INSTRUCTION MANUAL

Noveo*AIR*™

VARIABLE AIR EXHAUST SYSTEM

FOR

SPRAY BOOTH

INSTALLATION MANUAL

INDEX

Recommendations

Noveo Technologies would like to thank you for purchasing our Noveo*AIR* product.

In order to optimize your installation, we recommend that you carefully read this document.

This document contains information for the installation, use and maintenance of the *NoveoAIR* product.

DEFINITIONS

VFD:	Variable Frequency Drive
TEFC:	Totally Enclosed Fan Cooled
NVA Panel:	NoveoAIR™ Control Panel
VOC:	Volatile Organic Compounds
NVA-COV:	NoveoAIR Volatile Organic Compound Sensor
NVA-FS:	NoveoAIR Spray Detection Sensor

GENERAL

System objectives

The *NoveoAIR* system incorporates the necessary technology to efficiently operate paint booths. This technology automatically adjusts exhaust air volume proportional to usage generating the following advantages:

- Lowers energy costs (air exhaust, heating, cooling).
- Reduces maintenance costs (reduces motors and belt wear, reduces and monitors percent of filter saturation).
- Reduces noise pollution created by an exhaust operating at continuous maximum speed.
- Reduces greenhouse gas emissions.
- Protects the operator against Volatile Organic Compounds (VOCs).
- Improves comfort in the work environment.

INSTALLATION MANUAL of the NoveoAIR

SHIPPING DAMAGE – IMPORTANT:

Inspect for damage. If damaged, notify carrier in writing immediately.

PACKING SLIP:

Verify packing slip to ascertain that the complete order is received and that all items have been verified. In case of shortage, notify your Noveo Sales representative.

System Identification

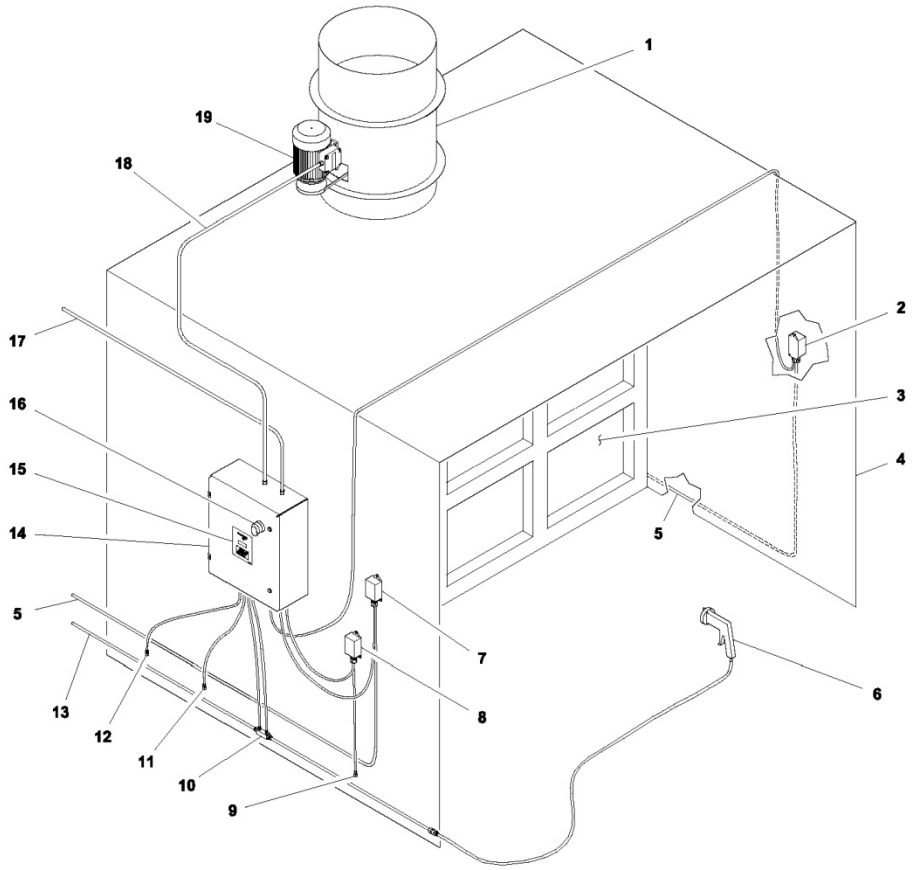
Noveo Technologies personalizes the *NoveoAIR* system according to the customer requirements.

Depending on your actual spray booth and the options selected, *Noveo Technologies* will develop a customized product identified by its unique code.

This unique code permits identification of your *NoveoAIR* system.

DESCRIPTION

Overview



1 - Exhaust
2 – Particle detection receptor*
3 – Booth filter
4 – Spray booth housing
5 – Pneumatic line 20 psi *
6 – Spray gun
7– Particle detection transmitter*
8 – VOC detection box
9 – VOC sensor
10 – Differential pressure block
11 – Sensor (+) filter obstruction*
12 - Sensor (–) filter obstruction*
13 – Main pneumatic line
14 – NoveoAIR control panel
15 – Keypad and display
16 – Disconnect switch handle
17 – Power (600 V)
18 – Power (motor)
19 - Motor

* Component available in option

Figure 1 – NoveoAIR Overview

Spray detection kit

Differential pressure block (refer to figure 1 - item 10)

Pneumatic piping kit

Variable speed high efficiency motor

(refer to figure 1 - item 19)

VOC detection kit

VOC sensor (refer to figure 1 - item 9)

VOC detection box (refer to figure 1 - item 8)

Pneumatic piping kit and electrical wiring

System options

Filter obstruction compensation kit

Sensor + filter obstruction (refer to figure 1 - item 11)

Sensor - filter obstruction (refer to figure 1 - item 12)

Pneumatic piping kit

Centris (CT 01 ; Microcontroller)

- Dimensions :
  4,66 po x 3,07 po (118,5 mm x 78 mm)
- Electrical characteristics :
  - ◊ Power :

Voltage: 24 Vca
Nominal power: 5 W
Frequency: 50-60Hz

- ◊ Inputs :

6 universal inputs: 0-5 Vcc for 10kΩ pullups
4 universal inputs: 0-5 Vcc for 10kΩ pullups or 232Ω pulldowns
2 high frequency numerical input

- ◊ Outputs :

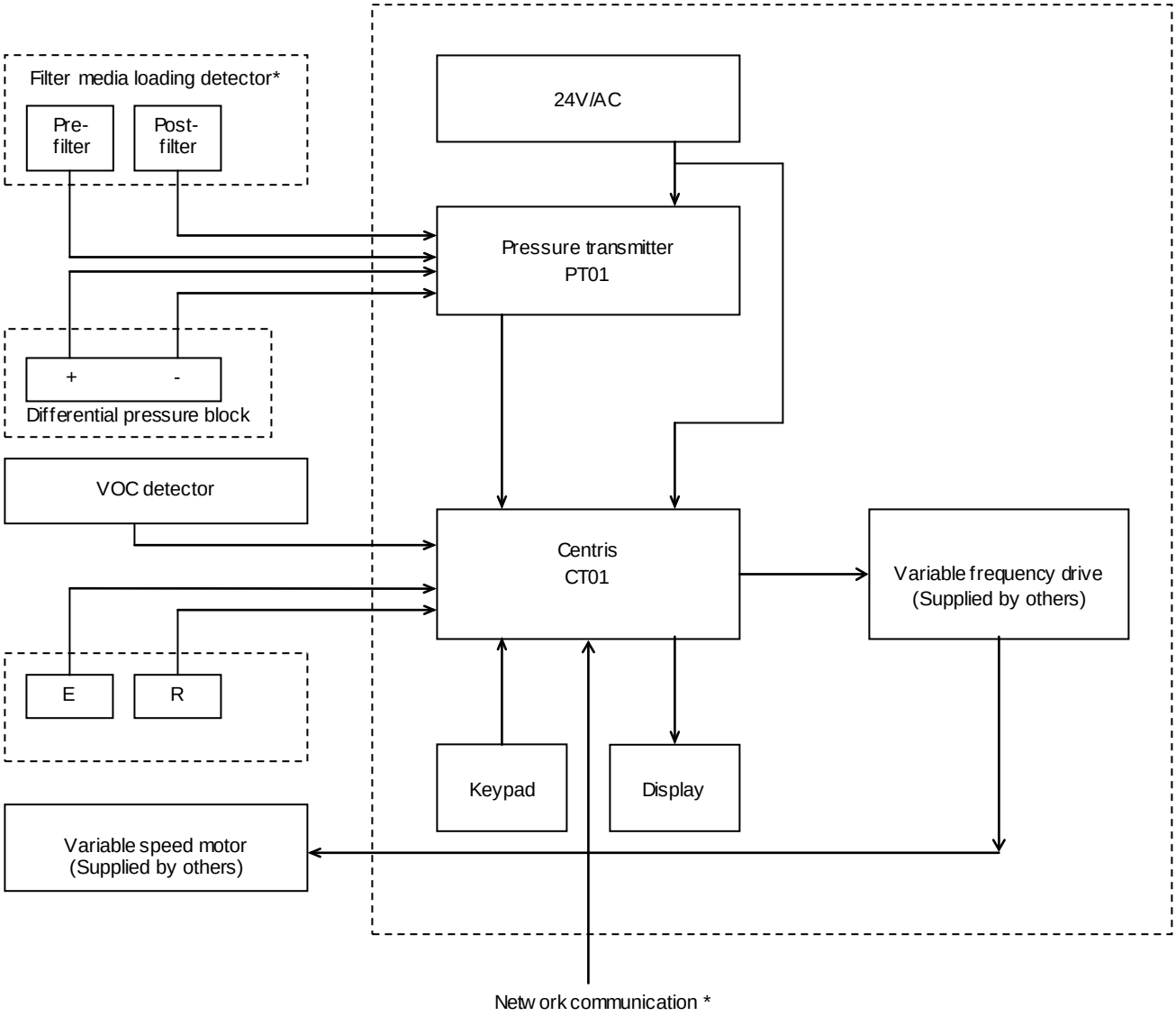
4 analogical outputs (0-10 Vcc)
6 numerical outputs (24 Vca)

- ◊ Communication :

1 keypad\display interface (I2C)

Figure 2 : Centris

Single line diagram



* : Component in option

Figure 3 – Single line diagram

Operation description

With the mode selector in AUTO position:

- The VOC detector samples residual VOC in the booth. If detected VOC level is greater than the set point value, the exhaust fan accelerates to remove the excess VOC (up to maximum speed).

When the user activates the spray gun:

- Air flow to the spray gun creates a signal (via the differential pressure block) which is transmitted via the centris to the variable speed drive (VFD), which in turn accelerates the exhaust motor to maximum speed.

When the user stops painting:

- The NoveoAIR system will gradually reduce the exhaust motor from maximum to moderate speed, then to minimum speed until it reaches the sleep mode. The exhaust volume and the operating time at each setting can be modified by the operator in the NoveoAIR control panel.

Component description

NoveoAIR control panel:

The NoveoAIR control panel receives information from the different sensors, sends the signal to adjust the exhaust speed according to the detected signals and then sets parameters accordingly.

Centris:

The Centris is the brain of the NoveoAIR system.

The Centris receives the data from the pressure transmitter and other sensors and then sends a command to the variable frequency drive.

The Centris also controls the display and receives the commands entered on the keypad.

Keypad with digital display:

The keypad permits setting out the system parameters and to visualize the system operation. It is simple to use with its navigation menu and default parameters.

The digital display panel provides the state of your system indicates the parameters of your installation and informs the operator if the system is operating correctly (or not).

Pressure transmitter

The pressure transmitter converts the pneumatic signal into an electrical signal which is then transmitted to the Centris.

Variable frequency drive

The variable frequency drive is controlled by the Centris which modifies the speed of the exhaust motor.

Mode selector

The mode selector allows the operator to select between the two available modes: Auto and Manual. When the Auto mode is selected, the system is controlled by the Centris program and the exhaust speed is adjusted depending on the exhaust requirements. When the Manual mode is selected, the exhaust speed is not controlled by the Centris and is set to maximum speed.

Spray detection kit:

The spray detection kit detects spray gun operation. The main component is the differential pressure block which offers a resistance to the airflow in the compressed air line which supplies the spray gun(s). The signal is transmitted to the pressure transducer.

Variable speed motor (not supplied by Noveo)

The variable speed motor varies the ventilation exhaust speed.

VOC detection kit – VOC's are substances contained in the atmosphere where painting is occurring

The VOC (Volatile Organic Compound) detection kit measures VOC's in the operator area and adjusts exhaust to remove the gasses.

The probe continuously samples the VOC level in the surrounding area to make certain the operator protection is maximized.

Filter loading compensation kit (in option)

The filter loading compensation kit detects the percent filter loading level by mean of two sensors located before and after the spray booth filters.

The system informs the operator of the percent filter loading level. A message is displayed when the filters should be replaced.

The system also compensates for the filter loading by adjusting the exhaust speed.

Network communication BACnet (in option)

The NoveoAIR system allows remote access to the system by means of a communication protocol called BACnet. The BACnet protocol is a communication standard, developed by ASHRAE, which allows for communication with most of the DDC building control systems.

The NoveoAIR system completely stands alone when not connected to a network but it can receive and exchange information when connected to a BACnet controller or interface.

WARNING

 Electric Danger

Safety precautions

The safety instructions included in this manual are intended to be used as a reminder to work safely and are not intended to bypass existing security rules.

An electric discharge can result in death or cause serious injury.

Do not touch an electric part under tension.

Touching an electric circuit under tension can cause a fatal discharge or serious burns.

The power supply and the internal circuits of the control panel are active as soon as the panel is under tension. A product that is incorrectly installed or grounded constitutes a danger.

Disconnect the power supply before performing product installation or maintenance work.

Lockout power supply before working on panel

Panel grounding is mandatory.

Wear a security harness if you must work above ground-level.

Workers Qualification

Only qualified electricians are authorized to install, maintain and repair a NoveoAIR installation.

Prerequisite

Material required

Before starting the installation, make certain all required components are available.
Please refer to the list of material supplied on the shipping invoice.

Tools required

Standard electrician tools are required.
Security harness (when necessary).
Lifting equipment depending on the location.

Installation

Select an appropriate location before beginning panel installation.

Safety precautions

 ***Before any installation, cut the power supply from the distribution network.***

NOVEOAIR Control panel

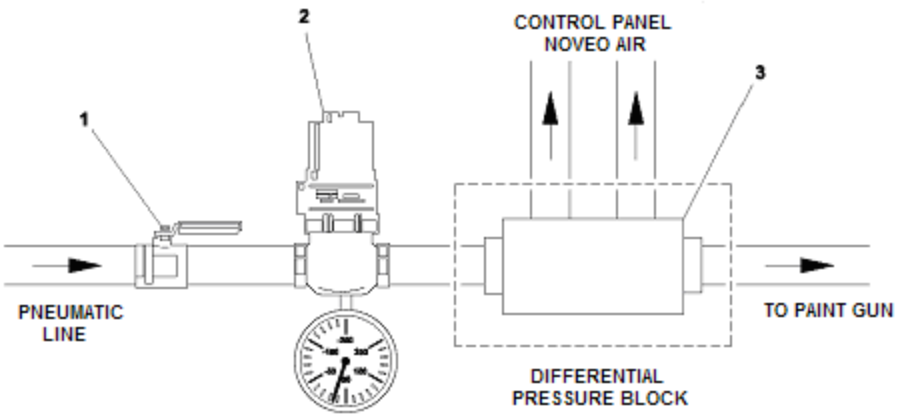
The NoveoAir control panel must be located outside the spray booth at a minimum distance of 1,5 m from the entrance. Canadian electrical code chapter 5 part 1 c22.10-07.

Never use silicone in a spray booth. It could damage the COV detector and interfere with the finishing of the product.

Make certain that the electrical system is designed to protect the Noveo panel (e.g. fuse or breaker rating).

Filter differential pressure detection

The differential pressure block must be installed only in the pneumatic line supplying the paint booth spray gun(s).



1 – Air shut-off valve 2 – Pressure regulator 3 – Differential pressure block

Figure 4 – Installation of pneumatic line for spray gun detection

The air valve and the pressure regulator are not supplied by Noveo.

The pneumatic line must be equipped with a pressure regulator located before the differential pressure block to reduce pressure surges in the supply air. Air surges can be interpreted like an utilization of the spray gun and also to detect precisely small air flow.

The pressure of the compressed air circuit at the differential pressure block must be limited to 100 PSI.

The differential pressure block is used to detect the air flow used for spraying paint. It is important that the compressed air line supplying pumps and other equipment bypasses the differential pressure block.

The differential pressure block allows the detection of a range of air flow from 0,5 to 50 Standard cubic feet per minute (SCFM). The block inlet and outlet connections are ½" NPT.

- Cut the air line supplying the spray gun(s) to be detected.
- Install the differential pressure block :
  - ◊ Unplug or cut the tubing where the differential pressure block will be installed.
  - ◊ Position the differential pressure block such that the ¼ inch pneumatic exit identified by « + » is located on the supply side or incoming pneumatic line and that the ¼ inch pneumatic exit identified by « - » is located on the spray gun side.
  - ◊ Use Teflon tape on all joints.
  - ◊ Tighten threaded joints.
- Connect the pneumatic tubing to the Control panel :
  - ◊ Position the ¼ inch flexible tubing from the differential pressure block to the corresponding pneumatic connection on the NoveoAIR control panel. Avoid twisting and cut tube to minimum length.
  - ◊ Connect the tube identified « + » from the differential pressure block to the corresponding connection on the NoveoAIR panel.
  - ◊ Connect the tube identified « - » from the differential pressure block to the corresponding connection on the NoveoAIR panel.
  - ◊ Attach the tubing at regular intervals with tyraps or any other appropriate method.
- If more than one differential pressure block must be installed, repeat the same procedure for each block and connect the tubing to the NoveoAIR control panel.

Variable speed motor (not supplied by Noveo)

Safety precautions:

Only qualified workers are authorized to install a new motor.

This equipment must be installed in accordance with the appropriate standards.

Disconnect electrical power supply.

- Remove existing motor (when required).

  ◊ If the previous system is equipped with variable pulley, measure the opening of the pulley before removal in order to set the same opening after installing the new motor.

- Variable speed motor installation

Do not install a disconnect between the variable frequency drive and the motor. Interrupting the power feed to a motor while in operation connected to a variable frequency drive can permanently damage the power circuit of the variable frequency drive. If a safety switch is required, post a notice suggesting stopping the ventilator before turning off this switch.

VOC detection kit

The VOC detector must be installed approximately 1 ft from the floor and away from the spraying area.

- Punch or drill a hole in the paint booth wall to install the sensor.
- Fasten the VOC sensor assembly.
- Connect the control cable to the NoveoAIR control panel.
  - ◊ Position the cable to in a way that it is protected and to avoid twisting it.
  - ◊ Attach the cable at regular intervals with tyraps or any other appropriate methods.

Install the VOC sensor according to the following sketch:

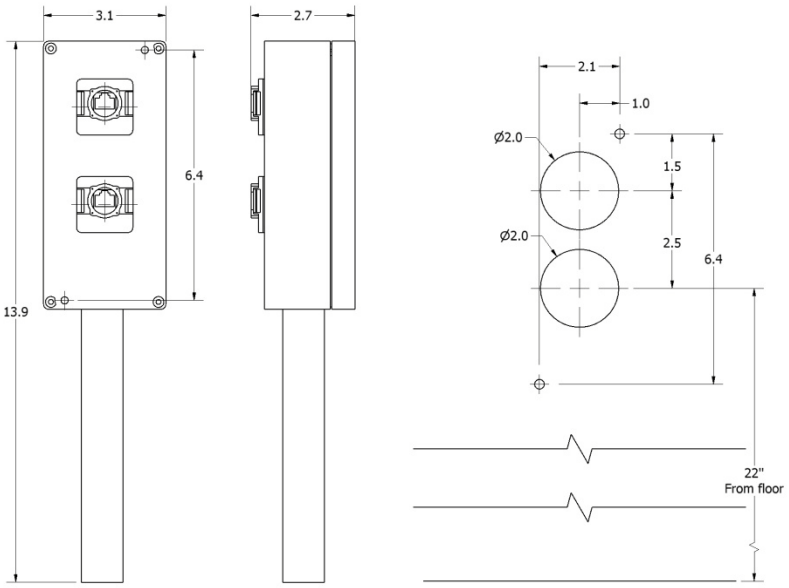


Figure 5 : VOC sensor

Install the sensor vertically with the element sensing protection tube at 12 inches from the floor.

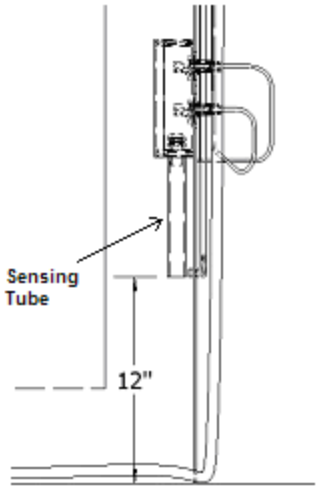


Figure 6 : Sensing tube

A) Installation of VOC sensor in an open face booth

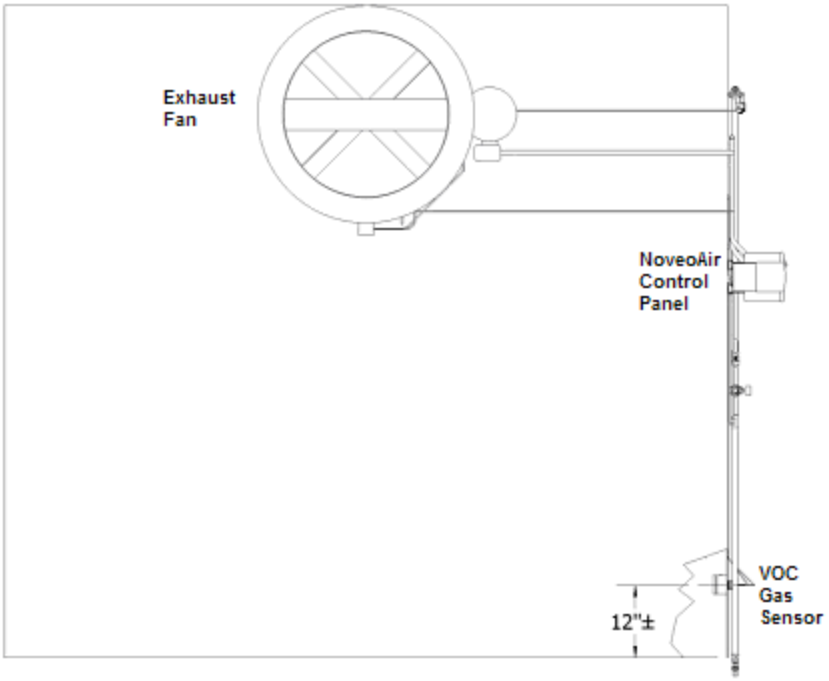


Figure 7 : Installation of VOC sensor in an open face booth

B) Installation of VOC sensor in a medium size closed booth

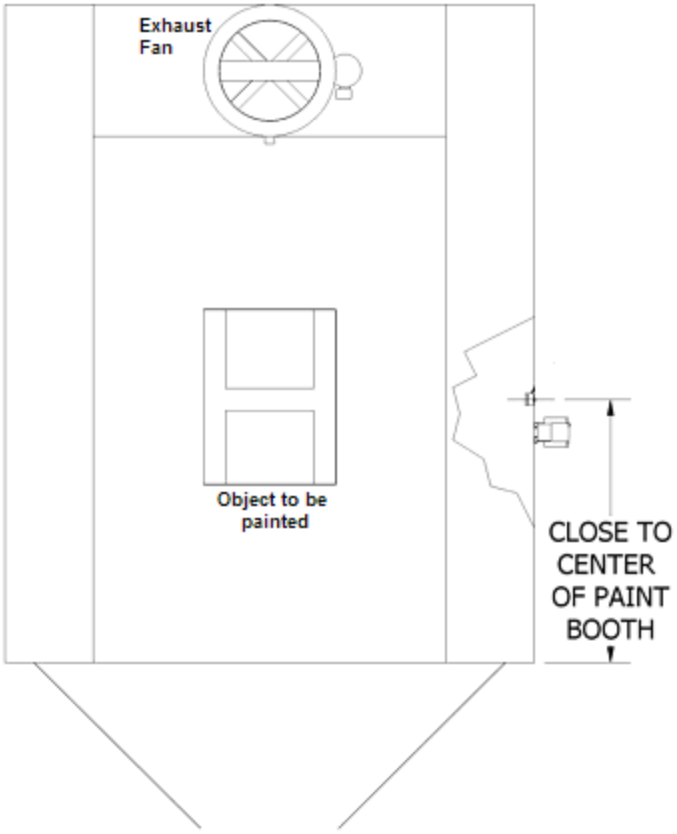


Figure 8 : Plan view of paint booth

C) Installation of VOC sensor in a large booth or paint area (2 sensors installed)

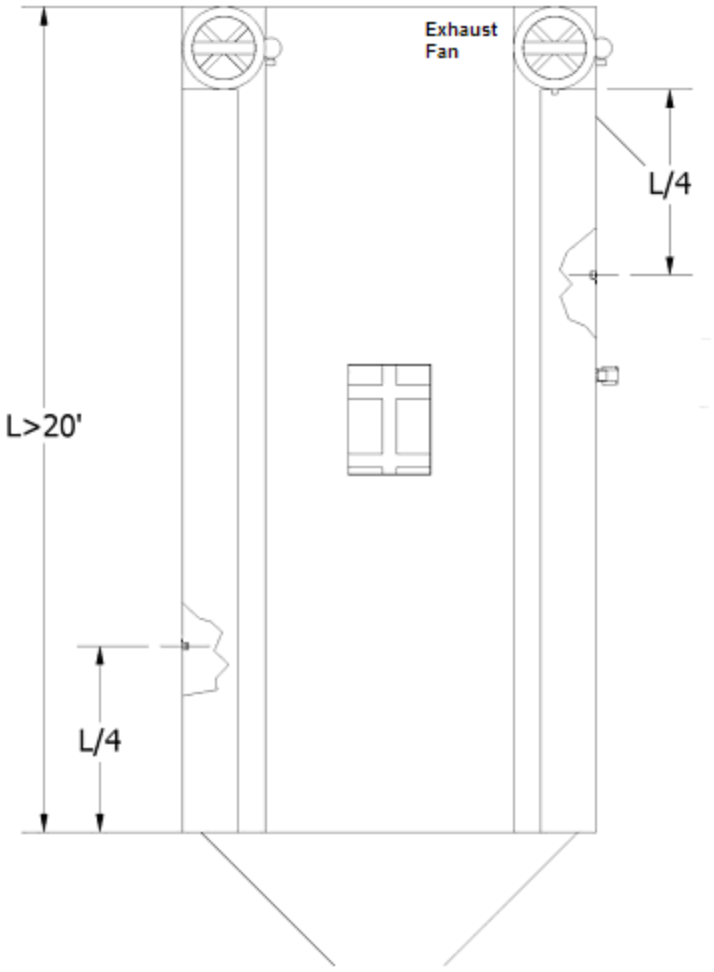


Figure 9 : Installation of VOC sensor in a large booth or paint area (2 sensors installed)

Filters loading compensation kit (in option)

The filter loading detectors must be installed perpendicularly to the air flow on each side of the spray booth filters.

- Drill two 9/16" holes through the paint booth wall approximately 4" each side of the filter bank.
- Install the bulkhead fittings. (Cowper 6590-04-00 or equivalent)
- Connect the pneumatic tubing to the NoveoAIR control panel and the bulkhead fittings:

  ◊ The sensor on upstream side (spray area) of the booth must be connected to the control panel on the connector identified by « + ».

  ◊ The sensor located downstream after the booth filters must be connected to the control panel on the connector identified by « - ».

  ◊ Position the tubing to avoid twisting and to adjust to length.

  ◊ Attach the tubing at regular intervals with tyraps or other appropriate methods.

START- UP

1.1 First start-up

Checklist before turning the power on:

- Verify electric and pneumatic installation :
  - ◊ Make sure that all electric connections were properly done.
  - ◊ Make sure that all pneumatic connections were properly done.
- Verify the position of the mode selector :
  - ◊ Open the NoveoAIR control panel.
  - ◊ Make sure that the mode selector is on AUTO.
  - ◊ Close and lock the control panel door.
- Verify that the disconnect switch handle of the NoveoAIR control panel is in the position « Off ».

Powering

- Verify for leaks on the compressed air circuit.

Turn on the power in the main electric panel.

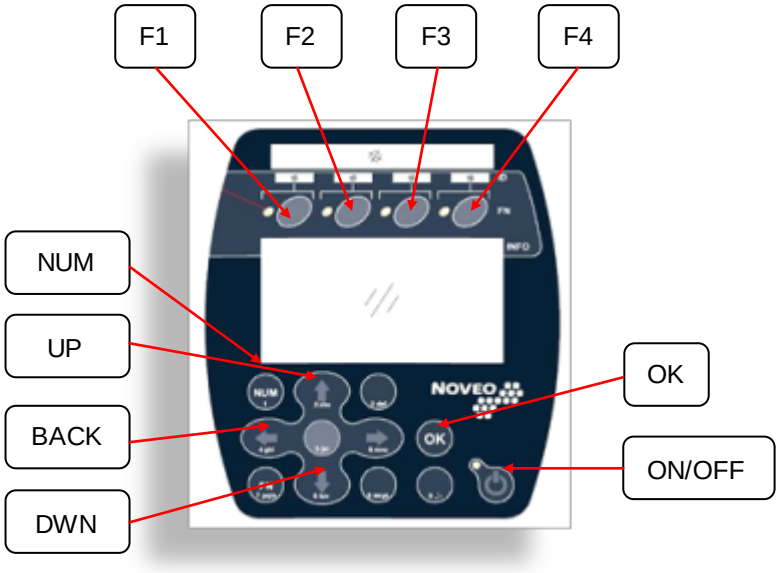
The following section describes the steps to follow for the start-up of the system and for setting the system parameters.

1.2 Checklist

- ☐ Check control cable installation
- ☐ Installation environment conforms to the Noveo system specifications for ambient conditions.
- ☐ The panel is mounted securely.
- ☐ Space around the panel meets the specifications for cooling.
- ☐ The motor and driven equipment are ready for start.
- ☐ The panel is properly grounded.
- ☐ The input power voltage matches the drive nominal input voltage.
- ☐ The input power (mains) fuses are installed.
- ☐ The motor connections at T1, T2 and T3 are connected and tightened.
- ☐ Make certain power factor compensation capacitors are not connected in the motor circuit.
- ☐ The control connections are connected.
- ☐ NO tools or foreign objects (such as drill shavings) are inside the panel.
- ☐ NO alternate power source for the motor (such as a bypass connection) is connected. No voltage is applied to the output of the panel.

General keyboard information

The different displays are activated by lightly pressing as required on the appropriate touch button. The most useful functions are described below.



GENERAL KEY DESCRIPTION

F1	FUNCTION KEY 1 (Generally used to toggle language)
F2	FUNCTION KEY 2
F3	FUNCTION KEY 3
F4	FUNCTION KEY 4
NUM	Generally used to enter into an **edit mode**. May also be used for switching from numeric to alphabetic key function.
UP	Scroll up key in a menu or a page
BACK	Return to previous menu
DWN	Scroll down key in a menu or a page
OK	Generally used to accept a selection (Enter function)
ON/OFF	Generally used to Start or Stop the unit.

TOUCH BUTTON

All touch buttons are pressure sensitive. To select appropriate menu, or selection, simply press on the appropriate button as indicated in the instructions.

LANGUAGE: Noveo provides a user choice; English or French. To transfer from English to French or vice versa, press F1

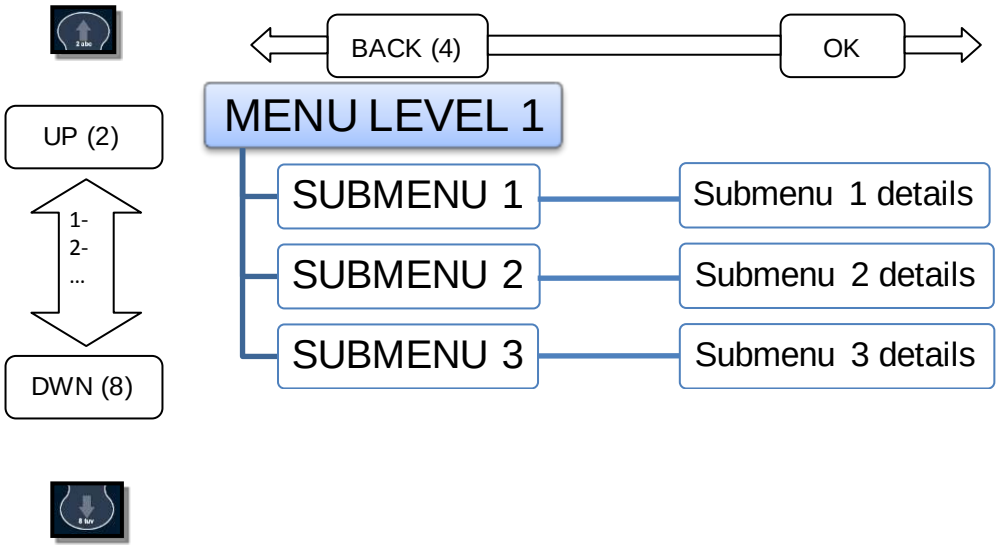
DISPLAY ILLUMINATION: To open the backlight and illuminate display press touch button (5)  . The display remains lit for ten (10) seconds. Press (5)  as required.

ALPHANUMERIC KEYS: When prompted to enter alphanumeric data, use keys with numbers or alphabetic indication. Numbers or letters are contextual. See an enlarged view of a key below:

This key allows for entering 5, j, k or l in alphanumeric mode.

SCROLLING LOGIC:

- To select a primary menu, scroll up or down by pressing the following touch button.
- To switch from a submenu, press BACK (left arrow) key.
- To enter a Submenu, press OK key.
- *Scroll position is indicated by the shadow covering the appropriate number.*



1.3 Initial Startup

Turn the by-pass switch to 0 or “off” position

The initial power-on should be made in this position.

Check for keyboard and display normal operation.

A welcome message should appear on the display indicating the system name and version of the program.

WARNING - Check motor rotation

Using Submenu **Manual Ctrl Motor**, start slowly the motor and check for rotation. SEE "A"

WARNING - Not doing so may result in dust contamination in paint booth area with air incoming from chimney!

Turn the by-pass switch in “by-pass” position

WARNING! Jog and check rotation before leaving the system exhaust at the maximum level. Check system operation, read the amperage and adjust the overload settings.

Turn the by-pass switch to 1 or “auto” position.

Start test spraying. The system should normally reach the maximum level of exhaust. Check system operation again.

Adjust Accel and Decel Slope

Use **Motor Ctrl Def.** submenu to adjust to appropriate level for the drive limitation and interlock with air make-up variation capability. SEE "B"

Adjust Spray detection Treshold

Use Gun Debit Def. Submenu to adjust Gun 1, Gun 2 and Gun 3 Treshold limits. SEE "C"

Adjust filters settings

Use Filter Def. submenu to set the filter OK and dirty settings SEE "D"

Adjust delays and output levels

Use Operator's Submenus 3, 4, 5 and 6 to set the output levels and setback delays SEE "E"

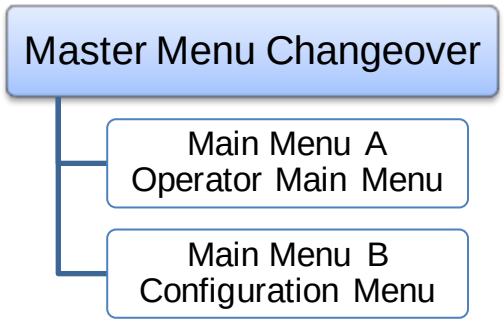
NOTE : All levels are factory presets. Nevertheless, the following section will provide extended instructions for adjusting the operating parameters and calibrating the sensors.

1.4 Extended configurations (using keyboard and display)

MAIN MENU

Use arrow keys and OK to access the following menus

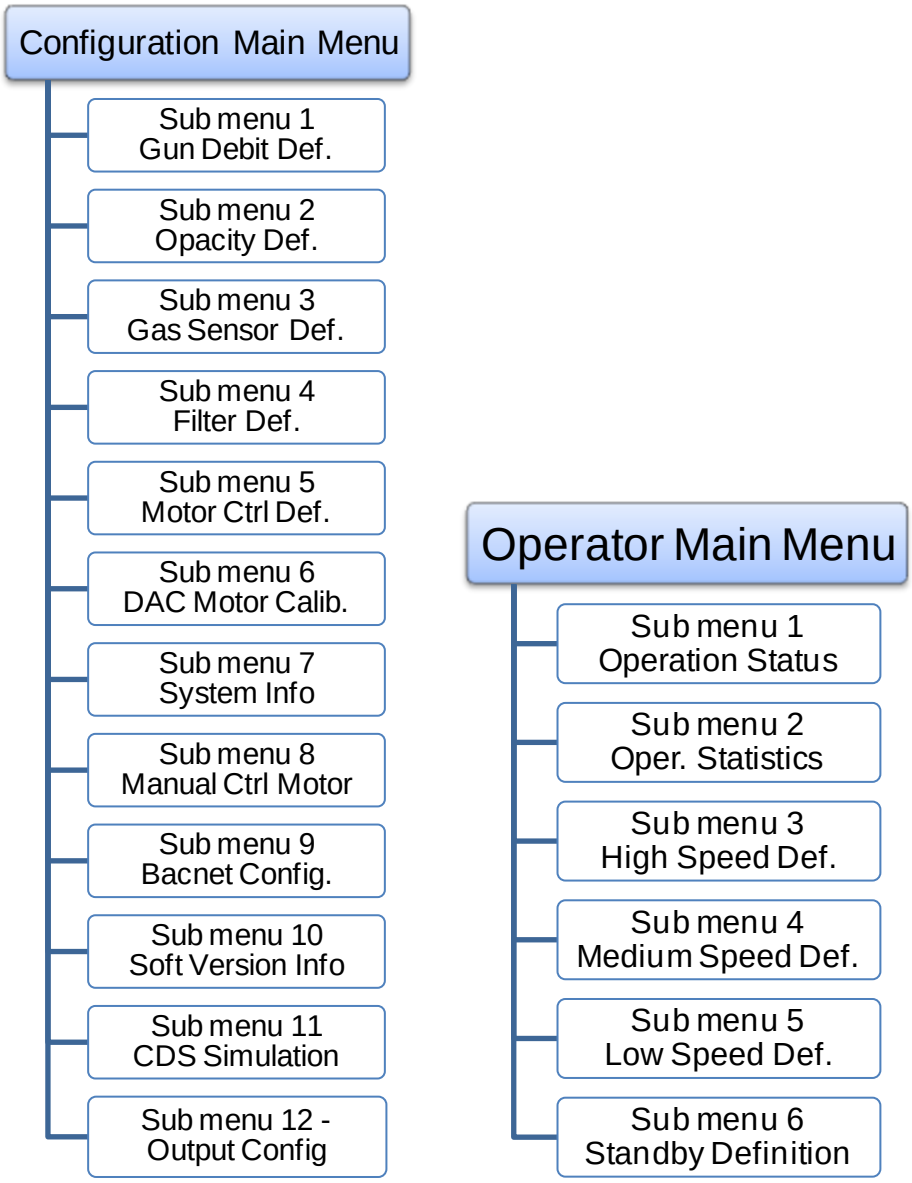
There are two (2) separate main menus: the operator level and the configuration level.



To switch between the Configuration Menu and the Configuration Menu, follow the instructions:

Under Operation Status, press (**POWER BUTTON**)  and while holding it pressed, press (**NUM**) and the following display appears. There are 11 options in the configuration menu. You can return to the primary menu anytime by pressing and holding the (**POWER BUTTON**) and press (**NUM**).

Operator Main Menu is described in section 5



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Under Operation Status, press (**POWER BUTTON**)  and while holding it pressed, press (**NUM**) and the following display appears. There are 11 options in the configuration menu. You can return to the primary menu anytime by pressing and holding the (**POWER BUTTON**) and press (**NUM**).

Configuration Main Menu

C

Sub menu 1- Gun Debit Def.

- **NOTE**: Before entering sub-menu Gun Debit Def. the user **MUST REFER TO ITEM 'SYSTEM INFO'** to obtain the low and high threshold values for each gun. When into SYSTEM INFO menu,
  1- Record the value with the paint gun at work. (value in mV)
  2- Record the value with ther paint gun at stop. (value in mV)
- **Gun 1 Threshd debt**
  - To select the sub-menu under Gun calibration, Scroll up (**2**) or down (**8**) until the shadow is positioned on No.1. Press (**OK**)
  - Use the pre recorded values and set the "low threshold" at [gun off value - 20%] and then press (**OK**) to confirm selection.
  - Use the pre recorded values and set the "high threshold" at [gun onvalue + 20%] and then press (**OK**) to confirm selection.
  - To return to menu 'Gun Calibration' press (**4**).
- **Gun 2 Threshd debt**
  - To calibrate Gun No.2, Scroll up (**2 h**) or down (**8 i**) until the shadow is positioned on No.2. Press (**OK**) and repeat previous steps. Gun No. 2 value are obtained under **'SYSTEM INFO'**
- **Gun 3 Threshd debt**
  - To calibrate Gun No.3, Scroll up (**2 h**) or down (**8 i**) until the shadow is positioned on No.3. Press (**OK**) and repeat previous steps. Gun No. 3 values are obtained under **'SYSTEM INFO'**
- **Number of guns**
  - To select the sub-menu 4 under 'Gun calibration', Scroll up (**2**) or down (**8**) until the shadow is positioned on No.4. Press (**OK**) and the following sub-menu will appear.
  - The minimum value is 1. Maximum number of gun is 3.To modify the number of guns press (**NUM**)

Sub menu 2 - Opacity Def.

Sub menu 3 - Gas Sensor Def.

Sub menu 4 - Filter Def.

Sub menu 5 - Motor Ctrl Def.

Sub menu 6 - DAC Motor Calib.

Sub menu 7 - System Info

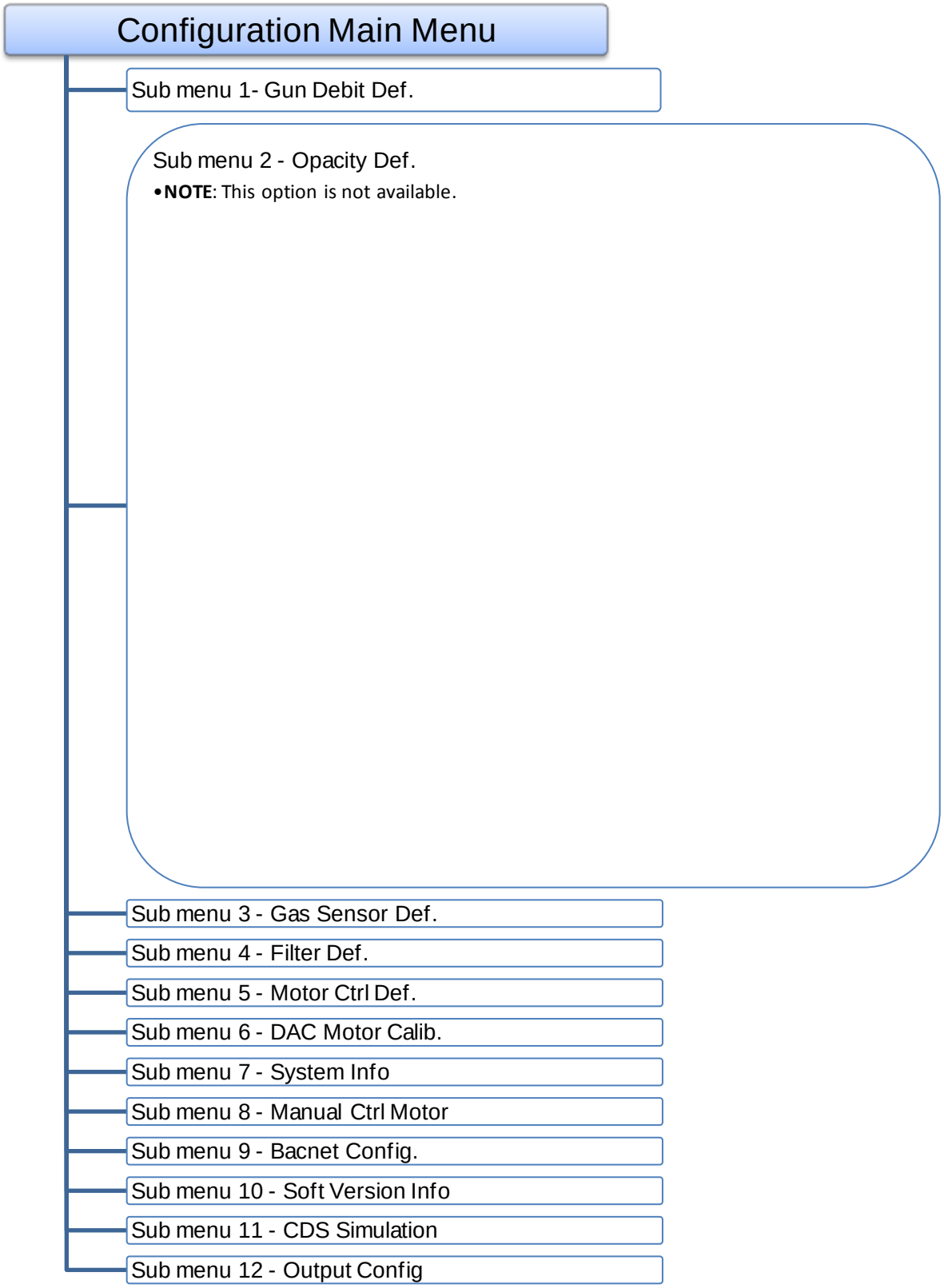
Sub menu 8 - Manual Ctrl Motor

Sub menu 9 - Bacnet Config.

Sub menu 10 - Soft Version Info

Sub menu 11 - CDS Simulation

Sub menu 12 - Output Config


Configuration Main Menu
Sub menu 1- Gun Debit Def.
Sub menu 2 - Opacity Def.
•NOTE: This option is not available.
Sub menu 3 - Gas Sensor Def.
Sub menu 4 - Filter Def.
Sub menu 5 - Motor Ctrl Def.
Sub menu 6 - DAC Motor Calib.
Sub menu 7 - System Info
Sub menu 8 - Manual Ctrl Motor
Sub menu 9 - Bacnet Config.
Sub menu 10 - Soft Version Info
Sub menu 11 - CDS Simulation
Sub menu 12 - Output Config

Configuration Main Menu

- Sub menu 1- Gun Debit Def.
- Sub menu 2 - Opacity Def.
- Sub menu 3 - Gas Sensor Def.
  - To select the sub-menu under Gaz Sensor Def., Scroll up (**2**) or down (**8**) until the shadow is positioned on No.3. Press Touch button (**OK**)
  - The gases present in a paint booth are Volatile Organic Compounds [VOC'S]. VOC'S are substances contained in the atmosphere where painting is occurring. The purpose of the VOC sensor is to detect excess gaseous substances within the painting area. Calibration of the COV sensor is essential.
  - **Low Limit**
    - To select the sub-menu Low Limit under Gaz Sensor Def., Scroll up (**2 h**) or down (**8 i**) until the shadow is positioned on No.1. Press Touch button (**OK**)
    - Enter the new desired value per example 150 ppm by pressing the appropriate touch buttons (**1**) + (**5**) + (**0**). Press (**OK**) to enter the value 150.
    - Scroll up (**2**) or down (**8**) to select OUI (Yes) or NON (No).
    - **NOTE**: Should by error the wrong numbers be entered use the power button to eliminate the unwanted or incorrect numbers. Should a number appear to the right of the flashing shadow, enter the numbers by pressing (OK) and the unwanted numbers to the right of the flashing shadow will simply disappear. The maximum Low Limit value is 5000. However, this value must be lower then the high limit. A practical low limit value should never be above the ports per million (ppm) recommended in labor and safety codes for your area.
  - **High Limit**
    - To select the sub-menu High Limit under Gaz Sensor Def., Scroll up (**2 h**) or down (**8 i**) until the shadow is positioned on No.2. Press (**OK**) and the following sub-menu will appear:
    - To modify the high limit value, press (**OK**)
    - Enter the new desired value per example 500 ppm by pressing the appropriate (**5**) + (**0**) + (**0**). Press (**OK**) to enter the value 500.
- Sub menu 4 - Filter Def.
- Sub menu 5 - Motor Ctrl Def.
- Sub menu 6 - DAC Motor Calib.
- Sub menu 7 - System Info
- Sub menu 8 - Manual Ctrl Motor
- Sub menu 9 - Bacnet Config.
- Sub menu 10 - Soft Version Info
- Sub menu 11 - CDS Simulation
- Sub menu 12 - Output Config

Configuration Main Menu

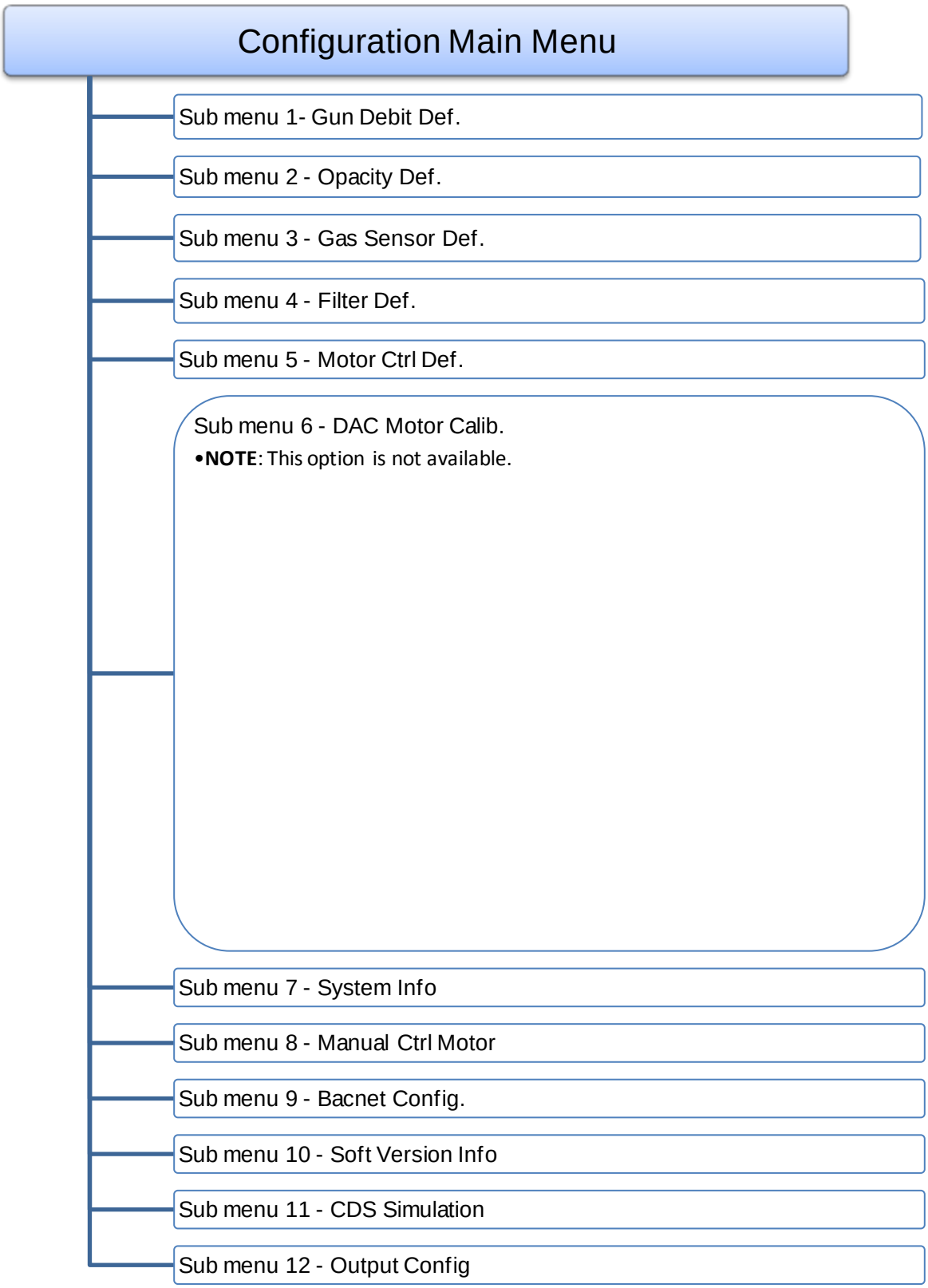
D

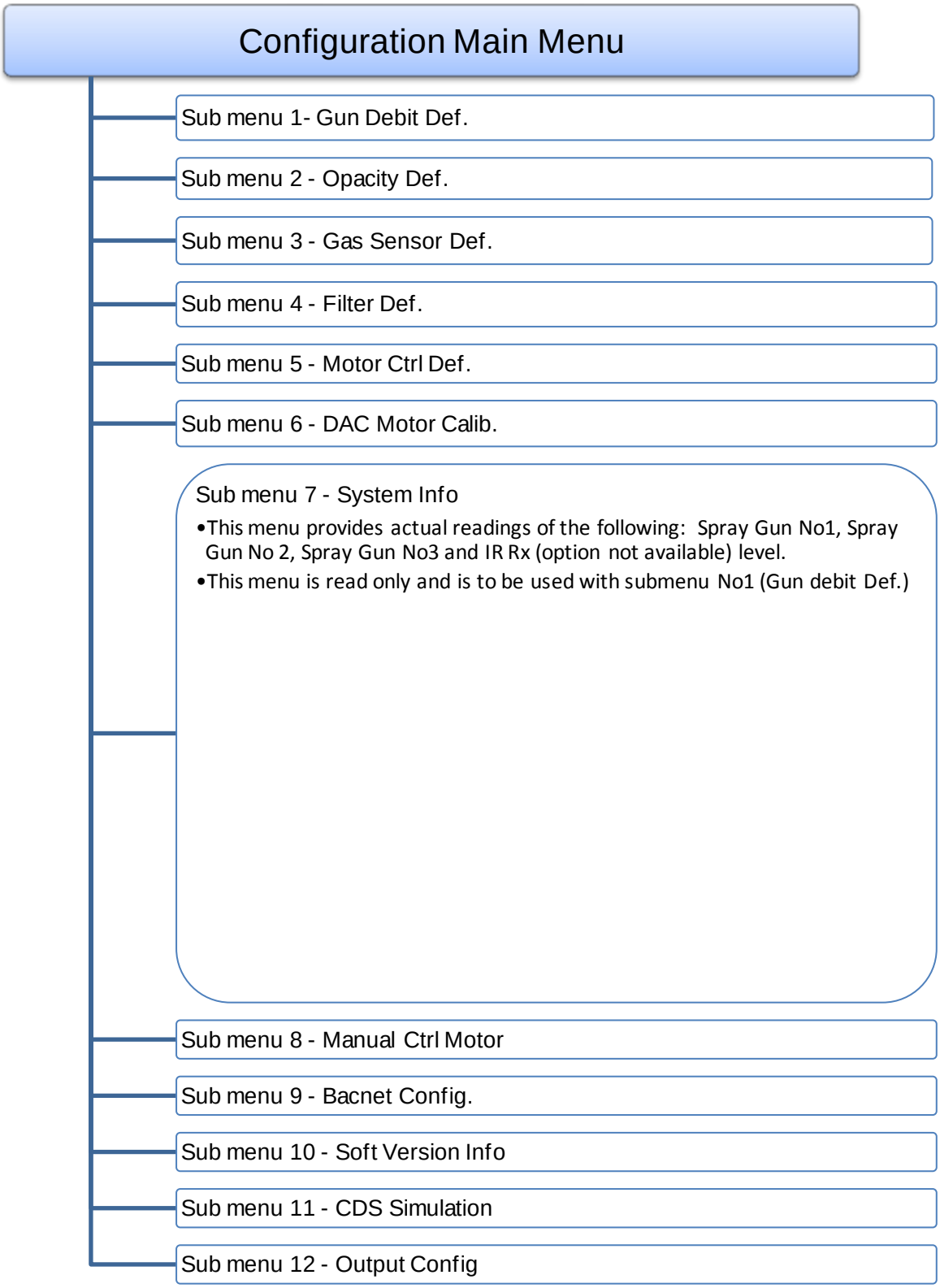
- Sub menu 1- Gun Debit Def.
- Sub menu 2 - Opacity Def.
- Sub menu 3 - Gas Sensor Def.
- Sub menu 4 - Filter Def.
  - To select the sub-menu under Filter Def., Scroll up (**2**) or down (**8**) until the shadow is positioned on No.4. Press Touch button (**OK**)
  - Filter clogging or loading (dirtiness) affects the exhauxt level of the paint booth. In the morning, with clean filters, the exhaust can be more than required because of the low restriction of the filters. On the opposite, after a period of time, the filters are clogged and then the air flow is reduced dramatically. This reduction of air flow can result in poor quality of paint work and inconfort for the operator.
  - **MAX OUTPUT** corresponds to the maximum exhaust level set for clean filters.
    - This value cannot be changed
  - **FILTER** corrersponds to the actual reading on the filters.
    - The value corresponding to mV results from pressure differential across the filters. Reading comes from a port connected into the filter box plenum (negative reading) and a port positionned into the work area (positive reading). The value is a direct substraction of the two readings.
  - **FILTER OK** corresponds to the Clean Filters setting.
    - To set this value, make sure clean filters are installed. Then, press F2 key to set the value corresponding to "Filter" reading. The value is automatically transfered and set.
  - **FILTER DRTY** corresponds to loaded filters (dirty filters)
    - To set this value, make sure to have loaded or cloggeg filters installed. Then, press F3 key to set the value corresponding to "Filter" reading. The value is automatically transfered and set.
  - No other action is required to set the filters.
- Sub menu 5 - Motor Ctrl Def.
- Sub menu 6 - DAC Motor Calib.
- Sub menu 7 - System Info
- Sub menu 8 - Manual Ctrl Motor
- Sub menu 9 - Bacnet Config.
- Sub menu 10 - Soft Version Info
- Sub menu 11 - CDS Simulation
- Sub menu 12 - Output Config

Configuration Main Menu

B

- Sub menu 1- Gun Debit Def.
- Sub menu 2 - Opacity Def.
- Sub menu 3 - Gas Sensor Def.
- Sub menu 4 - Filter Def.
- Sub menu 5 - Motor Ctrl Def.
  - To select the sub-menu under Motor Ctrl Def., Scroll up (**2**) or down (**8**) until the shadow is positioned on No.5. Press Touch button (**OK**)
  - Motor control definition menu is used to set the output parameters sent to the Drive. The maximum output voltage corresponds to the maximum exhaust level requested and the slope corresponds to the rate of change in exhaust rate. A slower exhaust change rate can be required for closed booth or area where a fast change could affect the process. A fastest rate of change will result in a more aggressive energy savings strategy.
  - **MAX OUTPUT** corresponds to the maximum DC voltage sent to Analog Input 1 to the Drive.
  - This value can be set fbetween 0 and 10000 mVDC (10 VDC), 10 VDC corresponding to 60 Hertz frequency, the normal speed without a drive installed. Default value is 10000 mV. To change this value, press "NUM" key and type the new value, press OK to accept and answer "YES" to confirm.
  - **SLOPE MAX** corresponds to the maximum rate of change for the Drive variation.
  - For example, if a change from 100% to 50% of exhaust rate must be provided in 5 seconds, **OUTPUT** voltage must change from 10000 mV to 5000 mV (10 to 5 VDC) in 5 seconds. Then rate of change mus be set to 1000 mV (1 VDC) per second. To change this value, press "NUM" key and type the new value, press OK to accept and answer "YES" to confirm.
- Sub menu 6 - DAC Motor Calib.
- Sub menu 7 - System Info
- Sub menu 8 - Manual Ctrl Motor
- Sub menu 9 - Bacnet Config.
- Sub menu 10 - Soft Version Info
- Sub menu 11 - CDS Simulation
- Sub menu 12 - Output Config


Configuration Main Menu
Sub menu 1- Gun Debit Def.
Sub menu 2 - Opacity Def.
Sub menu 3 - Gas Sensor Def.
Sub menu 4 - Filter Def.
Sub menu 5 - Motor Ctrl Def.
Sub menu 6 - DAC Motor Calib.
•NOTE: This option is not available.
Sub menu 7 - System Info
Sub menu 8 - Manual Ctrl Motor
Sub menu 9 - Bacnet Config.
Sub menu 10 - Soft Version Info
Sub menu 11 - CDS Simulation
Sub menu 12 - Output Config


Configuration Main Menu
Sub menu 1- Gun Debit Def.
Sub menu 2 - Opacity Def.
Sub menu 3 - Gas Sensor Def.
Sub menu 4 - Filter Def.
Sub menu 5 - Motor Ctrl Def.
Sub menu 6 - DAC Motor Calib.
Sub menu 7 - System Info
•This menu provides actual readings of the following: Spray Gun No1, Spray Gun No 2, Spray Gun No3 and IR Rx (option not available) level.
•This menu is read only and is to be used with submenu No1 (Gun debit Def.)
Sub menu 8 - Manual Ctrl Motor
Sub menu 9 - Bacnet Config.
Sub menu 10 - Soft Version Info
Sub menu 11 - CDS Simulation
Sub menu 12 - Output Config

Configuration Main Menu

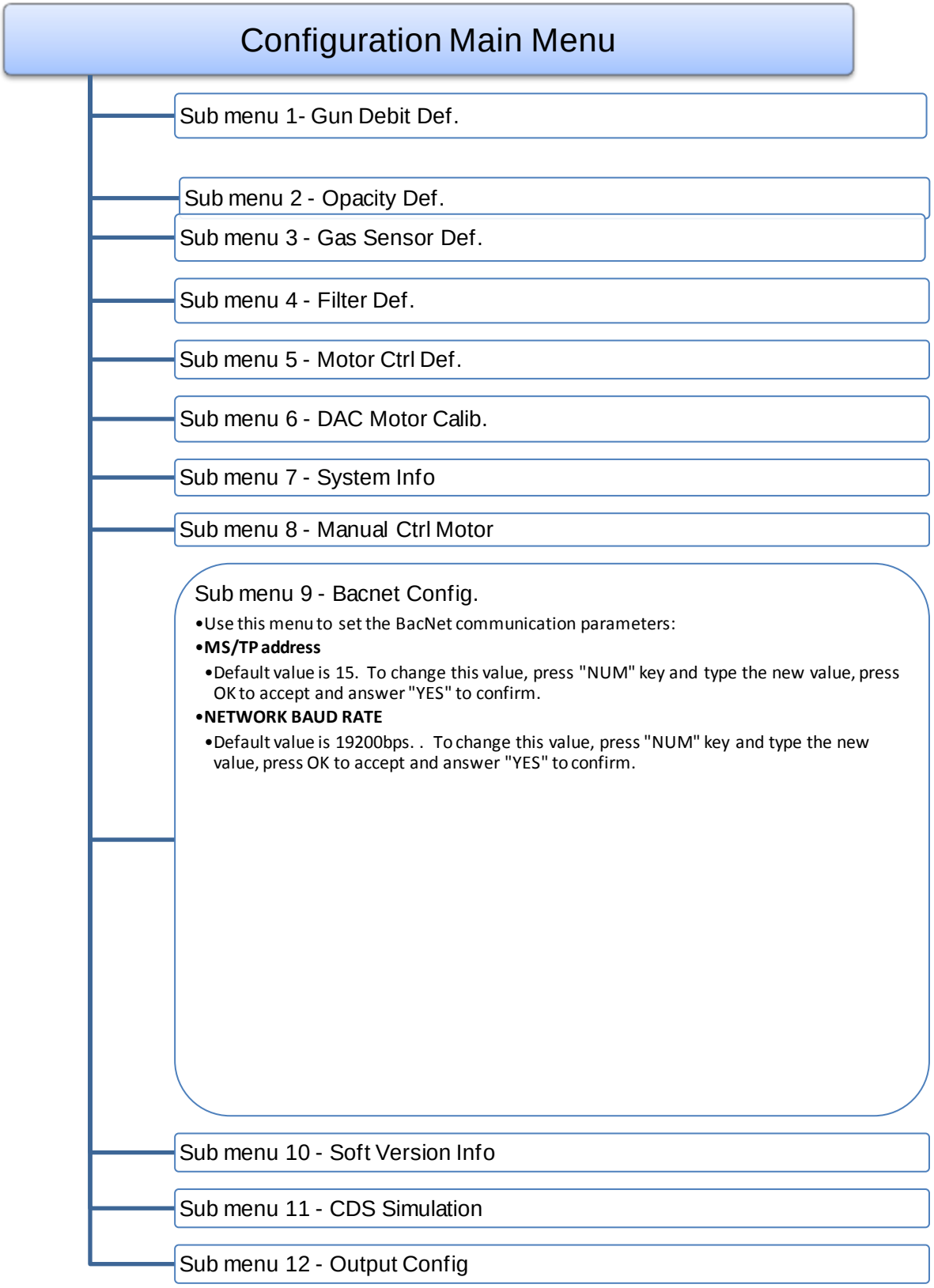
- Sub menu 1- Gun Debit Def.
- Sub menu 2 - Opacity Def.
- Sub menu 3 - Gas Sensor Def.
- Sub menu 4 - Filter Def.
- Sub menu 5 - Motor Ctrl Def.
- Sub menu 6 - DAC Motor Calib.
- Sub menu 7 - System Info

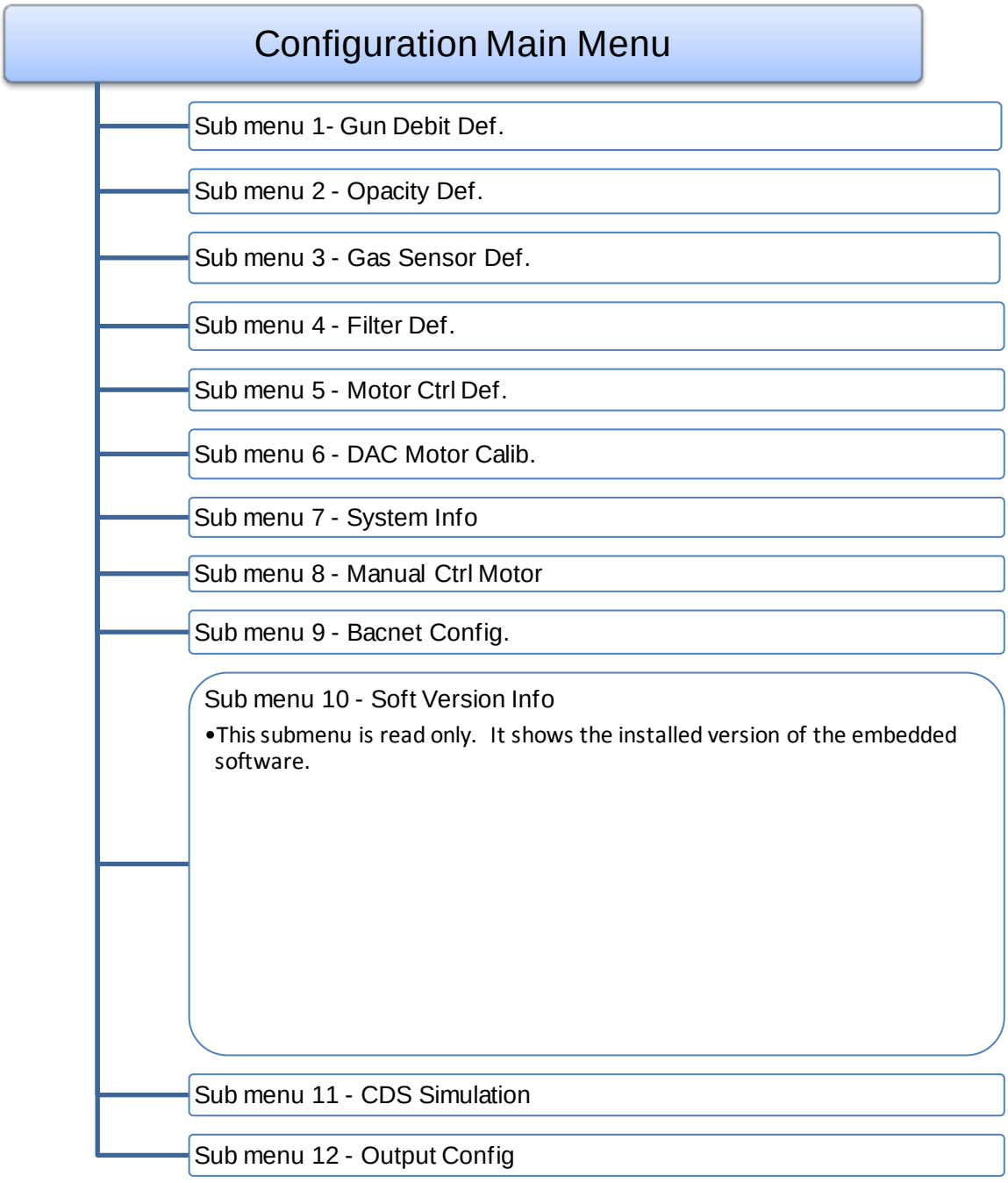
A

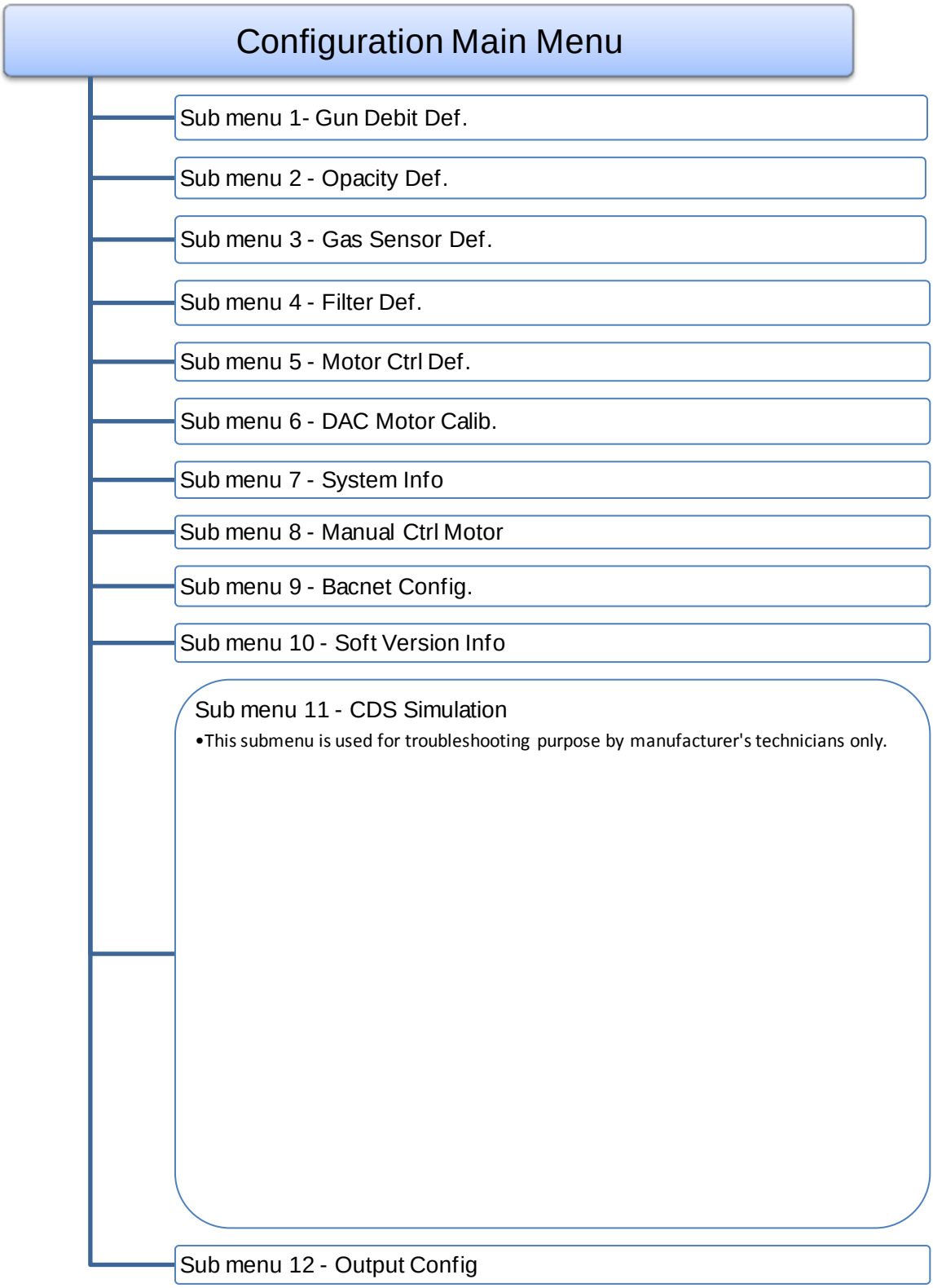
Sub menu 8 - Manual Ctrl Motor

- This menu should be used for start-up only. Yhis menu provides the ability to set the motor speed to MAX, 0% or any level per increment of 1%.
- It is wise to use this menu to check motor rotation. Not doing so may result in dust contamination in paint booth area with air incoming from chimney and dirty filters!
- **MOTOR 100%**
  - By pressing OK at this submenu, the exhaust level will be set at 100%. WARNING: improper rotation at this leven can cause severe cointamination. Check rotation before using this function.
- **MOTOR 0%**
  - By ressing OK at this submenu, Exhaust level will be forced to 0%.
- **MANUAL SPEED.** This is the most usefull function at start-up. Use this function to slowly increase (increments of 1%) the speed of the fan to check rotation or any other problems that may arise in increasing the speed.
  - Press OK at this submeny level entry. Default value is 0%. To increase motor speed, use UP arrow. To decrease, une DWN arrow.
- **Leaving this menu will reset the speed to automatic operating level.**

- Sub menu 9 - Bacnet Config.
- Sub menu 10 - Soft Version Info
- Sub menu 11 - CDS Simulation
- Sub menu 12 - Output Config


Configuration Main Menu
Sub menu 1- Gun Debit Def.
Sub menu 2 - Opacity Def.
Sub menu 3 - Gas Sensor Def.
Sub menu 4 - Filter Def.
Sub menu 5 - Motor Ctrl Def.
Sub menu 6 - DAC Motor Calib.
Sub menu 7 - System Info
Sub menu 8 - Manual Ctrl Motor
Sub menu 9 - Bacnet Config.
•Use this menu to set the BacNet communication parameters:
•MS/TP address
•Default value is 15. To change this value, press "NUM" key and type the new value, press OK to accept and answer "YES" to confirm.
•NETWORK BAUD RATE
•Default value is 19200bps. . To change this value, press "NUM" key and type the new value, press OK to accept and answer "YES" to confirm.
Sub menu 10 - Soft Version Info
Sub menu 11 - CDS Simulation
Sub menu 12 - Output Config


Configuration Main Menu
Sub menu 1- Gun Debit Def.
Sub menu 2 - Opacity Def.
Sub menu 3 - Gas Sensor Def.
Sub menu 4 - Filter Def.
Sub menu 5 - Motor Ctrl Def.
Sub menu 6 - DAC Motor Calib.
Sub menu 7 - System Info
Sub menu 8 - Manual Ctrl Motor
Sub menu 9 - Bacnet Config.
Sub menu 10 - Soft Version Info
•This submenu is read only. It shows the installed version of the embedded software.
Sub menu 11 - CDS Simulation
Sub menu 12 - Output Config


Configuration Main Menu
Sub menu 1- Gun Debit Def.
Sub menu 2 - Opacity Def.
Sub menu 3 - Gas Sensor Def.
Sub menu 4 - Filter Def.
Sub menu 5 - Motor Ctrl Def.
Sub menu 6 - DAC Motor Calib.
Sub menu 7 - System Info
Sub menu 8 - Manual Ctrl Motor
Sub menu 9 - Bacnet Config.
Sub menu 10 - Soft Version Info
Sub menu 11 - CDS Simulation
•This submenu is used for troubleshooting purpose by manufacturer's technicians only.
Sub menu 12 - Output Config

Configuration Main Menu

- Sub menu 1- Gun Debit Def.
- Sub menu 2 - Opacity Def.
- Sub menu 3 - Gas Sensor Def.
- Sub menu 4 - Filter Def.
- Sub menu 5 - Motor Ctrl Def.
- Sub menu 6 - DAC Motor Calib.
- Sub menu 7 - System Info
- Sub menu 8 - Manual Ctrl Motor
- Sub menu 9 - Bacnet Config.
- Sub menu 10 - Soft Version Info
- Sub menu 11 - CDS Simulation

Sub menu 12 - Output Config

- **ASCENDING SLOPE**
  - For example, if a change from 50% to 100% of output level rate must be provided in 5 seconds, **OUTPUT** voltage must change from 5000 mV to 10000 mV (5 to 10 VDC) in 5 seconds. Then rate of change mus be set to 1000 mV (1 VDC) per second. To change this value, press "NUM" key and type the new value, press OK to accept and answer "YES" to confirm
- **DESCENDING SLOPE**
  - For example, if a change from 100% to 50% of output level rate must be provided in 5 seconds, **OUTPUT** voltage must change from 10000 mV to 5000 mV (10 to 5 VDC) in 5 seconds. Then rate of change mus be set to 1000 mV (1 VDC) per second. To change this value, press "NUM" key and type the new value, press OK to accept and answer "YES" to confirm

OPERATION

2.1 Simplified operation

In most cases, the spray operation is detected through a flow meter device installed on the compressed air supply line. An airless system triggers the system through a direct input to the system.

In AUTO mode, the system is self operating:

- On spray detection, the exhaust fan starts at 100% level of pre-set exhaust.
- After stopping the spray operation, NOVEO-AIR™ reduces the air exhaust speed 50% and then continues reducing until it reaches "stand-by" mode. The air exhaust and the time settings for each mode are configured by the user at the User menu located on the NOVEO-AIR™ Control Panel.
- The VOC sensor always measure Solvents or Organic Volatile Compounds and adjust the exhaust according to a threshold level. At 100 PPM or less, there is no action. At a level of more than 100 PPM, exhaust is increased to maintain a reading close to the threshold level.
- The filter saturation sensor indicates to the NOVEO-AIR™ the level of filter saturation in the paint booth. NOVEO-AIR™ then adjusts the air exhaust according to the filter saturation.

In BY-PASS mode, the control system is by-passed. The exhaust levels rely on direct motor power connection through the cam switch. Exhaust level should be 100% as if there was no control system.

2.2 Extended operation sequences

In AUTO mode, the following parameters are continuously monitored:

Filter loading (dirty filters): The NOVEO-AIR™ system continuously readjust the exhaust level to maintain a constant exhaust throughout the days of operation. With new clean filters, the exhaust level is reduced to the set level. With the increase of static pressure reading through the filters, the fan speed is increased to maintain the same exhaust level.

Supply Air Solenoid valves control: In some situations depending on local jurisdictions, a solenoid valve is installed to shut-off compressed air that supply the spray gun in case of malfunction of the exhaust system. The NOVEO-AIR™ system maintains the same level of safety. A timed delay override permits compressed air to be present at the spray gun in order to detect spray operation. After a pre-programmed delay, the flow switch contact is re-enabled.

Operator Main Menu

Sub menu 1
Operation Status
GUN

- Inactive=No Spray or Active= Spray
- **IR**
  - IR stands for Infrared. This is an equipment option. An infrared particle detection system is used to detect paint particles in the air stream. The reading is in percent from 0% to 100%
- **FAN**
  - Fan RPM is measured from 0% (stopped) to 100% (Max speed)
- **GAS**
  - Gas [VOC'S (Volatile Organic Compounds)] is measured in percent and ppm's (parts per million). The maximum value is [100% and ppm's]. The range is adjustable.
- **DELAY**
  - Delay time is measured in seconds and is the time applicable during each different phases of the deceleration period.
  - After the gun trigger is released, the time displayed is the period between full speed and medium speed. Time delay is adjustable.
  - When the fan reaches medium speed, the time displayed is the period between medium and low speed. Time delay is adjustable.
  - When the fan reaches low speed, the time displayed is the period between medium and low speed. Time delay is adjustable.
- **FILTER**
  - Filter media loading is indicated by 'ok' or 'dirty'. Media loading values are adjustable.

Sub menu 2
Oper. Statistics

Sub menu 3
High Speed Def.

Sub menu 4
Medium Speed Def.

Sub menu 5
Low Speed Def.

Sub menu 6
Standby Definition

Operator Main Menu

E

Sub menu 1
Operation Status

Sub menu 2
Oper. Statistics

- **Spray Gun Statistics**
  - **Active**
    - Displayed value accumulates total spray gun elapse time in hours, minutes and seconds
  - **Inactive**
    - Displayed value accumulates total spray gun down time in hours, minutes and seconds
  - **Total**
    - Displayed value accumulates total spray gun time in hours, minutes and seconds from last reset.
  - **NOTE**: To reset digital timers to zero, turn off power to panel or open main disconnect located on the control panel front.
  - To return to sub menu under 'Operational Stats' press the touch button (**4 f**).
- **Fan Statistics**
  - **MAX**
    - Displayed value accumulates total fan operating time in hours, minutes and seconds.
  - **MED**
    - Displayed value accumulates total fan operating time at 80% speed in hours, minutes and seconds. Fan medium speed is adjustable (Refer to primary menu No.4).
  - **MIN**
    - Displayed value accumulates total fan operating time at 30% speed in hours, minutes and seconds. Fan minimum speed is adjustable (Refer to primary menu No.4 option 5).
  - **IDLE**
    - Displayed value accumulates total fan idle (Non-operating) time in hours, minutes and seconds.
    - To reset time to zero, turn off power to panel or open main disconnect located on control panel front.

Sub menu 3
High Speed Def.

Sub menu 4
Medium Speed Def.

Sub menu 5
Low Speed Def.

Sub menu 6
Standby Definition

Operator Main Menu

- Sub menu 1
  Operation Status
- Sub menu 2
  Oper. Statistics
- **E** Sub menu 3
  High Speed Def.

  - **SET BACK DELAY**
    - Set back delay is the interval (in seconds) from release of the spray gun trigger (stop painting) until the fan begins to slow down (decelerate).
    - The actual value is the number registered in the computer. Ex 12s and will vary according to the process.
    - To modify the delay interval, press touch button (**NUM**) and the following will appear on the display:
    - Press again (**NUM**) to enter a revised delay value (seconds) press the desired touch button.
    - Per example, press (**NUM**) for 1 + (**5**) will give you 15s when you press and release touch button (**OK**) and the following question will appear on the display
    - If the delay period is not acceptable, restart over the options of the High Speed Delay display by pressing **NUM** and choosing the best delay for your application.
  - **OUTPUT LEVEL**
    - Output Level is the maximum exhaust fan speed.
    - The sub-menu is then displayed by pressing the touch button (**OK**) with the following items appearing on the display:
    - To select the Output Level sub menu, scroll (2 **h**) or (8 **i**) until the shadow is positioned No. 2. Then, press the touch button (**OK**) to validate you choice and the following will appear on display;
    - The actual value is in percent of motor speed. Maximum speed of a nominal 1800 RPM motor is approx. 1750 RPM wich equals 100%.
- Sub menu 4
  Medium Speed Def.
- Sub menu 5
  Low Speed Def.
- Sub menu 6
  Standby Definition

Operator Main Menu

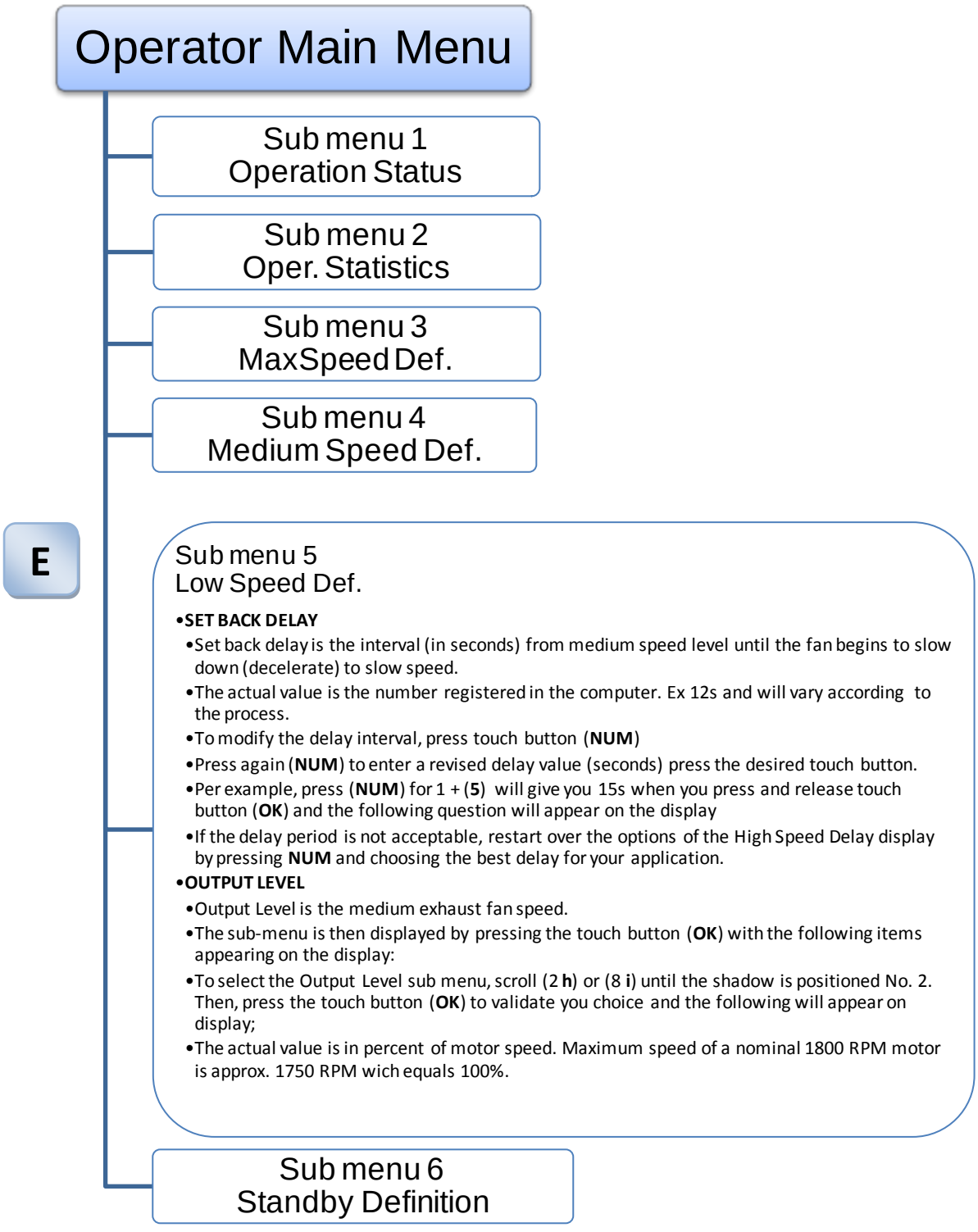
- Sub menu 1
  Operation Status
- Sub menu 2
  Oper. Statistics
- Sub menu 3
  MaxSpeed Def.

E

Sub menu 4
Medium Speed Def.

- **SET BACK DELAY**
  - Set back delay is the interval (in seconds) from maximum speed level until the fan begins to slow down (decelerate) to medium speed.
  - The actual value is the number registered in the computer. Ex 12s and will vary according to the process.
  - To modify the delay interval, press touch button (**NUM**)
  - Press again (**NUM**) to enter a revised delay value (seconds) press the desired touch button.
  - Per example, press (**NUM**) for 1 + (**5**) will give you 15s when you press and release touch button (**OK**) and the following question will appear on the display
  - If the delay period is not acceptable, restart over the options of the High Speed Delay display by pressing **NUM** and choosing the best delay for your application.
- **OUTPUT LEVEL**
  - Output Level is the medium exhaust fan speed.
  - The sub-menu is then displayed by pressing the touch button (**OK**) with the following items appearing on the display:
  - To select the Output Level sub menu, scroll (2 **h**) or (8 **i**) until the shadow is positioned No. 2. Then, press the touch button (**OK**) to validate you choice and the following will appear on display;
  - The actual value is in percent of motor speed. Maximum speed of a nominal 1800 RPM motor is approx. 1750 RPM wich equals 100%.

- Sub menu 5
  Low Speed Def.
- Sub menu 6
  Standby Definition


Operator Main Menu
Sub menu 1
Operation Status
Sub menu 2
Oper. Statistics
Sub menu 3
MaxSpeed Def.
Sub menu 4
Medium Speed Def.
E
Sub menu 5
Low Speed Def.
•SET BACK DELAY
•Set back delay is the interval (in seconds) from medium speed level until the fan begins to slow down (decelerate) to slow speed.
•The actual value is the number registered in the computer. Ex 12s and will vary according to the process.
•To modify the delay interval, press touch button (NUM)
•Press again (NUM) to enter a revised delay value (seconds) press the desired touch button.
•Per example, press (NUM) for 1 + (5) will give you 15s when you press and release touch button (OK) and the following question will appear on the display
•If the delay period is not acceptable, restart over the options of the High Speed Delay display by pressing NUM and choosing the best delay for your application.
•OUTPUT LEVEL
•Output Level is the medium exhaust fan speed.
•The sub-menu is then displayed by pressing the touch button (OK) with the following items appearing on the display:
•To select the Output Level sub menu, scroll (2 h) or (8 i) until the shadow is positioned No. 2. Then, press the touch button (OK) to validate you choice and the following will appear on display;
•The actual value is in percent of motor speed. Maximum speed of a nominal 1800 RPM motor is approx. 1750 RPM wich equals 100%.
Sub menu 6
Standby Definition

Operator Main Menu

- Sub menu 1 Operation Status
- Sub menu 2 Oper. Statistics
- Sub menu 3 MaxSpeed Def.
- Sub menu 4 Medium Speed Def.
- Sub menu 5 Low Speed Def.

E

Sub menu 6 Stand-by Definition

- **SET BACK DELAY**
  - Set back delay is the interval (in seconds) from low speed level until the fan begins to slow down (decelerate) to stand-by speed.
  - The actual value is the number registered in the computer. Ex 12s and will vary according to the process.
  - To modify the delay interval, press touch button (**NUM**)
  - Press again (**NUM**) to enter a revised delay value (seconds) press the desired touch button.
  - Per example, press (**NUM**) for 1 + (**5**) will give you 15s when you press and release touch button (**OK**) and the following question will appear on the display
  - If the delay period is not acceptable, restart over the options of the High Speed Delay display by pressing **NUM** and choosing the best delay for your application.
- **OUTPUT LEVEL**
  - Output Level is the medium exhaust fan speed.
  - The sub-menu is then displayed by pressing the touch button (**OK**) with the following items appearing on the display:
  - To select the Output Level sub menu, scroll (2 **h**) or (8 **i**) until the shadow is positioned No. 2. Then, press the touch button (**OK**) to validate you choice and the following will appear on display;
  - The actual value is in percent of motor speed. Maximum speed of a nominal 1800 RPM motor is approx. 1750 RPM wich equals 100%.

TROUBLESHOOTING

3.1 Questions and answers

When I use the paint gun, the paint booth exhaust fan doesn't start automatically

- Verify that paint gun is properly connected to the air line and the air flow sensor (aluminum block on the air line with 2 small plastic hoses)
- Verify that the power switch in the front of the Noveo panel is in "AUTO" position.
- Verify that main power switch or breaker is ON. If not, the display on the front of the Noveo panel will show nothing. In this case:
    - Check main breakers, fuses and switches
    - Turn off the Noveo panel power switch and open the door. Check the control fuse located inside the panel.

When I don't use the paint gun, the exhaust continues to run at full speed

- Diagnostic 1: The manual override switch is at position "ON". Reposition the switch to automatic position

- Diagnostic 2: On the Noveo keypad, scroll the primary menu to "operation status" and note the value of "Gun". When the gun(s) are in use, the value should be "active" and "inactive" when not used.

  If the display indicates active even if the gun is not in use, there is a problem with the "gun use detection":

  Be certain that you don't have a leak on the air flow sensor hoses (aluminum block on the air line) between the sensor and the Noveo panel.

  Turn off the power switch on the Noveo panel and open the front door. Listen for an air leak, especially in the Noveo module on the left where red hoses are connected.

  Check if a piece of pneumatic equipment such as a paint mixer or manual sanding tool is connected on the air line equipped with the flow detector (aluminum block on the air pipe). The auxiliary equipment such as paint mixers, manual sanding tool, etc. must be connected to the air line upstream from the aluminum block.

Repair the air leak if applicable or place the manual switch in position “ON” and call a technician or follow the gun detection calibration instructions in the start-up section.

When I don’t use the paint gun, sometimes the paint booth exhaust fan start and stop with no reasons

- Diagnostic 1: Be sure that a pressure regulator is located upstream of the flow sensor (aluminum block with 2 plastic hoses)

  You must have a pressure drop of at least 10-15 PSI between the output of the regulator and the main air line

  Important fluctuations inside the air lines where the air flow detector is located can simulate the operation of a paint gun and start the exhaust fan. An automatic purging system or a dust collector pulse air system is sufficient to create an important pressure drop in the air pipes. Adjust the pressure regulator at a lower pressure to reduce the effect of the drop, install an air tank or change the configuration of the pipes.

- Diagnostic 2: Be sure that a pressure regulator is located upstream of the flow sensor (aluminium block with 2 plastic hoses)

  You must have a pressure drop of at least 10-15 PSI between the output of the regulator and the main air line

  If the sensitivity of the air flow detector is too high, the system will detect fluctuations within the air pipes. Refer to the start-up manual, follow the instructions under the topic “Air flow sensor calibration” or call a technician.

I have a solenoid valve controlled by the Noveo system and it doesn’t open even when the exhaust fan runs.

<u>Be certain the problem is not a pneumatic trouble such a closed manual valve or stopped compressor!!</u>

Solenoid valve is sometime required by code to interrupt the air supply feeding the paint gun when exhaust fan is stopped. Noveo system provides a dry contact for the control of the solenoid valve. Even if the system is in standby and the exhaust fan doesn’t run, the solenoid stays open. When use of the paint gun occurs, the exhaust fan accelerates to full speed and the filter differential pressure detector sends a proof of exhaust to the Noveo system. If there is no proof after few seconds, solenoid valve close.

- ***Diagnostic 1:*** Noveo system hasn’t received the exhaust confirmation.

  If filters are not present, system will not detect the exhaust proof

If the type of filter has changed and the restriction is lower than the original filters, the filter recalibration needs to be done. Follow the instructions under the topic “Filter calibration” in the start-up manual or call a technician.

To reset the exhaust proof system protection, turn off the main power switch and turn it on. Solenoid valve will open and the system will be ready to operate.

- ***Diagnostic 2:*** Solenoid valve never opens, even after the reset of the Noveo panel.

  It’s probably an electrical problem. Power supply for the solenoid valve comes from an exterior source and NOT from the Noveo panel.

  Call an electrician and verify the power source (breaker, fuse, etc.).

  Verify the solenoid is working properly

3.2 Service recommendations

For service, please call your local Noveo service representative.

To contact NOVEO:

Tel: 450-444-2044 toll free: 1-877-314-2044
Fax: 450-444-2088
Email: info@noveo.ca
Web: www.noveo.ca

Noveo Technologies Group Inc
9655A, Ignace,
Brossard, Qc, Canada
J4Y 2P3

MAINTENANCE

4.1 Recommended schedule

MONTHLY	Check for pressure ports cleanliness. Check for obstructions in the VOC sensor tubing.
EVERY 3 MONTHS	Check fan operation. Check belt wear. Test by-pass operation. Check amperage of motor and readjust overload protection settings if required.
ANUALLY	Check air balancing and check the minimum and maximum exhaust settings Test VOC sensor calibration

4.2 Replacement parts list

WARRANTY

5.1 Limited warranty

Noveo guarantees the equipment and parts installed for one period of one (1) year after the original installation date. The guarantees on the components manufactured by a manufacturer other than Noveo are covered by the guarantee of the original manufacturer. The parts prone to wear are not guaranteed.

Damages resulting from a cause beyond control (an unforeseen and irresistible event external making impossible to respect an engagement);(b) delays caused by governmental action, strike, fire, flight, flood, insurrection, war, spite or any other event independent of the will of Noveo; (c) the malfunction, partial or total of the equipment caused by the parts damaged because of the lack of power, cause beyond control, normal disasters, natural disasters or climatic conditions; (d) repairs or installation by the unauthorized people; (e) lack to follow instructions of use, care or maintenance of the equipment. In all the cases, the responsibility for Noveo is limited to the purchase price for the equipment and the parts sold by Noveo.

5.2 Liability limits

The manufacturer is not responsible for:

Any costs resulting from a failure if the installation, commissioning, repair, alteration, or ambient conditions of the system do not fulfil the requirements specified in the documentation delivered with the unit and other relevant documentation.

Units subjected to misuse, negligence or accident.

Units comprised of materials provided or designs stipulated by the purchaser. In no event shall the manufacturer, its suppliers or subcontractors be liable for special, indirect, incidental or consequential damages, losses or penalties. This is the sole and exclusive warranty given by the manufacturer with respect to the equipment and is in lieu of and excludes all other warranties, express or implied, arising by operation of law or otherwise, including, but not limited to, any implied warranties of merchantability or fitness for a particular purpose.

APPENDIX A

APPENDIX B