses 2-5.

5.0 Operating Modes

5.1 General

The MDC can be configured to operate in four different modes:

- Monitor (default)
- Monitor & Control
- Constant Volume / Constant Pressure
- Modbus Relay

In "Monitor" and "Modbus Relay" modes the fans remain in their factory default settings other than their Modbus addresses. In "Monitor & Control" and "Constant Volume / Constant Pressure" modes the MDC automatically changes the settings of each fan to allow speed control via Modbus as opposed to the factory settings of 0-10V analogue input control, and therefore the analogue inputs of the fan motors are disabled. There is no need to manually change individual fan settings, the MDC does this automatically.

In addition to changing the operational mode of the MDC, it is also possible to change different parameters of the fans and the controller such as RPM limits, Control Voltage Cap, Input Voltage Cap, Alarm Output, BMS Settings, LCD Brightness, Main Menu lock as well as to reset the fans and controllers to their factory default condition.

5.2 Accessing the main menu

Modifying the operational mode and configuring the control parameters is available via the Main Menu, which can be accessed using the keypad see **H6 – Status**. Scroll through the fans using the BACK button until Fan 1 status screen is shown. Pressing the BACK button twice again accesses the Main Menu. It is possible to prevent unauthorised access to the main menu by locking it. Details on activating the lock and the key sequence to allow Main Menu access is detailed on **5.7 Advanced Settings Submenu**

Most of the options in the Main Menu and its submenus can also be modified remotely by a Modbus Master connected to the MDC's RS485 slave port. See **Appendix E – Modbus Holding Registers** for more details.

⚠ IMPORTANT

The Main Menu is intended for configuration purposes only and therefore the entire controller's monitor and/or control operations will be halted whilst on the Main Menu or any of its submenus except 'Set Speed' submenu.

Halting does not apply if the configuration parameters are changed via the RS485 slave port whilst the MDC is in a status or power screen, however, most changes made in the Main Menu either locally or remotely will trigger a power cycle to both fans and controller in order to activate the new parameters.

The four operational modes are selectable in the Main Menu using menu option 'Operation Mode'. Please note that all fans must have been addressed for this option to become available.

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5.3 Monitor mode (default operation)

In “Monitor” operating mode the fans in the array are following a speed control command from a separate source, for example a 0-10VDC or 4-20mA control, or a sensor input to the fan. In this operating mode, the MDC is just a monitoring device extracting information from the Modbus registers in each fan.

In “Monitor” operating mode it is also possible to monitor either a pressure differential or calculate the volume flow in real-time by using an external 0-10V differential pressure sensor connected to the MDC. This information will be displayed in the Power Meter screen. See **H7 – Operation Mode – Monitor** for how to enter Monitor mode.

5.3.1 Monitor mode: single fan connection

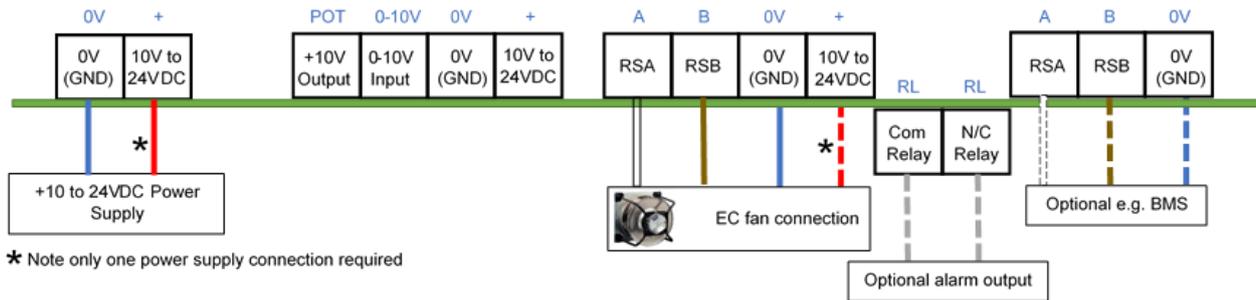


Figure 8 – Typical wiring diagram for Monitor operating mode - single fan monitoring

⚠ CAUTION: Risk of damaging the fan if two power supplies are connected at the same time
Do not connect the fan’s 10Vdc output to the controller if powering the controller from an external supply

⚠ IMPORTANT:
 The +10Vdc 10mA supply from a single fan can be used to power the controller, but the controller may lose power if certain faults are experienced by the fan. Furthermore, the LCD brightness would be dimmed if using only one 10Vdc 10mA supply. It is generally recommended that an external +24V DC power supply is used to power the MDC unit for these reasons.

5.3.2 Monitor mode: multiple fan connection

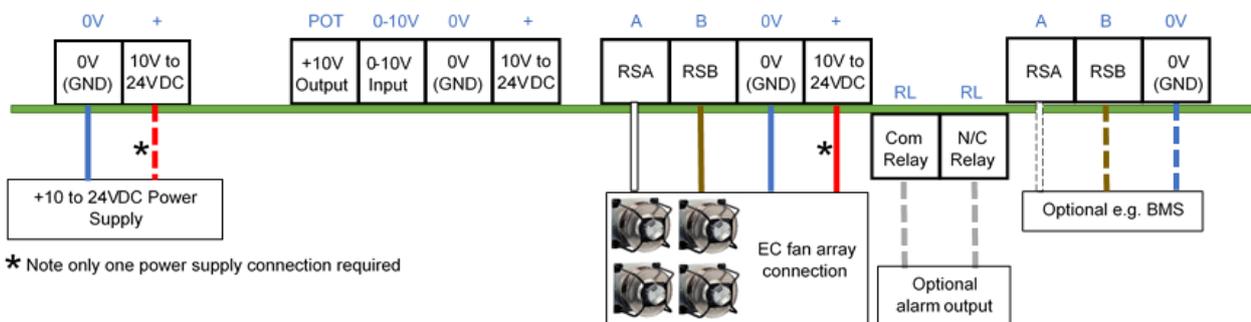


Figure 9 - Typical wiring diagram for Monitor operating mode - multiple fan monitoring

⚠ CAUTION: Risk of damaging the fan if two power supplies are connected at the same time
Do not connect the fan's 10Vdc output to the controller if powering the controller from an external supply

5.3.3 Monitor mode: pressure sensor connection – differential pressure or volume measurement

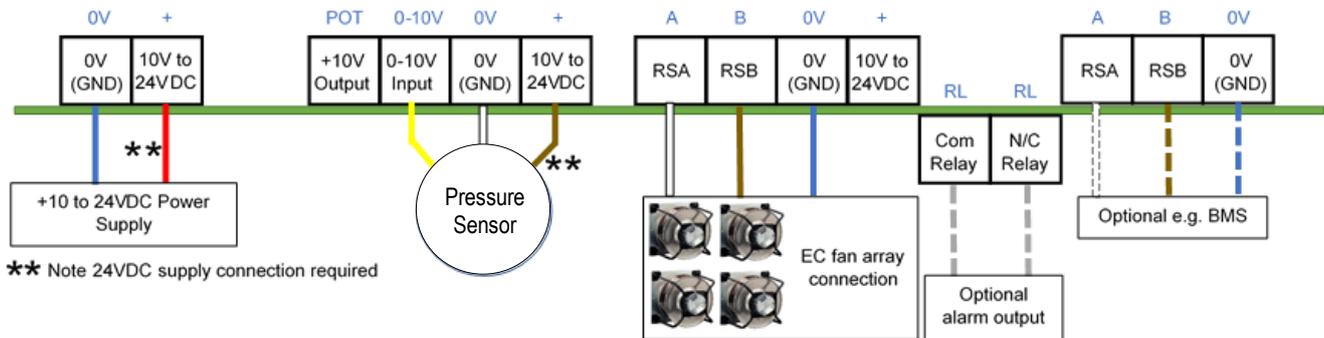


Figure 10 - Typical wiring diagram for Monitor operating mode – using external sensor monitoring

⚠ Note: On the diagram above, the MDC must be powered using an external 24VDC supply to provide power to the pressure sensor. Alternatively, the sensor can be powered externally in case it is desired to supply the MDC with a voltage below +24VDC. However, GND connections must be shared between the sensor's external supply and the MDC's supply.

5.4 Monitor & Control mode

5.4.1 General

In “Monitor & Control” operating mode, the fans will no longer respond to a separate speed signal, such as a 0-10V analogue input signal connected to the Analogue input terminal at the fan. In this mode, the fan speed is entirely controlled by the MDC via Modbus. The MDC can receive an analogue input signal to set the speed to all fans within the array, or the fan speeds can be set by a Modbus master writing to the MDC's Holding Register 4, or locally by using the MDC's keypad.

See **H8 – Operation Mode - Monitor & Control** for how to enter Monitor & Control mode.

In “Monitor & Control” operating mode three control options are available:

0-10V Input

The MDC is configured to respond to a 0-10VDC input voltage from an external source. This can be from either a BMS or from a 10kΩ potentiometer using a +10VDC supply.

MODBUS Control

The MDC is configured to receive Modbus commands from a BMS or an application controller to set speed of the fan array using the MDC's Holding Register 4. The MDC will relay the new set point to the fan array whilst retaining the monitoring and alarm functionality.

Keypad – Manual operation

It is possible to control the fans by setting the speed using the keypad. If this option is chosen, a new submenu called “Set Speed” will become available inside the Main Menu, where it is possible to set the speed of all fans using the keypad. See **H11 – Keypad Control**.

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5.4.1.2 Measuring the fan performance using a pressure sensor

When “Monitor & Control” operating mode is selected it is also possible to connect a 0-10V differential pressure sensor to the 0-10V input terminal of the controller and use this to display the current pressure in the fan array or to calculate the total volume flow. If that is the case, the MDC’s 0-10V Input control mode will become unavailable as it will be used to read the output voltage from the sensor.

5.4.1.3 Control options in Monitor & Control mode

The MDC can be configured to respond to each of the three control options individually or in a combination.

One Control input

If only one control option is selected it will only respond to the output from the source specified (i.e. if keypad control is specified, the MDC will respond only to a speed setpoint change made at the keypad whilst in the Set Speed menu).

Multiple Control Inputs

There may be a requirement for more than one control input option, such as in the case of manual override. The MDC can select either two of the three options or all three options to change the speed of the fan array. Using multiple control inputs prioritises the last instruction received.

Example: with the controller configured to receive control signals from all three sources:

- Using a potentiometer, the control signal is adjusted to 3.5V - fans run at 35% speed
- The BMS then writes a value of 50 to the MDC’s Holding Register 4 – fans increase speed to 50%
- The keypad is then used to slow the fans to 20% speed – the fans decrease their speed to 20%
- The BMS writes 70 to the MDC’s Holding Register 4 – the fans accelerate to 70% speed, etc

⚠ IMPORTANT

If the speed setpoint is changed using the controller’s keypad or the 0-10V input, the latest setpoint is recalled by the controller in the event of a power cycle.

If the speed setpoint is changed using MODBUS, that speed setpoint is not recalled by the controller following a power cycle unless “Save MODBUS Control Speed Setpoint” register is set.

Please see **Appendix E – Modbus Holding Registers** for more details and Caution

5.4.2.1 0-10V Input control option using a potentiometer and 10VDC supply from the fans

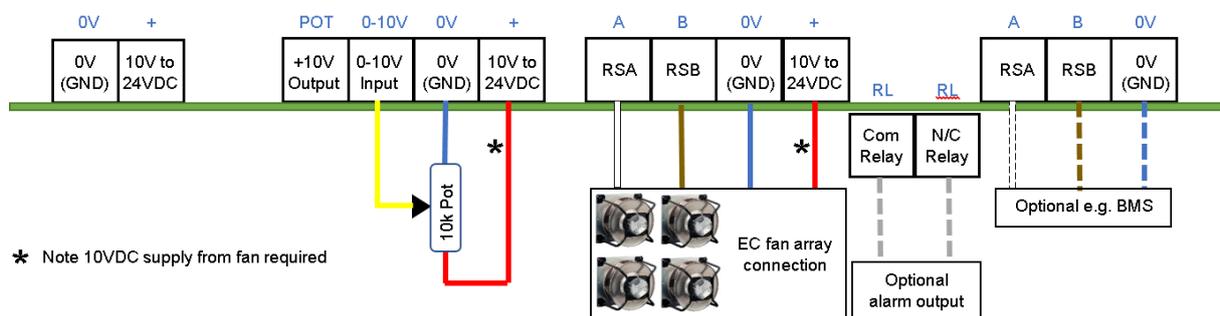


Figure 11 - Typical wiring diagram for Monitor & Control operating mode – potentiometer control signal and fan 10VDC supply

5.4.2.2 0-10V Input control option using potentiometer and the on-board 10VDC supply

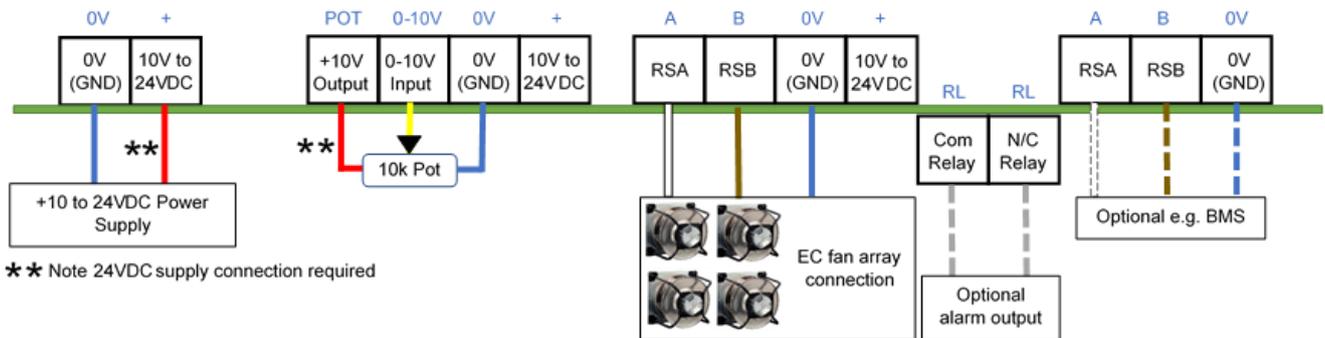


Figure 12 - Typical wiring diagram for Monitor & Control operating mode – potentiometer control signal and on-board 10VDC supply

5.4.2.2 0-10V Input control option using an external 0-10V control signal

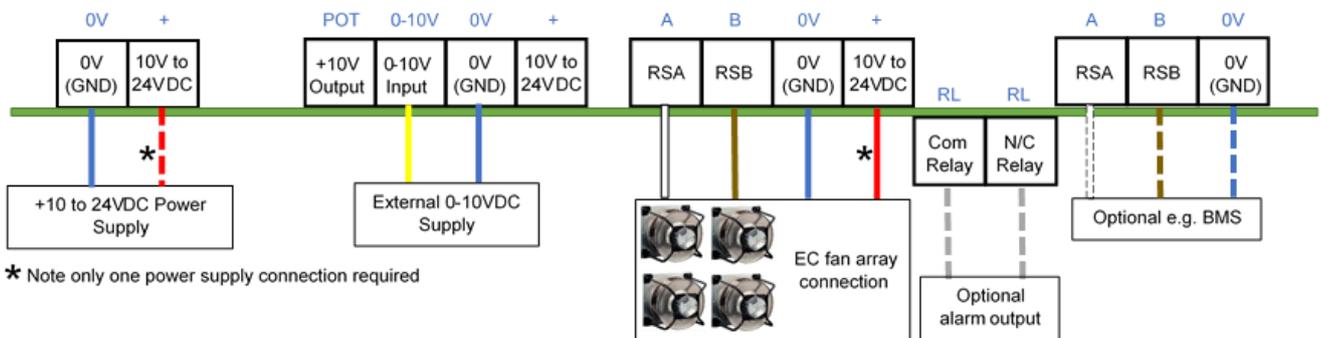


Figure 13 - Typical wiring diagram for Monitor & Control operating mode – external 0-10V control signal

⚠ CAUTION: Risk of damaging the fan if two power supplies are connected at the same time
Do not connect the fan's 10Vdc output to the controller if powering the controller from an external supply

5.4.3 Modbus control option

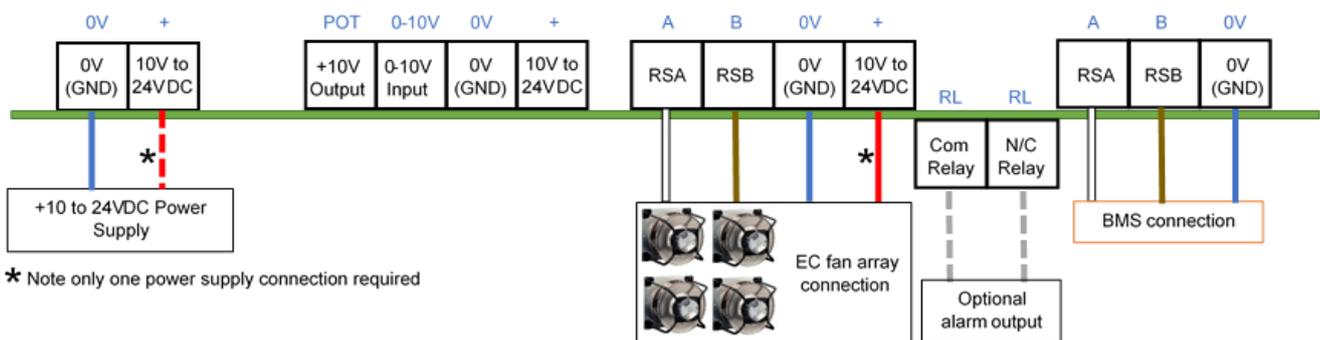


Figure 14 - Typical wiring diagram for Monitor & Control operating mode - Modbus RS485 control signal

⚠ CAUTION: Risk of damaging the fan if two power supplies are connected at the same time
Do not connect the fan's 10Vdc output to the controller if powering the controller from an external supply

5.4.4 Keypad control option

Control via the MDC's keypad on Main Menu -> Set Speed submenu

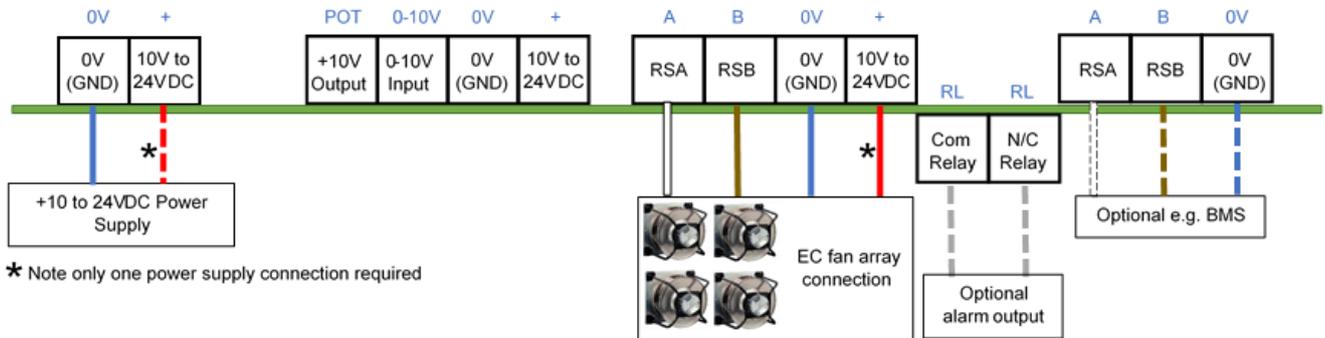


Figure 15 - Typical wiring diagram for Monitor & Control operating mode - keypad control signal

⚠ CAUTION: Risk of damaging the fan if two power supplies are connected at the same time
Do not connect the fan's 10Vdc output to the controller if powering the controller from an external supply

5.4.5 Differential pressure or volume flow measurement when using Modbus and/or Keypad control options

Control via external Modbus master and/or controller's keypad. The 0-10V input is used by the pressure sensor

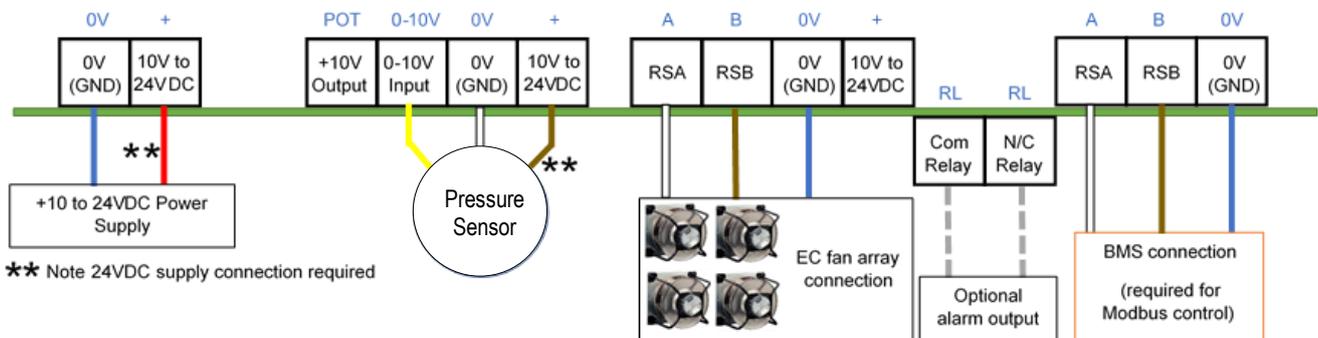


Figure 16 - Typical wiring diagram for Monitor & Control operating mode - using external sensor monitoring

5.5 Constant Volume/Constant Pressure operating mode

5.5.1 General

The MDC can be used with the 0-10V differential pressure sensor to maintain a set point of constant volume or constant pressure of the system in which the fans are installed. The options for controlling the fan array are to maintain a constant volume or constant pressure varying the fan speed based on the voltage output from the sensor and the constant volume or constant pressure set point. The response of the system is adjusted by changing the Proportional, Integral and Derivative (PID) control to determine how fast or slow the fan speed output signal can change.

5.5.2 Constant volume/constant pressure mode

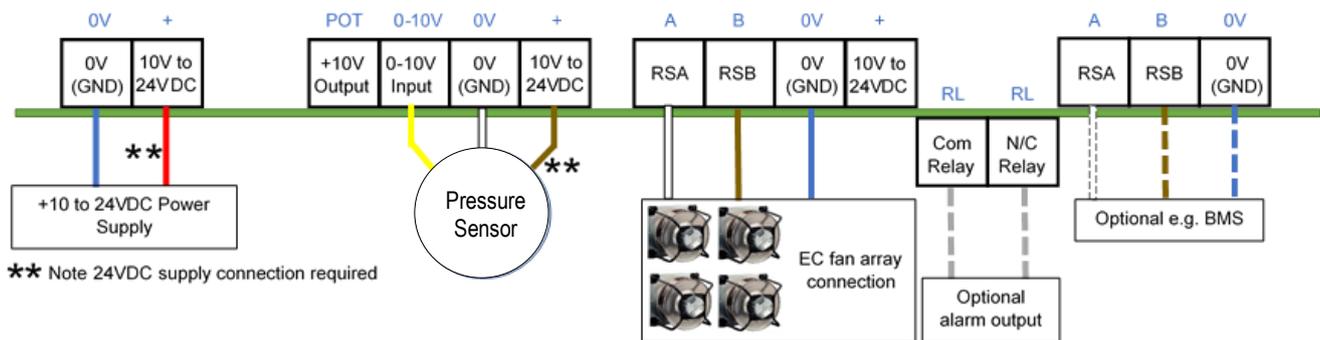


Figure 17 - Typical wiring diagram for Constant volume / Constant pressure operating mode

When in Constant Volume / Constant Pressure operating mode, the Power Meter screen will include a real-time display of the volume / pressure being maintained by the fan array. From the Power Meter screen, it is possible to adjust the constant volume/pressure setpoint by pressing ENTER button twice whilst holding UP and DOWN buttons, see **H6 – Status**. The setpoints can also be adjusted via the Main Menu or via Modbus (see **Appendix E – Modbus Holding Registers** for more details).

It is also possible to enable a sensor alarm in the main menu, see **H17 – Advanced Settings – Alarm Output (Sensor Enabled)**.

If the sensor alarm is enabled, the MDC will trigger an alarm when the fans reach 100% speed and the volume / pressure is below the constant volume / pressure setpoint. There is a time delay from when the alarm condition is sensed to when the MDC opens the alarm relay and turns on the red LED.

Enabling the sensor alarm will also cause the MDC to open the alarm relay and turn on the red LED in case the sensor is accidentally disconnected.

The PID control settings for the Constant Volume / Constant Pressure algorithm can be adjusted using either 'Main Menu>Advanced Settings>PID Settings' or via Modbus - Please see **Appendix E – Modbus Holding Registers** for more details.

5.6 Modbus relay operating mode

The MDC can be installed on an RS485 Modbus network and configured to act as a relay for a BMS or another Modbus master device to access a subnetwork of fans as on the example shown below:

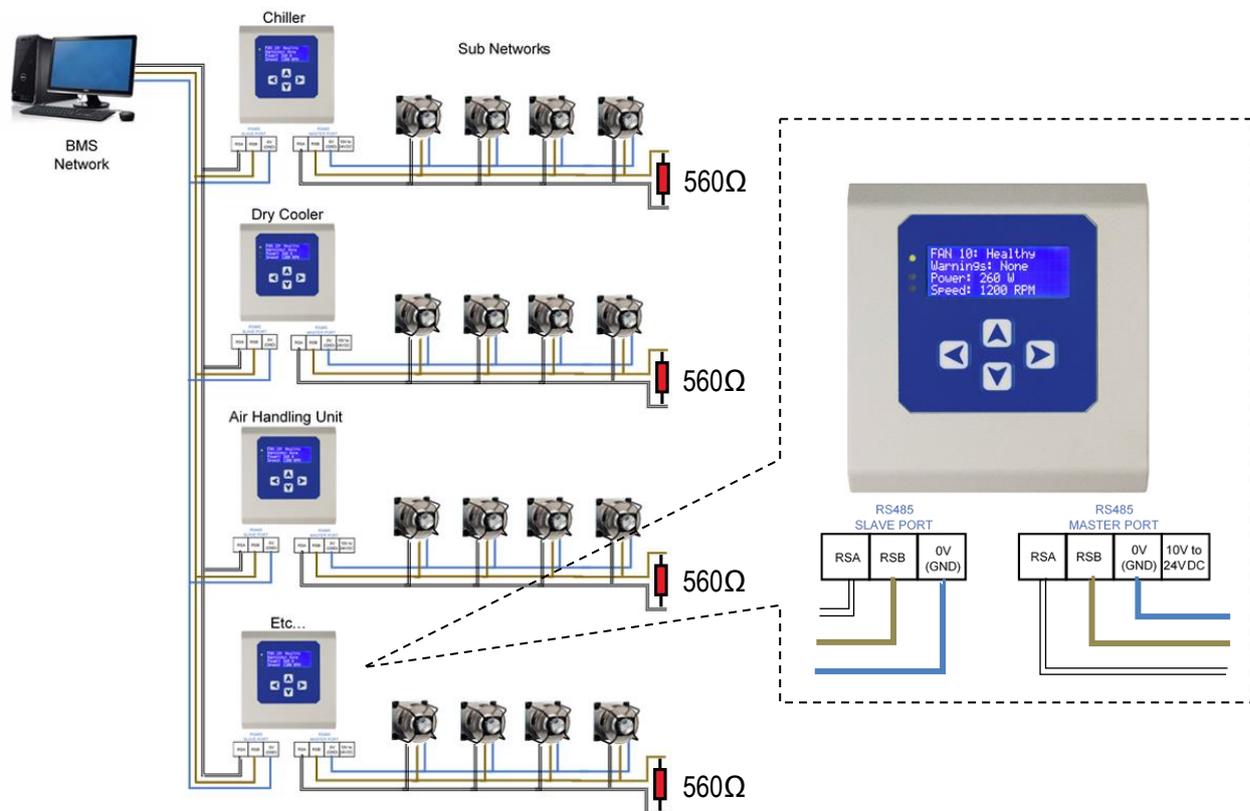


Figure 18 – MDCs operating as Modbus Relays connected to a BMS network and sub-networks of fans

In Modbus Relay mode, the MDC ceases all control and monitoring operations and becomes a relay for messages and commands between a Modbus master and each fan within the fan array. See **H10 – Operation Mode - Modbus Relay** for how to enter Modbus Relay mode.

This operating mode allows full access to the Modbus registers inside each fan according to the ebmpapst parameter specification for Modbus enabled motors version 5. A copy of this parameter specification is available on request by e-mail at info@uk.ebmpapst.com.

See **Appendix G – Example of Modbus Relay Operation** for a working example of the Modbus Relay operation.

NOTE: The MDC re-maps all individual fan Modbus registers to register addresses at the MDC network address e.g. fan 1 holding register D000 is MDC's holding register 200 (hex), fan 2 holding register D000 is MDC's holding register 400 (hex) and so on. Therefore, all subnetworks of fans Modbus registers may be accessed by the BMS. The fan register contents are not stored at the MDC: when an MDC fan register is accessed, this triggers a read/write of data to/from the fan. The data is then passed on by the MDC to the BMS.

See **Appendix E – Modbus Holding Registers** for more details.

5.7 Advanced Settings Submenu

This submenu allows modification to different parameters of the controller and fans, depending on the selected operating mode of the MDC.

- **RPM Limit (See H13 – Advanced Settings – RPM Limit)**

The MDC will transmit a Modbus command via the RS485 network to set the maximum speed limit of the fans in the array. This setting will be stored in non-volatile memory in the fans, after which the fans and controller will perform a power reset to activate the new operating parameters. There are two options available in this sub-menu:

- **RPM Limit All Fans**
 - **Custom RPM:** Broadcasts a custom RPM to all fans
 - **Set to Max RPM:** Read the maximum RPM limit of each fan and use this data to set each fan to its maximum RPM limit
- **RPM Limit Single Fan**
 - Provides a list of all fans and their individual RPM limits allowing the RPM limit of individual fans to be changed
- **0-10V Control Cap (See H14 – Advanced Settings – 0-10V Control Cap):**
 - This option is only available when operating in “Monitor” mode.
 - The MDC will transmit a Modbus command via the RS485 network to set the minimum and maximum control input signal the fan will respond to. This value is broadcast to all fans and stored in their non-volatile memory followed by a power reset to activate the new parameters.
 - The range of values are 0 to 9V for the minimum setpoint and 1V to 10V for the maximum setpoint
- **0-10V Input Cap (See H15 – Advanced Settings – 0-10V Input Cap):**
 - This option is only available when operating in “Monitor & Control” mode.
 - The MDC will store the minimum and maximum setpoints in its non-volatile memory, and will cap the control signal received on its 0-10V input port accordingly
 - The ranges of values are 0 to 9V for the minimum setpoint and 1V to 10V for the maximum setpoint
- **Alarm Output:** There are two options available on this submenu.
 - From Fans (**See H16 – Advanced Settings – Alarm Output (Sensor Disabled)**)
 - Dictates what type of faults will cause the alarm output relay to open:
 - Alarms
 - Warnings
 - Alarms or Warnings
 - Relay Disabled (Default)
 - From Sensor (**See H17 – Advanced Settings – Alarm Output (Sensor Enabled)**)
 - Available only when monitoring a sensor or when in constant volume / pressure operating mode
 - If monitoring a sensor, a threshold must be entered for the relay to open and the red LED to switch on when the sensor reading is below that threshold:
 - Example 1: Using a 500Pa sensor while monitoring pressure (metric) and setting the sensor alarm threshold to 50%, the alarm will trigger when the sensor reading is at 250Pa or below.

- Example 2: Using a 1000Pa sensor while monitoring volume (metric) in a 4-fan array, with a k-factor of 120 (total k-factor of 480), setting the sensor alarm threshold to 50% will cause an alarm when the sensor reading is below 50% of the maximum volume, in this case below 7589 m³/h
 - When in Constant Volume/Pressure mode, the threshold is fixed to 100%. The relay will open, and the red LED will switch on when the fan array reaches 100% and the sensor reading is below the constant volume / constant pressure setpoint.
- **BMS Settings (See H18 – Advanced Settings – BMS Settings)**
 - Configures the parameters of the controller's Modbus slave port
 - The default settings are:
 - Modbus Address: 1
 - Baud Rate: 9600
 - Parity: None
 - Stop Bits: 1
- **Menu Lock (See H19 – Advanced Settings – Main Menu Lock)**
 - Enables/Disables the normal access to the Main Menu screen
 - **Disabled (Default):** main menu is accessible by pressing BACK button twice whilst on Fan 1 status screen
 - **Enabled:** main menu is accessible whilst on Fan 1 status screen by pressing ENTER button twice while holding UP and DOWN buttons
- **LDC Brightness (See H20 – Advanced Settings – LCD Brightness)**
 - Allows a selection of different LCD brightness settings

 **Note:** We recommend leaving the LCD Brightness at its factory default of “Auto-Detect” to avoid display flickering and/or input voltage drop if a higher brightness setting is selected but the power supply to the MDC does not have enough supply current e.g. when powering the MDC using 1 or 2 fan's 10Vdc supply and setting the LCD Backlight to “Maximum”

- **Factory Settings (See H21 – Advanced Settings – Factory Reset)**
 - This will erase any stored information in the controller, and will change all fans to Modbus Address 1
- **Measurement Unit (See H22 – Advanced Settings – Measurement Unit):**
 - This option is only available when monitoring a sensor or when in constant volume / constant pressure operating mode.
 - Selects which measurement unit is used by the MDC depending on the unit type selected:
 - m³/h (cubic metre per hour) or CFM (cubic feet per minute) for volume
 - Pa (Pascal) or in.w.g. (inch water gauge) for pressure
- **PID Settings (See H23 – Advanced Settings – PID Settings):**
 - This option is only available when in constant volume / constant pressure operating mode
 - Allows the configuration of the P, I and D elements of the controller's PID control

 **Caution:** Incorrect PID settings may cause unstable operation of the control loop

5.8 Fan replacement

The MDC allows a single fan in the array to be replaced at a time. It is important that the replacement fan is in its factory default conditions with Modbus Address 1, Baud 19200 and parity 8E1.

When replacing a fan, first go to a status screen of any fan and then, if the fan to be replaced is still operating:

- Disconnect it from the RS485 and wait for the MDC to display this fan's status screen showing that the fan lost its communication
- Replace the fan and connect the new fan to the RS485 network
- Switch the new fan on
- Wait for the MDC to identify the new fan – a new screen should appear see **H4 – Fan Replacement**
- Press ENTER button to add the new fan to the array: the fan number and Modbus address of the replaced fan will be assigned to the replacement fan

6.0 Fault Indication

The fault indication system has been prioritised as per the following:

- Loss of Modbus communication between controller and fans – High Priority
- Fan Alarms – Medium Priority
- Fan Warnings – Low Priority

6.1 Loss of communication and fan alarms

When a fan is being monitored and any fan in the array losses its Modbus communication with the controller, the controller will switch on the red LED and jump to that fan's status screen. The same applies if a fan has an alarm.

However, if another loss of communication or fan alarm is triggered from a different fan in the array, the MDC will jump to that different fan status screen, so it always displays the most recent fan experiencing a loss of communication or fan alarm. Figures 19 and 20 below show a fan that lost its communication and a fan with a single alarm:



Figure 19 - Communication Lost

Figure 20 - Fan Alarm

If a fan has more than one alarm, they will be displayed in a list as they occur, and the alarm counter will increment. The LCD can display up to 3 fan alarms per fan.

In the event of a fan switching off or losing its communication due to one or more alarms, the alarms will (in most cases) be logged inside that fan's MDC dedicated Holding Register. See **Appendix C – Remote Monitoring & Control** for more details.

6.2 Warning indications

Contrasting to a communication loss or a fan alarm, the MDC will not jump to a fan's status screen in the case of a fan warning. Instead, the MDC will switch on the yellow LED, and once that fan's status screen has been located, the fan will have its status changed to "Warning". Figures 21 and 22 below show a single fan that has two warnings:

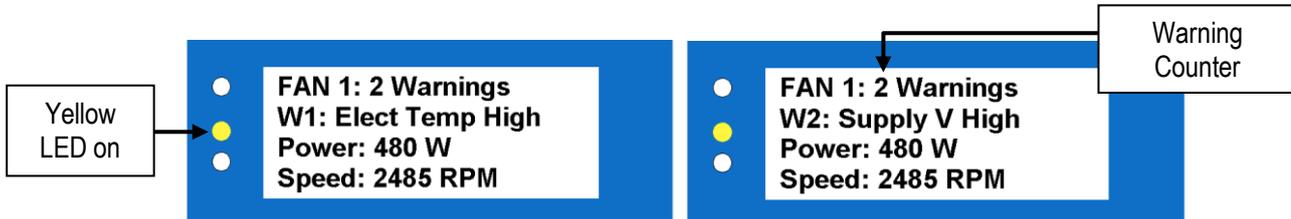


Figure 21 - Example of a first warning on a fan Figure 22 - Example of a second warning on a fan

When a fan has more than one warning, they will be displayed in sequence on the same line, approximately 3 seconds apart from each other e.g. Figures 20 and 21 above are separated by approximately 3 seconds.

⚠ Note: If the fan is switched off after experiencing alarms or warnings, the MDC will, in most cases, save those alarms and/or warnings into their respective holding registers, which are accessible via the MDC's RS485 slave port. These holding registers will be defaulted to '0' if the MDC is power cycled.

7.0 Replacing the controller

If the controller unit becomes faulty and needs to be replaced, ensure the new controller is at its factory default settings before connecting to the fan network, and then select "Fan Addressing" and "Existing Fan Array". Wait for the verification to finish and then either proceed with the suggested number of fans, or manually select the exact number of fans in the array using the UP and DOWN buttons. Confirm by pressing the ENTER button. The controller will then power cycle and display the status screen of Fan 1.

⚠ Note: The new controller will not identify any set points or configuration parameters from its predecessor other than the fan speed control method e.g. Analogue 0-10V or RS485 because that is stored in the fans.

⚠ Note: The new controller must be manually re-configured to fully match its predecessor settings such as Operating Mode, Alarm Mode, BMS settings, etc.

For more information see **H2 – Fan Addressing - Existing Fan Array - Initial Setup**.

8.0 Transport & Storage

- PCBs should be transported in anti-static build-up bag or static dissipative bags.
- Store in a dry environment
- Storage temperature: -30°C to +70°C.

9.0 Maintenance and servicing

There are no user serviceable parts

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10.0 Copy of CE certificate front sheet

Part No - CN1116

0225

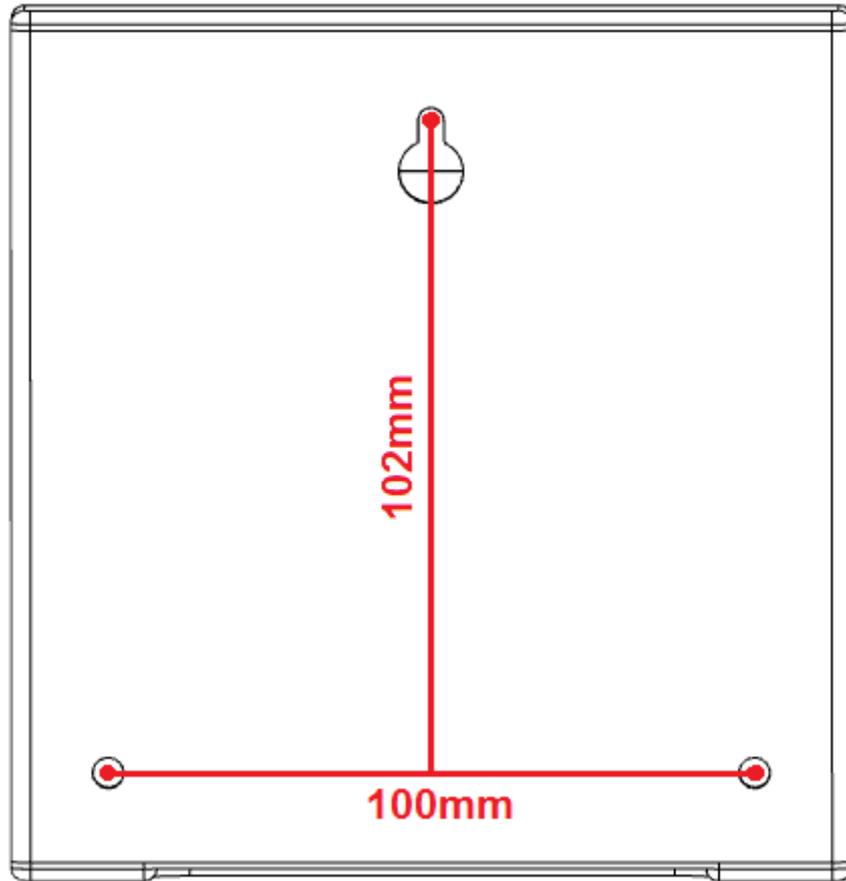
Certificate No - CN1116CE

CE DECLARATION OF CONFORMITY		
Declaration		
We, ebm-papst UK Ltd, Chelmsford Business Park, Chelmsford, Essex CM2 5EZ certify that the product(s) listed are in conformity with;		
Electromagnetic Compatibility Directive 2014/30/EU Household and similar electrical appliances - Safety General Requirements BS EN 60335-1:2012+A13:2017		
	Declaration Approved	Technical File Compiled
Name	G. M. Lockwood	Felipe Pagliarini
Position	Technical Director	Electronic Design Engineer
Signature		
Date of Declaration	07-Sep-2019	07-Sep-2019
Issue / Bug No	Issue 1	Issue 1
Part number:	CN1116	
Description:	Modbus Display & Control	
The product(s) have been assessed by the application of the following Standards; BS EN 60335-1:2012+A13:2017 - Household and similar electrical appliances- Safety General requirements BS EN 61000-4-2 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Electrostatic discharge immunity test. BS EN 61000-4-3 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Radiated, radio-frequency, electromagnetic field immunity test		

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Appendix A – Physical Details

There are two $\varnothing 2.4$ mm (bottom) and one $\varnothing 5$ mm (top) fixing holes available as shown below:



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Appendix B – Electrical Connections

The following is an image of the PCB showing location and identity of connectors and pin functions.

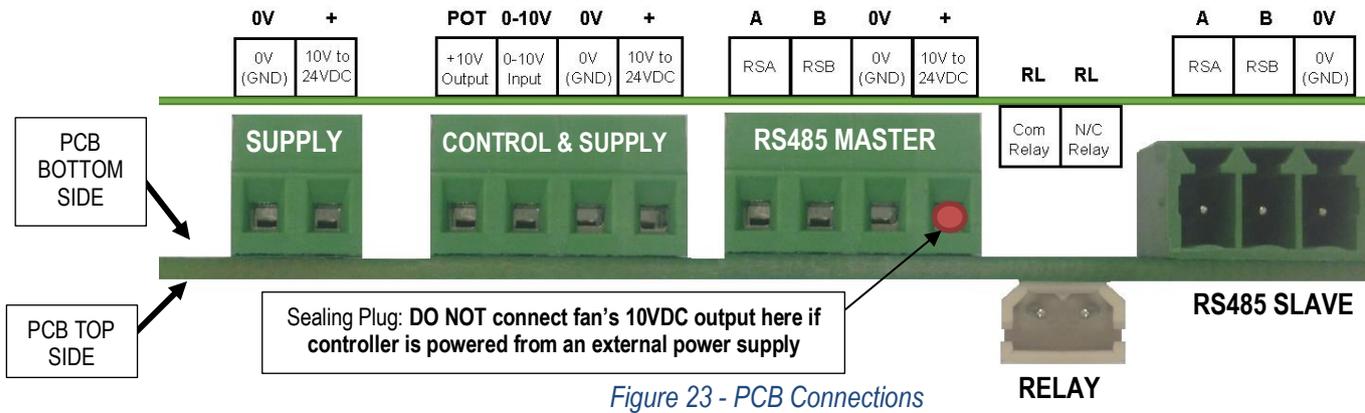


Figure 23 - PCB Connections

PCB Bottom Side	PCB Label	Connection
Supply	0V	Common 0V (GND)
	+	Power Supply +
Control & Supply	POT	+10VDC Output (only when Supply is 24VDC)
	0-10V	Speed Control Input / Pressure Sensor Input
	0V	Common 0V (GND)
	+	Power supply +
RS485 Master (Fans)	A	RS485 'A' from Fans
	B	RS485 'B' from Fans
	0V	Common 0V (GND)
	+	Power supply +
RS485 Slave (BMS or other Modbus Master device)	A	RS485 'A' from 3 rd Party System e.g. BMS
	B	RS485 'B' from 3 rd Party System e.g. BMS
	0V	Common 0V (GND)

Table 4 – PCB Bottom Side Connector Identities and Pin Functions

3-way Pluggable Connector – Manufacturer: IMO Precision Controls – Part Number: 20.1550M/3-E

Note: All “Power supply +” and “+24V” terminals are common (i.e. connected together)
All “0V” terminals are common (i.e. connected together)

PCB Top Side	PCB Label	Connection
Configurable Alarm Output Relay 60V DC max 300mA (2-way)	RL	Common Relay Contact
	RL	Normally Closed Relay Contact

Table 5 – PCB Top Side Connector and Pin Function

2-way Pluggable Connector

Crimp terminal AWG 22 to AWG28

– Manufacturer: Molex – Part Number: 57-37-5023

– Manufacturer Molex – Part number 08-70-1040

Note: There are two other connection points on the controller not detailed in this manual that currently do not have any function

Appendix C – Remote Monitoring & Control

By connecting the MDC to a RS485 Modbus Master device (e.g. BMS) it is possible to remotely monitor and/or control the fan array or individual fans within an array. The MDC response time to Modbus Master requests is 500ms for “locally stored” registers, and 1 second for “retrieved from fan” registers.

The Modbus Master device must have a minimum “Slave Response Timeout” of 1 second when polling “locally stored” registers, 2 seconds when polling “retrieved from fan” registers and 2 seconds when polling both.

The “retrieved from fan” registers are available in any operating mode, whereas in Modbus Relay Mode the “locally stored” fan registers will not be updated.

The supported Modbus Function Codes are: [03] Read Holding Register(s), [04] Read Input Register(s), [05] Write Holding Register and [16] Write Multiple Holding Registers.

⚠ IMPORTANT: Do not read/write more than 13 consecutive “locally stored” registers at a time, or more than 9 consecutive “retrieved from fan” registers at a time, otherwise a Modbus Exception Response will occur. See “Appendix D – Modbus Input Registers” and “Appendix E – Modbus Holding Registers” for details of registers and register types

C.1 Remote Monitoring

The remote monitoring of individual fan parameters is achieved by reading Modbus registers from either the MDC locally stored registers or retrieved from fan registers. The MDC has dedicated local holding registers for each fan, for certain parameters, which hold the same values as those displayed on the LCD. An advantage of using those dedicated registers is that, for example, the fan speed is available from a single “locally stored register” as opposed to reading and combining the values of two “retrieved from the fan” registers to derive the fan speed.

The monitoring of system parameters, such as total power consumption, group alarms, etc is achieved by reading the MDC Input Registers Addresses 1 to 6. See **Appendix D – Modbus Input Registers**

C.2 Remote Fan Array Control

Remote fan array speed control is achieved via Modbus by changing the value of certain MDC Holding Registers such as speed or target pressure/volume. The most common Holding Registers used for remote control are:

- Fan Array Set Speed Register
 - Broadcasts a new speed to all fans within the fan array
- Fan Array RPM Limit
 - Broadcasts a new RPM limit value to all fans within the fan array
- Target Constant Pressure
 - Sets a new target pressure setpoint
- Target Constant Volume
 - Sets a new target volume setpoint

See **Appendix E – Modbus Holding Registers** for more details

⚠ NOTE: Remote fan array control is only available during “Monitor & Control”, “Constant Volume/Pressure” or “Modbus Relay” operating modes

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C.3 Remote Single Fan Speed Control

To remotely control the speed of a single fan in the array, the MDC must be either set to “Modbus Relay” mode (see **Appendix G – Example of Modbus Relay Operation**) or set to “Monitor Only” operating mode, and then manually change each fan’s “Set Value Source” register value to “RS485” via Modbus.

Appendix D – Modbus Input Registers

ADDR (hex)	DESCRIPTION	VALUE RANGE	DETAILS
Controller’s Dedicated Modbus Input Registers (Locally Stored Registers)			
0	MDC FIRMWARE REVISION	0 TO 65535	N/A
1	TOTAL NUMBER OF FANS	1 TO 100	FANS ADDRESSED AND CONNECTED TO THE MDC
2	TOTAL FANS WITH ALARMS	0 TO 100	FANS DISPLAYING ONE OR MORE ALARM CONDITION
3	TOTAL NON-RESPONSIVE FANS	0 TO 100	FANS NOT RESPONDING TO MODBUS MESSAGES FROM THE MDC
4	TOTAL FANS WITH WARNINGS	0 TO 100	FANS DISPLAYING ONE OR MORE WARNING CONDITIONS
5	TOTAL POWER CONSUMPTION	0 TO 65535	REGISTER VALUE IS: $\frac{\text{Total Power Consumption}}{10}$
6	SENSOR READING	0 TO 65535	REGISTER VALUE DEPENDS ON THE SELECTED MEASUREMENT UNIT *(see below)
7	MDC FAN STATUS HOLDING REGISTERS UPDATE FLAG	0 AND 1	REGISTER VALUE WILL CYCLE BETWEEN 0 AND 1 EACH TIME THE MDC HAS FINISHED UPDATING THE VALUES OF ALL REGISTERS AT ADDRESSES STARTING AT CB00 UP TO: $CB00 + (\text{Number of Fans} * 0x80)$
Direct Access to Individual Fan Input Registers (Retrieved from Fan Registers)			
200-3FF	FAN 1 INPUT REGISTERS D000-D2FF		
400-5FF	FAN 2 INPUT REGISTERS D000-D2FF		
C800-C9FF	FAN 100 INPUT REGISTERS D000-D2FF		

Table 6 - Modbus Input Registers

*** MDC Input Register Address 6 Value:**

If measurement unit is m³/h: $\frac{m^3/h}{10}$

If measurement unit is Pa: *Pa*

If measurement unit is cfm: $\frac{cfm}{10}$

If measurement unit is in.w.g: *in.w.g* * 1000

⚠ IMPORTANT: Do not to read/write more than 13 consecutive “locally stored” registers at a time, or more than 9 consecutive “retrieved from fan” registers at a time, otherwise a Modbus Exception Response will occur

Appendix E – Modbus Holding Registers

ADDR (hex)	DESCRIPTION (Locally Stored Registers)
0	Operating Mode
1	Save MODBUS Control Speed Setpoint (<i>See Caution Below</i>)
2	MDC 0-10V Input Control Mode Enable/Disable
3	Keypad Control Mode Enable/Disable
4	Fan Array Set Speed Register
5	Menu Lock Enable/Disable
6	Fan Array RPM Limit
7	Fan Array Maximum RPM Limit
8	MDC Alarm Mode
9	Sensor Alarm Enable/Disable
A	Sensor Alarm Threshold
B	External Pressure Sensor Monitoring Enable/Disable
C	Constant Flow Unit (Pressure or Volume)
D	Sensor Measurement Unit (metric or imperial)
E	Sensor Type (50Pa, 200Pa, 500Pa, 1000Pa or 2000Pa)
F	Fan k-Factor
10	Target Constant Pressure
11	Target Constant Volume
12	PID P Value
13	PID I Value
14	PID D Value
15	Controller Uptime (High Bytes)
16	Controller Uptime (Low Bytes)

Table 7 – Controller's Dedicated Modbus Holding Registers Part 1

⚠ IMPORTANT: Do not to read/write more than 13 consecutive “locally stored” registers at a time otherwise a Modbus Exception Response will occur

ADDR (hex)	DESCRIPTION (Locally Stored Registers)
CB00	FAN 1 - FAN RESPONSIVE (1=YES / 0= NO)
CB01	FAN 1 - ALARM REGISTER 1 (SEE APPENDIX F)
CB02	FAN 1 - ALARM REGISTER 2 (SEE APPENDIX F)
CB03	FAN 1 - WARNING REGISTER 1 (SEE APPENDIX F)
CB04	FAN 1 - WARNING REGISTER 2 (SEE APPENDIX F)
CB05	FAN 1 - WARNING REGISTER 3 (SEE APPENDIX F)
CB06	FAN 1 - POWER (W)
CB07	FAN 1 - SPEED (RPM)
CB08	FAN 1 - RPM LIMIT (RPM)
CB09	FAN 1 - MOTOR TEMPERATURE (°C)
CB0A	FAN 1 - ELECTRONICS TEMPERATURE (°C)
CB0B	FAN 1 - HOURS RUN (hours)
CB0C	FAN 1 - CONTROL (0-100%)
CB80	FAN 2 - FAN RESPONSIVE (1=YES / 0= NO)
CB81	FAN 2 - ALARM REGISTER 1 (SEE APPENDIX F)
CB82	FAN 2 - ALARM REGISTER 2 (SEE APPENDIX F)
CB83	FAN 2 - WARNING REGISTER 1 (SEE APPENDIX F)
CB84	FAN 2 - WARNING REGISTER 2(SEE APPENDIX F)
CB85	FAN 2 - WARNING REGISTER 3 (SEE APPENDIX F)
CB86	FAN 2 - POWER (W)
CB87	FAN 2 - SPEED (RPM)
CB88	FAN 2 - RPM LIMIT (RPM)
CB89	FAN 2 - MOTOR TEMPERATURE (°C)
CB8A	FAN 2 - ELECTRONICS TEMPERATURE (°C)
CB8B	FAN 2 - HOURS RUN (hours)
CB8C	FAN 2 - CONTROL (0-100%)
ETC	

Table 8 – Controller’s Dedicated Modbus Holding Registers Part 2

Direct Access to Individual Fan Holding Registers (Retrieved from Fan Registers)	
200-3FF	FAN 1 HOLDING REGISTERS D000-D2FF
400-5FF	FAN 2 HOLDING REGISTERS D000-D2FF
C800-C9FF	FAN 100 HOLDING REGISTERS D000-D2FF

Table 9 – Direct Access to Individual Fan Holding Registers

⚠ IMPORTANT: Do not to read/write more than 13 consecutive “locally stored” registers at a time, or more than 9 consecutive “retrieved from fan” registers at a time, otherwise a Modbus Exception Response will occur

Fan	Address (Hex)						
1	CB00	26	D780	51	E400	76	F080
2	CB80	27	D800	52	E480	77	F100
3	CC00	28	D880	53	E500	78	F180
4	CC80	29	D900	54	E580	79	F200
5	CD00	30	D980	55	E600	80	F280
6	CD80	31	DA00	56	E680	81	F300
7	CE00	32	DA80	57	E700	82	F380
8	CE80	33	DB00	58	E780	83	F400
9	CF00	34	DB80	59	E800	84	F480
10	CF80	35	DC00	60	E880	85	F500
11	D000	36	DC80	61	E900	86	F580
12	D080	37	DD00	62	E980	87	F600
13	D100	38	DD80	63	EA00	88	F680
14	D180	39	DE00	64	EA80	89	F700
15	D200	40	DE80	65	EB00	90	F780
16	D280	41	DF00	66	EB80	91	F800
17	D300	42	DF80	67	EC00	92	F880
18	D380	43	E000	68	EC80	93	F900
19	D400	44	E080	69	ED00	94	F980
20	D480	45	E100	70	ED80	95	FA00
21	D500	46	E180	71	EE00	96	FA80
22	D580	47	E200	72	EE80	97	FB00
23	D600	48	E280	73	EF00	98	FB80
24	D680	49	E300	74	EF80	99	FC00
25	D700	50	E380	75	F000	100	FC80

Table 10 - Full Modbus Register Map for Locally Stored Holding Registers

Each fan has a set of dedicated holding registers locally stored in the MDC, which are automatically updated. The fan parameters stored in those registers is available on Table 8.

⚠ NOTE: These registers are not automatically updated during Modbus Relay operating mode

Operating Mode –Sets the MDC Operating Mode

Address (Hex): 0

Availability: All operating modes

Values: 0=Monitor (default) / 1=Monitor & Control / 2=Constant Volume/Constant Pressure / 3=Transparent Mode

NOTE: Value is stored in non-volatile memory in the MDC

Save MODBUS Control Speed Setpoint–Enables the latest change at Fan Array Set Speed Register to be saved in the controller’s non-volatile memory

Address (Hex): 1

Availability: Monitor & Control Mode

Values: 0=OFF (default) / 1=ON

⚠ CAUTION: The “Save MODBUS Control Speed Setpoint” register must not be activated if the “Fan Array Set Speed” register is repeatedly write accessed at frequent intervals

If this instruction is not observed, there is a risk the controller’s memory will be permanently destroyed

If this function is activated, the maximum number of times “Fan Array Set Speed” can be write accessed over the entire service life of the controller is 10,000

MDC 0-10V Input Control Mode – Allows the fan array to be controlled via a 0-10V signal fed to the MDC’s 0-10V input

Address (Hex): 2

Availability: Monitor & Control

Values: 0=OFF / 1=ON (default)

NOTE: Value is stored in non-volatile memory in the MDC

Keypad Control Mode– Allows the fan array to be speed controlled using the MDC’s keypad

Address (Hex): 3

Availability: Monitor & Control

Values: 0=OFF (default) / 1=ON

NOTE: Value is stored in non-volatile memory in the MDC

Fan Array Set Speed Register – Sets the speed of the fan array

Address (Hex): 4

Availability: Monitor & Control

Values: 0 to 100 (%)

NOTE: Register available only when “Modbus” control mode is one of the selected control modes

Menu Lock – Enables menu lock from fan status screen

Address (Hex): 5

Availability: Monitor, Monitor & Control, Constant Volume/Constant Pressure, Modbus Relay

Values: 0=OFF (default) / 1=ON

NOTE: Value is stored in non-volatile memory in the MDC

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Fan Array RPM Limit – Sets all fan’s RPM limit to this value

Address (Hex): 6

Availability: Monitor, Monitor & Control

Values: 0 to Max RPM (fan datasheet). If value is set too high, it will be automatically capped to the fan’s maximum RPM limit

NOTE: Value is stored in non-volatile memory in the fans

Fan Array Maximum RPM Limit – Automatically set each fan to its maximum RPM limit

Address (Hex): 7

Availability: Monitor, Monitor & Control

Values: 0=OFF / 1=ON (returns to 0 after command completes)

NOTE: RPM limit value is stored in non-volatile memory in the fans

MDC Alarm Mode –Type of faults that cause the MDC alarm output relay to open

Address (Hex): 8

Availability: Monitor, Monitor & Control, Constant Volume/Constant Pressure

Values: 0 = Fan Alarms / 1 = Fan Warnings / 2 = Fan Alarms & Fan Warnings / 3 = Disabled (Default)

NOTE: Value is stored in non-volatile memory in the MDC

Sensor Alarm – Alarm active if pressure sensor reads above a certain threshold

Address (Hex): 9

Availability: Monitor Only, Monitor & Control, Constant Volume/Constant Pressure

Values: 0=OFF (default) / 1=ON

NOTES: Value is stored in non-volatile memory in the MDC. If controller is set to Constant Volume/Pressure mode, then an alarm will be generated whenever the fan array reaches 100% speed and is not able to reach the target pressure/volume setpoint. An alarm is also triggered when the pressure sensor is disconnected from the MDC.

Sensor Alarm Threshold – The threshold used to trip the alarm output once Sensor Reading exceeds the threshold value.

Address (Hex): A

Availability: Monitor, Monitor & Control

Values: 0 to 100 (%). Default is 50.

NOTE: Value is stored in non-volatile memory in the MDC. If operating mode is Constant Volume/Constant Pressure, the value of this register is fixed to 100

External Pressure Sensor Monitoring – Enables/disables the monitoring of a 0-10V pressure sensor

Address (Hex): B

Availability: Monitor, Monitor & Control

Values: 0=OFF (default) / 1=ON

NOTE: Value is stored in non-volatile memory in the MDC. The value of this register is irrelevant during Constant Volume / Constant Pressure operation.

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Constant Flow Unit – Type of unit used by the MDC to process the sensor readings

Address (Hex): C

Availability: Monitor, Monitor & Control, Constant Volume/Constant Pressure

Values: 0=Volume (default) / 1=Pressure

NOTE: Value is stored in non-volatile memory in the MDC

Sensor Measurement Unit – Type of pressure unit (Pa or in.w.g) or volume unit (m3/h or CFM) used for display and/or control purposes

Address (Hex): D

Availability: Monitor, Monitor & Control, Constant Volume/Constant Pressure

Values: 0 (default) Metric / 1= Imperial

NOTES: Value is stored in non-volatile memory in the MDC.

Sensor Type – Type of pressure sensor attached to the MDC

Address (Hex): E

Availability: Monitor, Monitor & Control, Constant Volume/Constant Pressure

Values: 0=50Pa (default) / 1=200Pa / 2=500Pa / 3=1000Pa / 4=2000Pa

NOTE: Value is stored in non-volatile memory in the MDC

Fan k-Factor – The fan k-Factor used during Volume Flow monitoring or Constant Volume operation

Address (Hex): F

Availability: Monitor, Monitor & Control, Constant Volume/Constant Pressure

Values: 0 (default) to 1200

NOTES: Value is stored in non-volatile memory in the MDC. Sensor Unit must be set to 0

Target Pressure – Sets the target pressure to be maintained by the fan array

Address (Hex): 10

Availability: Constant Volume/Constant Pressure

Minimum value = 0

Maximum Value:

$$Pa = \textit{SensorRange}$$

$$\text{inwg} = (\textit{SensorRange} * 0.004014631332) * 1000$$

NOTES: Value is stored in non-volatile memory in the MDC.

Target Volume – Sets the target volume to be maintained by the fan array

Address (Hex): 11

Availability: Constant Volume/Constant Pressure

Minimum value = 0

Maximum Value:

$$m^3/h = \frac{\sqrt{SensorRange} * (fan_k_factor * total_number_of_fans)}{10}$$

$$cfm = \frac{(\sqrt{SensorRange} * (fan_k_factor * total_number_of_fans)) * 0.588577778691}{10}$$

NOTES: Value is stored in non-volatile memory in the MDC

PID P-Value – Sets the proportional value of the controller’s PID control algorithm

Address (Hex): 12

Availability: Constant Volume/Constant Pressure

Values: 0 to 1000 (default = 15)

NOTE: Value is stored in non-volatile memory in the MDC

PID I-Value – Sets the integral value of the controller’s PID control algorithm

Address (Hex): 13

Availability: Constant Volume/Constant Pressure

Values: 0 to 1000 (default = 30)

NOTE: Value is stored in non-volatile memory in the MDC

PID D-Value – Sets the derivative value of the controller’s PID control algorithm

Address (Hex): 14

Availability: Constant Volume/Constant Pressure

Values: 0 to 1000 (default = 0)

NOTE: Value is stored in non-volatile memory in the MDC

Controller Uptime High Bytes – Higher 16-bits of the Controller Uptime counter

Address (Hex): 15

Controller Uptime Low Bytes – Lower 16-bits of the Controller Uptime counter

Address (Hex): 16

NOTE: The Controller Uptime counter is in seconds and stored as unsigned integer. This counter will reset at every power cycle.

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Appendix F – Alarms and Warnings Holding Registers Breakdown

ALARMS REGISTERS	
ALARM REGISTER 1 VALUE	ALARM TYPE
10000	MAINS UNDERVOLTAGE
1000	POWER MODULE OVERHEATED
100	MASTER/SLAVE COMMS ERROR
10	MOTOR OVERHEATED
1	HALL SENSOR ERROR
ALARM REGISTER 2 VALUE	ALARM TYPE
10	MOTOR LOCKED
1	DC-LINK UNDERVOLTAGE

Table 11 – Alarms Registers Breakdown

EXAMPLE: If a fan has “Hall Sensor Error” and “Motor Overheated” alarms then:

Alarm Register 1 = 11

Alarm Register 2 = 0

WARNINGS REGISTERS	
WARNING REGISTER 1 VALUE	WARNING TYPE
10000	CURRENT LIMIT
1000	HIGH LINE IMPEDANCE
100	POWER LIMITATION IN MESH
10	OUTPUT STAGE TEMPERATURE HIGH
1	MOTOR TEMPERATURE HIGH
WARNING REGISTER 2 VALUE	WARNING TYPE
10000	ELECTRONICS TEMPERATURE HIGH
1000	LOW DC-LINK VOLTAGE
100	BRAKE OPERATION
10	ACTUAL SPEED LESS THAN LIMIT SPEED
1	CABLE BREAK
WARNING REGISTER 3 VALUE	WARNING TYPE
1000	HEATING ACTIVATED
100	HIGH DC-LINK VOLTAGE
10	HIGH SUPPLY VOLTAGE
1	SHEDDING FUNCTION

Table 12 – Warning Registers Breakdown

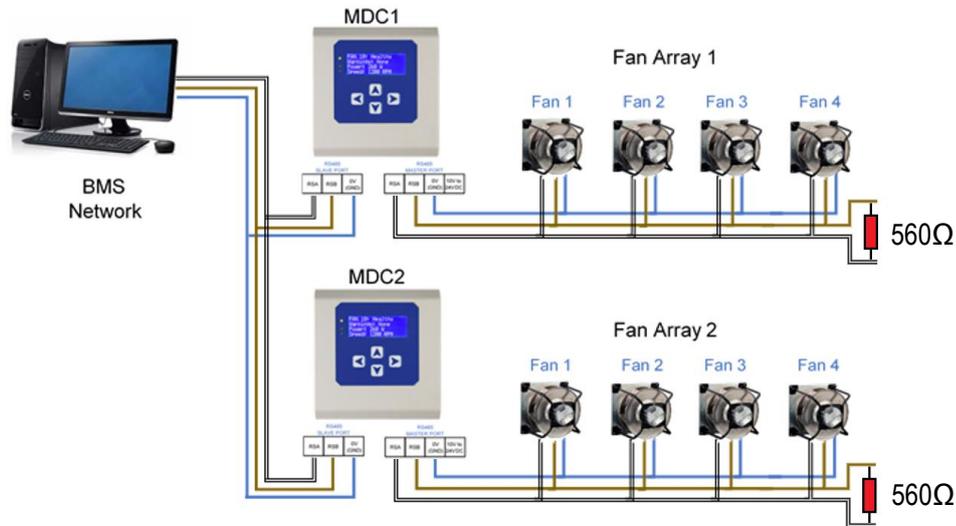
EXAMPLE: If fan has “High Line Impedance”, “Cable Break” and “Low DC-Link Voltage” warnings then:

Warning Register 1 = 1000

Warning Register 2 = 1001

Warning Register 3 = 0

Appendix G – Example of Modbus Relay Operation



Initial Configuration Steps

- BMS Network has slave addresses 1 and 2 available i.e. not taken by any other device
- Both MDCs have successfully addressed all their respective fans
- Both MDCs have changed their operating mode to “Monitor & Control” (the control mode is not important)
 - See **H8 – Operation Mode - Monitor & Control**
 - This step is purely taken to set all fans to “Modbus” speed control as opposed to their factory settings of “Analogue 0-10V” speed control
- MDC1 Modbus Slave address is kept at its factory setting value of “1”
- MDC2 Modbus Slave address has been changed to “2”
 - See **H18 – Advanced Settings – BMS Settings**
- Both MDCs have changed their operating mode to “Modbus Relay”
 - See **H10 – Operation Mode - Modbus Relay**

Example of setting the speed of Fan 4 (at Fan Array 1) to 100%: BMS writes “65535” to holding register address (hex) 801 of MDC2 at Modbus slave address 1, which causes the controller to write that value to the fan

Example of reading the Motor Status Register of Fan 3 (at Fan Array 2): BMS reads input register address (hex) 40B of MDC 2 at Modbus slave address 2, which causes the controller to retrieve the status of that fan and respond to the BMS with that value

⚠ IMPORTANT: Do not to read/write more than 9 consecutive “retrieved from fan” registers at a time, otherwise a Modbus Exception Response will occur

⚠ NOTE: The MDC will respond to the BMS after the communication with the fan has completed. A Modbus Exception Response will be returned to the BMS if the read/write to the fan has failed

Fan	Address (Hex)						
1	200	26	3400	51	6600	76	9800
2	400	27	3600	52	6800	77	9A00
3	600	28	3800	53	6A00	78	9C00
4	800	29	3A00	54	6C00	79	9E00
5	A00	30	3C00	55	6E00	80	A000
6	C00	31	3E00	56	7000	81	A200
7	E00	32	4000	57	7200	82	A400
8	1000	33	4200	58	7400	83	A600
9	1200	34	4400	59	7600	84	A800
10	1400	35	4600	60	7800	85	AA00
11	1600	36	4800	61	7A00	86	AC00
12	1800	37	4A00	62	7C00	87	AE00
13	1A00	38	4C00	63	7E00	88	B000
14	1C00	39	4E00	64	8000	89	B200
15	1E00	40	5000	65	8200	90	B400
16	2000	41	5200	66	8400	91	B600
17	2200	42	5400	67	8600	92	B800
18	2400	43	5600	68	8800	93	BA00
19	2600	44	5800	69	8A00	94	BC00
20	2800	45	5A00	70	8C00	95	BE00
21	2A00	46	5C00	71	8E00	96	C000
22	2C00	47	5E00	72	9000	97	C200
23	2E00	48	6000	73	9200	98	C400
24	3000	49	6200	74	9400	99	C600
25	3200	50	6400	75	9600	100	C800

Table 13 – Full Modbus Relay Register Map (retrieved from fan registers)

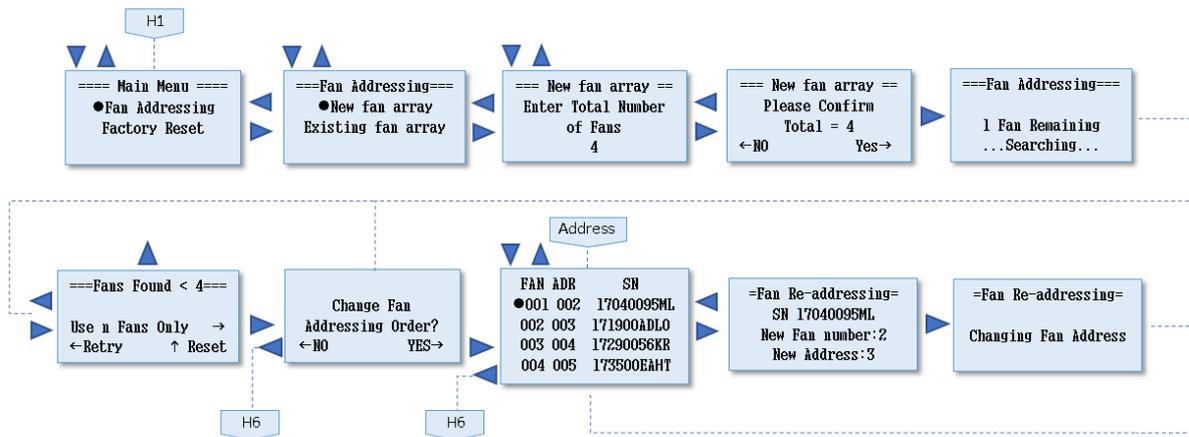
Each MDC address above corresponds to that fan's local address D000.

Example: Fan 1 Register D000 is MDC Slave Register Address 200 (HEX), Fan 1 Register D001 is MDC Slave Register Address 201 (HEX), etc

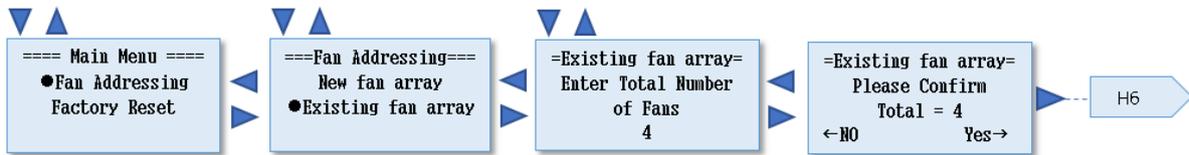
This table applies to both Holding and Input registers.

Appendix H – Menu Structure Flow Chart

H1 – Fan Addressing - New Fan Array -Initial Setup



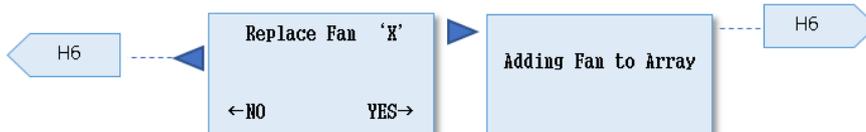
H2 – Fan Addressing - Existing Fan Array - Initial Setup



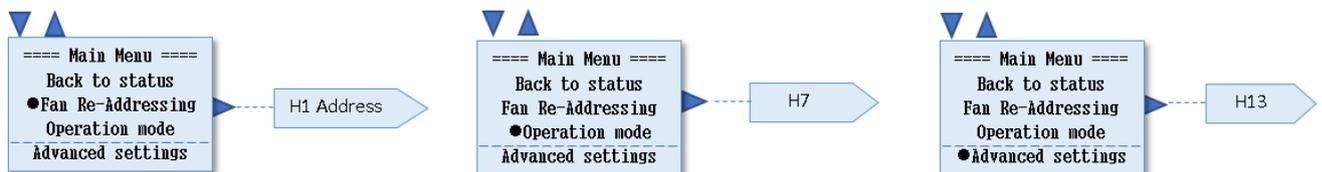
H3 – Initial Factory Reset



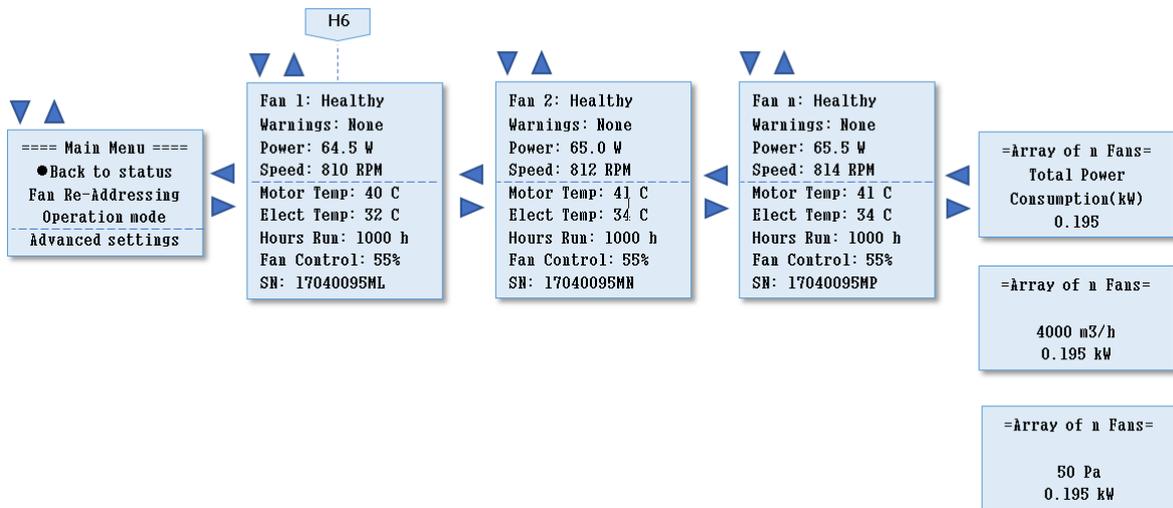
H4 – Fan Replacement



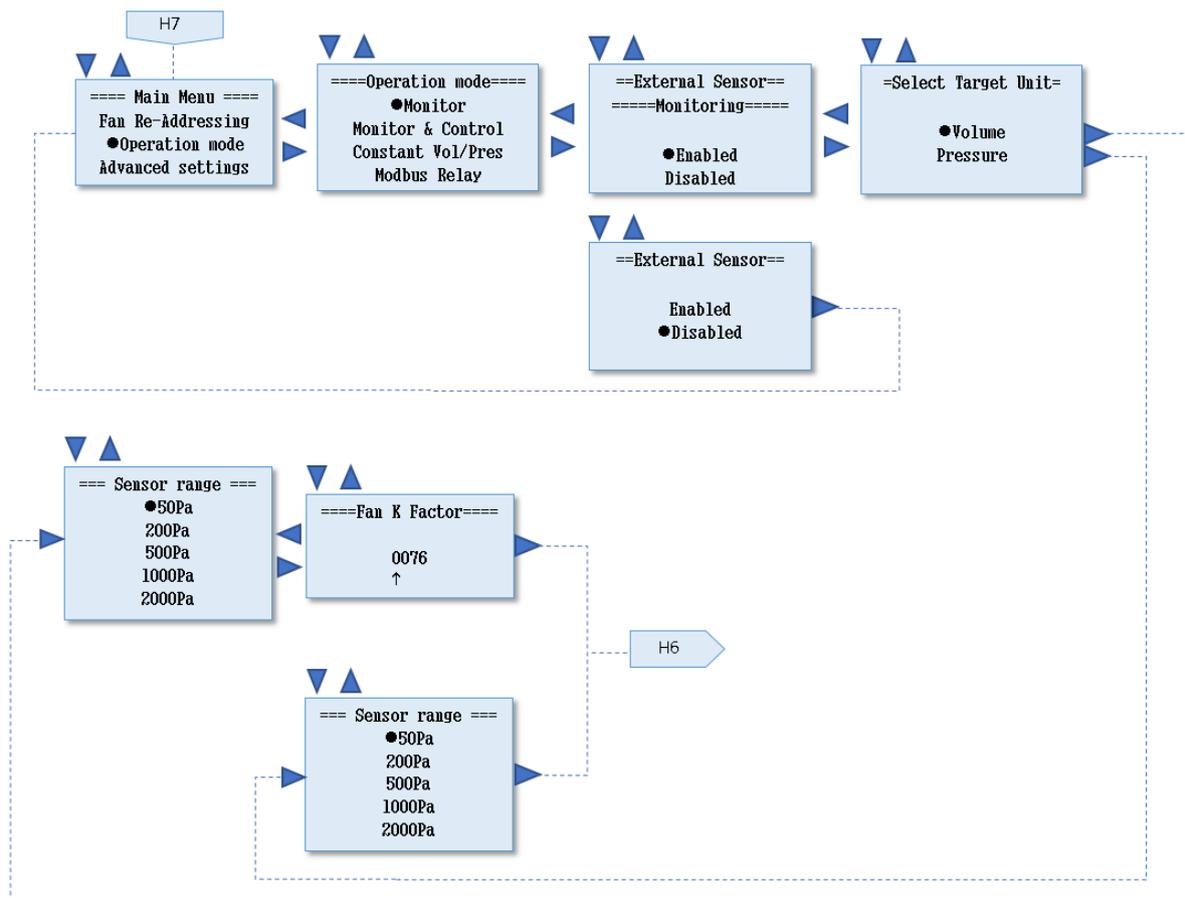
H5 – Main Menu



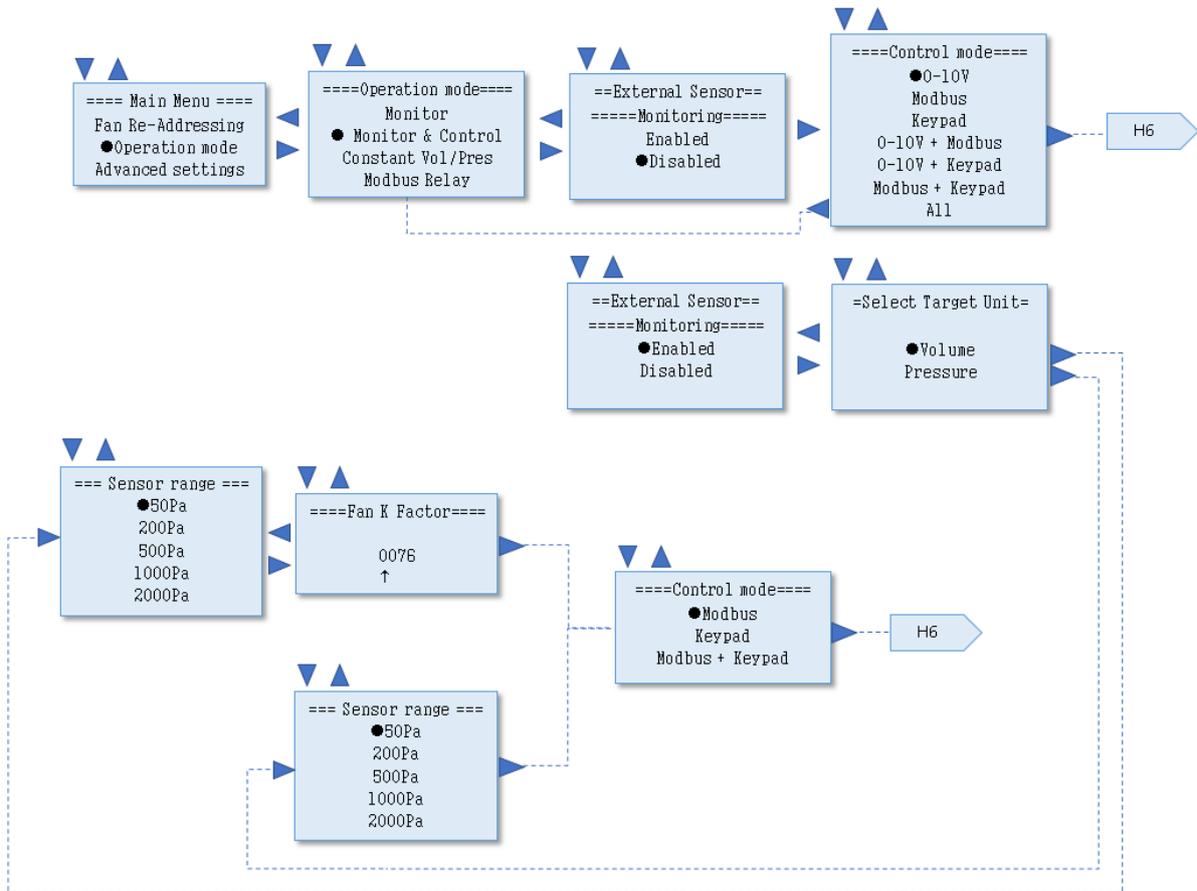
H6 – Status



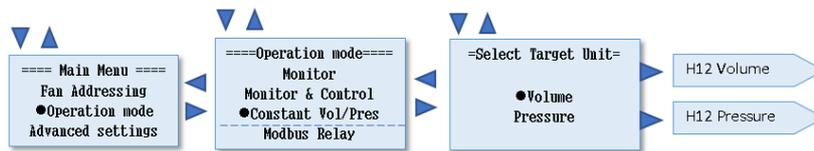
H7 – Operation Mode – Monitor



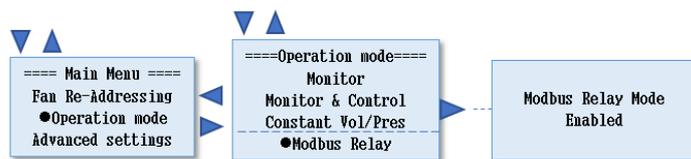
H8 – Operation Mode - Monitor & Control



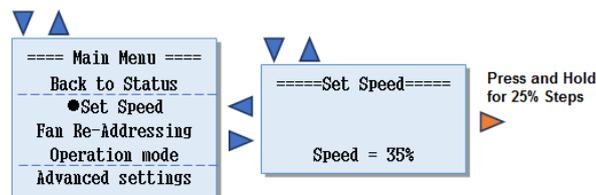
H9 – Operation Mode - Constant Volume / Constant Pressure



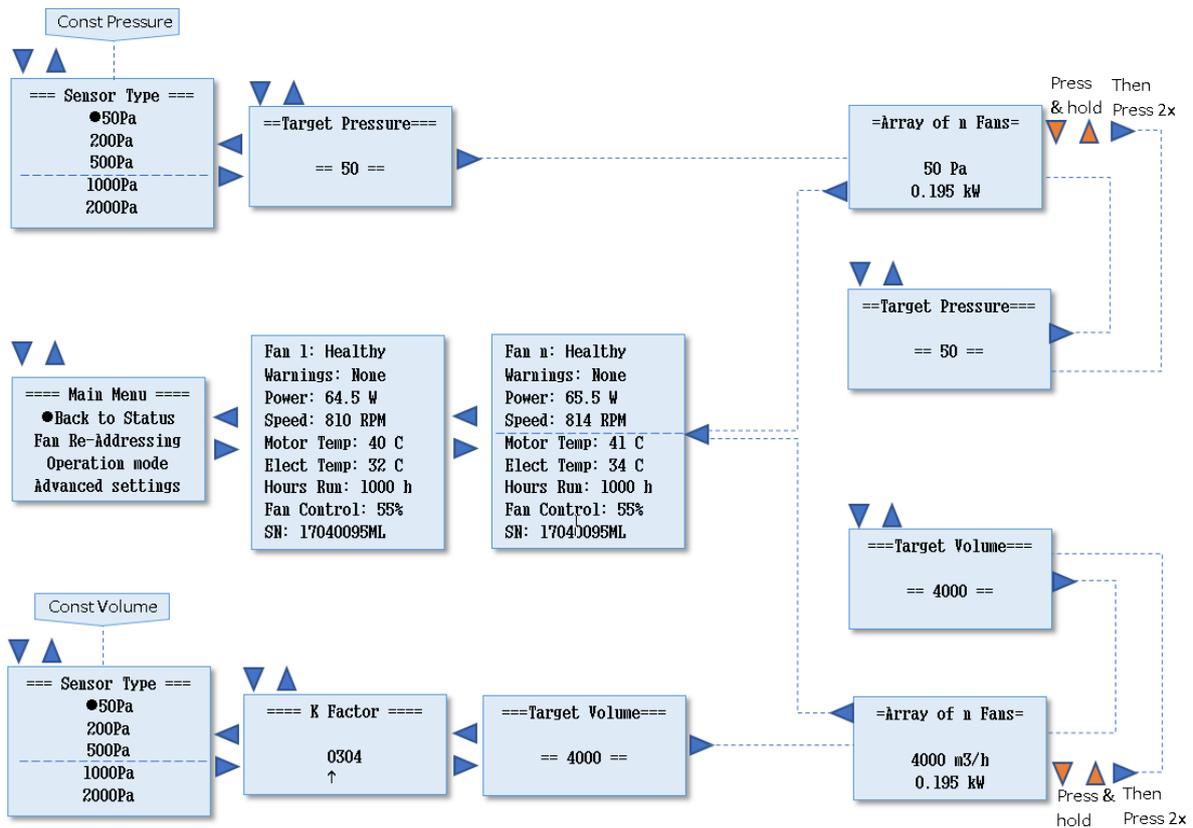
H10 – Operation Mode - Modbus Relay



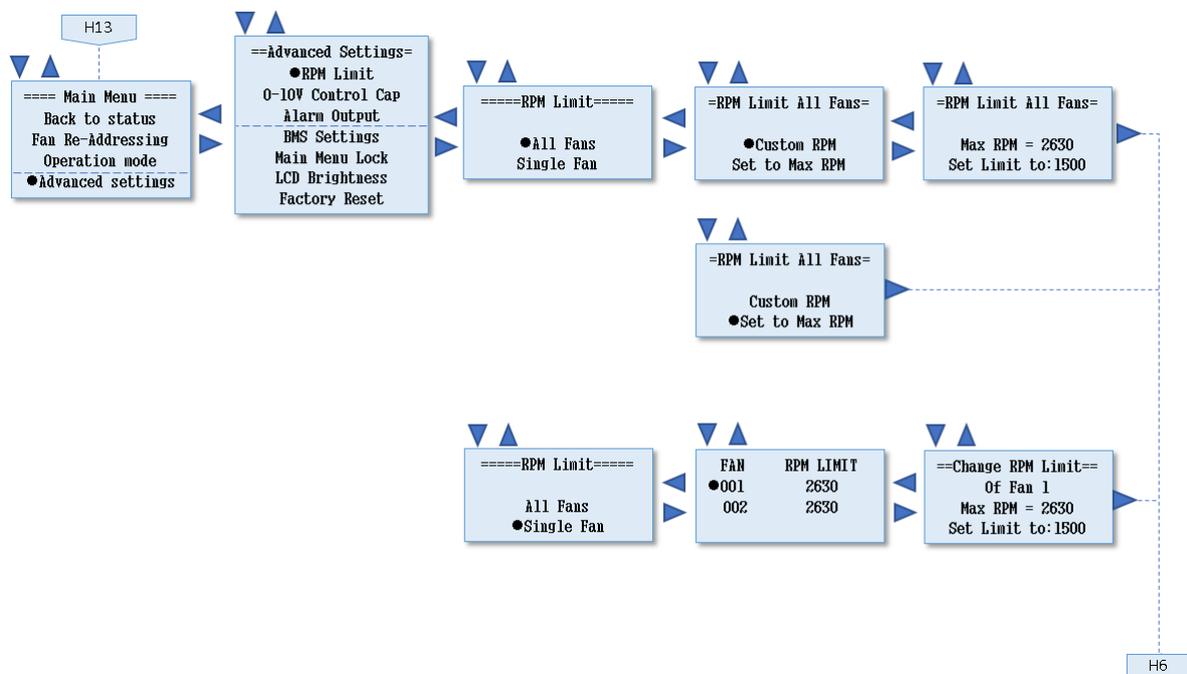
H11 – Keypad Control



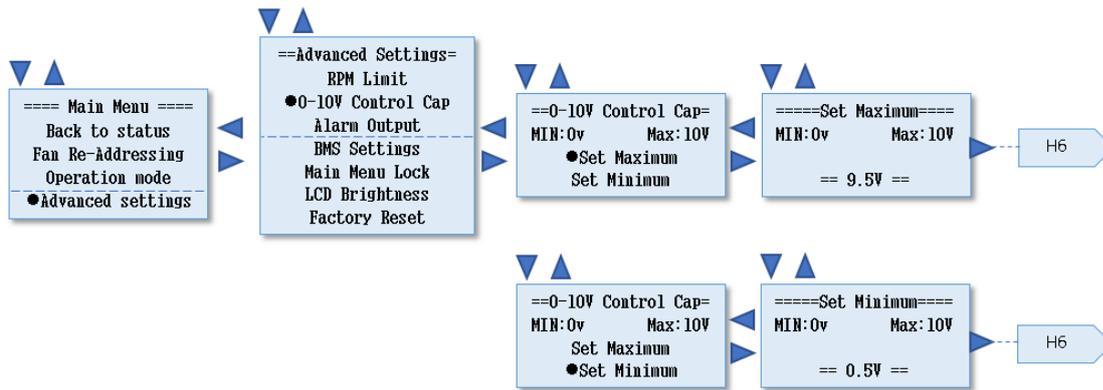
H12 – Operation Mode - Constant Volume / Constant Pressure Details



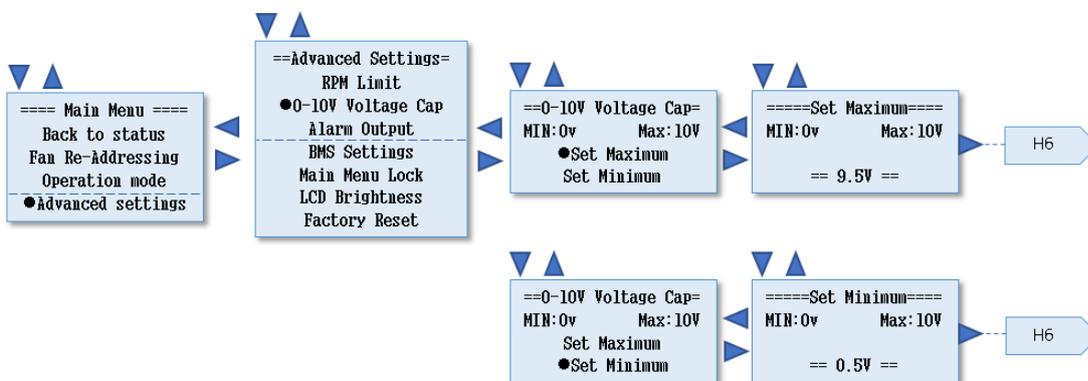
H13 – Advanced Settings – RPM Limit



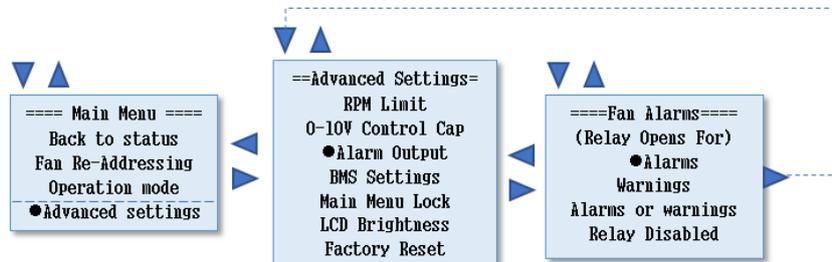
H14 – Advanced Settings – 0-10V Control Cap



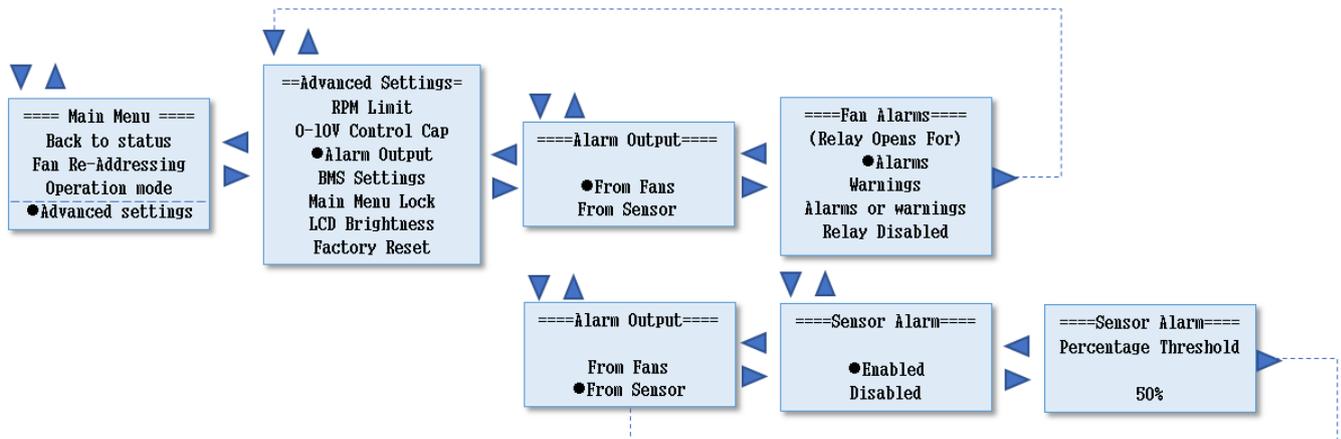
H15 – Advanced Settings – 0-10V Input Cap



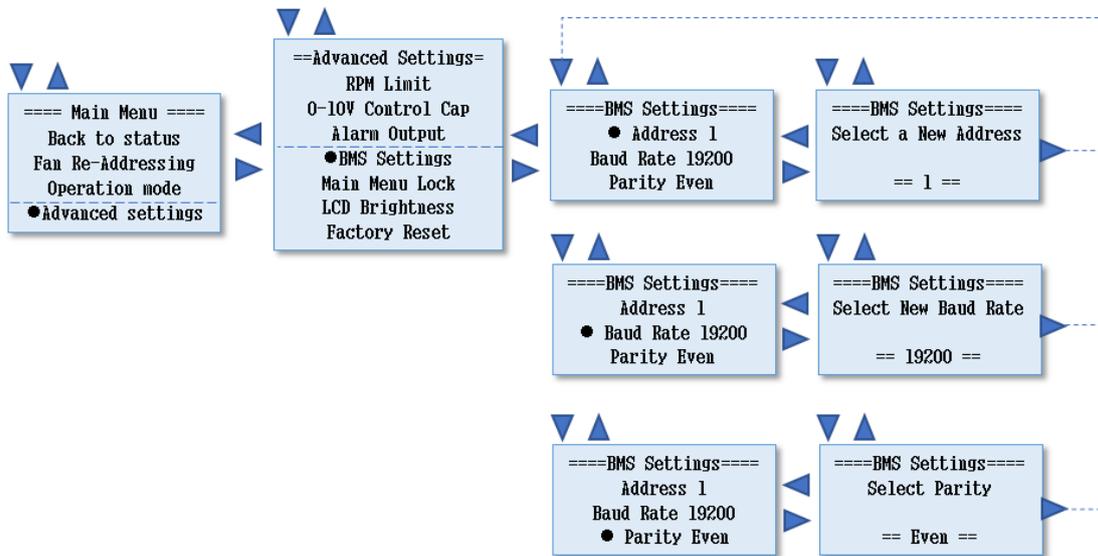
H16 – Advanced Settings – Alarm Output (Sensor Disabled)



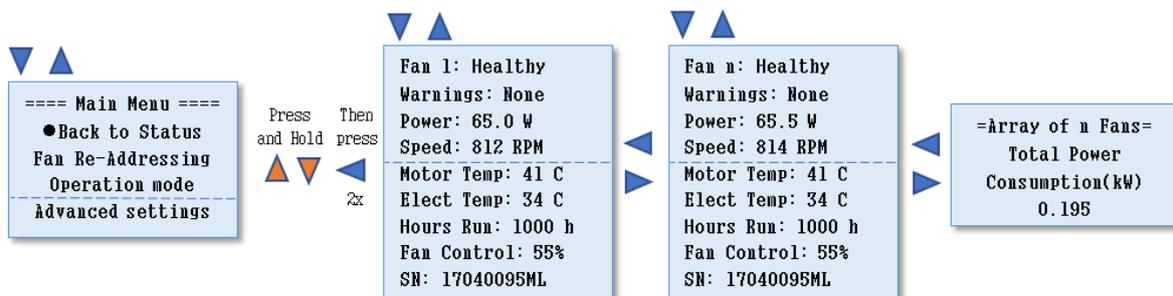
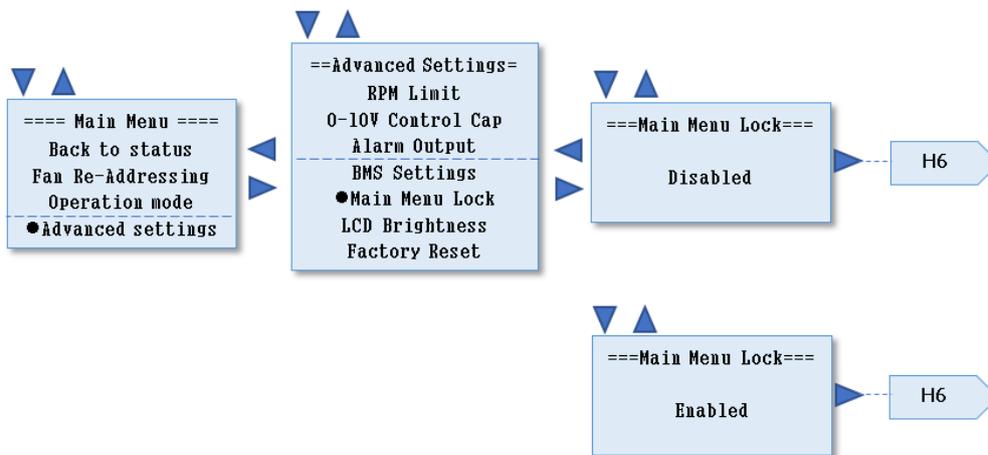
H17 – Advanced Settings – Alarm Output (Sensor Enabled)



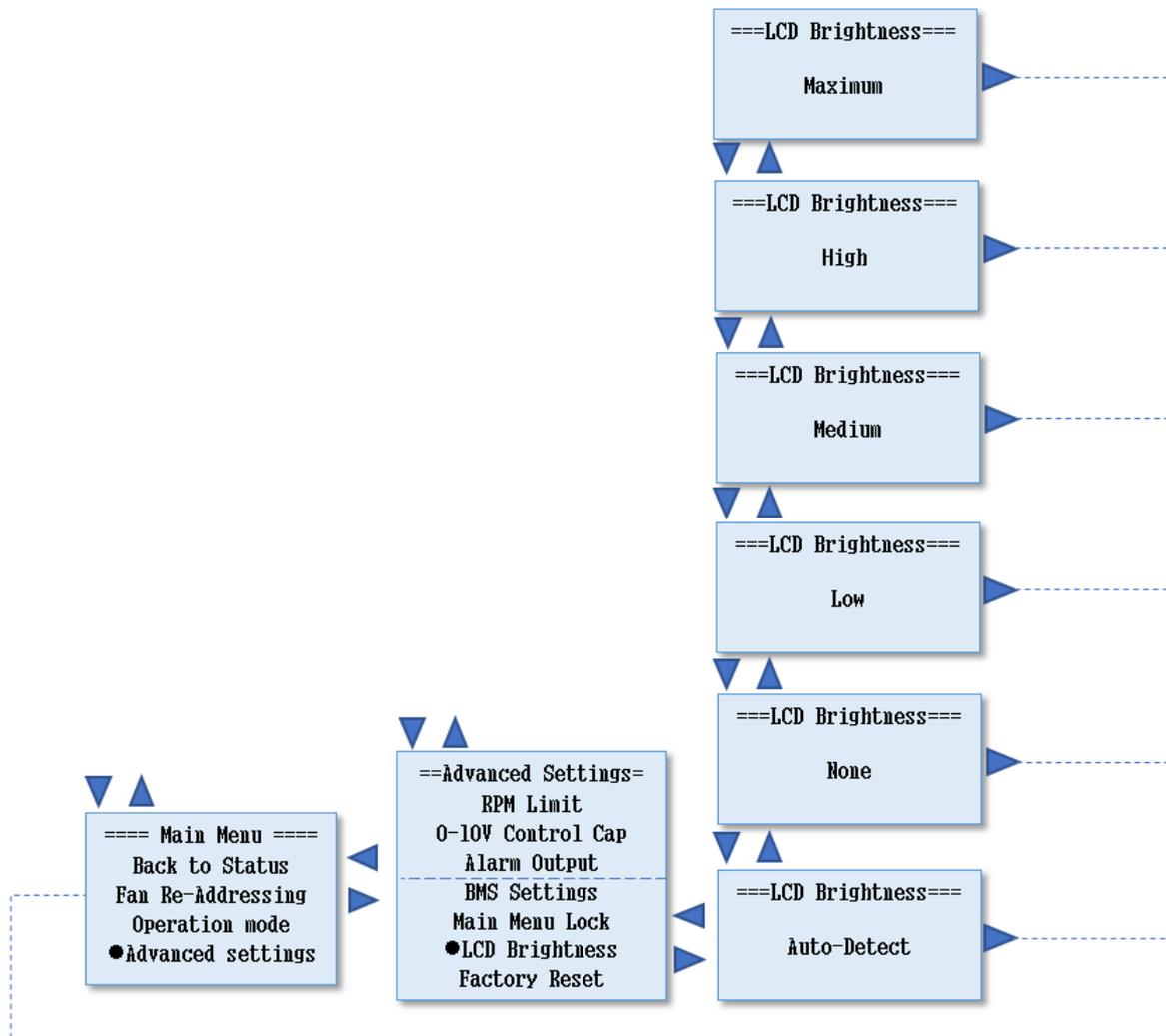
H18 – Advanced Settings – BMS Settings



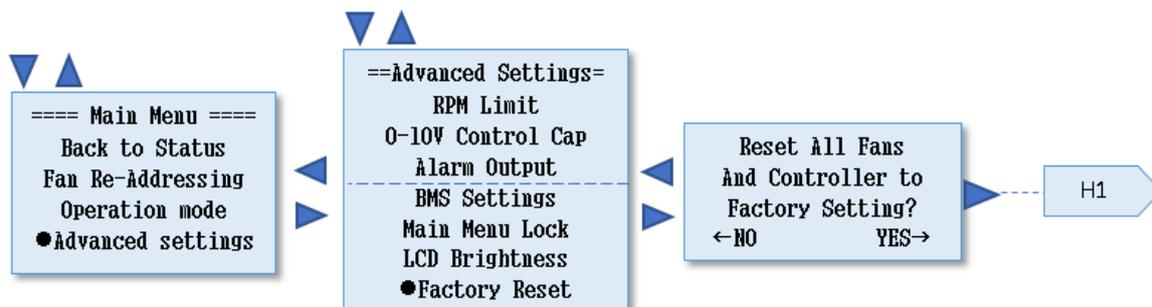
H19 – Advanced Settings – Main Menu Lock



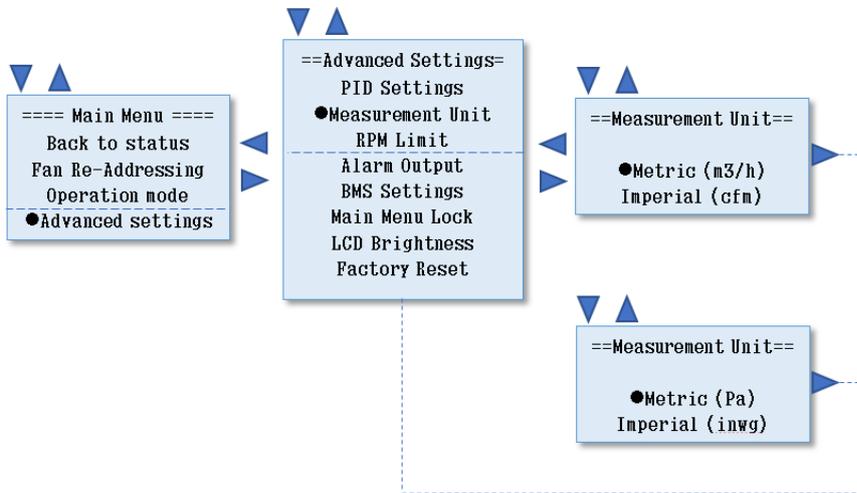
H20 – Advanced Settings – LCD Brightness



H21 – Advanced Settings – Factory Reset



H22 – Advanced Settings – Measurement Unit



H23 – Advanced Settings – PID Settings

