OPERATION MANUAL

LAMBDA MASSFLOW – Gas Flow Controller and Meter

LAMBDA MASSFLOW gas flow controller – gas flow meter

MASSFLOW is a mass flow gas regulation system specially designed for the use together with LAMBDA MINIFOR laboratory fermenters and bioreactors. The MASSFLOW allows a precise metering or automatic control of pH in cell cultures without the need of any other gas station.

- Allows the metering and/or control of pH of cell cultures by controlled addition of gaseous CO_2, N_2 or any other gas with a suitable controller
- Can be also used independently, since all functions can be accessed from the front panel
- High-quality laminar mass flow sensor
- Mass flow cell shows a minimal pressure drop
- Linearity error less than ± 3 % reading (which is much better than precision expressed as percent of full scale used by some producers)
- The repeatability is better than ± 0.5% reading
- The flow rate can be programmed (controller only) and the volume totalized
- The flow rate is regulated by a special proportional needle valve controlled by a microprocessor (controller only)

LAMBDA Laboratory Instruments

is the developer and producer of special laboratory instruments mainly for biotechnology, microbiology, food and agricultural, chemical and pharmaceutical research and development as well as for general laboratory and research applications.

LAMBDA MINIFOR – highly innovative and compact fermenter/bioreactor system for laboratory scale fermentation and cell cultures

LAMBDA OMNICOLL – fraction collector-sampler for unlimited number of fractions

LAMBDA PRECIFLOW, MULTIFLOW, HIFLOW and MAXIFLOW peristaltic pumps – reliable, precise and extremely compact

LAMBDA SAFETY POWDER DOSER – allows automatic feeding of powders without spoon. Safe operation with hazardous material (GLP)

LAMBDA VIT-FIT polyvalent syringe pump with extremely robust mechanics – programmable infusion and filling from micro syringes to large volume syringes of 150 ml without adapter

LAMBDA MASSFLOW – precise gas flow measurement and control with data acquisition option

LAMBDA PUMP-FLOW INTEGRATOR – with LAMBDA pumps and doser allows the visualization and recording of the pumped volume

TABLE OF CONTENTS

1 Setting up MASSFLOW GAS FLOW CONTROLLER / METER 3
1.1 Power Supply 3
1.2 Gas input and output 4
1.3 Setting of the flow rate (controller only) 4
2 Flow rate programming (controller only) 5
2.1 Start of the program 8
2.2 Reading the program 8
2.3 Deleting the program 9
3 Remote controls 9
3.1 ON/OFF remote control (controller only) 9
3.2 Proportional flow rate control (controller only) 9
3.3 PC control 10
3.4 Setting up the address for PC control 10
4 Volume totalizer 10
4.1 Setting of correction coefficient for other gases (only MASSFLOW 500) 11
4.2 Setting of the sensitivity of remote regulation (controller only) 12
5 Use of MASSFLOW for pH control during cell culture (controller only) 13
6 Technical specifications 13
6.1 General specification 13
6.2 Remote control (Inputs/outputs) 14
6.3 Input (12 V DC) 14
7 ACCESSORIES AND SPARE PARTS 14
7.1 Pump/gas flow integrator (Art. No. 4803) 14
7.2 PNet control software for peristaltic and syringe pumps, DOSER or MASSFLOW (Art. No. 6600) 15
7.3 List of accessories and spare parts 15
8 Appendix 16
8.1 RS communication protocol for LAMBDA MASSFLOW gas flow controller 16
8.2 Examples 17
8.3 How to set the MASSFLOW gas flow controller address? 17
8.4 RS-connection scheme 17
8.5 RS communication protocol for the on-board INTEGRATOR (optional) 18
9 Guarantee 20

1 SETTING UP MASSFLOW GAS FLOW CONTROLLER / METER

1.1 Power Supply

When used together with the LAMBDA MINIFOR laboratory bioreactor the MASSFLOW gas flow controller or meter is connected with the corresponding 8-pole cable to the “PUMP”-socket at the rear of the MINIFOR laboratory fermenter-bioreactor. The other side of the cable is plugged into the REMOTE-socket at the rear of the MASSFLOW.

Figure 1.1-1 One end of the 8-pole cable should be connected to the “PUMP”- socket at the rear of the MINIFOR laboratory fermenter-bioreactor control unit.

Figure 1.1-2 Other end of the 8-pole cable should be connected to the REMOTE-socket at the rear of the MASSFLOW gas flow measurement and controller.

When used independently of the MINIFOR laboratory bioreactor-fermentor, a universal plug-in power supply (100-240 V AC/50-60 Hz, 12 VDC, 24 W) is used (art. no. 4821).

Figure 1.1-3 5-pole connector of the universal plug-in power supply (100-240 V AC/50-60 Hz, 12 VDC, 24 W) cable.

Figure 1.1-4 Plug the connector of power supply cable into the “POWER” socket (12 V) at the rear of the MASSFLOW gas flow controller or meter and secure it.

When the MASSFLOW is connected to the power supply, all LEDs and the display are lighted shortly. This allows a function control of all signal elements.

The flow rate ranges depend on the MASSFLOW model and are as follows:

MASSFLOW 5000 (controller or meter) (art. no. 8071 or 8071-s)	0.00 to 5.00 l/min in 0.01 l/min steps
MASSFLOW 500 (controller or meter) (art. no. 8072 or 8072-s)	0 to 500 ml/min in 1 ml/min steps
MASSFLOW 500 hs (high sensitivity)(meter only) (art. no. 8072-hs)	0 to 99.9 ml/min in 0.1 ml/min steps & 100 to 500 ml/min in 1 ml/min steps (auto-range)

1.2 Gas input and output

Figure 1.2-1 Connect the gas tubing (inside diameter about 5.5 to 6 mm) to the gas **IN** nozzle and secured it in place with appropriate clamps.

The maximal gas pressure is 0.2 MPa (2 atm or 30 psig). Higher pressures will damage the instrument!

Fix the other tubing onto the gas OUT nozzle. Open the gas supply. The regulating valve is closed and no gas comes out from the output.

1.3 Setting of the flow rate (controller only)

Figure 1.3-1 Press the **SET** button. The corresponding LED will light and the display shows the pre-set value of flow rate.

Figure 1.3-2 Set a desired flow rate with the buttons **Λ Λ Λ** under the LED display.

Figure 1.3-3 Press the **SET** button again. The LED is switched off and the display shows the actual flow rate. It should indicate 0.0 l/min.

Figure 1.3-4 Press the **ON/OFF** button. After about 10 seconds (about 30 seconds for low flow rates), the flow rate will progressively attain the pre-set value.

2 FLOW RATE PROGRAMMING (CONTROLLER ONLY)

Up to 99 pairs of flow rates and time periods can be programmed. This allows almost any flow rate profile to be obtained.

Figure 2-1 To enter the programming sequence press simultaneously the **REMOTE** and **RUN** buttons until the message ***"PGM"*** appears on the display.

Figure 2-2 Press the **ON/OFF** button. The message ***"F01"*** will appear for one second on the display followed by the value of the flow rate for the first step, which has been stored in memory.

If the MASSFLOW is new or the previous program has been deleted the value 0.00 (or 000 for MASSFLOW 500) will be displayed.

Figure 2-3 Press the buttons **Λ Λ Λ** under the display to select the desired flow rate value of the first step (for example: 100 ml/min for MASSFLOW 500 or 0.1 l/min for MASSFLOW 5000).

Figure 2-4 Press the **ON/OFF** button again. The message ***"t01"*** will appear on the display indicating that the time period of the first step can be programmed. The display will then show the time period memorized earlier for the first step.

Figure 2-5 Select the time duration of the first flow rate (for example: 005 = five minutes).

Figure 2-6 Press the **ON/OFF** button. ***"F02"*** message will appear on the display and after one second, the value of the flow rate in the memory will be displayed.

Figure 2-7 Select the value of the flow rate of the second step by pressing the **Λ Λ Λ** under the display.

Figure 2-8 Press the **ON/OFF** button. The message ***"t02"*** will shortly appear on the display followed by the duration, which has been memorized earlier.

Figure 2-9 Select the new time duration for the second flow rate.

Figure 2-10 After having entered the time of the last step, press the **ON/OFF** button. For example: ***"F03"***

In a similar way all other flow rate and time duration steps could be programmed.

Figure 2-11 The flow rate (000) of the next step which will not be programmed appears on the display. Do not change the flow rate (000).

Figure 2-12 Press both **REMOTE** and **RUN** buttons simultaneously to see the message ***"C"*** on the display. This function allows to repeat the program from once (if you select ***"01"***) up to 255 times (if you select ***"255"***).

Figure 2-13 If you wish to repeat the same program twice, increase the cycle number to ***"002"*** by pressing the buttons **Λ Λ Λ** below the display.

Figure 2-14 Press the **ON/OFF** button to confirm the selected cycle. The message ***"End"*** will appear on the display and the instrument is ready for use.

You have also the possibility to let the program repeat continuously until the MASSFLOW is switched off manually. In this case select c = ***"00"*** – this means infinite number of cycles (endless loop operation).

2.1 Start of the program

Figure 2.1-1 The program is started by pressing the **RUN** button and the corresponding LED will light. The flow rate of the first step will appear on the display if the **SET** button is activated.

Figure 2.1-2 Otherwise, the reading 000 (or 0.00 for MASSFLOW 5000) seen at the beginning will increase progressively until the programmed flow rate is attained. This may take about 15 seconds depending upon the selected flow rate.

During the execution of the program it is possible to modify manually the flow rate or even stop the flow rate with **ON/OFF** button. However, the program will go further when the next step is executed. This allows performing certain emergency manipulations without terminating the program.

The running program can be terminated definitively by pressing the **RUN** button. The corresponding LED will go out.

After the last step of the program the gas flow will be stopped.

The maximum time period, which can be programmed in one step, is 255 min. If the time period is set to 000, then the step time is not limited and the flow rate will continue until the instrument is switched off.

If you wish to maintain a certain flow rate at the end of the program, set the duration of the last step to 000. Such time is not defined and the flow rate will be maintained until the MASSFLOW is switched off manually or the power supply is disconnected.

2.2 Reading the program

Reading the program is the same as the programming described above. No modification is made by the buttons under the display.

After the last step a simultaneous pressing of the **REMOTE** and **RUN** buttons will end the reading process. The message ***"END"*** will appear on the display. Pressing the **RUN** button will start the program.

2.3 Deleting the program

Figure 2.3-1 Press **RUN** and **REMOTE** buttons simultaneously. The message "***PGM"*** will appear on the display.

Figure 2.3-2 Continuous pressing of **REMOTE** and **RUN** buttons even after the indication of ***"PGM"*** ends up with the ***"cLE"*** message. This indicates that the program has been deleted from the memory.

3 REMOTE CONTROLS

3.1 ON/OFF remote control (controller only)

The gas flow rate can be switched off by applying a voltage (3 -12 V) to the contact no. 5 of the eight-pole socket (Figure 6.2-1) in the rear of the MASSFLOW (0 V is connected to the pole no. 3). The 12 V voltage can also be taken from the contact no. 4 of the socket). The applied voltage will stop the gas flow. When this voltage disappears the gas flow will go on until it is switched off by the ON/OFF button.

Remark: *In some cases a reversed logic for the remote control might be desired. Please contact us in this case.*

3.2 Proportional flow rate control (controller only)

The gas flow rate can be regulated over the whole range of 0.0 to 5.0 l/min for the MASSFLOW 5000 (or 0 to 500 ml/min for the MASSFLOW 500) by an external DC voltage 0 to 10 V applied to the contact no. 1 of the rear side socket (REMOTE). The 0V line must be connected to the contact no. 3 of the same socket (Figure 6.2-1). The remote control is activated by pressing the REMOTE button. The corresponding REMOTE LED is lit.

For safety reasons the voltage of the external signal must **not exceed** 48 V to earth!

3.3 PC control

If the instrument has been equipped with the optional RS-232 or RS-485 interface, it can be controlled digitally, e.g. from a PC by ***PNet control software***.

The line should be connected according to Figure 6.2-1. (A resistor of 100 ohms should be connected between both RS-485 lines, if it is not already present. This resistor is not part of MASSFLOW or any other LAMBDA instrument.) When the digital control is activated the REMOTE LED is on and all manual commands (with exception of the SET button) are blocked.

For the MASSFLOW meter (flow measurement only) the measured flow values can be accessed over the RS-protocol as well as the total gas volume, if the internal INTEGRATOR (optional) has been installed.

3.4 Setting up the address for PC control

The digital control requires an attribution of an appropriate address to the MASSFLOW. This is done in the following way: Pull out the power supply cable from the rear of the MASSFLOW.

Figure 3.4-1 Press and hold the **SET** button while plugging the cable into the socket again. The front panel illuminates and the display shows ***"A00"***.

Figure 3.4-2 Release the **SET** button. Select the desired address from 0 to 99 and press the **ON/OFF** button to save it.

4 VOLUME TOTALIZER

The MASSFLOW generates an electric signal after a delivery of each 5 ml of gas (for MASSFLOW 5000 range 0 to 5 l/min) or 0.5 ml (for MASSFLOW 500 range 0 to 500 ml/min). This signal can be accessed through the optional internal INTEGRATOR (art. no. 4803). The full range volume of the integrator is 327'680 ml (for the MASSFLOW 5000) and 32'500 ml (for the MASSFLOW 500). After this an automatic reset will set the integrator to zero and the integration will continue. In connection with a PC any volume from 5 ml (0.5 ml) upwards can be recorded (PNet, FNet or SIAM).

The **MASSFLOW 500 high-sensitivity** gas flow meter offers the possibility to measure small negative flows of gases (e.g. backflows). The RUN LED indicates a positive gas flow whereas the REMOTE LED indicates a negative gas flow. When the internal INTEGRATOR has been activated (optional), the corresponding INTEGRATOR pulses (corresponding to 0.5 ml each) are indicated by the blinking of the SET LED for positive gas flow and by the blinking of the ON LED for negative gas flow.

4.1 Setting of correction coefficient for other gases (only MASSFLOW 500)

MASSFLOW 5000 does not allow the setting of the correction coefficient for other gases. For the air-calibrated (standard) MASSFLOW 5000 oxygen as well as nitrogen can also be used. If another gas (e.g. for CO_2) should be controlled or measured, a pre-calibrated MASSFLOW 5000 instrument should be used. Please contact us in this case.

MASSFLOW 500 can be used for measurements and control of flow rates of other gases. Because different gases have different heat capacities, a correction must be performed.

Let flow the new gas to assure that the MASSFLOW 500 sensor is **completely** filled with new gas. The setting of new correction coefficient (see correction factors in table 1) is done by the following procedure:

Make sure that there is no gas flow when performing the zero setting. Switch off the power supply. Press continuously the button **RUN** while connecting the power supply to mains. The message ***"NUL"*** will appear for one second on the display followed by the value of actual zero setting. Wait until the reading will stabilize and then press the button **ON/OFF**. The value will be set to the new zero corresponding to the gas used. The message ***"SLP"*** (slope) will appear on the display followed by the value of actual correction coefficient CFV (for air, nitrogen and oxygen it is 100, for CO2 it is 070 - this corresponds to CFV coefficient value 1 in Table 1). Set the coefficient corresponding to the new gas and press the button **ON/OFF**. The value of the new coefficient is saved and the MASSFLOW is ready for use.

The correction range of MASSFLOW is 001 to 185 corresponding to CFV values of 0.01 to 1.85 (see Table 1).

The correction coefficient will affect the measurement range. For the correction coefficient 100 (air, oxygen, nitrogen) the range corresponds to 0 to 500 ml/min. For the correction coefficient 070 (carbon dioxide CO_2) the range is reduced correspondingly to 0 to 350 ml/min.

It is not possible to measure exactly helium and hydrogen, because of their very different properties. If only less precise flow rate value indication is required, leave the setting for nitrogen and divide the displayed value by 10 to obtain the real flow rates with these gases. The regulation will proceed normally. For precise measurements of these gases it is preferable to use instruments calibrated for these gases.

Gas	Factor CFV for Normalized Volume Flow	Factor CFM for Mass Flow
N_2	1	1
O_2	0.992	1.14
Air dry	0.998	1.026
Air 100% relative humidity	0.996	1.017
CO_2	0.70	1.10
CH_4	0.90	0.51
C_2H_6	0.48	0.52
C_3H_8	0.32	0.51
Ar	1.27	1.80
He	ca. 9	ca. 1.3
H_2	ca. 10	ca. 0.6

Table 1: Correction factors CFV and CFM at 23°C for calibration with N_2.

4.2 Setting of the sensitivity of remote regulation (controller only)

In certain situations, especially for cell cultures with low volume of medium, the use of the full range of flow rates is not required but much finer regulation is needed. For this use the MASSFLOW is equipped by sensitivity adjustment in the range 0 to 100 %.

Switch off the power supply. Press continuously the button **Λ** used for setting hundreds digit under the display while connecting the power supply to mains. The message ***"Att"*** (attenuation) will appear for one second on the display followed by the value of actual sensitivity/attenuation value. Select the required attenuation value (for example 50 for the sensitivity reduction to one half or 10 for ten times reduced sensitivity). The maximum flow rate value will decrease correspondingly and the regulation of e.g. dissolved oxygen or pH will be smoother.

Remark: *The value 000 is identical to 100 %.*

5 USE OF MASSFLOW FOR PH CONTROL DURING CELL CULTURE (CONTROLLER ONLY)

The pH of a cell culture media can be maintained constant by controlled addition of gaseous carbon dioxide (CO_2). The MASSFLOW is ideal for this purpose.

Connect the CO_2 gas tubing to the MASSFLOW and to the gas inlet of the bioreactor. Plug the remote control cable of the MASSFLOW to the pump socket (ACID) in the rear side of MINIFOR laboratory-scale bioreactor. Press the REMOTE button on the MASSFLOW and switch the flow regulator on with the ON/OFF button. The pH of the medium will be controlled automatically.

If the actual pH of the medium is much higher than the pre-set value on the MINIFOR, the initial flow of Carbon dioxide may be very high. To prevent this, it is advised to start with a manual control of CO_2 addition until both, the actual and pre-set pH values are almost identical. Only then the REMOTE button is pressed and the automatic control is started.

Make sure not to place the tubing containing CO_2 gas in water. Water would dissolve CO_2 and flow back into the instrument. This could damage MASSFLOW!

6 TECHNICAL SPECIFICATIONS

6.1 General specification

Type:	LAMBDA MASSFLOW – microprocessor-controlled gas flow controller (controller only) and gas flow meter
Accuracy:	± 3% reading or 1 digit
Repeatability:	± 0.5 % reading or 1 digit
Flow range:	
MASSFLOW 5000	0-5.00 l/min in 0.01 l/min steps (controller or meter)
MASSFLOW 500	0-500 ml/min in 1 ml/min steps (controller or meter)
MASSFLOW 500 hs	Auto-range: 0-99.9 ml/min in 0.1 ml/min steps and 100-500 ml/min in 1 ml/min steps (meter only)
Calibration:	nitrogen/air (pre-calibrated sensors for other gases available on request)
Non-volatile memory:	storage of all settings
Maximum pressure:	0.2 MPa
Interface:	RS-485 or RS-232 (optional)
Power supply:	90–240 V/50–60 Hz AC plug-in power supply with DC 12V/24W output; possible field operation on 12 V accumulator
Dimensions:	10.5 (W) x 8 (H) x 17 (D) cm
Weight:	0.8 kg
Safety:	CE, meets IEC 1010/1 norm for laboratory instruments
Operation temperature:	0-40 °C
Operation humidity:	0-90% RH, not condensing
Remote control:	0-10 V; (option 0-20 or 4-20 mA) (controller only)

6.2 Remote control (Inputs/outputs)

No.	*Colour*	*Description*
1	*yellow*	*(+) input remote flow control 0-10V *)*
2	*grey*	*pulses (1 pulse = 5 ml of gas for MASSFLOW 5000 and 0.5 ml for MASSFLOW 500, 0 and 12V)*
3	*green*	*earth, 0 V*
4	*brown*	*+ 12 V*
5	*white*	*(+) input remote ON/OFF; 0V = ON, 3–12 V = OFF (this logic can be inversed on demand)*
6	*pink*	*earth, ground (GND)*
7	*red*	*RS 485 B (-)*
8	*blue*	*RS 485 A (+)*

**) (zero line connected to the contact no. 3)*

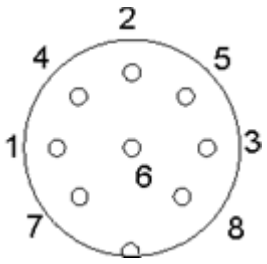

Figure 6.2-1 8-pole connector

6.3 Input (12 V DC)

Contact No.	*Description*
1	*+ 12 V DC*
2	*0 V*
3	*not connected*

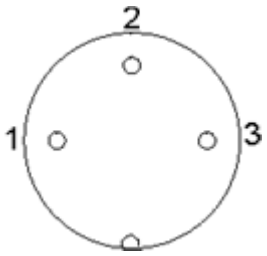

Figure 6.3-1 3-pole connector

7 ACCESSORIES AND SPARE PARTS

7.1 Pump/gas flow integrator (Art. No. 4803)

The FLOW INTEGRATOR allows a precise integration of the amount of gas, which has passed through the MASSFLOW gas controller.

The electric pulses, corresponding to 5 ml of gas (e.g. air, nitrogen, oxygen) for the MASSFLOW 5000 (and 0.5 ml for the MASSFLOW 500), are registered and using the RS-interface, the gas volume can be recorded on a PC (for example using the fermentation software FNet or SIAM or the pump control software PNet).

In processes where the gas flow is controlled e.g. by a pH-stat during a cell culture to keep the pH of the medium constant, it is often important to know when and how much acid (such as carbon dioxide) or base (nitrogen in cell cultures) was added. This data yields important information about the process, its kinetics, time of completion etc.

Another use of the INTEGRATOR is the measurement of enzyme activities (esterases, amidases, lactamases and other enzymes).

The PUMP/GAS-FLOW INTEGRATOR can now be electronically implemented inside the MASSFLOW gas flow regulator and, therefore, does not require any additional valuable laboratory bench space.

7.2 PNet control software for peristaltic and syringe pumps, DOSER or MASSFLOW (Art. No. 6600)

PNet is a PC control software for the remote control of LAMBDA laboratory instruments (peristaltic pumps PRECIFLOW, MULTIFLOW, HIFLOW, MAXIFLOW, syringe pump VIT-FIT, powder dosing instrument DOSER and gas flow controller MASSFLOW).

The pumps are connected to the computer through a RS-232 or RS-485 interface. Up to 6 LAMBDA laboratory instruments and 12 INTEGRATORs can be connected and controlled simultaneously.

7.3 List of accessories and spare parts

Art. No.	***Accessories***
4803	*PUMP-FLOW INTEGRATOR (for LAMBDA pumps, DOSER and MASSFLOW)*
4810	*Pump remote control (analog and digital) cable, 8 poles*
4802	*Pump ON/OFF remote control cable, 2 poles (open ends)*
4824	*Cable for inverted analog ON/OFF control, 8 poles*
	Interface and Control software
4822	*RS232 interface (for connection of the instruments to the serial port)*
4816	*RS485 interface (for connection of the instruments to the serial port)*
4817	*RS232/485 converter*
4818	*Power supply for RS232/485 converter (5V/1W)*
4819	*RS-line connection cable (serial)*
6600	*PNet control software for peristaltic and syringe pumps, DOSER or MASSFLOW*
800202	*Quadruple plug box (Power and RS-connection for up to 4 LAMBDA laboratory instruments)*
	Spare parts
4821	*Plug-in power supply (12V/24W) for PRECIFLOW, MULTIFLOW, DOSER, MASSFLOW*
4815	Silicone tubing 3/5mm x 10m
800113	*Stainless steel tubing clamp*

8 APPENDIX

8.1 RS communication protocol for LAMBDA MASSFLOW gas flow controller

8.1.1 Format of data sent by the PC to the pump and back

Data sent by the PC: *#ss mm a ddd qs c*
Data sent back by the mass flow controller: *<mm ss a ddd qs c*

where,

#	is the first sign of a command sent by PC (master)
<	is the first sign of a message sent by mass flow controller (slave)
ss	is the address of the mass flow controller
mm	is the address of the PC
r	set gas flow (when sent as a command)
r	indicates positive flow value (when received from the massflow)
l	indicates negative flow value (when received from the massflow)
ddd	is the gas flow rate (3 ASCII numbers from 0 to 9; sent from the highest order digit to the lowest order digit)
qs	is the control sum in HEX format (2 ASCII signs of the type 0…9ABCDEF)
c	is the end sign cr (carriage return) The gas flow controller will fulfill the task and block any manual command on the pump front panel.

8.1.2 Commands not containing data

# ss mm **g** qs c	activates the local command of the gas flow controller
# ss mm **s** qs c	the gas flow is stopped (gas flow rate 0)
# ss mm **G** qs c	to send the measured gas flow rate to the PC
# ss mm **M** qs c	to send the measured gas flow rate to the PC (the same as G)
# ss mm **V** qs c	state of the gas flow controller (reads the set value)

The commands **M** and **G** correspond to a flow rate range of 000 to 500 ml/min (in 1 ml/min steps).

8.1.3 Checksum control

The PC sends: #0201*r*123*EE*cr

The control sum (checksum) *qs* is made in the following way (only the **last byte** (2 ASCII characters of the type 0…9ABCDEF) is taken):

#	0	2	0	1	r	1	2	3	EE (last byte)	cr
23h	+30h	+32h	+30h	+31h	+72h	+31h	+32h	+33h	=1**EE**h	0Dh

8.1.4 Format of the data transmission

Speed: 2400 Bd (Baud)
8 data bits, odd parity, 1 stop bit

8.2 Examples

Address of the PC: 01
Address of the gas flow controller: 02

The PC sends: #0201*r*123*EEcr*
The gas flow controller will set the flow rate to 123

The PC sends: #0201*V*0*Bcr*
The answer of flow controller (set value): <0102*r*12307*cr*

The PC sends: #0201*G*2*D*cr
The answer of the measured (positive) flow rate: <0102*r*12206*cr*

The PC sends: #0201*s*59*cr*
The gas flow controller stops (gas flow rate is 0).

The PC sends: #0201*g*4*Dcr*
The mass flow controller will go to the local command (front panel is activated).

8.3 How to set the MASSFLOW gas flow controller address?

The digital control requires an attribution of an appropriate address to the MASSFLOW. To look up/modify the instrument address, pull out the power supply cable from the rear of the MASSFLOW. Press and hold the **SET** button while plugging the cable into the socket again.

The front panel illuminates and the display shows "**A00**". Release the **SET** button. This number from 00 to 99 is the current address of the powder dosing instrument. To change the address press the buttons **Λ Λ Λ** under the display until the desired number is obtained.

To confirm and save the address, press the **ON/OFF** button.

8.4 RS-connection scheme

The 8-pole DIN connector "REMOTE" is used for the remote control and RS-485 connection. When the optional RS-485 interface is available the pins are used as follows:

No.	***Colour***	***Description***
1	*yellow*	*(+) input remote flow control 0-10V *)*
2	*grey*	*pulses (1 pulse = 5 ml of gas for MASSFLOW 5000 and 0.5 ml for MASSFLOW 500, 0 and 12V)*
3	*green*	*earth, 0 V*
4	*brown*	*+ 12 V*
5	*white*	*(+) input remote ON/OFF; 0V = ON, 3–12 V = OFF (this logic can be inversed on demand)*
6	*pink*	*earth, ground (GND)*
7	*red*	*RS 485 B (-)*
8	*blue*	*RS 485 A (+)*
		**) (zero line connected to the contact no. 3)*

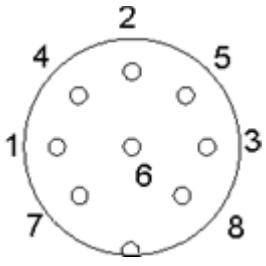

Figure 8.4-1: 8 pole connector

8.5 RS communication protocol for the on-board INTEGRATOR (optional)

8.5.1 Communication between the PC and the INTEGRATOR of the LAMBDA instrument

From the PC to the INTEGRATOR:

#ss mm z qs c

From the INTEGRATOR to the PC:

<mm ss = qs c confirmation of the reception of a command

<mm ss dddd qs c sending of the requested data

where,

#	is the first sign of a command sent by the MASTER (PC)
<	is the first sign of a message sent by the SLAVE (INTEGRATOR)
ss	is the address of the subordinate station (address of the instrument with integrated INTEGRATOR)
mm	is the address of the commanding station (PC)
z	is a command (see below): small letters indicate a command, capital letters request data transfer from the subordinate station
=	confirmation of reception
aa	new address of the subordinate station (ss) (two numbers and possibly other ASCII characters A B C D E F)
dddd	transferred data (values are two bytes in hexadecimal form. Single bytes are transformed into two ASCII characters 0,..,9,A,B,C,D,E,F)
qs	is the control sum (obtained by the addition modulo 256 of binary values of all preceding characters including the leading sign) in HEX format (2 ASCII signs of the type 0…9ABCDEF)
c	is the end sign cr (carriage return)

8.5.2 Commands for the INTEGRATOR

n	reset (sets the INTEGRATOR to zero)
i	start of integration
e	stop of integration
I	sends the integrated value (positive-negative)
N	sends the integrated value “I” and sets the integrator to zero (both registers)
R	sends the integrated value of the positive flow (2 bytes HEX = 4 ASCII)
L	sends the integrated value of the negative flow (2 bytes HEX = 4 ASCII)

8.5.3 Examples

Address of the PC: 01
Address of the instrument with on-board INTEGRATOR: 02

The PC sends: #0201I2Fcr

The control sum (checksum) *qs* is made in the following way (only the **last byte** (2 ASCII characters of the type 0…9ABCDEF) is taken):

#	0	2	0	1	I	2F (last byte)	cr
23h	+30h	+32h	+30h	+31h	+49h	=**12F**h	0Dh

The PC sends: #0201i4Fcr
i.e. in hexadecimal form: 23h 30h 32h 30h 31h 69h 34h 46h 0Dh
This means: For a subordinate station (SLAVE) with address 02 from commanding station (MASTER) with address 01
Start of integration
The control sum is 14Fh (last byte: **4F**); end of message *cr* (carriage return)
The INTEGRATOR answers: <0102=3C*cr*

The PC sends: #0201N34*cr*
The INTEGRATOR answers: <0102N03C225*cr* (integrated value is 03C2h) and resets to zero

The PC sends: #0201e4B*cr*
The integration will be stopped and the command will be confirmed.
The INTEGRATOR answers: <0102=3C*cr*

9 GUARANTEE

LAMBDA provides a two-year guarantee on material and manufacturing defects, if the instrument was used according to the operation manual.

Conditions of guarantee:

- The instrument must be returned with a complete description of the defect or problem. In order to send back the equipment for repair, you will need a returns authorization number from LAMBDA.
- The customer will send the instrument to our service office.
- Damage or loss of items during transport will not be compensated for by LAMBDA.
- Failure to fulfil these requirements will disqualify the customer from compensation.

Serial Number: _____
Guarantee from: _____

LAMBDA Laboratory Instruments
Sihlbruggstrasse 105
CH-6340 Baar
SWITZERLAND – EUROPE
Tel.: +41 444 50 20 71
Fax: +41 444 50 20 72

E-mail: support@lambda-instruments.com
Web: www.lambda-instruments.com

LAMBDA CZ s.r.o.
Lozíbky 1
CZ-61400 Brno
CZECH REPUBLIC – EUROPE

Hotline: +420 603 274 677

www.lambda-instruments.com