Application Note:

Installation Manual

Interfacing the MAC View**® Greenhouse Gas Analyser HW 2.0 / HW 3.0 / HW 4.0 with a climate computer, climate control system or process computer**

This manual describes the way of connecting the MacView® - Greenhouse Analyser to a climate computer, climate control system or process computer. The connection can be done at different levels. This can be done in an easy way, but also in an more advanced way where it is possible to sent or receive additional information from and to the climate computer.

*Broadly it is useful to connect the MAC*View*® -Greenhouse GA by one of the 2 described ways below:*

1. **4-20mA analogue output of the GA + status information from 0-4 mA**
2. **4-20mA analogue output of the GA + relay-alarm**

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Available interfaces between the MACView® Greenhouse Gas Analyser and climate computer, climate control system or process computer
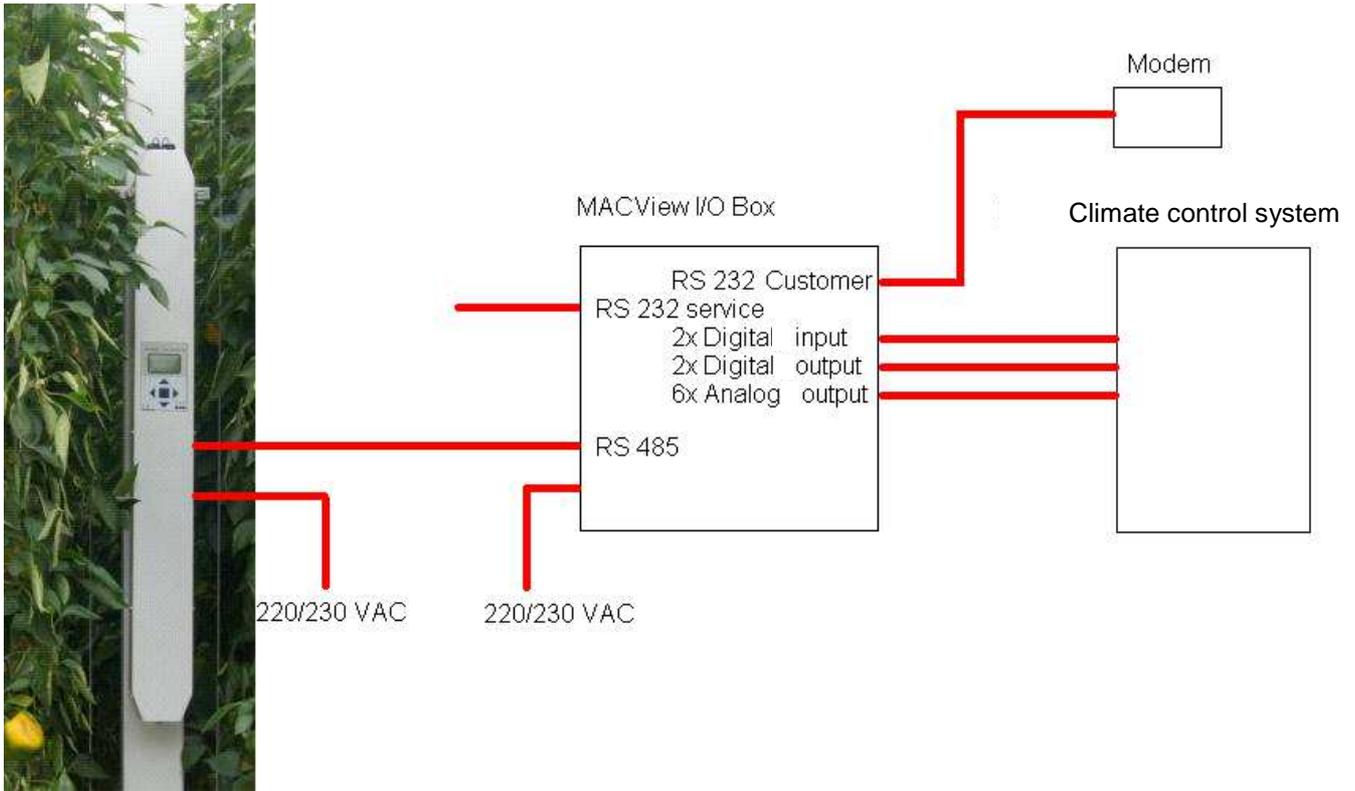
Figure 1: Overview of available interfaces

*Figure 2: Setup example of a greenhouse / office –climate computer.*

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West

East

North
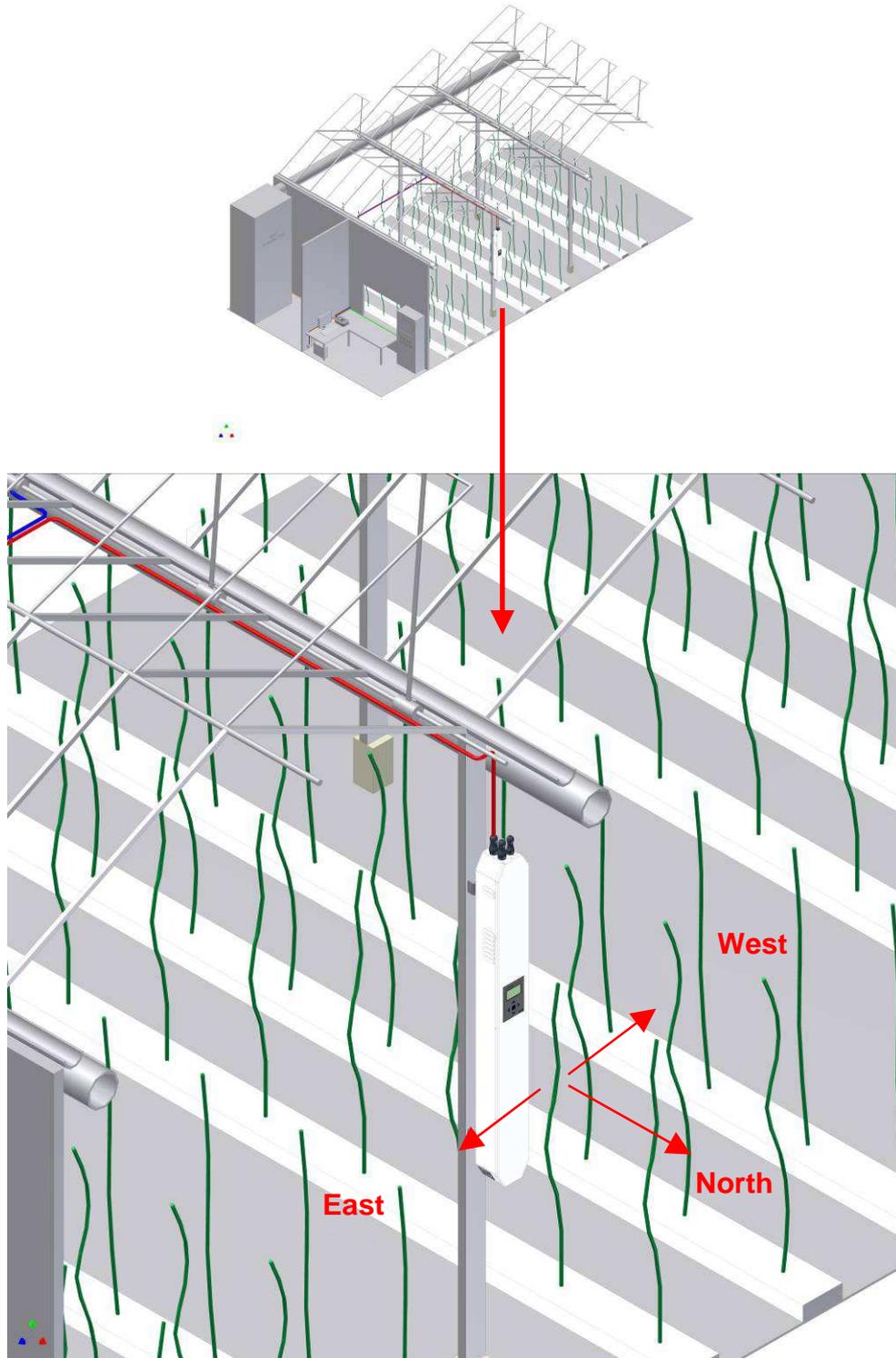
Figure 3: Presentation example inside the greenhouse.
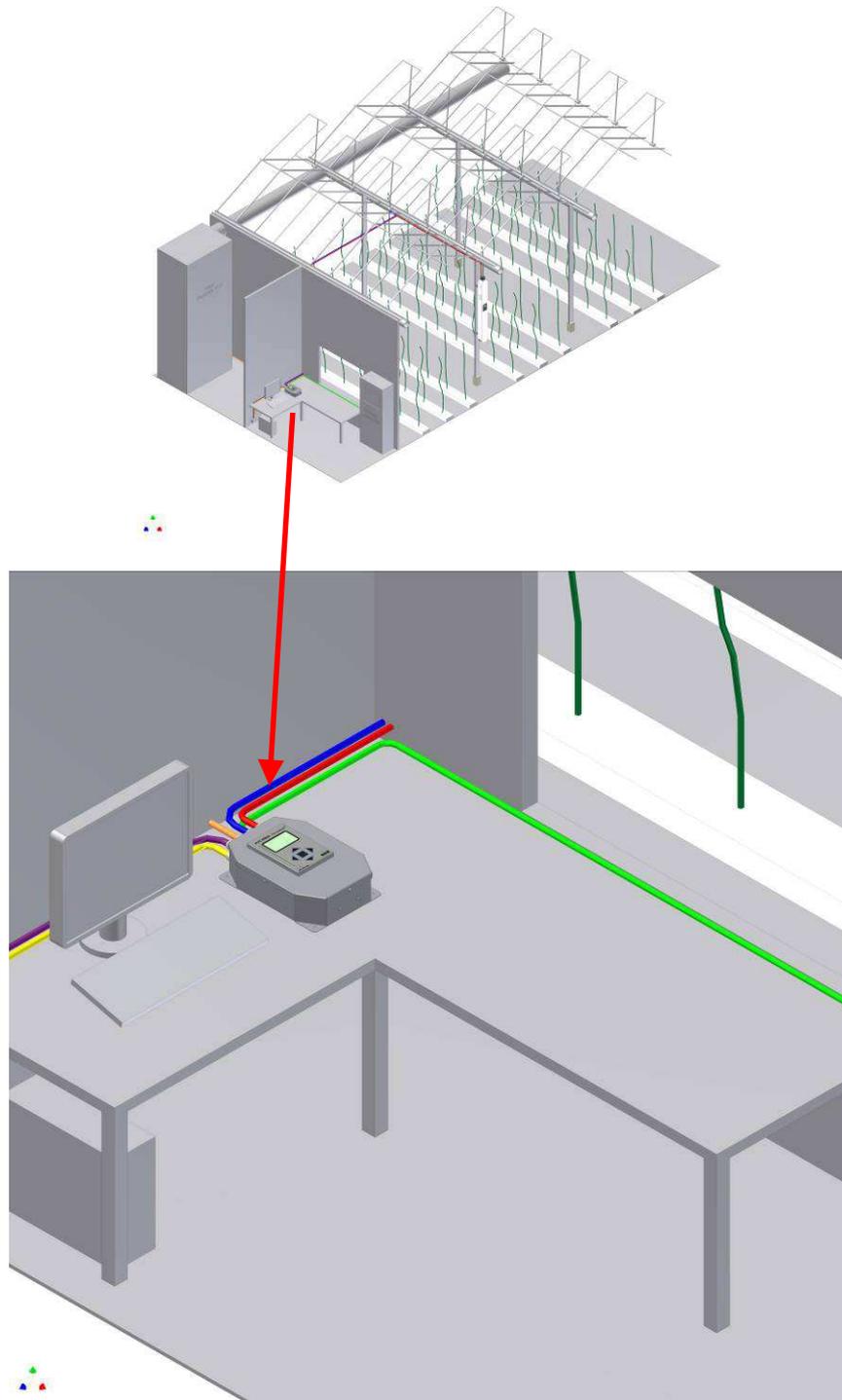
Figure 4: Demonstration example inside the office with the IO-BOX connected to the climate computer.
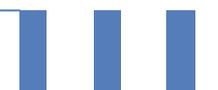
General

The MAC**View**® Greenhouse GA includes 2 parts which are connected to each other and also connected with a climate computer or satellite (remote I/O).

The MAC**View**® Greenhouse GA will be installed inside the greenhouse. This machine is the main part that'll provide measurements. The generated information from out of this system will be transmitted to an I/O-BOX, which is in the office or at least nearby the I/O from the climate computer, by using CAT-5 UTP wiring. There is an option of using a satellite, D-sat or remote I/O as I/O for the climate computer.
The I/O-BOX has a control unit with a display and buttons, which looks exactly the same as the control unit of the MAC**View**® Gas Analyser. Furthermore, the I/O-BOX also has build-in I/O channels to communicate with the outside world. This could be both analogue and digitally outputs.

These analogue en digital inputs and outputs of the I/O – BOX could be connected to the analogue inputs of the climate computer (See the green wire in figure 2 and figure 4). By that it is possible to read the values of the MAC**View**® Greenhouse Analyser out of the climate computer. The I/O-BOX is, in fact, an remote I/O station. The MAC**View**® GA's data is sent digitally to the I/O-BOX. Thereafter the I/O-BOX sends the received data as analogue data to the climate computer. The I/O-BOX could be connected to basically every brand of climate computer.

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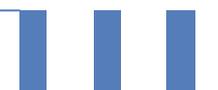
Considerations for installation / mounting

We recommend to choose the position of the MAC**View**® Greenhouse Gas Analyser in agreement with EMS. As usual the MAC**View**® GA would be, seen from the inlet of CO_2 in the greenhouse, installed at 1/3 of the distance. Below are 2 examples given from out the practice in which way the MAC**View**® GA should been installed. Thereby it's advisable to install the MAC**View**® GA in the vicinage or already excising measure point or box like RV, temperature or light.

There should be primary paid attention to the following points:

1. The most important criterion to the position where the MAC**View**® GA shall be placed is the measure position, seen from out of the CO_2's mean pipe, with respect to the CO_2 distributors / CO_2 hoses.
2. The MAC**View**® GA only might be mounted at the (main) path side. All proceedings have to be done from standing on the (main) path.
3. The MAC**View**® GA's front must be positioned to the north, or as second alternative to the north-east.
4. The MA**C**View® GA should be mounted at a height, on which the display is on the same height as the users' eyes. Definitely not higher!
5. There should be enough free space on where the MAC**View**® GA will be mounted. There may not be any stuff mounted on the same place as where the MAC**View**® will come mounted (like: socket, main wall, chargers). If there is, for instance, a electrical outlet, another position for the MAC**View**® should be chosen.
6. Be sure that the MAC**View**® GA isn't mounted at the same place of a water supply. The risk of water damage on the MAC**View**® will be higher if so.
7. The MAC**View**® GA shouldn't be mounted to closely to sulfur generators. (If there are). If sulfur generators are being used in the greenhouse, ensure the position of the generators and the analyser is chosen that way the analyser is positioned right between the generators, with as much as possible equal distances.
8. The MAC**View**® GA is powered with 230V. It's very helpful if a wall socket is available. Note that the 230V plug always is connected to the main wall. Sometimes they remove plugs to use the socket for other equipment. Logically the MA**C**View® GA will stop running then and needs a new start-up / warm-up time. This is unacceptable if the MA**C**View® GA is connected to controlling systems like let's say the climate computer or a climate control system. If the main wall is used by more equipment than the MAC**View**® GA only, a power strip is needed.
9. <u>Preferably we want to ask the installer or grower for taking a photo of the imagined place prior to the moment the MAC**View®** will be mounted.</u> This picture would then be reviewed by EMS whether or not the imagined place is a good one.
10. What are the path numbers the MAC**View**® GA going to become mounted? ………………………..
11. How many connections would there be made?...

In figure 5 two examples are given of possible CO_2 dosing installations and how the MAC**View**® needs to be mounted.
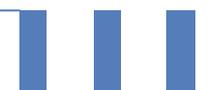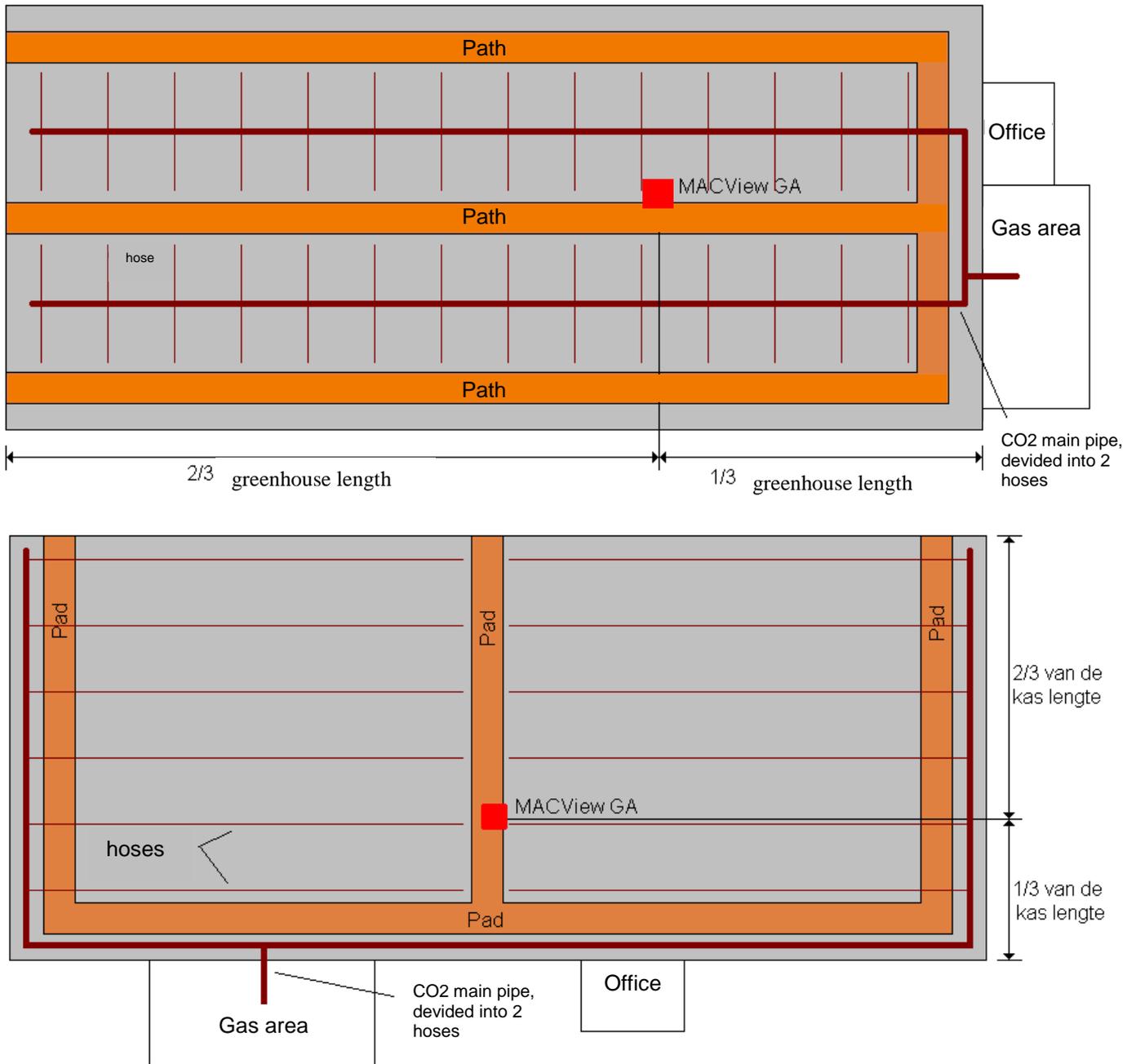
*Figure 5: Two examples of CO2 dose units. The position of the MAC**View**® GA is given by the red sign.*

The MAC**View**® I/O BOX should preferably be placed somewhere in the office, or at a central place where the climate system is positioned as well. This climate computer needs to support receiving up to 6 analogue inputs, 2 digital inputs and 2 digital outputs.

220/230 VAC

Both the MAC**View**® Greenhouse Analyser as well as the IO-BOX needs to be plugged into the 220/230VAC mains by using a 220/230VAC cable. Normally those cables have a length of about 3 meters (118") and are included with both systems. It's possible to connect a plug to a separate cable; therefore, the user isn't bound to the 3 meter (118") which is included with both systems.

RS 485

This is the connection between the MAC**View**® Greenhouse Analyser and the IO-BOX (See the red lines in figure 2, 3 and 4). This connection makes it possible to transport data over long distances.
This connection may be no longer as 1000 meters (39,37" or 0.62 miles). If this length is exceeded, in agreement with EMS should bus amplifiers be placed. As type of cable UTP (network) could be used.
This type of cable is not included, but the needed plug for the MAC**View**® Gas Analyser is. The other side of the cable must be connected in the MAC**View**® I/O BOX on terminal block J10.

> *! NOTE! It is essential that TXA and TXB are connected by using one twisted pair wirings and RXA and RXB with another twisted pair.*
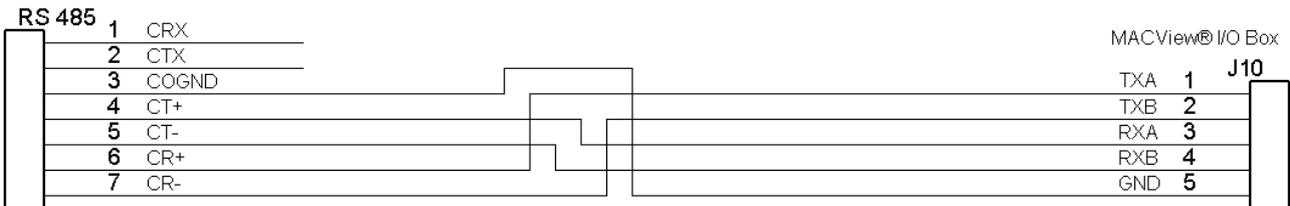
Figure 6: Wirings of RS 485

RS 232 Customer (See also figure 4; J11 and J12 MACView® I/O BOX)

Via this connection a computer or permanent service connection could be connected. This connection have than to be connected with an (A)DSL modem or wireless GPRS / UMTS modem.

There are two options as type of RS232 connection.
1) Standard SUB-d connector (J12 MAC**View**® I/O Box)
2) Terminal Block J11

RS 232 Service (See also figure 7; J1 and J9 MACView® I/O BOX)

This connector is meant to use by EMS as service connection. This connector isn't useful for the user.

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Digital input (See also figure 7; J6 and J7 MAC**View**® I/O BOX)

The MAC**View**® Greenhouse Gas Analyser has two digital inputs. This inputs are galvanic isolated, potential free and accepts signals of 5-30Vdc / 5-24Vac. Input 1 is strictly necessary needed for the back-flush signal between de climate computer and the MACView® Greenhouse Gas Analyser, for example during sprinkling or when crop is sprayed with pesticides. See for more information "Configurations and menu options of the MAC**View**® Greenhouse Gas Analyser" (Digital input).

Din 1)   5 – 30Vdc / 5 – 24 Vac: Back-flush contact
Din 2)   5 – 30Vdc / 5 – 24 Vac: Reserve

Digital output (See also figure 7; J3 and J24 MAC**View**® I/O Box)

The MAC**View**® Greenhouse Gas Analyser has two digital outputs. This contacts are both galvanic isolated by using a potential free relay. Switching limit is 24V AC/DC with a maximum of 1 Ampere. The output is configured as changeover switch.

One of these digital outputs is strictly necessary if error status transmitting to the climate computer is used.

Dout 1)   Potential free changeover switch: Error statuses
Dout 2)   Potential free changeover switch: Reserve
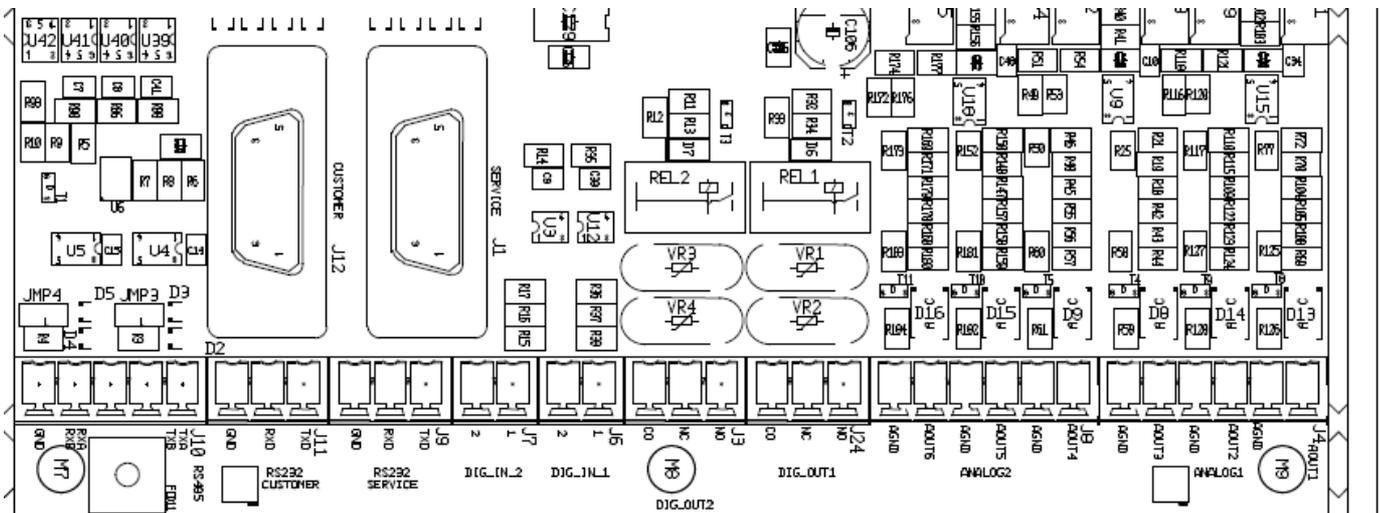
*Figure 7: Terminal Blocks in the MAC**View**® I/O BOX*

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Analogue outputs (See also figure 7; J4 and J8)

The MAC**View**® Greenhouse Gas Analyser has 6 analogue outputs.

! NOTE! The analogue outputs aren't galvanic isolated !

The load resistance needs to be within 50 to 450 Ohm (With using values outside the 50-450Ohm range, calibration of the outputs would be needed).

Five of the six analogue outputs have to be connected to the climate computer, climate control system or process computer.

Aout 1)   4-20 mA analogue output for input 1: NO (Nitric Oxide) (Essential connection)
Aout 2)   4-20 mA analogue output for input 2: NO2 (Nitric Dioxide) (Essential connection)
Aout 3)   4-20 mA analogue output for input 3: C2H4 (Ethylene) (Essential connection)
Aout 4)   4-20 mA analogue output for input 4: CO (Carbon Monoxide) (Essential connection)
Aout 5)   4-20 mA analogue output for input 5: CO2 (Carbon Dioxide) (Essential connection)
Aout 6)   4-20 mA analogue output for input 6: Reserve (have to be connected) (Is being used as for example as additional NO_x control parameter or HC measurements)

This results into a necessary 12 cores shielded connection. Off course, it is possible to use more shielded cables with less cores together.

! NOTE! The wiring of this connection should be shielded and at ONE side connected to GND or AGND!

The shielding of the analogue output wiring should be shielded and one side of it (climate computer) must be connected to (A)GND. The shielding at the other side of the wiring shouldn't be connected! (So, don't connect it to the GND or AGND from the MACView® I/O BOX). If the shielding needs to be connected at the side of the MACView I/O BOX, the user/installer can use the AGND terminal block of the regarding output.

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Configurations and menu options of the MAC**View**® Greenhouse Gas Analyser

Digital Input

Through the digital input the user could force the system to go into back-flush or standby mode.
Via digital input 1 it is possible to tell the system that spraying or irrigation (with pesticides) will start.
When input 1 is confirmed by the climate computer, the analyser will go into the back-flush mode.
Internal pumps will be stopped and valves are going positioning in the right mode, so that the analyser has got an optimum protection against harmful gases.

If the system isn't put in this back-flush mode and harmful gases or liquids are been used (oxidizing remedies, oily remedies, corrosive remedies etc), this could lead to damage to the inside of the MACView® GA!!

To put the system in back-flush mode, the digital input needs to be triggered for a minimum of 1 minute. Thereafter the system jumps into the back-flush mode. The activated back-flush mode takes usually 12 hours. Thereafter the system jumps to the start-up mode. As an example when it is useful to use back-flush, is when the grower wants to irrigate, spraying, or is using oxidizing, oily or corrosive materials around the analyser. The difference between standby and back-flush is that directly after the (configurable) back-flush timer the system restarts itself automatically.

During culling and disinfection the greenhouse (when there's a prolonged use of disinfectants and / or sprays), it will be more useful to remove the analyser temporarily and return it after the culling and disinfection are finished.

When the digital input is triggered for more than 5 seconds, but less than a minute, the analyser would going into standby. From the moment the input falls low, within the times mentioned before, the analysers will jump into standby mode. To return from standby to normal mode, the input needs to be triggered again for a minimum of 5 seconds and less than 1 minute. Thereafter the system will return to start-up mode.

The standby mode is usually meant for crop rotation. Protect the analyser when it's removed during the crop rotation by, for example, a bag.

The digital input can be switched by putting 5-30Vdc or 5-24Vac on the terminal blocks. The availability of a voltage difference corresponds to the state "active" or "on" and a lack of a voltage difference corresponds to "non active" or "off".

Analogue outputs

The analogue outputs are meant for controlling external equipment, based on the measured concentrations of NO, NO_2, C_2H_4, CO and CO_2. This external equipment could be a climate system, climate control system or process computer or an external display unit.

The coupling between the analyser and external equipment can have a multiple purpose. So it is possible to control the aeration windows, CO_2 gift or ventilation based on the measured gas values. The lower the measured harmfully gases, the less ventilation is needed. Another purpose could be the possibility of measuring all parameters by the climate computer, display those values and let's give alarms on it.

The analysers' analogue output is 16 bits. The measure ranges of 4-20mA are set to a scaling of 0-2000 ppb by default. It is possible to set the scaling to 0-1000ppb (adjustable on the menu). This decreasing of the ppb range could be done in case the climate computer has a lower resolution than the analysers' output. Therefore resolution or accuracy will be loosen.
In general there will be advised to keep the measurable range (ppb) 2 to 4 times lower as the resolution is be able to. Advised settings are written down in the table below. The highest priority needs to be chosen if possible. This priority depends on the resolution of the climate system. The higher the resolution, the higher the quality of connection would be.

Priority	Measure range GA (ppb or ppm)	Measure range Climate system (ppb)	Resolution analogue output GA	Resolution analogue input climate computer
4 (Advised)	2000	2000	16	16
3	2000	2000	16	14
2	2000	2000	16	12
1	1000	1000	16	10

Table 1: Overview of the MACView® Greenhouse Gas Analysers analogue output ranges

Priority	NO (ppb)	NO2 (ppb)	C2H4 (ppb)	CO (ppb)	CO2 (ppm)	Reserve (NOx) (ppm)
Measure range	2000	2000	2000	2000	2000	2000
Output	1	2	3	4	5	6

Table 2: Overview Gas types per analogue output of the MACView® Greenhouse Gas Analyser

In menu "Setp. anal. out 1" until the menu "Setp. anal. out 5" the measure range is adjustable per gas. If 2000pbb is chosen for instance, the analyser would, with a measured value of 40ppb, set the corresponding output to 2% because of 40/2000 = 2%. The analogue output level is a percentage. Therefore any value above the adjusted value would result into 100%. This percentage is presented at the analogue outputs as voltage or current value, depending on the adjustments in the menu's "Mode analogue out 1" to "Mode analogue output 5". In these menu's the corresponding analogue outputs are configurable to different behaviours.

The analogue interfaces (inputs) of the climate computer can be configured at one of below:
- 0-10 Volt (Only for short shielded wires with a maximum length of 10m)
- 0-20 mA
- 4-20 mA   **(Recommended second choice)**
- 4-20 mA & status   **(Recommended first choice)**
- EMS Specific
Descriptions of the different configurations are written below.

Mode 0-10V

In this configuration there will be a voltage of 0-10V be presented on the analogue output.
0V corresponds to 0% and 10V to 100%.

The voltage on the terminal blocks is given by the following formula:
Voltage out = 10 Volt * (measured concentration / setpoint concentration).

The maximum load resistance in this configuration is 600 Ohm.

> **Warning! In this configuration, warnings and critical errors can't be provided on the analogue outputs! If wanted, the relay in the analyser itself should be used. In a critical situation, the analogue outputs will reach the maximum concentration setpoint (Normally 2000ppb).**

Mode 0-20mA

In this configuration there will be a current of 0-20mA be presented through the analogue output.
0mA corresponds to 0% and 20mA to 100%.

The current through the analogue output is given by the following formula:

Current out = 20mA * (measured concentration / setpoint concentration).

The maximum load resistance in this configuration is 450 Ohm.

The advantage of this mode is, current compared to voltage outputs, that, in practice, the length of cable/wiring for current output is irrelevant. The cable/wring may have an unlimited length, providing that the resistance of both the cable and the system doesn't pass the 450 Ohm. Cables can be seen as series resistance.

> **Warning! In this configuration, warnings and critical errors can't be provided on the analogue outputs! If wanted, the relay in the analyser itself should be used. In a critical situation, the analogue outputs will reach the maximum concentration setpoint (Normally 2000ppb).**

Mode 4-20mA

In this configuration there will be a current of 4-20mA be presented through the analogue output., where 4 mA corresponds to 0% and 20 mA to 100%.

The current through the analogue output is given by the following formula:

Current out = 4mA + 20mA * (measured concentration / setpoint concentration).

The maximum load resistance in this configuration is 450 Ohm.

The advantage of this method compared to 0-20mA control is:

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o Errors such as a broken cable, system failure or a critical error are automatically detectable and wouldn't be presented as a concentration of 0 ppb.
o Offset errors in the signal can be solved by calibration.

Warning! In this configuration, warnings and critical errors can't be provided on the analogue outputs! If wanted, the relay in the analyser itself should be used. In a critical situation, the analogue outputs will reach the maximum concentration setpoint (Normally 2000ppb).

Mode 4-20mA with status information (Recommended)

The functionality of this mode is the same as 4-20mA control, only this mode has a addition.
This addition contains the possibility of sending status signals. These status signals shows with which measure mode the analyser is busy with. This is especial useful for the more advanced process computers and PC's. On the PC monitor the status information could be displayed and correct conclusions can be easily interpreted. These status signals are in the 0-4mA range. In the next overview the used current and meanings are shown.

Signal	Status	Meaning
0 mA	Off	The system is powered off , defect, or there's a faulty cable.
0.5 mA	Calibration alarm	The system is giving a warn, because the calibration is expired for more than 14 months. If the system is giving this status, it is strongly recommended to let performance a new calibration.
1 mA	Critical error	The system has an error, which only can be solved with the help of the manufacturer. Give a look at the systems' screen for any message.
1.5 mA	Standby	The system is in standby mode at the moment.
2 mA	Warning	The system has an error, which needs to be manually reset. In this situation, the system is working properly, but has detected a problem in the system. It is possible that the system is trying to solve the problem itself. The manufacturer should be called if the error returns. It is possible that the system gives this error while executing the verification mode.
2.5 mA	Start-Up	The system is in the start-up or warm-up mode
3 mA	Back-Flush	The system is in back-flush.
3.5 mA	Verification	The system is in verification mode.
4-20 mA	Measuring	The system is in measure mode and is showing the measured values in the range of 4-20mA on the analogue outputs.

Table 3: Meanings of mA output levels of the MACView® Greenhouse Gas Analyser

Relays

The analyser has two relays to perform error notifications or on/off controlling. Relay1 is used for analyser error notifications to the climate computer. The grower is then getting an alert when the analyser has detected a failure.
This relay contact is required when the analyser is going to be connected to a climate computer. Thereby, the grower has to be informed, when a failure occurs. The digital input of the climate computer should therefore been coupled to a clear message to the user, by for instance, a pop-up on the monitor, an sms, e-mail or any other clearly visible way of alerting. This relay output must be used!

The relay can be connected in two different ways for controlling or alerting: normally closed (break contact) or as normally open (make contact). If "Normally closed (N.C.)" is used, the circuit, in which the relay is connected, is always closed. This circuit would be broken when an alarm is coming in. If "Normally open (N.O.)" is used, the circuit, in which the relay is connected, is always open during non-error moments en would be closed when an alarm is coming in. For the correct connection of these two configurations, please read chapter "Installation and montage".

If the relay is used as for error notifications, an alert appears during the activity of a warn, or during a critical error. With this the user is able to detect when the analyser has gotten an error or failure.

> **The error notification functionality of the relay is the default configuration of the relay. Not using the relay or changing the relays functionality to one of the described below, is at own risk.**

If on/off control is used, an alarm occurs when the measured concentration exceeds the in menu "Relay upper limit" configured value for longer than the time value, set in menu "Relay delay". The alarm is immediately cancelled when the measured concentrations decreases to below the value set in menu "Relay lower limit".

If the relay is used for dumping condense water from an air conditioner or dehumidifier, a valve is connected to the normally open (N.O.) relay contact. The air cooler is emptied during the start of the verification mode. This option requires an adjustment in the EMS menu; Consult EMS for this.
The menu's "Relay upper limit", "Relay lower limit" and "Relay delay" are not available with this configuration.

The relays are able to switch 24 VAC, 1A. To switch heavier loads, an auxiliary relay should be used.

> **If heavier loads, larger than 24VAC 1A, are connected to the analysers' relay without an auxiliary relay, life-threatening situations or damaging to the analyser could occur!**

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Normal operation

In normal operations the sequence of modes after connecting the analyser to the mains are as follow:

Mode	Theoretically needed time
Warming up	1 min – 1 dag
Start-up	5 – 90 minutes
Measuring	5 - 90 minutes
Verification	5 - 90 minutes
Measuring	5 - 90 minutes
Verification	5 - 90 minutes
Etc..	

Table 4: *Duration per operation mode of the MACView® Greenhouse Gas Analyser*

- In practice the analyser would try to do measurements as much as possible and the less as possible verification modes (5 minutes a mode is normal).
- The refreshing rate of the analogue output is 60 seconds (1 value a minute).
- The back-flush mode or standby mode can be started by triggering the digital input. The system confirms via the analogue output if the system is actually into the requested mode.

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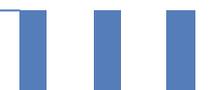
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